Integrated Water Management Forums

DRAFT Greater Metropolitan Melbourne Catchment Scale Integrated Water Management Plan

Assessing and driving progress towards strategic outcomes

Yarra

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This Plan was developed by the IWM Forums and working groups, with facilitation from the Department of Environment, Land, Water and Planning (DELWP) and assistance from the Melbourne Catchments Consortium, led by E2Designlab, and supported by Spatial Vision, Tract, Rain Consulting, Water Futures Consulting, Flying Blue Fish and the Cooperative Research Centre for Water Sensitive Cities.

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Integrated Water Management for the Yarra Catchment

A Catchment-scale IWM plan

Integrated water management (IWM)[1] by its very nature requires collaboration and cross-outcome thinking. Over recent years on a global stage, the Melbourne region is at the forefront of in the application of an integrated approach to water management, which considers all elements of the water cycle together. IWM thinking has influenced policy and practice and driven innovation and wide-spread learning across the planning, engineering and urban design sectors, helping to transition away from a siloed approach to management of streams of water, and driving an outcome-based approach that delivers multiple benefits to the community.

Often, IWM planning and initiatives have focussed on specific development areas or specific municipalities or organisational boundaries. This has limited our consideration of cross-boundary issues, and has missed the opportunity to drive focussed collaboration around agreed and consistent outcomes. A more effective approach to IWM has been driven through the creation of the Integrated Water Management Framework for Victoria.[2] This led to the formation of the five IWM Forums across the five major waterway Catchments in the Greater Metropolitan Melbourne region. These major waterways are Yarra River, Maribyrnong River, Werribee River, Dandenong Creek (including Western Mornington Peninsula) and Bunyip and Tarago rivers in the Western Port. The IWM Forums bring together all organisations with an interest in the water cycle to identify, prioritise and oversee the implementation of collaborative water opportunities.

A Catchment Scale IWM Plan has been developed for each of the five Greater Metropolitan Melbourne IWM Forum Areas: Werribee, Maribyrnong, Yarra, Dandenong and Western Port. The intent, the scale and the collaborative nature of these IWM Plans make them the first of their kind, continuing Melbourne's journey as a world-leader in IWM. The Plans will build on the work completed to date by the five metro IWM Forums to further develop a shared understanding of future direction.

Our vision for the future

Each IWM Forum developed a Catchment-specific vision based on the opportunities and challenges specific to the Catchment. The vision, along with the Catchment context, are captured in the Strategic Directions Statement.[3]

The overarching vision for the Yarra Catchment is:

> *Working together, Yarra is a world-leading water sensitive Catchment and our communities are healthy and thriving. We honour the land and the water of the Birrarung and its tributaries as the lifeblood of the Catchment.*

The vision is underpinned by seven strategic outcomes. These outcomes provide a framework that recognises the multiple benefits that IWM delivers and drives the creation of holistic solutions. The seven strategic outcomes also provide a consistent structure for this IWM Plan. They are:

1. Safe, secure and affordable water supplies in an uncertain future
2. Effective and affordable wastewater systems
3. Existing and future flood risks are managed to maximise outcomes for the community
4. Healthy and valued waterways and marine environments
5. Healthy and valued urban and rural landscapes

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[1] IWM is a collaborative approach to water planning and management that brings together organisations with an interest in all aspects of the water cycle, including waterways and bays, wastewater management, alternative and potable water supply, stormwater management and water treatment. It considers environment, social and economic benefits.

[2] Victorian Government (2017). Integrated Water Management Framework for Victoria. Available at: https://www.water.vic.gov.au/liveable/integrated-water-management-program

[3] IWM Forums (2018). Strategic Directions Statement. Available at: https://www.water.vic.gov.au/liveable/integrated-water-management-program/forums

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6. Community values are reflected in place-based planning
7. Diverse jobs, economic benefits and innovation

This Plan also recognise that all seven outcomes need to be supported by three strategic enablers, which reflect the ability and willingness of organisations to implement IWM by focusing on Commitment, Collaboration and Capacity.

A Plan to measure and drive change

This Plan is centred around a set of indicators and measures that can be used to assess, monitor and stimulate progress towards the strategic outcomes. The indicators and measures are used to:

- Articulate performance targets against the seven IWM strategic outcomes.
- Assess and prioritise IWM projects and policies that will help us achieve those targets.
- Provide a basis for future monitoring and assessment of progress against the seven strategic outcomes IWM at a Catchment scale.

The indicators and measures are summarised in the following section, along with the performance targets for the Yarra catchment.

The importance of embedding the performance targets is acknowledged. The Victorian State Government (DELWP) is leading an ongoing program of work to inform policy change and investigate the feasibility of some embedding pathways. Possible mechanisms were initially explored as part of the target development process (described in Background Appendix B: Collaborative Plan development process), with further work to be undertaken as part of subsequent planning activities. Notably, the development of Catchment-scale IWM Action Plans and a Monitoring, Evaluation, Reporting and Improvement (MERI) Framework will help to define specific embedding mechanisms, as well provide partners with a way to track progress over time.

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Assessing our progress

A spatial appreciation

Assessment of progress across seven strategic outcomes and across the five Catchments requires a vast array of data, which spans the Greater Metropolitan Melbourne Region. Data has been sourced from organisations who play a role in managing water across the Catchments and was processed, amalgamated and assembled according to a consistent set of assumptions in early 2020. The baseline year for the analysis is the 2018/2019 financial year.

All data was sourced at the finest spatial scale available, but often was not available as spatial (i.e. GIS) data. Accordingly, the data points have been nominated spatially based on the information available and converted to a spatial data set. All data has been assigned at four spatial resolutions:

1. **Sub-Catchment (SC):** Totals for the 69 sub-catchment defined by the Healthy Waterways Strategy.[4] These sub-catchments are within, and align with, the overall boundaries of the five major Catchments.
2. **Local Government Area (LGA):** Totals for the 38 municipality areas within the Greater Metropolitan Melbourne Region. Some municipalities which only have a small area of land within the Catchments have been excluded from the data analysis.[5]
3. **Catchment:** Totals for each of the five major Catchments: Werribee, Maribyrnong, Yarra, Dandenong and Western Port.
4. **Region:** Totals for the Greater Metropolitan Melbourne Region.

[4] Melbourne Water (2018) Healthy Waterways Strategy 2018-28. Available at: https://www.melbournewater.com.au/about/strategies-and-reports/healthy-waterways-strategy

[5] Specifically, this relates to the City of Greater Geelong, Hepburn Shire Council, Murrindindi Shire Council, and Golden Plains Shire Council.

This Plan presents maps using both sub-catchment and LGA delineations, depending on which is more pertinent to the discussion at hand. Data and the relevant maps are available for download at four resolutions via an online portal.

A temporal appreciation

This Plan acts to baseline our progress against the seven strategic outcomes in terms of an agreed set of indicators and measures, largely based on observed data. Further, this plan anticipates possible future pathways by considering two time periods: 2030 and 2050. Accordingly, the Plan is framed with reference to three ‘states’:

- **Current State**: The current performance, based on data that represents the 2018/2019 financial year.
- **Future Reference State (2030 and 2050):** The projected future performance, based on assumptions agreed with the IWM Forums which represent a possible future akin to a business-as-usual scenario. Given the current roles and policy framework for IWM, this is far from a ‘do-nothing’ scenario, but instead it represents likely performance if we continue to adopt IWM at a similar pace, under our current roles, and under the same policy and regulatory conditions.
- **Future Desired State (2030 and 2050):** The projected future performance that will deliver the desirable outcomes in line with the seven strategic outcomes for the Catchments. Targets have been defined for the 2030 and 2050 desired states, which allow us to measure the gap between the current state, the ‘reference state’ and the ‘desired’ state for 2030 and 2050, thereby enabling coordinated and targeted action to be taken at a Catchment scale.

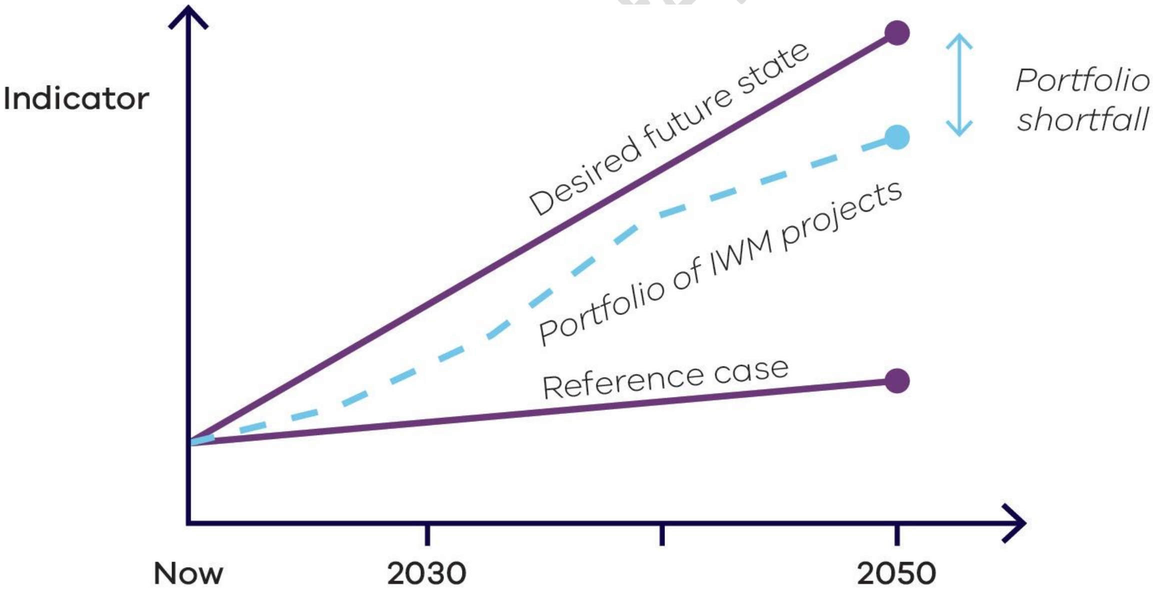

Figure 1: The performance of indicators and their measures is defined for a ‘reference state’ and a ‘desired state’ allowing the gap between the two to be bridged by IWM projects and initiatives

The process used to define and develop these three ‘states’ is described in Background Appendix B: Collaborative Plan development process.

Indicators and Measures

The indicators and corresponding measures that have been selected by the IWM Forums to measure our progress against the enablers and the seven strategic outcomes are summarised in the table below. These indicators and measures were defined through a collaborative process, considering key focus areas to drive progress, the availability and suitability of data, and the practicalities of future monitoring and measurement.

There are two types of measures:

- **Leading measure:** A measure that is forward-facing, where desired state outcomes are clear and where performance targets have been set for the future.
- **Lagging measure:** A measure that is reflective of our journey, through which we will learn more over time to help to define desired outcomes and associated actions. These lagging indicators do not have performance targets set against them and are nominated for ongoing monitoring only.

A total of 20 indicators have been defined for the region, with 28 measures used to track our progress. Of the 28 measures, 22 are leading measures and 6 are lagging measures.

Table 1: Indicators and measures

	Indicator	Measure	Type
Enablers	E1 Increase organisational commitment to IWM	Rating of vision, leadership and long-term commitment through vision statement and objectives articulated in corporate documents (out of 5)	Leading
	E2 Increase stakeholder capacity to successfully deliver IWM	Rating of knowledge, skills and organisational capacity (out of 5)	Leading
	E3 Increase collaboration and partnerships across industry and government	Rating of cross-sector institutional arrangements and processes (out of 5)	Leading

Strategic outcome	Indicator	Measure	Type
1. Safe, secure and affordable water supplies in an uncertain future	1.1 Decrease potable water use	a. Litres/per person/day residential potable water use	Leading
		b. ML/year non-residential potable water use	Lagging
	1.2 Increase use of fit-for-purpose water source	a. Percent of total water use which is provided from alternative water sources[6]	Lagging
		b. ML/year of alternative water sources that substitutes potable mains water supply	Leading
2. Effective and affordable wastewater system	2.1 Increase use of resources recovered from wastewater to stimulate a circular economy	a. ML/year of recycled water delivered to customers	Leading
		b. Percent of nitrogen recovered at treatment facilities for beneficial use	Leading
		c. Percent of carbon recovered at treatment facilities for beneficial use	Leading
3. Existing and future flood risks are managed to maximise outcomes for the community	3.1 Reduce flooding impacts on communities	Dollar ($) reduction in Annual Average Damage (AAD) delivered by flood management initiatives	Leading
	3.2 Increase surface runoff storage created through multifunctional assets	Cubic meters of effective flood storage volume created as part of multi-functional assets	Lagging
	3.3 Increase cross-consideration of flood mitigation and integrated water management	Percent of projects that cross-consider IWM and flood mitigation opportunities as part of their design	Leading

[6] In this document, alternative water sources refer to recycled water, greywater, rainwater and urban stormwater.

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Strategic outcome	Indicator	Measure	Type
4. Healthy and valued waterways and marine environments	4.1 Reduce the total urban stormwater runoff volume discharged to receiving waters	ML/year of mean annual runoff volume reduction	Leading
	4.2 Decrease pollutants discharged to receiving waters	a. Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters	Leading
		b. kg/year mean annual Total Nitrogen (TN) prevented from discharging to receiving waters	Leading
	4.3 Increase environmental benefit to waterways through addition of water to the environmental water reserve, which is of an appropriate quality, magnitude, duration and timing	Additional ML/yr of water allocated to environmental water reserve that increases environmental benefits in waterways	Leading
5. Healthy urban and rural landscapes	5.1 Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply	Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply	Leading
	5.2 Increase provision of alternative water sources for adequate irrigation of public open spaces	a. Percent of the total area of active public open space (sports fields and organised recreation) supported by an alternative water source	Leading
		b. Percent of the total area of passive public open space (parkland and gardens) supported by an alternative water source	Leading
	5.3 Reduce urban heat for the purposes of enhancing human thermal comfort	Degree Celsius reduction in land surface temperature attributed to IWM in urban areas	Lagging
6. Community values are reflected in place-based planning	6.1 Increase the capacity of Traditional Owners to partner in IWM programs, planning, policy and project delivery, as well as the capability of other IWM partner organisations to partner with Traditional Owners in IWM programs, planning, policy and project delivery	a. Rating of Traditional Owners' capacity to partner in IWM programs, policy, planning and projects	Leading
		b. Rating of other IWM partner organisations' capability to partner with Traditional Owners in IWM programs, policy, planning and projects	Leading
	6.2 Increase IWM's contribution to a community's sense of place, health, and well-being	Blue-green infrastructure created or enhanced by IWM as a proportion of land area (%)	Lagging
	6.3 Improve communities' connection with and understanding of the water cycle	Rating of community literacy regarding the water cycle (out of 5)	Leading
	6.4 Increase consideration of the water cycle in town planning	Rating of whether water is a key element in city planning and design process (out of 5)	Leading
7. Jobs, economic benefits and innovation	7.1 Increase the use of alternative water sources for products and services	a. ML/year of alternative water supplied to agricultural production	Leading
		b. ML/year of alternative water supplied to businesses and industry (>10ML/year)	Lagging

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Interactions between measures

By its very nature, integrated water management is highly interconnected, with initiatives and interventions potentially impacting or benefiting various outcomes and parts of the water cycle. The indicators and measures selected are specifically chosen to assess progress against particular outcomes, however they are inherently interrelated. However, this inter-relationship is not fixed. It varies depending on the IWM interventions or initiatives taken. A few examples of the interactions and how they can vary are:

- **Interactions between measure 4.1. ML/year of mean annual runoff volume reduction and measure 4.2b. Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters**: These two measures support Strategic Outcome 4, healthy waterways and marine environments, and they are closely interrelated in most cases. However, their impact on each measure depends on the context and the intervention proposed. For example, harvesting of runoff or infiltration would benefit measure 4.1 but the impact on 4.2b would depend on scale, scope and design of the harvesting or infiltration systems and the corresponding concentrations of pollutants removed.
- **Interactions between measure 1.2b. ML/year of alternative water sources that substitutes potable mains water supply and 2.1a. ML/year of recycled water delivered to customers**: Delivery of recycled water interventions will benefit measure 2.1a, and will also benefit 1.2b in some cases, however this depends on whether the intervention acts to substitute for potable supply. A recycled water supply to homes to provide for toilet flushing would substitute for potable supply, thereby allowing potable resources to be conserved for other uses. However, provision of recycled water to an agricultural area that does not utilise potable water resources would not assist in the potable water supply-demand balance, and would therefore not contribute to measure 1.2b.
- **Interactions between measure 5.1. Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply and measure 5.3. Degree Celsius reduction in land surface temperature attributed to IWM in urban areas**: These two measures support Strategic Outcome 5, healthy urban and rural landscapes, and they are closely interrelated in most cases. Measure 5.1 directly measures interventions that provide water to street trees, while measure 5.3 measures the resulting benefits for urban heat reduction. Interventions that benefit 5.1 will always impact 5.3, but to different extents, depending on the location of the tree and the impact that the provision of water has on canopy size, and therefore on shading and evapotranspiration effects that result in localised cooling. However, measure 5.3 will also be impacted by a range of other interventions, including the increased irrigation and infiltration, support of trees on private land, and the introduction of increased vegetated land cover.
- **Interactions between measure 7.1b. ML/year of alternative water supplied to businesses and industry (>10ML/year) and measure 1.1b. ML/year non-residential potable water use:** In the vast majority of cases, interventions that impact 7.1b will also impact measure 1.1b. However, measure 7.1b considers how IWM can support economic outcomes, by providing alternative water sources to major business and industrial users, a subset of 'non-residential' users are measured by 1.1b. Measure 1.1b specifically considers how we are decreasing potable water use, so as long as the interventions that impact 7.1b substitute potable water use, it will be counted, though this may not always be the case, or may not represent 100% of the use, if, for example, the major user can utilise more water as a result of securing an alternative water supply or replace another source such as groundwater.

The figure below diagrammatically demonstrates the extent of the interrelationships between selected leading measures based on the assessment of the Current State and the IWM interventions that have been delivered to date. The thickness of connection indicates how strong the relationship is between measures. The thickness of the band at the edge of the circle indicates how interrelated each measure is.

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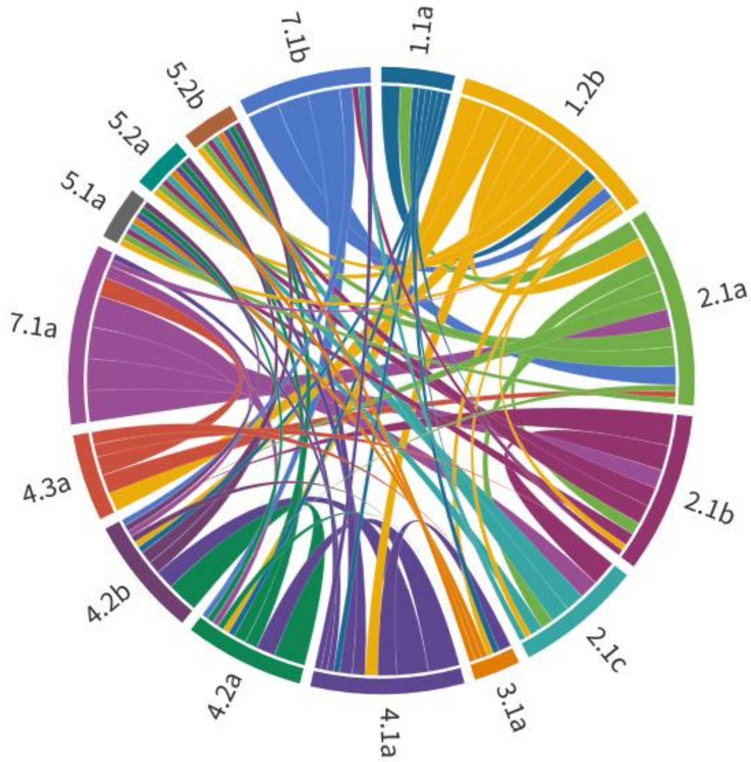

Figure 2: Diagrammatic representation of interrelationships between selected leading indicators based on current state interventions.

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Introducing the Catchments

The Greater Metropolitan Melbourne Region has five major waterway Catchment boundaries within the Port Phillip and Western Port Catchments. Each Catchment has its own characteristics, challenges, and opportunities, but all Catchments are also bound by collective goals at a regional level. An IWM plan has been developed for each of the five Catchments using a consistent analysis framework for the region, to allow Catchment strategies to be efficiently monitored and implemented, while tailoring local actions to meet local needs.

This plan is for the Yarra Catchment.

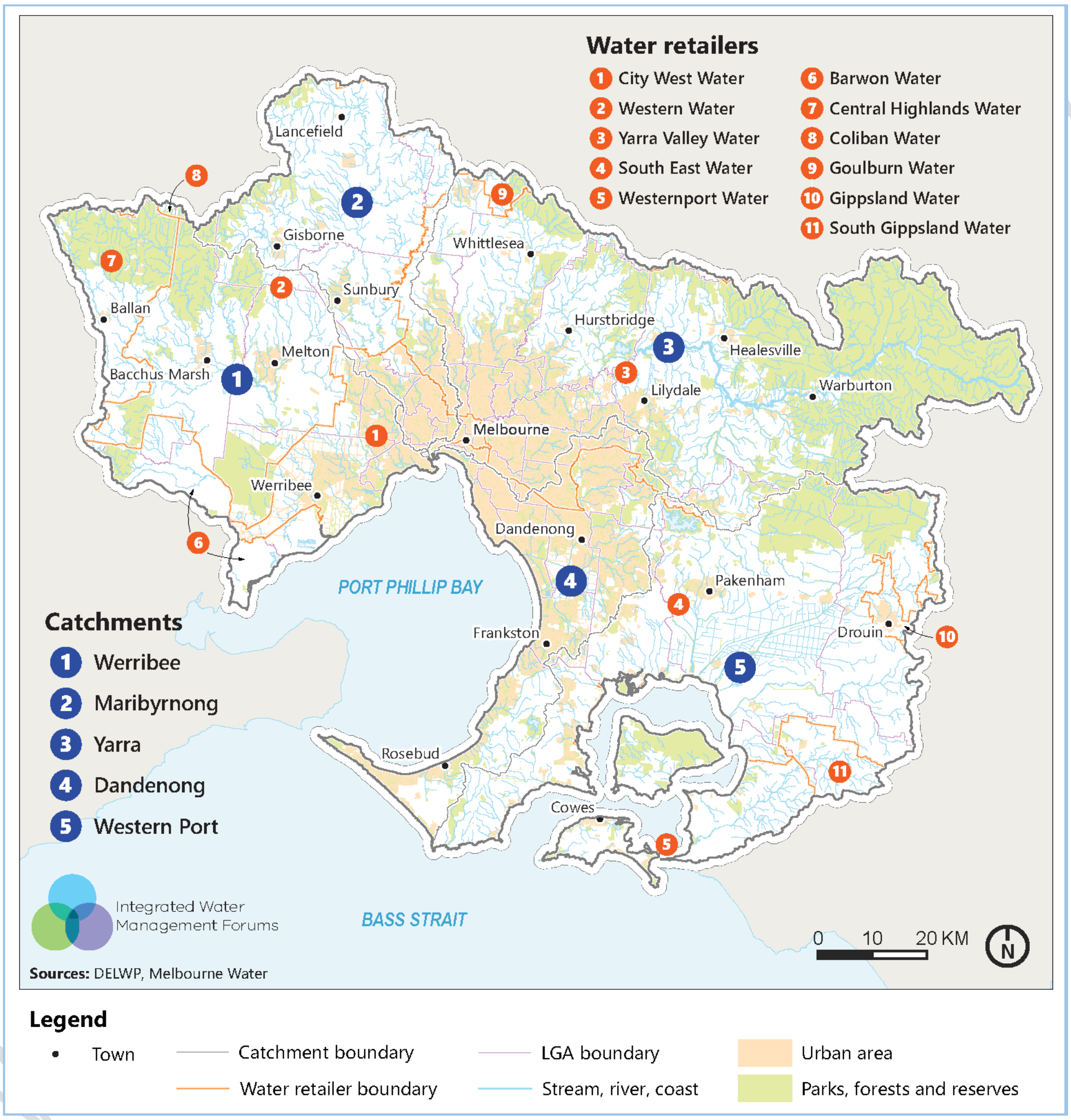

Figure 3: Overview of Catchments and administrative boundaries

The extent and the key features of the Yarra Catchment are shown in the figure below.

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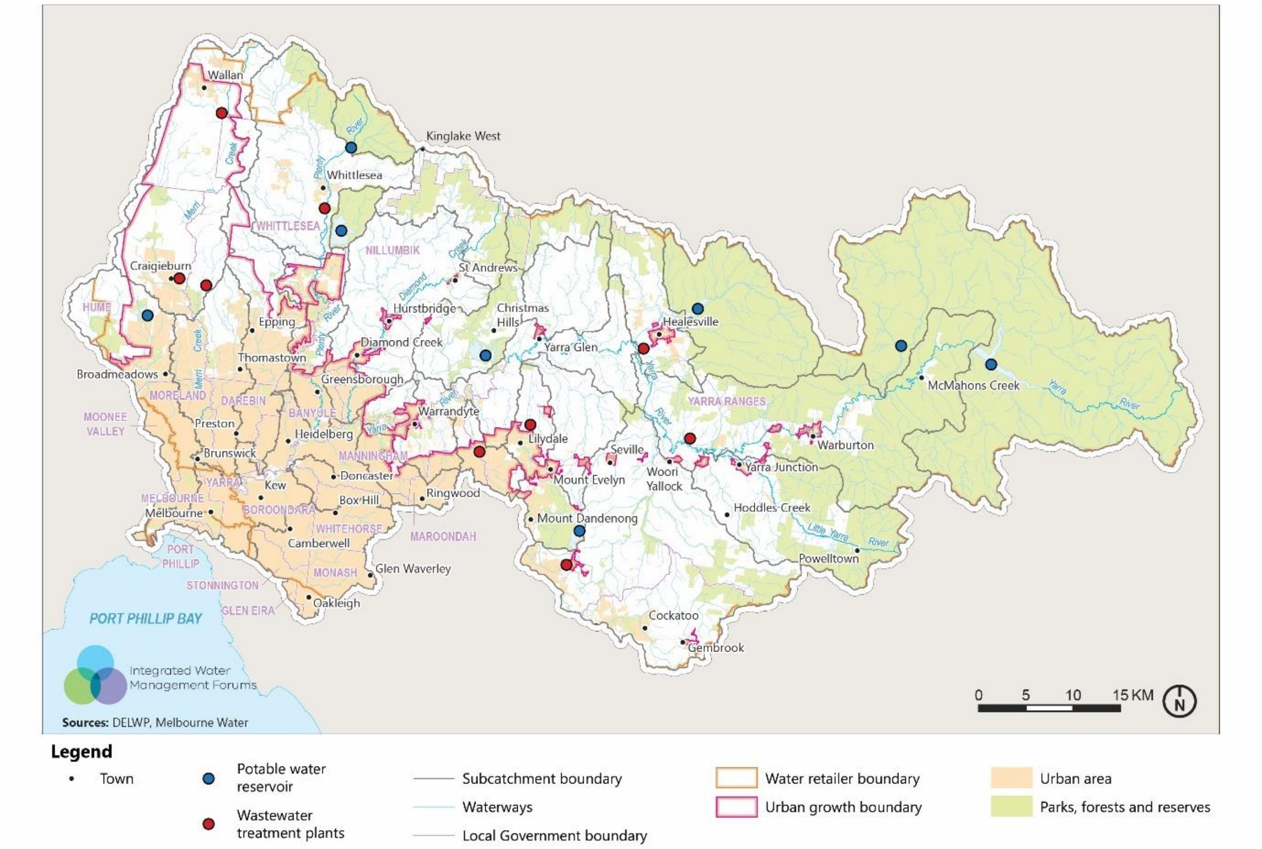

Figure 4: The Yarra Catchment

Catchment context and key drivers

The Strategic Directions Statement provides an overview of the Catchment context and case for IWM. Many drivers are regional, and shared across Catchments. An overview of the key drivers that make the Catchment unique are presented in the table below.

Table 2: Key Catchment-specific IWM drivers at a glance for the Yarra Catchment

Strategic Outcome	Key Catchment-specific drivers at a glance
1 - Safe, secure and affordable supplies in an uncertain future	• Urban water security is a challenge in the Catchment due to rapid population growth and greenfield development. • Surface water in the Yarra Catchment is shared equally between consumptive use and the environment. Long-term surface water availability is expected to decline by 16%[7].
2 - Effective and affordable wastewater systems	• While most of the Catchment's wastewater is managed in neighbouring Catchments, there are a number of locally managed plants that could provide treated wastewater and nutrients for beneficial use.
3 - Existing and future flood risks are managed to maximise outcomes for the community	• Parts of the Catchment are prone to flooding during periods of heavy rain, particularly areas nearest the Maribyrnong River, such as the suburbs of Maribyrnong and Moonee Valley.

[7] DELWP (2020). Long-term Water Resource Assessment. Available at: https://www.water.vic.gov.au/planning-and-entitlements/long-term-assessments-and-strategies/long-term-water-resource-assessment

4 - Healthy and valued waterways and marine environments	• The existing environmental entitlements for the Yarra River do not fully address the flow-stressed nature of this important river system. • Priority areas for runoff reduction in Upper Merri and Yarra Ranges. • The Yarra Catchment has the largest urbanised area and high rainfall, resulting in the largest contributions of pollutants from runoff to Port Phillip Bay.[8] • The Yarra River is defined as a single living and integrated natural entity for protection under the *Yarra River Protection (Wilip-gin Birrarung murron) Act 2017*. Amendment VC197 delivers permanent planning protections for the Yarra River between Richmond and Warrandyte to prevent any inappropriate development that could harm the waterway.
5 - Healthy and valued urban and rural landscapes	• High vulnerability to heat waves, particularly in the Whittlesea and Hume local government areas and around the northern growth corridor, meaning water in the landscape is more important to reduce risk.
6 - Community values are reflected in place-based planning	• Significant growth areas planned in the northern growth area. Also, significant infill in existing urban areas. • *Water and Catchment Legislation Amendment Act 2019* provides for greater consideration of recreational and Aboriginal cultural values in the management and planning of waterways and Catchments.
7 - Jobs, economic benefits and innovation	• Major agriculture and viticulture areas, with non-urban land uses making up 57% of the Catchment. • Significant proportion of region's industrial and commercial land uses, including three National Employment and Innovation Clusters (NEIC) and the second largest State Significant Industrial Precinct (SSIP) at the Northern SSIP.

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Overarching drivers of change in the future

The five Catchments will each change fundamentally in the future due to two key driving forces:

- population growth (and corresponding urbanisation); and
- climate change.

These two major driving forces will substantially alter the water and pollutant balance for each Catchment, while also changing the needs and well-being of communities, businesses, and our environment. The anticipated changes in population and climate are discussed below.

Population growth and urbanisation

The Greater Metropolitan Melbourne Region will change substantially over the next 30 years. Land uses within the region are varied and as shown in the figure below. The existing urbanised area radiates out from the central business district, accommodating a mix of residential, commercial and industrial land uses. However, the majority of land by area across five Catchments is currently not urban land, with large areas of grassland, grazing land, horticulture and forested areas on the outer areas of the region. Accordingly, there is an urban-rural land use mix within all Catchments, which provides an important backdrop that drives different IWM opportunities through those land use interactions. Denser, more impervious, urbanised areas have high water demand, but also generate large volumes of potential alternative water resources through the creation of wastewater and stormwater. Agricultural and productive land uses in the rural areas of the Catchments often also have significant water demands, but tend to rely on direct rainfall, river water and groundwater resources. By connecting urban and rural water management through an integrated approach there are opportunities to optimise water resource portfolios and support local economies while building regional resilience.

[8] Victoria State Government (2017) Port Phillip Bay Environmental Management Plan 2017-2027: Supporting Document. Available: https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0034/88756/PPB-EMP-2017-Supporting-Doc.pdf

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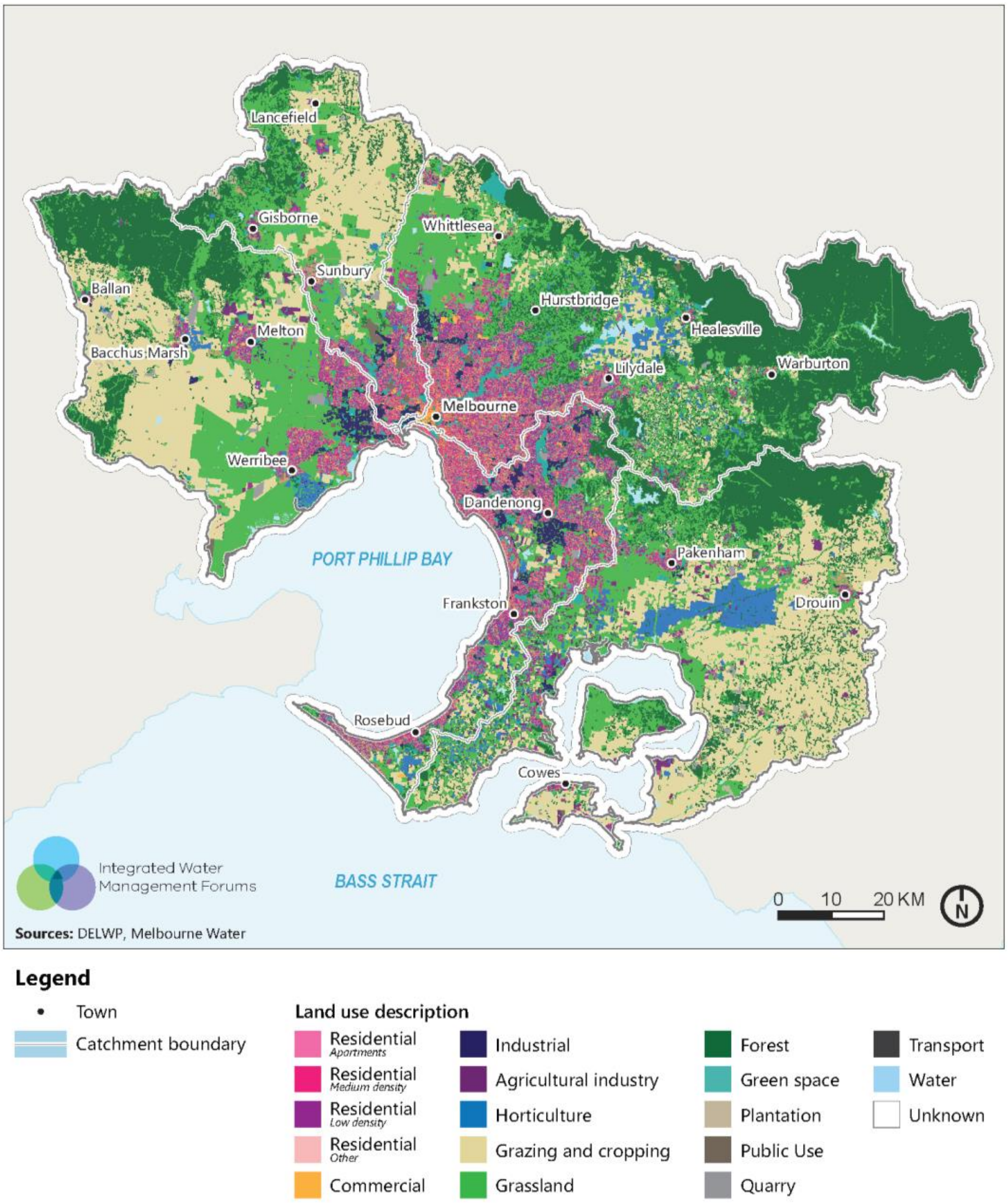

Figure 5: Land uses across the region (2018 data)

The Yarra IWM Forum Area is home to one-third of Victoria's population, or approximately 1.8 million people. The Catchment's population is predicted to reach 3.13 million by 2050.[9] Substantial urban and greenfield growth will occur here in the next two decades. Expanding satellite cities at Parkville, La Trobe and Monash will soon support more residents and provide employment opportunities for tens of thousands of people. Key planned regeneration projects in the CBD and Fisherman's Bend will also increase local populations and change land uses. The densification of inner Melbourne and middle ring suburbs, coupled with rapid growth through outer Catchment areas, including Craigieburn, Kalkallo, Wallan and Lilydale, highlights the need for integrated Catchment planning and management to maintain and improve liveability for community well-being and economic prosperity. The figures below show the anticipated changes in population density and urban land use change between the current state and 2050.

[9] DELWP (2019). Victoria in Future 2019 (VIF2019). Available at: https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future

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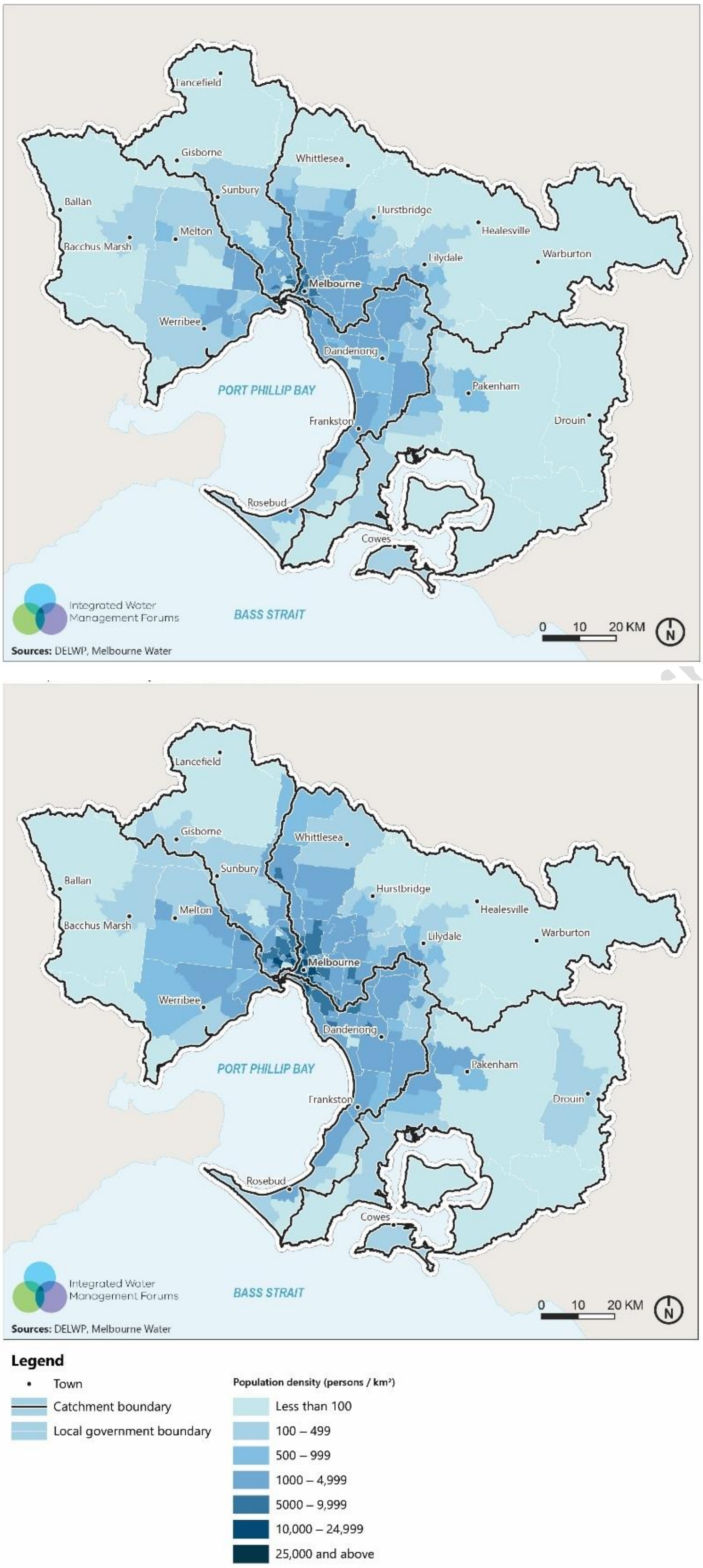

Figure 6: Population density (current state and 2050 reference state)

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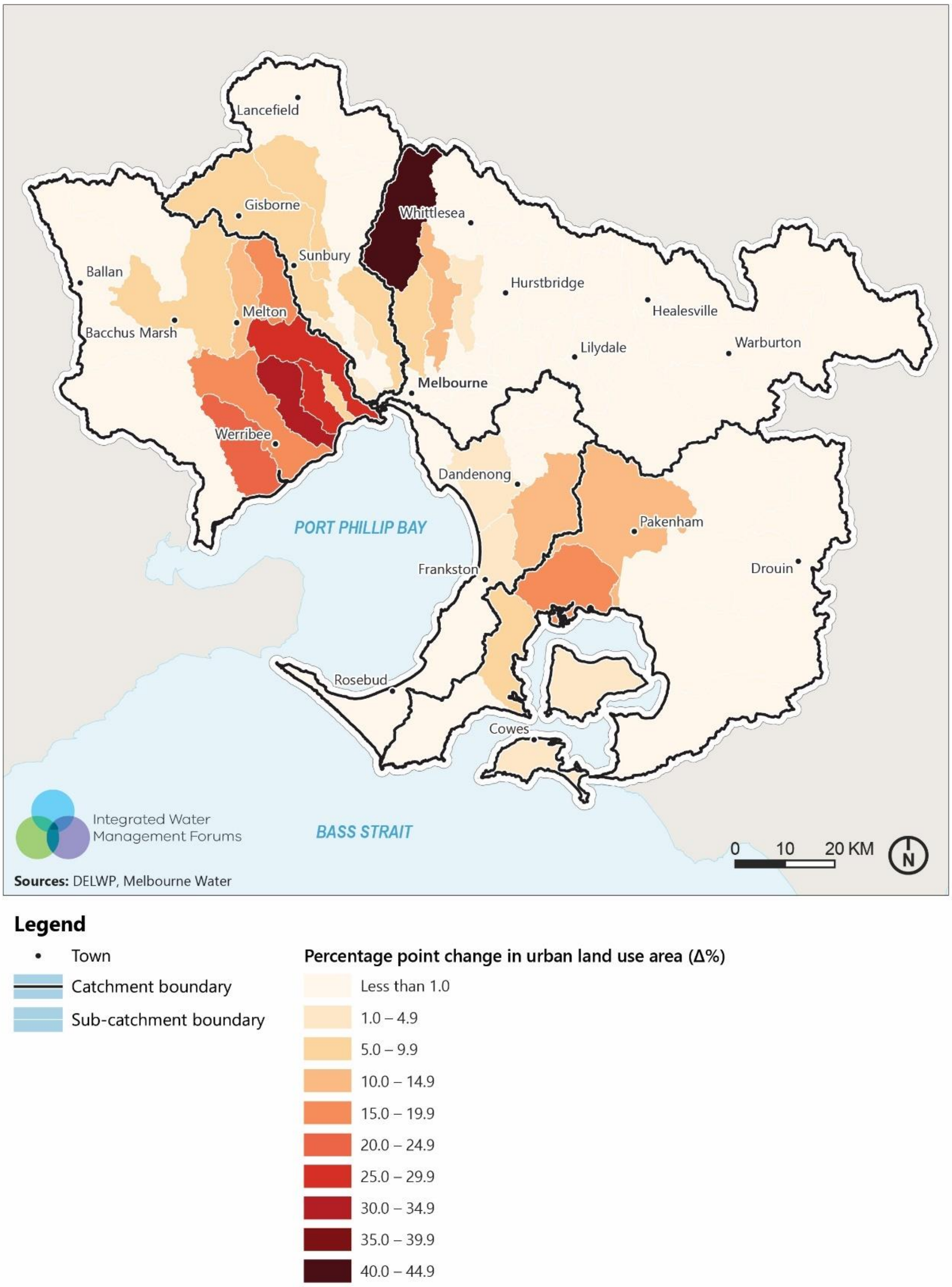

Figure 7: Projected change in urban land use area (2018-2050)

Climate change

Together with the major population increases anticipated over the next three decades, climate change presents a critical challenge for all five Catchments. By 2040, temperatures across the Greater Melbourne Metropolitan Region are expected to rise by an average of 1.3°C under a medium climate change scenario.[10] The risk of fire in forests and grasslands will remain high under these conditions. The increased risk of bushfire poses a serious threat to the Catchment's communities, infrastructure and high-value native forests including water supply Catchments and ecosystems.

The impact of the urban heat island effect will also increase, with greater densification in urban areas meaning they will be more vulnerable to heat waves than more rural or peri-urban areas. At present, heat waves in Melbourne have a greater negative effect on population health than any other climate-related issue.[11] The ongoing availability of water in the environment will be vital to reduce the risk of heat stress and improve cooling in the most vulnerable areas of the Catchment. Potential evapotranspiration (PET) is expected to increase by 4.7% by 2040 under a medium climate change scenario.

Whilst the region is predicted to see more frequent, intense rainfall events that will increase the risk of flooding, all Catchments will experience a reduction in average annual rainfall in the future. This change is consistent with conditions predicted across the state as Victoria becomes warmer and drier.[12] Changes in rainfall in the future, combined with increased development and growing populations, will place more pressure on water services in the Catchment.

Climate change has been considered in all aspects of the water cycle analysis in this report, using the most appropriate projections and sources of information available to the analysis at hand. Further details on how climate has been considered is provided with regard to each aspect of the water cycle described in Background Appendix A: Water and Pollutant Balance Analysis.

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[10] DELWP (2020). Guidelines for Assessing the Impact of Climate Change on Water Supplies.
[11] Coates L, Haynes K, O'Brien J, McAneney J, and Dimer de Oliveir F. (2014). Exploring 167 years of vulnerability: an examination of extreme heat events in Australia 1844–2010. *Environmental Science & Policy*,42, pp.33-34. Open access, available at: https://www.sciencedirect.com/science/article/pii/S1462901114000999
[12] DELWP and CSIRO (2019). Victoria's Climate Science Report 2019. Available at: https://www.climatechange.vic.gov.au/victorias-changing-climate

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Water and pollutant balance – now and in the future

Population growth and climate change will fundamentally alter the water and pollutant balances for the Catchments and for the region as a whole. Our collective efforts to deliver IWM initiatives and investments under the future reference state are expected to abate negative impacts or enhance positive outcomes to a certain degree, however, for most components of the water cycle there is still much left to be gained. The overarching changes to the water balance are:

- An increasing population will further increase the total water demands, though the per person demand is anticipated to decrease due to trends towards higher density housing, more efficient appliances, and gradual renewal of the housing stock. This increase in demand will also generate an increase in wastewater.
- Generally, we expect a hotter, drier future for the Greater Metropolitan Melbourne Region. Future climate projections show significant variations in future rainfall, and in the resulting runoff from the Catchments. The 'maximum consensus' rainfall projection presented for rainfall and runoff modelling in this report actually shows a short-term decrease in rainfall and runoff, followed by an increase. The water and pollutant balances are presented as annual values, and therefore do not show the impacts of more frequent extreme rainfall events.
- Under the future reference state it has been assumed that we will continue current initiatives, maintain existing policy and carry through committed projects, which will result in some significant changes to the water and pollutant balance, including;
    - A more diversified portfolio of water supplies, with recycled water use most prevalent on the edges of the urban area and in growth areas, and rainwater and stormwater harvesting more common in established areas, and
    - Increased removal of pollutants from receiving environments due to continued delivery of WSUD, stormwater harvesting, rural land improvements, waterway enhancements and wastewater treatment.

A summary water and pollutant balance is provided below.

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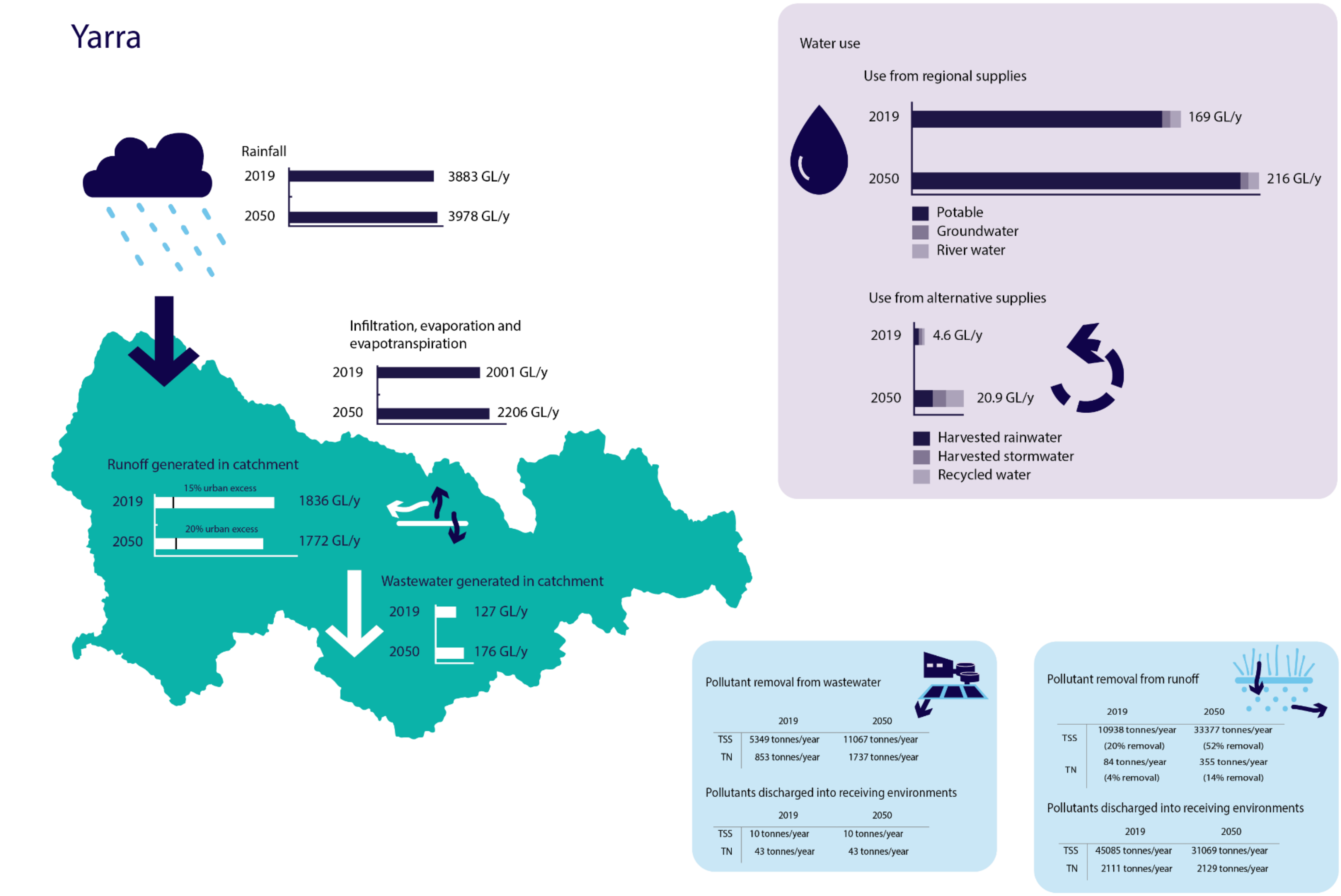

Figure 8: Yarra water balance

Setting the way forward

This Plan provides a framework to drive action and investment in IWM across the Greater Metropolitan Melbourne Region. The following chapters provide a detailed description of the drivers for each of the strategic outcome areas, the selected indicators and measures, and their performance in the current state and future reference state. A future 'desired state' has also been defined for each of the leading measures, based on desired outcomes we want to achieve, and consideration of the 'interventions' that could be delivered to help to drive change.

The desired state target for each of the leading measures and the outcomes this will drive are summarised in the table below.

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Table 3: Summary of desired state outcomes and targets for leading measures

	Leading Measure	Desired state targets (Catchment)		What outcome will these targets deliver?
		2030	**2050**	
Enablers	E1 Rating of vision, leadership and long-term commitment through vision statement and objectives articulated in corporate documents (out of 5)	4	5	This target will drive commitment and leadership to IWM planning and practice. It must be in place early as a key enabler to deliver the IWM Plan.
	E2 Rating of knowledge, skills and organisational capacity (out of 5)	4	5	This target will drive organisational capacity and capability building to deliver the IWM Plan.
	E3 Rating of cross-sector institutional arrangements and processes (out of 5)	4	5	This target will help ensure mechanisms for collaboration and cross-working are in place early to enable truly integrated management of the water cycle.

Strategic outcome	Leading Measure	Desired state targets (Catchment)		What outcome will these targets deliver?
		2030	**2050**	
1. Safe, secure and affordable water supplies in an uncertain future	1.1a. Litres/per person/day residential potable water use	To be defined by the GMMUWSS[13]		
	1.2b. ML/year of alternative water[14] sources that substitutes potable mains water supply	14 GL	Regional target of 150 GL	As the climate changes and the population of the region grows, modelling of supply and demand shows there could be future shortfalls, meaning we need to either increase Melbourne's potable water supply portfolio or reduce demand. By delivering 150GL/year of alternative water supplies by 2050 that will substitute potable water supplies, we will significantly reduce the risk of future shortfalls by diversifying our water supplies and making use of resources that might otherwise be wasted.
2. Effective and affordable wastewater system	2.1a. ML/year of recycled water delivered to customers	Regional target of 85 GL	Regional target of 230 GL	Recycled water is an under-utilised resource that is mostly climate independent (unlike stormwater) and has significant potential to underpin Melbourne's water security. In achieving this target, the Melbourne region will be a world leader in advancing a circular economy and will be on track to beneficially use 100% of our water and resources by 2070 while ensuring affordability for current and future generations of

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[13] The Greater Metropolitan Melbourne Urban Water Systems Strategy (GMMUWSS) is a collaborative strategy under development. This figure should be available in early 2022.
[14] Including recycled water, greywater, rainwater and urban stormwater.

Strategic outcome	Leading Measure	Desired state targets (Catchment)		What outcome will these targets deliver?
		2030	2050	
				Melburnians. It is recommended as a target range, to ensure a variety of options can be explored to drive the most effective and beneficial outcomes. Recycled water supplies that contribute to this indicator may also contribute to measure 1.2b where potable water supply is substituted, though this may not be the case for agricultural and environmental supplies.
	2.1b. Percent of nitrogen recovered at treatment facilities for beneficial use	N/A	Regional weighted average of 94%	The proposed 2050 targets for nitrogen and carbon removal from wastewater are based on the concept of a major paradigm shift in how we manage, or 'treat', sewage. Currently, treatment paradigms are based on seeing nitrogen and carbon as contaminants which need to be reduced to make the water safe for environmental discharge. These targets will drive a change that re-frames wastewater as a key resource, from which resources can be harvested for beneficial use.
	2.1c. Percent of carbon recovered at treatment facilities for beneficial use	N/A	Regional weighted average of 67%	
3. Existing and future flood risks are managed to maximise outcomes for the community	3.1 Dollar ($) reduction in Annual Average Damage (AAD) delivered by flood management initiatives	$10 million	Regional target of $408 million	A 2050 target of a $408 million reduction in Average Annual Damages has been set for the region which seeks to negate the increases expected due to both climate change and urban consolidation, thereby ensuring that the impacts of flooding in the region do not significantly increase in the future.
	3.3 Percent of projects that cross-consider IWM and flood mitigation opportunities as part of their design	100%	100%	A target of 100% has been set for all Catchments for 2050, with the aim of driving a step-change in practice that better integrates flood mitigation with IWM and vice versa. This will ensure that opportunities are taken to drive multiple benefits through investments in interventions.
4. Healthy and valued waterways and marine environments	4.1 ML/year of mean annual runoff volume reduction	21 GL	71 GL	The regional target for this measure aims to protect and enhance our valued waterways for future generations to enjoy, by ensuring that we take opportunities to reduce runoff from impervious areas, and mimic natural flows in the areas where it matters most. The 'urban excess' proportion of runoff is anticipated to increase by 283GL/year by 2050. The regional target aims to remove a majority of that increase in targeted locations where our waterways are most vulnerable to flow increases.
	4.2a. Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters	Meet the SEPP (waters) targets for pollutants entering Port Phillip Bay and Western Port which represent a no net increase compared to baseline loads.		Evidence shows increases in pollutants could trigger more persistent algal blooms and poor water quality at beaches, which would have the potential to reduce tourism contribution to the economy by at least $68 million per year and reduce the value of
	4.2b. kg/year mean annual Total Nitrogen (TN) prevented from discharging to receiving waters			

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Strategic outcome	Leading Measure	Desired state targets (Catchment)		What outcome will these targets deliver?
		2030	2050	
				enjoyment derived by locals and tourists from visiting the Bay by $39 million per year.[15] These targets will protect the health of Port Phillip Bay and Western Port in the region by avoiding an increase in the pollutant loads entering the Bays.
	4.3 Additional ML/yr of water allocated to environmental water reserve that increases environmental benefits in waterways	To be defined by the CGRSWS[16]		
5. Healthy urban and rural landscapes	5.1 Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply	8%	21%	The target for tree irrigation using alternative sources will drive a change in practice across the region that will support our healthy, thriving street trees in a sustainable way. Provision of water, whether passive irrigation from adjacent runoff or permanent active irrigation systems using recycled water, will support both existing and new trees in the anticipated future hotter, drier climates, where more than half of our tree population is expected to struggle without support. By also designing an environment for new trees where water is more consistently available, we will create healthier and larger tree canopies with a longer life span, which will provide shade, habitat, amenity and natural cooling for communities. The targets anticipate Living Melbourne targets being achieved and supporting at least 50% of new street trees in growth areas and 25% of replacement trees and new trees planted in existing areas with irrigation from either stormwater runoff or recycled water.
	5.2a. Percent of the total area of active public open space (sports fields and organised recreation) supported by an alternative water source	18%	50%	By supporting this proportion of active open spaces with irrigation, modelling has shown that we will reduce the average land surface temperature across a Local Government Area by up to 5 degrees Celsius on an extreme heat day. A reduction of that magnitude directly reduces heat mortality and adverse health impacts. Added to this, increased irrigation will support sport and recreation and provide amenity value for local communities, all while utilising alternative water resources that can be drawn on during drought without depleting our precious potable water supplies.
	5.2b. Percent of the total area of passive public open space (parkland and gardens) supported by an alternative water source	2%	30%	This target will ensure we take opportunities to support passive open space irrigation where it makes sense, to enrich communities by providing healthier, greener and multi-functional open spaces. Passive open spaces are often well-utilised by the community for walking, exercising, picnicking and playing. They also act as important refuges on

[15] EPA (2020). Background information: Draft Urban Stormwater Management Guidance Consultation Guide. Available at: https://www.epa.vic.gov.au/about-epa/publications/1829
[16] The Central and Gippsland Region Sustainable Water Strategy (CGRSWS) is currently undertaking this assessment with a final recommendation anticipated in early 2022.

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Strategic outcome	Leading Measure	Desired state targets (Catchment)		What outcome will these targets deliver?
		2030	2050	
				extreme heat days. Green links are often better distributed throughout neighbourhoods than more formal active open spaces. While historically most passive open space hasn't been supported by irrigation, this target recognises the growing appreciation of the many benefits this could bring to communities in targeted areas, all the while utilising alternative water resources that might otherwise be wasted.
6. Community values are reflected in place-based planning	6.1a. Rating of Traditional Owners' capacity to partner in IWM programs, policy, planning and projects	Subject to ongoing discussion with Traditional Owners and the results of a survey distributed to all IWM Forum organisations in May 2021		
	6.1b. Rating of other IWM partner organisations' capability to partner with Traditional Owners in IWM programs, policy, planning and projects			
	6.3 Rating of community literacy regarding the water cycle (out of 5)	4	5	This target will drive community support and stewardship for IWM solutions.
	6.4 Rating of whether water is a key element in city planning and design process (out of 5)	4	5	This target will drive an integrated approach to planning at all scales, which plans for and enables the delivery of integrated water management.
7. Jobs, economic benefits and innovation	7.1a. ML/year of alternative water supplied to agricultural production	2 GL	7 GL	This target will drive continuing to support Melbourne's population with local food supply (continuing the existing proportion of 41%), by supporting and enhancing the Melbourne region's food bowl through the supply of alternative water resources. River, Catchment runoff and groundwater supplies, the primary sources of water for agricultural production, are likely to decrease in the future due to the impacts of climate change. The provision of alternative water supplies, including recycled water and urban stormwater, to support agricultural production will make use of local resources and build resilience into the sector.

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Enablers

Strategic enablers represent a series of useful indicators and measures that are overarching to the success of the seven key strategic outcomes. Without these fundamental factors in place, the mainstreaming of IWM will remain challenging. This is in recognition of the fact that across Greater Metropolitan Melbourne there are multiple organisations that hold responsibility for managing the urban water cycle, with a collaborative and integrated approach essential for effective planning and delivery of IWM initiatives.

Three Catchment scale indicators and measures have been identified. These strategic enablers reflect the ability and willingness of organisations to implement IWM: Commitment, Collaboration and Capacity. Importantly these enabling factors may also assist to identify important projects that are essential to fully embed IWM into organisational practices.

The case for change

Transitioning to integrated water management

Traditionally, the water cycle has been managed through centralised supply, sanitation, and drainage infrastructure in a largely predictable environment of demand, supply and waterway management. However, population growth in the context of climate change has led to stressed ecosystems and increasing unpredictability around water supply, requiring an adaptive approach to urban water management. Key to this approach is a shift in the commitment, capacity and attitudes of all water sector stakeholders.[17]

A significant amount of research has been undertaken both within Melbourne and across Australia to identify the current state of urban water management and the key elements required to transition to an ideal state as a Water Sensitive City. A Water Sensitive City is used to define those cities where water related policies, practices, operations and initiatives enable liveability, sustainability, productivity and resilience.[18] Integrated water management is both an essential pathway and outcome of this state, resulting in an adaptive, resilient city capable of addressing emerging challenges in a considered fashion.

The Urban Water Management Transitions Framework introduces distinct development phases that can assist in identifying the enablers required for progressing toward a water sensitive city.[19] A key pillar is the need for water sensitive communities and institutions that are informed and engaged around the water cycle and actively working together to deliver and co-manage water services.

The IWM Forum process can assist stakeholders within each Catchment to define and follow their own transitions pathway, by creating a collaborative environment that supports and enables innovative Catchment scale planning and project delivery. To assess the current state of each Catchment, we drew on Council reported data sets and industry tools designed specifically to assess local governments transition to a Water

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[17] Brown, R., Rogers, B., Werbeloff, L. (2016). Moving toward Water Sensitive Cities: A guidance manual for strategists and policy makers. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities. Available at: https://watersensitivecities.org.au/content/moving-toward-water-sensitive-cities/

[18] CRC for Water Sensitive Cities (2021). What is a water sensitive city? Available at: https://watersensitivecities.org.au/what-is-a-water-sensitive-city/

[19] Brown, R.R., Keath, N. and Wong, T.H., 2009. Urban water management in cities: historical, current and future regimes. *Water Science and Technology*, 59(5), pp.847-855. Open access, available at: https://iwaponline.com/wst/article/59/5/847/15553/Urban-water-management-in-cities-historical

Sensitive City state, such as the Water Sensitive Cities Index rating tool developed by the CRC for Water Sensitive Cities.[20]

Strategic enablers play a key role in assessing the current environment for enabling such change. To date, Catchment stakeholders have effectively worked together to create Strategic Direction Statements that set a joint vision and strategic outcomes, and identify and progress opportunities and priorities for the short term. This demonstrates an intent to overcome institutional barriers and geographical boundaries, and identify and implement short term priority projects that have a higher impact on adopted strategic outcomes. This sets the stage for the next phase of planning, supporting a Catchment based approach to growth that advances progress towards a Water Sensitive City.

Organisational leadership and commitment, together with organisational skills and capacity, form a key backdrop to enabling supportive governance and cross institutional engagement across the sector. The selected indicators and measures are key enablers that support successful delivery of this process. Future Forum processes and action planning could incorporate a deeper review and acknowledgement of Catchment specific barriers to Catchment scale planning and action, to support the ongoing transition to collaborative IWM.

The current state analysis of the ratings of these three enabling factors shows fairly consistent results on average across the four Council cluster categories (see Background Appendix B for Council Cluster categories and designations) as summarised in the table below.

Table 4: Combined rating across the three enablers for different council clusters

Indicators	Current state rating across the three enabling factors		
	Average	Minimum	Maximum
Inner	3.2	2.0	4.0
Suburban	3.0	2.0	4.0
Growth	3.1	2.5	4.0
Outer	2.0	0.0	4.0

The outer councils showed the largest variation in the enabler ratings, with some showing very low ratings, perhaps reflecting limited resources and skills within these areas to support IWM.

Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 5: Indicators and Measures for Strategic Outcome 1

Indicators	Measures
E1: Increase organisational commitment to IWM	Rating of vision, leadership and long-term commitment through vision statement and objectives articulated in corporate documents
E2: Increase stakeholder capacity to successfully deliver IWM	Rating of knowledge, skills and organisational capacity
E3: Increase collaboration and partnerships across industry and government	Rating of cross-sector institutional arrangements and processes

[20] CRC for Water Sensitive Cities (2021). Water Sensitive Cities Index. Available at: https://watersensitivecities.org.au/water-sensitive-cities-index-tool/

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Indicator E1: Increase organisational commitment to IWM

Measure E1: Rating of vision, leadership and long-term commitment through vision statement and objectives articulated in corporate documents

This measure tracks the degree to which organisational leadership is supportive of the adopted vision and water management agenda, and able to strategically commit to and initiate IWM initiatives. Advanced levels of commitment translate into an increasing presence of champions and leaders across the organisation, further demonstrating the commitment to the adopted vision and key values, including local and regional liveability, sustainability and resilience. This creates an organisational culture that supports innovation and collaboration, leading to a shift in processes and practices towards the implementation of IWM. This is further reinforced by the embedding of place-based IWM visions and narratives within organisational policy, planning and budgeting.

This is a rated indicator, out of a maximum of 5, as described in the table below. The rating definitions have been adapted from the Water Sensitive Cities Index.

Table 6: Rating of vision, leadership and long-term commitment

1	2	3	4	5
No recognition of the value of integrated water management. Leadership of organisations is possibly hostile to such an agenda.	At least one leader of considerable seniority values integrated water management but generally lacks opportunity to initiate change.	Several leaders of considerable seniority value integrated water management and undertake initiatives for change.	Multiple leaders endorsing integrated water management and initiatives to achieve it. Champions present across the organisation(s). Incentives, such as awards and other signs of recognition of water leadership are present. Long-term vision and narrative endorsing liveability, sustainability or resilience in a meaningful manner embedded in official policy and ongoing funding is available to deliver it.	A critical mass of leaders endorsing liveability, sustainability or resilience water agenda endorsing initiatives towards achieving the vision. Several (relative to organisation size) champions are present promoting and advocating coalitions supporting water agenda. Project teams typically include a water vision champion. Incentives, such as awards and other signs of recognition of water leadership are highly regarded distinctions in the organisation(s). Long-term vision and narrative meaningfully endorses liveability, sustainability and resilience. The vision and narrative are part of official policy and documents. Commitment to the vision is apparent through initiatives (e.g. long term, cross-government planning functions) and considerable funding.

Table 7: Measure overview

Measure E1: Rating of vision, leadership and long-term commitment through vision statement and objectives articulated in corporate documents parameters						
Indicator type	Leading					
Desired State Target Scale	Catchment-scale					
Measure performance and targets						
Rating	**Region**	**Werribee**	**Maribyrnong**	**Yarra**	**Dandenong**	**Westernport**
Current state	3.1	3.1	2.8	2.8	3.4	3.5

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	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	3.1	3.4	3.1	3.4	2.9	3.3	3.0	3.3	3.3	3.4	3.4	3.6
Desired state	4.5	5	5	5	5	5	4	5	4.5	5	4	5

Table 8: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to rate community literacy regarding the water cycle. Conducted by E2Designlab in February-March 2020.
CRC for Water Sensitive Cities, Water Sensitive Cities Indexing, conducted 2017-2020. Water sensitive city indexing was conducted for 10 local councils, providing more advanced understanding across some areas addressed in the Catchment Scale IWM Plan Councils Survey.
Key assumptions
Responses to the Council Survey were rated 1 to 5, with 1 reflecting no recognition by leadership of the value of integrated water management with 5 reflecting a critical mass of organisational leaders endorsing liveability, sustainability or resilience water agendas together with initiatives towards achieving the vision.
The current state rating was increased universally by 0.5 by 2050 under the future reference state, based on anticipated increases in commitment and leadership within organisations except where an LGA already received a rating of 4 or higher. It is assumed no change occurs before 2030.It is assumed that this uplift occurs after 2030 but before 2050, reflecting the time needed to instil changes in policy and practice to cement an uplift in outcomes.

Current state

Current state ratings of indicator E1 were collated for different LGA clusters to reflect the performance of all stakeholders involved in water management within suburban councils, inner metro councils, growth area councils and outer metro councils. In general, ratings for LGAs indicated a higher performance against this indicator in growth area council areas, while the lowest performance was observed for outer council areas.[21] Specifically, growth area council areas exhibited the highest ratings under the current state (3.3) while outer metro council areas demonstrated the lowest (2.7).

Performance across the Catchment

Performance ratings around organisational commitment to IWM planning for the Yarra Catchment fluctuate between 2 and 4. Lower ratings are characterised by more limited leadership opportunities to initiate change through IWM planning, while the highest ratings for the Cities of Banyule, Port Phillip, Yarra and Baw Baw Shire are characterised by a clear and embedded long term vision endorsing liveability, sustainability and resilience, with multiple leaders and champions working together to endorse and achieve IWM planning objectives.

Future reference state

Under the future reference state, E1 ratings are expected to increase from the current state by 0.3 - 0.4 for all council clusters, recognising the ongoing efforts to prioritise IWM at a leadership level. Similar to the current state, inner growth area councils are predicted to demonstrate the highest average E1 ratings (3.6; increase of 0.3 compared to current state) while outer metro councils are expected to exhibit the lowest (3.1; increase of 0.4 compared to current state).

Table 9: Current and reference state performance for measure E1 by council cluster

	2018	**2050**
Inner Metro Council	3.1	3.4
Suburban Councils	3.0	3.4
Growth Area Councils	3.3	3.6
Outer Metro Councils	2.7	3.1

[21] Based on the council survey and Water Sensitive City index results (where available).

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Performance across the Catchment

Under the future reference state, organisational commitment to IWM is expected to show a marginal increase.

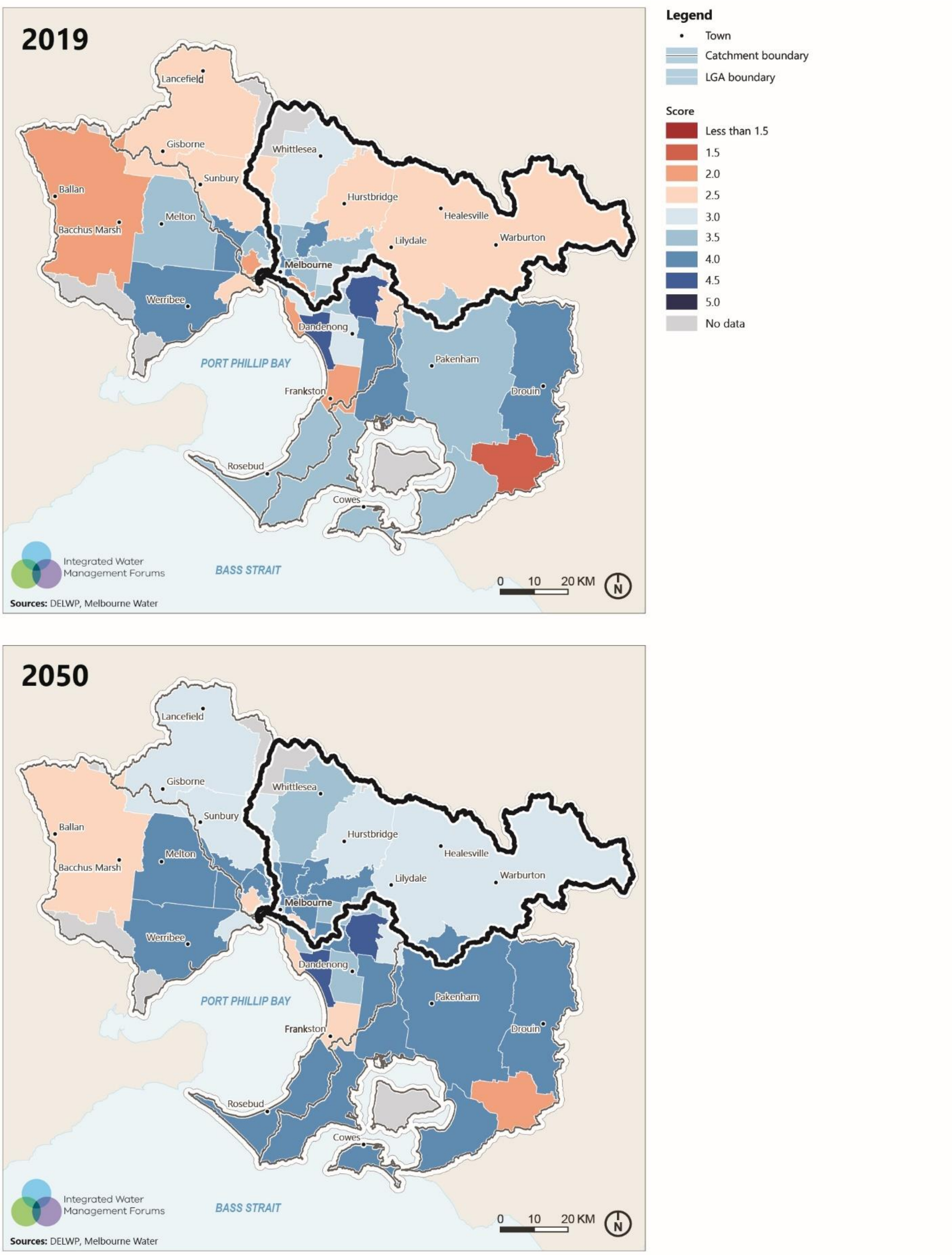

Figure 9: Measure E1. Rating of vision, leadership and long-term commitment through vision statement and objectives articulated in corporate documents (current and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

While there are no targets set out in existing strategies, the metric is constructed around an 'ideal' rating of 5 based on the achievement of this key performance indicator which is key to the creation of a Water Sensitive City.[22]

Possible future interventions

Effective leaders can help articulate and document an overall shared IWM vision, defining mutually beneficial outcomes for all stakeholders. They can also help operationalise the vision and strategic outcomes by shaping organisational cultures that support innovative, collaborative and reflective practices.[23] There are several water sector programs directed at strengthening leadership capacity, including,

- The International Water Centre's nine-month Water Leadership Program, and smaller programs it runs for specific organisations.[24]
- The Peter Cullen Trust's Science to Policy Leadership Program.[25]
- The Insight – Executive Leadership for Women in Water Program.[26]
- Other interventions may focus on increasing organisational commitment through: Cultural change programs aimed at establishing a desired organisational culture that encourages continual learning, adaptive management, responsible risk-taking, innovation and sustainability.
- Vision and strategy development to guide planners, designers and decision-makers in strategically planning and managing initiatives that facilitate and operationalise the transition to IWM.[27]

Desired state target recommendations

2050 Regional and Catchment Targets

The target for this measure is 5, reflecting the need for commitment at an organisational level, and the associated organisational culture, to both drive and implement IWM. It is recognised that the other targets in this plan cannot be achieved without commitment and leadership.

2030 Regional and Catchment Targets

A 2030 target has been selected for each Catchment that accelerates our path towards a rating 5, recognising the importance of leadership and commitment from the early stages, to support delivery of IWM.

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[22] CRC for Water Sensitive Cities (2018) Water Sensitive City Index. Available at: https://watersensitivecities.org.au/water-sensitive-cities-index-tool/

[23] Taylor, A.C. (2009). Sustainable urban water management: Understanding and fostering champions of change. *Water Science and Technology*, 59(5), pp.883-891.Open access, available at: https://iwaponline.com/wst/article/59/5/883/15559/Sustainable-urban-water-management-understanding

[24] International Water Centre (2021). Professional development. Available at: https://www.watercentre.org/study/courses/?course_type=professional-development#filter

[25] Peter Cullen Water and Environment Trust (2021). Science to Policy Leadership Program. Available at: https://www.petercullentrust.org.au/science-to-policy/

[26] DELWP (2020). Insight: Executive Leadership for Women in Water Program. Available at: https://www.water.vic.gov.au/water-for-victoria/innovation/insight

[27] See for example, Rogers, B.C., Gunn, A., Hammer, K., Chesterfield, C. (2021). An enhanced WSC visioning and transition planning methodology. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities. Available at: https://watersensitivecities.org.au/content/an-enhanced-wsc-visioning-and-transition-planning-methodology/

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Indicator E2: Increase stakeholder capacity to successfully deliver IWM

Measure E2: Rating of knowledge, skills and organisational capacity

This measure rates the knowledge and skills of key water related organisations in the Catchment, together with organisational capacity to successfully deliver IWM. Assessment parameters include the presence of IWM and multi-disciplinary skill sets and their application across planning processes. It also includes consideration of the presence of a strong learning and growth culture that can work to maintain organisational capacity. Ideally such organisations would rely on robust science for decision making and would be supportive of research and capacity programs.

This is a rated indicator, out of a maximum of 5, as described in the table below. The rating definitions have been adapted from the Water Sensitive Cities Index.

Table 10: Rating of knowledge, skills and organisational capacity

1	2	3	4	5
Integrated water-related skills and knowledge are rare in water-related organisations in the region. Engineering dominates organisational skills.	Integrated water-related skills and knowledge are available in the key water-related organisations in the region, but limited to a few individuals. Engineering dominates organisational skills.	Integrated water-related skills and knowledge are actively maintained and updated across the key water-related organisations in the region. Engineering skills are complemented by other disciplinary skills (for example, landscape and ecology). Some connection(s)/alliance(s) with knowledge brokering organisation(s) is/are in place.	Integrated water-related skills and knowledge are influenced by science, actively maintained and updated across the key water-related organisations in the region. Regular connection(s)/alliance(s) with knowledge brokering organisation(s) is/are in place. Multi-disciplinary skills are common (for example, landscape and ecology, social and urban design). This extends to embedding multidisciplinary skills into key decision-making positions/groups.	Integrated water-related skills and knowledge are influenced by science, actively maintained across the key water-related organisations in the region. A strong learning culture means knowledge and skill needs are regularly reassessed and updated. Multi-disciplinary skills are common (for example, landscape and ecology, social and urban design, architecture) and applied to projects and decision-making. Organisations support (e.g. fund) research and knowledge brokering programs (such as, capacity building programs).

Table 11: Measure overview

Measure E2: Rating of knowledge, skills and organisational capacity parameters						
Indicator type	Leading					
Desired State Target Scale	Region, Catchment					
Measure performance and targets						
Rating	**Region**	**Werribee**	**Maribyrnong**	**Yarra**	**Dandenong**	**Westernport**
Current state	2.9	2.8	2.6	2.8	3.0	3.3

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	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	2.9	3.3	2.8	3.3	2.7	3.2	2.9	3.3	3.0	3.3	3.3	3.5
Desired state	4.5	5	5	5	5	5	4	5	4.5	5	4.5	5

Table 12: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to rate community literacy regarding the water cycle. Conducted by E2Designlab in February-March 2020. CRC for Water Sensitive Cities, Water Sensitive Cities Indexing, conducted 2017-2020. Water sensitive city indexing was conducted for 10 local councils, providing more advanced understanding across some areas addressed in the Catchment Scale IWM Plan Councils Survey.
Key assumptions
Responses to the Council Survey were rated 1 to 5, with 1 reflecting limited integrated water skills and knowledge and 5 reflecting the presence and application of strong integrated and multi disciplinary skills and knowledge across IWM planning, design and delivery processes. The current state rating was increased universally by 0.5 by 2050 under the future reference state, based on anticipated increases in knowledge, skills and organisational capacity except where an LGA already received a rating of 4 or higher. It is assumed no change occurs before 2030.It is assumed that this uplift occurs after 2030 but before 2050, reflecting the time needed to instil changes in policy and practice to cement an uplift in outcomes.

Current state

Current state ratings of indicator E2 were collated for different LGA clusters to reflect the performance of all stakeholders involved in water management within suburban councils, inner metro councils, growth area councils and outer metro councils. In general, ratings for LGAs indicated a higher performance in inner metro council areas, perhaps recognising a greater resource base to support IWM.[28] On average, suburban councils exhibited the lowest ratings under the current state (2.8), while inner metro councils demonstrated the highest (3.2).

Performance across the Catchment

Stakeholder capacity to deliver IWM in the Yarra Catchment is generally above average, with ratings fluctuating between 2 and 4.5. This suggests that for some councils, IWM skills are in part less interdisciplinary in nature, with a tendency towards traditional engineering skills limited to a few individuals. For higher performing councils such as Yarra, Moreland and Port Phillip, there is a stronger drive to maintain, update and grow IWM skills and knowledge across other council areas and key decision-making functions, enabling a robust and interdisciplinary approach to IWM planning.

Future reference state

Under the future reference state, E2 ratings are expected to increase from the current state by 0.4 - 0.6 for all council clusters, recognising the ongoing initiatives to support capacity building and knowledge transfer. Similar to the current state, inner metro councils are predicted to demonstrate the highest average E2 ratings (3.6; average increase of 0.4 compared to current state), while suburban and outer metro councils are expected to exhibit the lowest (3.2; increase of 0.4 relative to current state).

Table 13: Current and reference state performance for measure E2 by council cluster

	2018	2050
Inner Metro Council	3.2	3.6
Suburban Councils	2.8	3.2
Growth Area Councils	2.9	3.4
Outer Metro Councils	2.8	3.2

[28] Based on the council survey and Water Sensitive City index results (where available).

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Performance across the Catchment

Under the future reference state, organisational capacity to deliver IWM is expected to show a marginal increase.

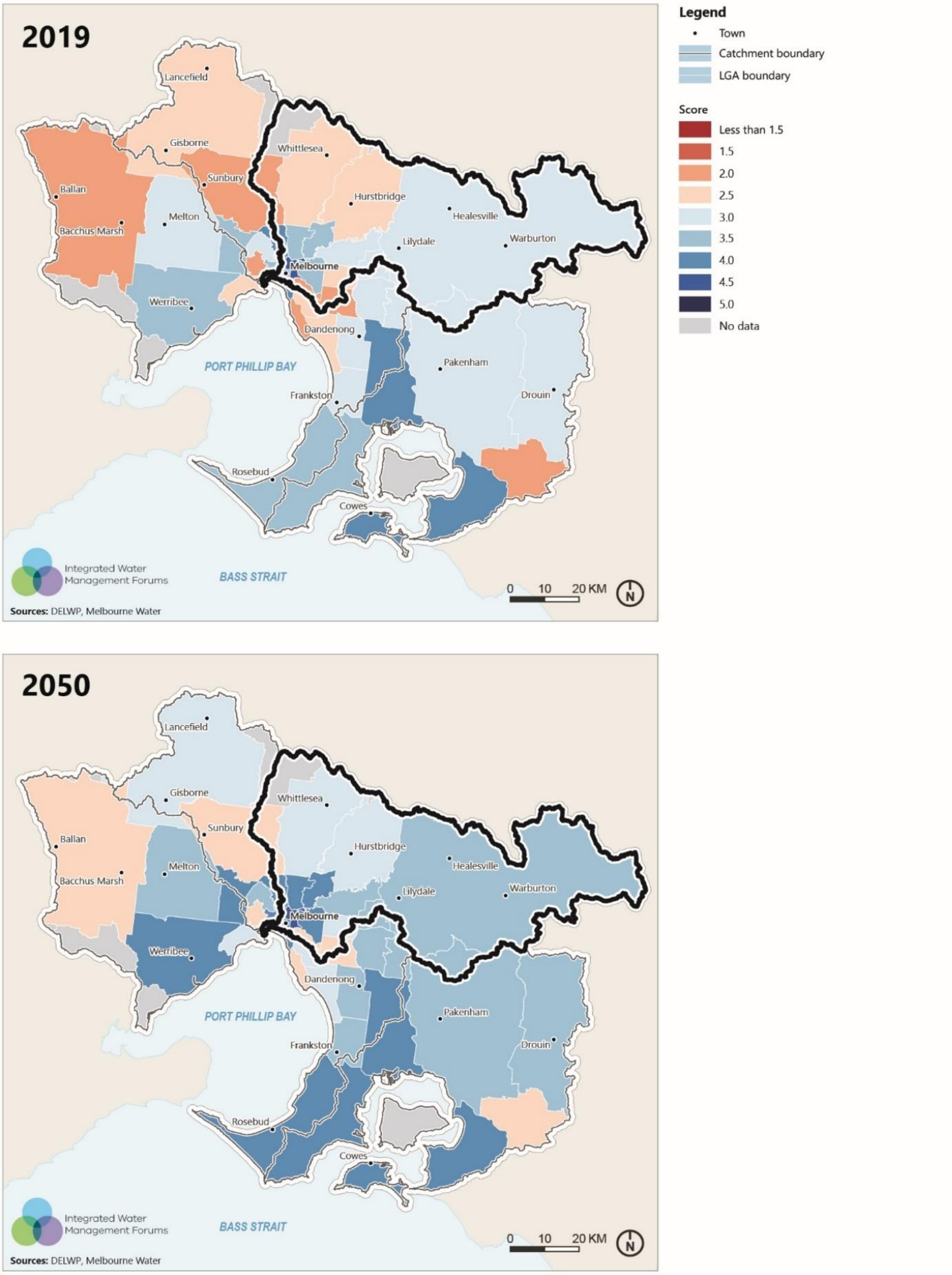

Figure 10: Measure E2. Rating of knowledge, skills and organisational capacity (current and future reference state)

Future desired state

Existing targets and referenceable evidence

While there are no existing targets set out in existing strategies, the metric is constructed around an 'ideal' rating of 5 based on the achievement of this key performance indicator which is key to the creation of a Water Sensitive City.[29]

Possible future interventions

Sector specific professional development is delivered by industry bodies such as Australian Water Association, Planning Institute of Australia, Australian Institute of Landscape Architects, Engineers Australia, etc.

Organisational capacity needs to be built across individuals, within organisations teams/departments and across organisations.[30] Examples of initiatives to strengthen individual and inter-organisational capacity, include:

- Build the capacity of individuals to exert influence and drive change (e.g. staff training programs, HR recruitment policies). Delivering IWM requires T-shaped water professionals that hold *deep* disciplinary knowledge, as well as *breadth* of understanding to be able to collaboratively operate across functional and/or organisational boundaries.[31]
- Develop intra-organisational capacity, such as the key processes, systems, cultures and resources within organisations to promote IWM.
- Strengthen inter-organisational capacity, such as mechanisms to foster better communication and coordination between key organisations and professional disciplines (e.g. establish inter-organisational communities of practice).
- Document institutional rules and incentives, such as regulations, policies and incentives that drive the adoption of IWM.
- Establish IWM working groups with representatives from different departments across the organisations. Work on local projects and how IWM concepts can be integrated to optimise beneficial outcomes.
- Take IWM learnings to develop processes and procedures to operationalise IWM and embed into mainstream practices, involving officers, middle managers and executives.
- Monitoring, reporting and reflection are critical part of on-going learning culture across an organisation.

Desired state target recommendations

2050 Regional and Catchment Targets

The target for this measure is 5, reflecting the need for practitioners and organisations to have the capacity and capability to deliver IWM. It is recognised that the other targets in this plan cannot be achieved without first investing in the people and enabling tools that will drive and support IWM solutions.

2030 Regional and Catchment Targets

A 2030 target has been selected for each Catchment that accelerates our path towards a rating 5, recognising the importance of building capacity early, to support delivery of IWM.

[29] CRC for Water Sensitive Cities (2018) Water Sensitive City Index. Available at: https://watersensitivecities.org.au/water-sensitive-cities-index-tool/

[30] Brown, R.R. (2008). Local institutional development and organizational change for advancing sustainable urban water futures. *Environmental Management*, 41(2), pp. 221–233.

[31] McIntosh, B.S. and Taylor, A., 2013. Developing T-shaped water professionals: Building capacity in collaboration, learning, and leadership to drive innovation. *Journal of Contemporary Water Research & Educatio*n, 150(1), pp.6-17. Open access, available at: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1936-704X.2013.03143.x

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Indicator E3: Increase collaboration and partnerships across industry and government

Measure E3: Rating of cross-sector institutional arrangements and processes

This measure assesses whether the institutional arrangements and processes required to achieve IWM are in place and embedded across the sector. This includes policies, strategies and practices to support liveability, sustainability and resilience. Institutional processes and arrangements should be adaptive and collaborative, and partnerships should be based on transparent reporting at all stages of project delivery and design. The establishment of such partnerships should be based on recognition of joint accountability, common targets and measures, and shared investment or maintenance responsibilities.

The regional approach adopted by the IWM Forums exemplifies the beginnings of a robust and transparent process of collaboration amongst local governments, water corporations and other relevant stakeholders with an interest in water. Under the future reference state, it is assumed that a structured Catchment scale collaboration akin to the existing IWM forum program continues.

This is a rated indicator, out of a maximum of 5, as described in the table below. The rating definitions have been adapted from the Water Sensitive Cities Index.

Table 14: Rating of cross-sector institutional arrangements and processes

1	2	3	4	5
Relevant institutional arrangements and processes are lacking, ad hoc or in continuous flux. Organisations act on their own and no input from other stakeholders is sought at any stage of any project.	Some relevant institutional arrangements and processes are present. Coordination between organisations is sometimes sought if strictly necessary or externally enforced.	Relevant institutional arrangements and processes are transparent to the general public and embedded in policies and strategies. Some collaboration and participation is typically occurring at some stage of projects. Some degree of policy to ensure inter-organisational platforms and working groups are formed.	Relevant institutional arrangements and processes are fully transparent to the general public and thoroughly embedded in policies and strategies. Organisations monitor, evaluate and adapt these processes and arrangements according to changing circumstances and new practical or scientific insights. Agencies are required to share information and transparent public reporting occurs to ensure coordination and inter-agency networks. Collaboration and participation with relevant stakeholders in some stages of all projects is sought as a rule which is supported by official policies. Several ongoing partnerships are established with the aim of developing joint accountability strategies e.g. targets, KPIs, shared investment or maintenance responsibilities.	Relevant institutional arrangements and processes are thoroughly embedded in policies and strategies reflecting cumulative experience and built up tradition relating to water practices supporting liveability, sustainability and resilience. Organisations monitor, evaluate and adapt these processes and arrangements according to changing circumstances and new practical or scientific insights. Agencies are required to share information and transparent public reporting occurs to ensure coordination and inter-agency networks. Collaboration and participation with relevant stakeholders in all stages of all projects occurs. Work is also undertaken across policy portfolios (e.g. energy, transport, health etc.). Many ongoing partnerships are established with joint accountability common e.g. targets, KPIs, shared investment or maintenance responsibilities

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Table 15: Measure overview

Measure E3: Rating of cross-sector institutional arrangements and processes parameters												
Indicator type	Leading											
Desired State Target Scale	Region, Catchment											
Measure performance and targets												
Rating	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Westernport**	
Current state	2.9		2.7		2.8		2.8		2.9		3.4	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	2.9	3.4	2.7	3.2	2.9	3.4	2.9	3.4	2.9	3.3	3.4	3.7
Desired state	4.5	5	5	5	5	5	4	5	4	5	4.5	5

Table 16: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to rate community literacy regarding the water cycle. Conducted by E2Designlab in February-March 2020. CRC for Water Sensitive Cities, Water Sensitive Cities Indexing, conducted 2017-2020. Water sensitive city indexing was conducted for 10 local councils, providing more advanced understanding across some areas addressed in the Catchment Scale IWM Plan Councils Survey.
Key assumptions
Responses to the Council Survey were rated 1 to 5, with 1 reflecting a general lack of cross collaboration with limited institutional processes or input from other stakeholders and 5 reflecting high levels of cross collaboration evidenced in institutional processes and multi stakeholder networks and partnerships, with joint accountabilities and shared responsibilities. The current state rating was increased universally by 0.5 by 2050 under the future reference state, based on anticipated increases in collaboration and partnerships except where an LGA already received a rating of 4 or higher. It is assumed no change occurs before 2030. It is assumed that this uplift occurs after 2030 but before 2050, reflecting the time needed to instil changes in policy and practice to cement an uplift in outcomes.

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Current state

Current state ratings of indicator E3 were collated for different LGA clusters to reflect the performance of all stakeholders involved in water management within suburban council areas, inner metro council areas, growth area council areas and outer metro council areas. In general, ratings for LGAs indicated a higher performance in inner metro council areas, but was fairly consistent across council areas.[32] On average, suburban councils exhibited the lowest E3 ratings under the current state (2.8), while inner metro councils demonstrated the highest (3.2).

Performance across the Catchment

Current cross-sectoral institutional arrangements, partnerships and processes to deliver IWM in the Yarra Catchment are rated as above average, with ratings fluctuating between 2 and 4. A notable proportion of

[32] Based on the council survey and Water Sensitive City index results (where available).

respondents provided ratings of 3 and above, suggesting there is sufficient evidence that key processes and arrangements supporting collaborative partnerships are embedded in council policies and strategies, as well as in key stages of project delivery. Ratings for Baw Baw, Boroondara, Moreland, Port Phillip and Yarra are the highest and suggest a greater level of transparency around these arrangements, with more advanced inter-agency reporting and joint accountabilities where appropriate. Where ratings are lower, these suggest that for some councils there are limited collaborative processes in place other than those arising from essential or externally required arrangements. The current state is further demonstrated through the collaboration undertaken to date by IWM Forum partners, working in a transparent and considered manner to develop a shared vision and strategic outcome areas for the Catchment.

Future reference state

Under the future reference state, E3 ratings are expected to increase from current state ratings by 0.3 - 0.5 for all council clusters, recognising the ongoing commitments to collaboration through the IWM forums and similar vehicles. Similar to the current state, inner metro council areas are predicted to demonstrate the highest average E3 ratings (3.5; increase of 0.3 relative to current state), while suburban and outer metro council areas are expected to exhibit the lowest (3.3; increases of 0.5 and 0.3 compared to current state values, respectively).

Table 17: Current and reference state performance for measure E3 by council cluster

	2018	2050
Inner Metro Council	3.2	3.5
Suburban Councils	2.8	3.3
Growth Area Councils	2.9	3.4
Outer Metro Councils	3.0	3.3

Performance across the Catchment

Under the future reference state, cross-sector arrangements and processes are expected to show a marginal improvement.

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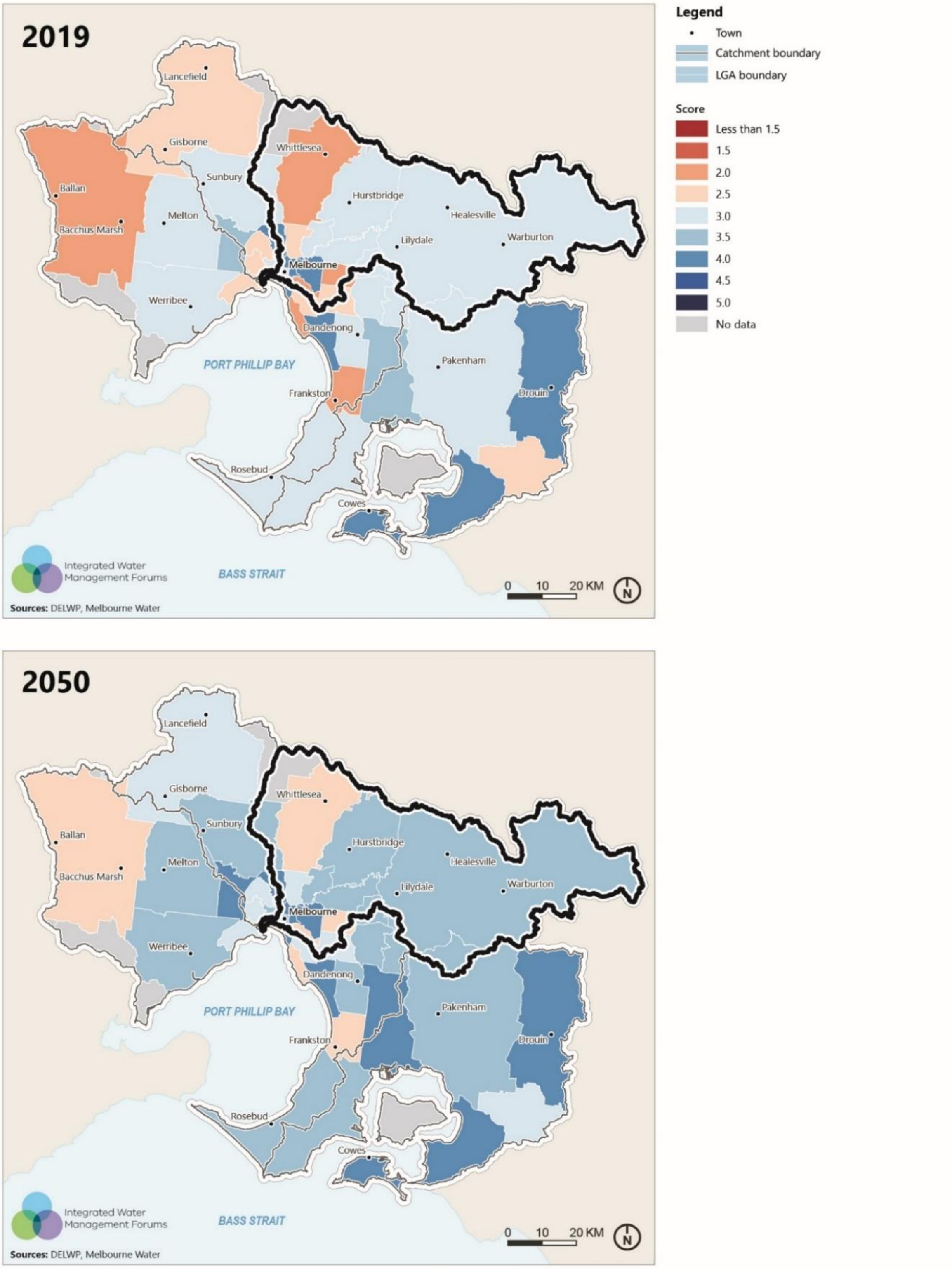

Figure 11: Measure E3. Rating of cross-sector institutional arrangements and processes (current and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

While there are no existing targets set out in existing strategies, the metric is constructed around an 'ideal' rating of 5 based on the achievement of this key performance indicator which is key to the creation of a Water Sensitive City.[33]

Possible future interventions

Inter-organisational collaboration to overcome 'silos' and inflexible processes, requires adaptive approaches with clear roles and responsibilities. IWM forums/working groups are a great example of a governance structure creating an enabling environment conducive to cross sector institutional arrangements that support effective collaboration.

Examples of initiatives to strengthen inter-organisational collaboration, include:

- Developing a shared and common vision or agenda that provides a compelling basis for collaboration and gives each collaborator a clear and meaningful sense of purpose.[34]
- Coordinate delivery of on-the-ground projects with different aspects of IWM and at different scales to build awareness, industry confidence, share learnings, and accelerate innovation.
- Establish permanent, placed- based multidisciplinary teams working in shared office space and supported by temporary project-based working groups drawn from key organisations required for successful delivery.
- Identify where specific roles and responsibilities need to be clarified (e.g. planning approvals, asset management responsibilities, monitoring and reporting, etc.) supported by formal documentation where required.
- Complex large-scale projects could benefit from an overarching steering group established with representatives from different sectors/organisations (each reporting to their execs) and have the authority to provide resources in pursuit of necessary changes to implement the IWM vision for the precinct/region.
- A 'political champion' in State government may be needed to overcome disagreements between government agencies.
- Establish IWM communities of practice and knowledge networks that involve local practitioners with common needs to share knowledge and strengthen existing networks.

Desired state target recommendations

2050 Regional and Catchment Targets

The target for this measure is 5, reflecting the need for communication and collaboration between organisations to enable delivery of IWM. It is recognised that the other targets in this plan cannot be achieved without working together to drive and support IWM solutions.

2030 Regional and Catchment Targets

A 2030 target has been selected for each Catchment that accelerates our path towards a rating 5, recognising the importance of working collaboratively from the start, to support delivery of IWM.

[33] CRC for Water Sensitive Cities (2018). Water Sensitive City Index. Available at: https://watersensitivecities.org.au/water-sensitive-cities-index-tool/

[34] See for example, Malekpour, S., Tawfik, S. and Chesterfield, C. (2020). Designing cross-sectoral collaborations for integrated urban and water planning. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities. Available at: https://watersensitivecities.org.au/content/designing-cross-sectoral-collaborations-for-integrated-urban-and-water-planning/

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Strategic Outcome 1 - Safe, secure and affordable water supplies in an uncertain future

The safety, security and affordability of water supply can be improved through IWM by reducing the demand on Melbourne's potable water resources and substituting alternative resources for fit-for-purpose uses. The indicators and measures in this strategic outcome focus on understanding how we are working to protect and conserve our precious potable water resources, and how effectively we are delivering alternative water supplies.

The case for change

Potable water

The Melbourne Water potable water supply system which services the majority of the metropolitan area draws from four major water supply Catchments: the Thomson, Upper Yarra and Maroondah and O'Shannassy Catchments. All of these Catchments are located to the east of Melbourne and are predominantly made up of national parks or state forests, offering protected and high quality water supplies.

While the majority of the metropolitan region is serviced by the Melbourne Water supply system, water corporations on the edges of the region draw water supplies from a mix of sources (see Figure below).

Potable water use varies across the metropolitan area based on a range of influences, including community behaviour, the efficiency of water supply systems and fixtures, the presence of industrial and commercial water uses and the availability and take up of alternative water sources. The current use of potable water and its spatial variation was examined as part of the current state analysis. In the future, under the reference state, potable water use is expected to change due to the impacts of population growth and climate change, as well as through the influences of community behaviour and technological change.

The figure below shows the total potable water use in each sub-catchment in the current state and the future reference state. The distribution and intensity of potable water use is explored by measures 1.1a and 1.1b.

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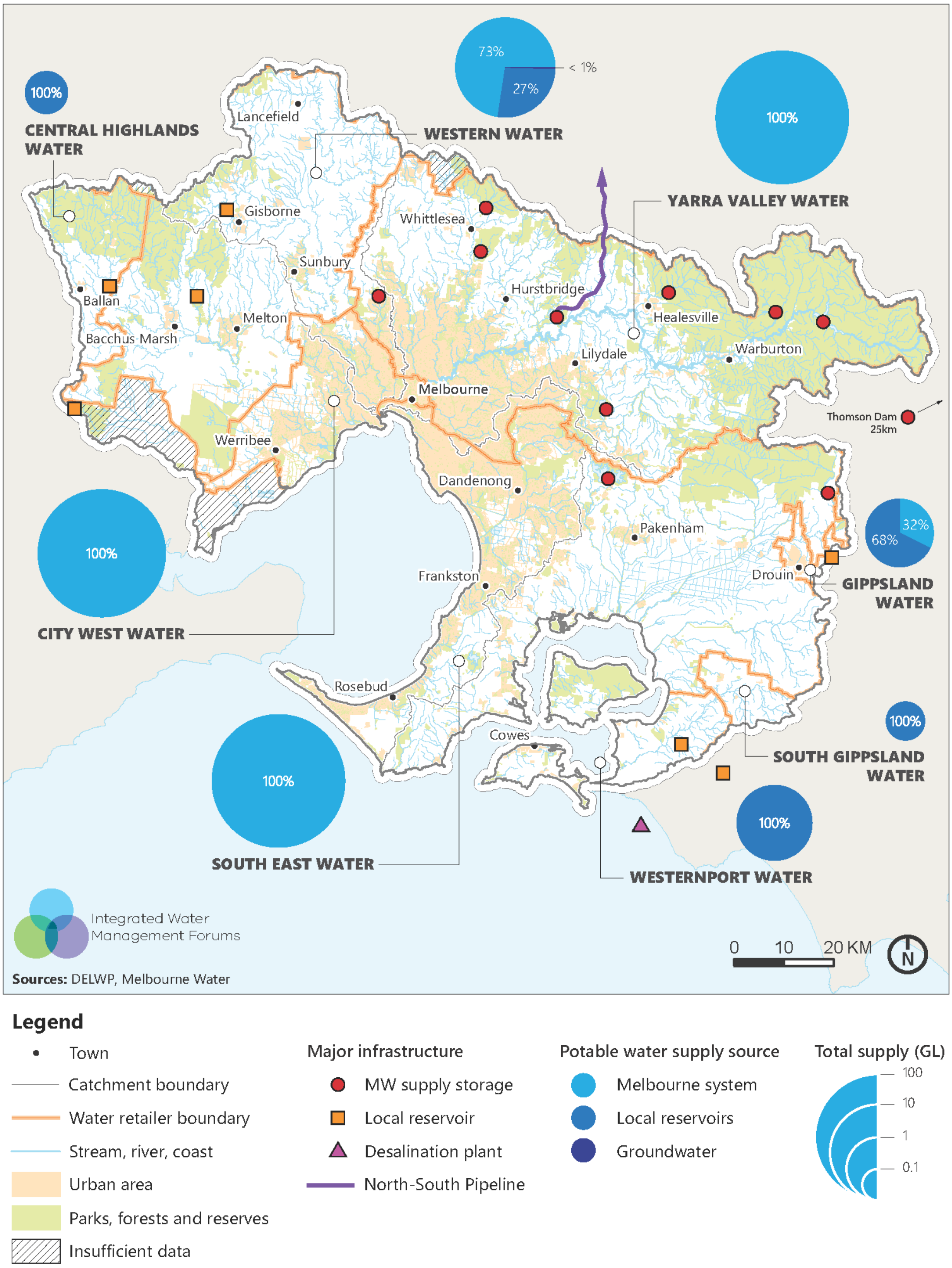

Figure 12: Potable water supplies across the region

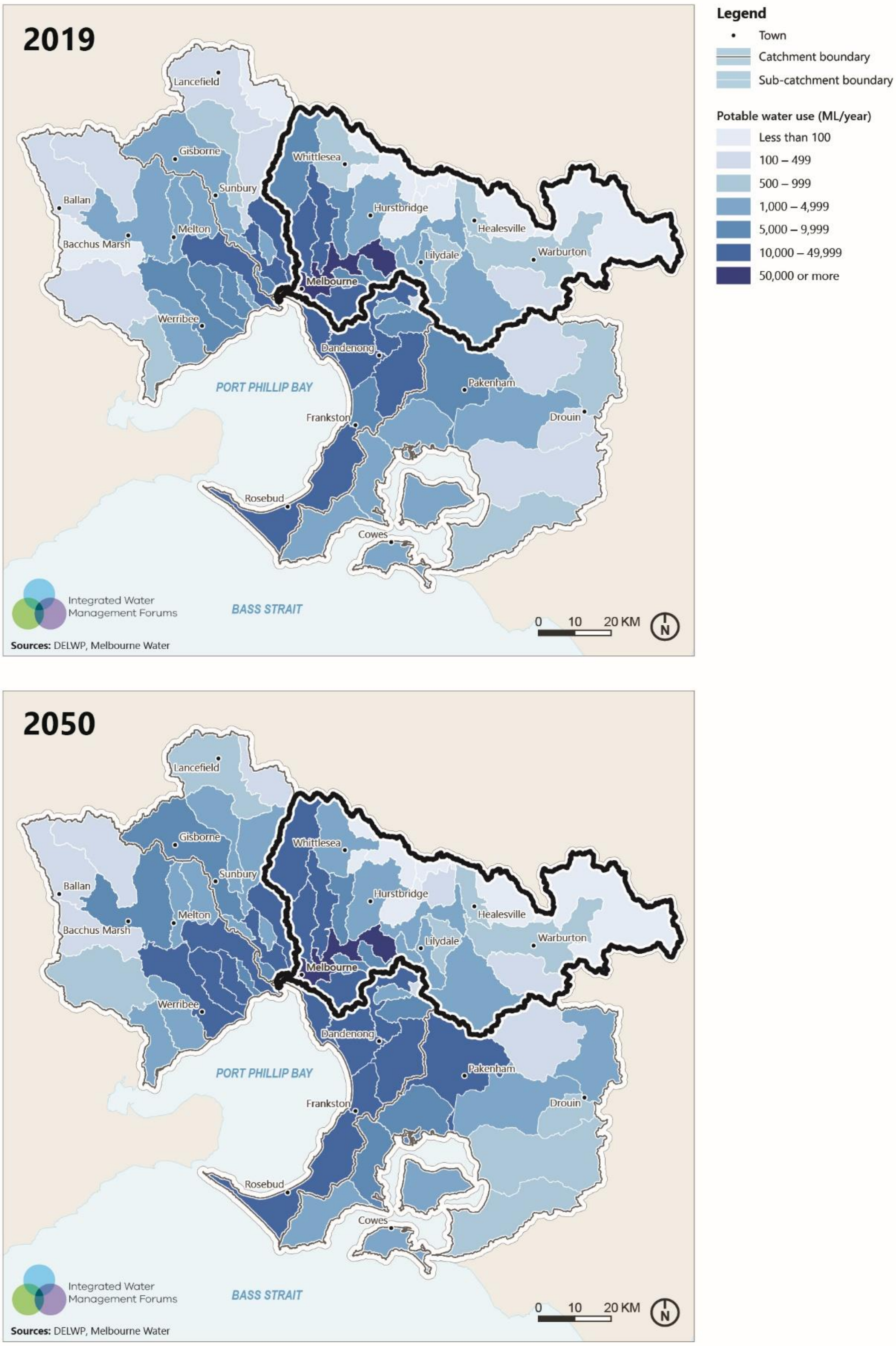

Figure 13: Potable water use across the region (current state and 2050 reference state)

Population growth and climate change will place pressure on the surface water resources that the Greater Metropolitan Melbourne Region relies on for potable water supply, increasing the need for new water resources to be added to the current supply mix. Bushfires pose an ongoing threat to the forests in the primary water supply Catchments, and Catchment yields are declining as rainfall patterns change and Catchments

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become drier. Therefore, the diversification of the water supply in the metropolitan area is important to add resilience, and to support population growth.[35]

Modelling of the Melbourne Water supply system shows that a significant shortfall between demand and supply is likely in the next 50 years.[36] Unless significant alternative water supplies are available, greater reliance on desalination to supplement this water supply shortfall is inevitable. A 125GL order was made for water from the desalination plant in 2019/2020 and this has been repeated again for 2020/2021. The Melbourne Water supply system is also connected to the Goulburn supply system by the North-South pipeline. However, water supply is only permitted to be provided by this system under certain conditions and is currently not drawn on.

Water supply authorities on the edges of the Melbourne Metropolitan Catchments are generally experiencing limitations in the water supplies from local reservoirs and groundwater as the population grows and the climate changes. As a result, these areas are likely to draw more heavily on the Melbourne Water supply system in the future. Under the future reference state, other than the committed investments in alternative water resources, it is assumed that shortfalls in Melbourne's water supply are provided by desalinated water (with additional capacity being added to meet need).[37]

River water and groundwater

River water and groundwater are also used directly for agribusiness, domestic purposes and to support some industrial processes, predominantly on the rural fringes of the metropolitan area. Both river water and groundwater are experiencing challenges due to a changing climate, and both are intrinsically linked to the health of local ecosystems. Accordingly, these resources are actively managed in terms of where and how the water is used. Groundwater is managed and licenced to users by Southern Rural Water in the Greater Metropolitan Melbourne Region. Melbourne Water manages licences for the Yarra Catchment. While licences for groundwater and river use commonly provide an upper limit to use, a large number of licences are underutilised or dormant. A changing climate is also affecting the reliability of river supplies, so licence holders are looking for alternative supplies in some areas.

Aquifers could also play an important role in the future of IWM by acting as storages for alternative water supplies. Managed aquifer recharge schemes have been implemented in several locations across Melbourne.

River water use is concentrated in sub-catchments of major waterways where extraction is permitted, with the largest extractions seen in the Western Port, Yarra and Dandenong Catchments, and in the Werribee catchment around the Werribee River.

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[35] State Government of Victoria (2017). Plan Melbourne 2017-2050. Policy 6.3.1 Reduce pressure on water supplies by making the best use of all water sources. Available at: https://www.planmelbourne.vic.gov.au/; State Government of Victoria (2016). Water for Victoria. Available at: https://www.water.vic.gov.au/water-for-victoria

[36] Melbourne Water (2017). Melbourne Water System Strategy. Available at: https://www.melbournewater.com.au/about/strategies-and-reports/melbourne-water-system-strategy

[37] Southern Rural Water (2014). Port Phillip and Western Port Groundwater Atlas. Available at: http://gwhub.srw.com.au/port-phillip-western-port-overview

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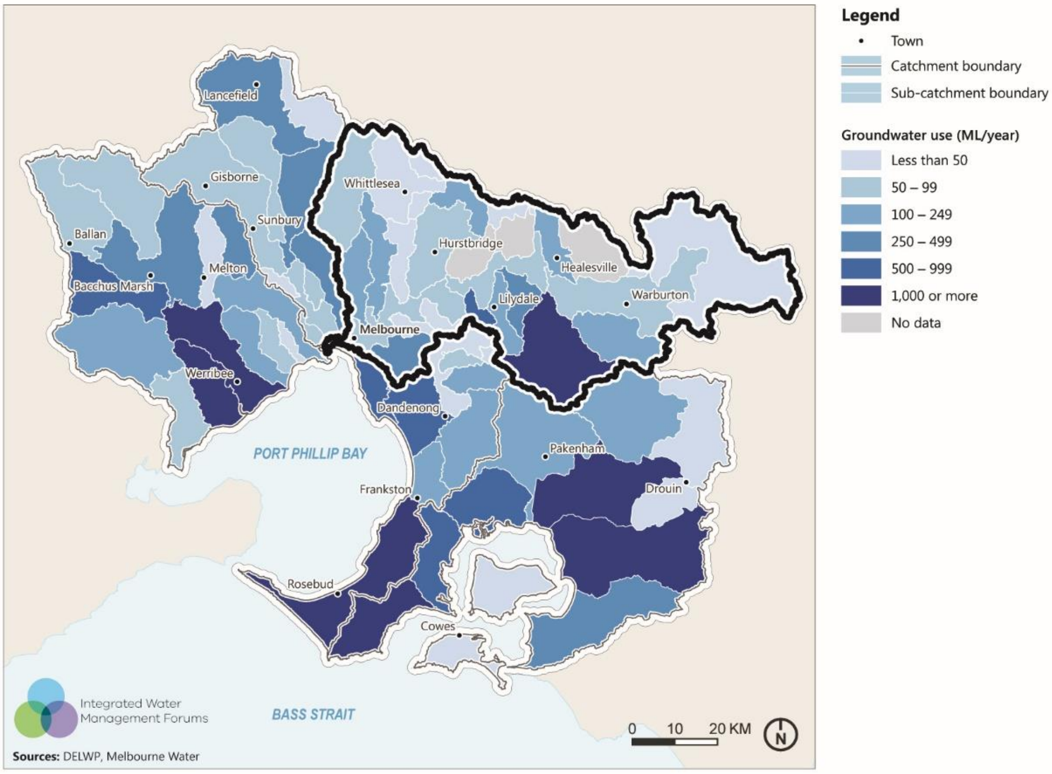

Figure 14: Groundwater use across the region

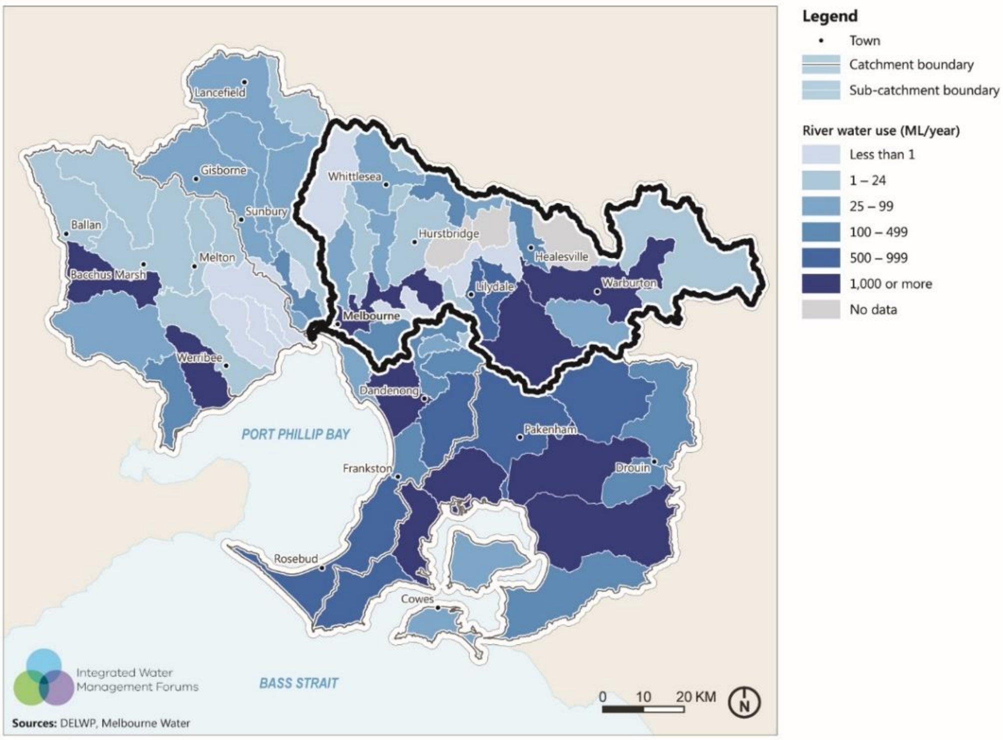

Figure 15: River water use across the region

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Alternative water

Recycled water, rainwater and stormwater are an increasingly important part of the water resource portfolio in the Greater Metropolitan Melbourne Region. Under the future reference state, recycled water use is expected to increase significantly, particularly in mandated growth areas. In other growth areas and infill areas, the use of rainwater is expected to increase. While across established area s, it is expected that councils will continue to deliver stormwater harvesting schemes for open space irrigation. The details of the methodologies and data used to estimate the use of alternative water sources, along with the estimated total alternative water use per sub-catchment and local government area is provided in Background Appendix A: Water and Pollutant Balance Analysis. Measures 1.2a and 1.2b (described in the following sections) consider the relative use of alternative water sources.

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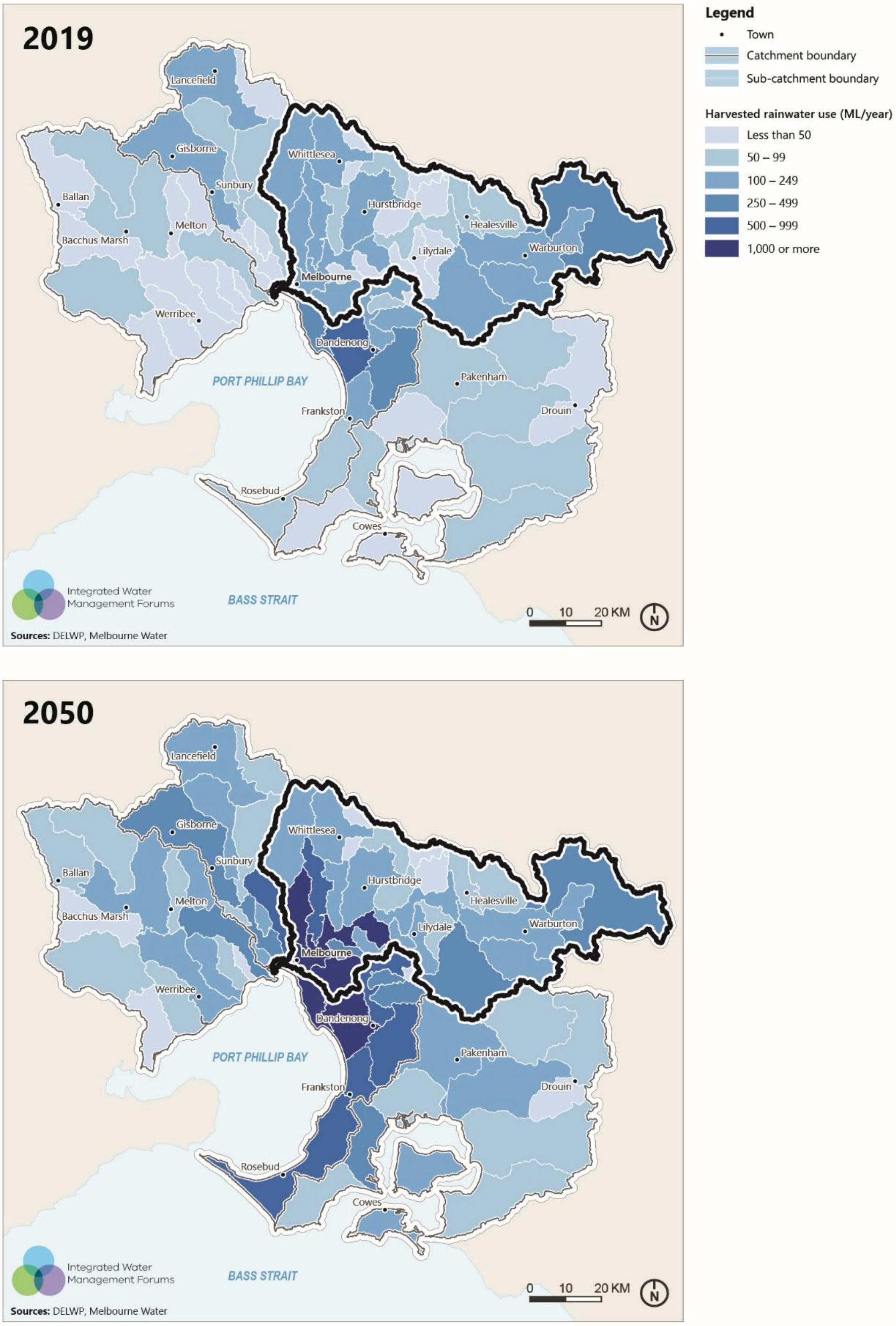

Figure 16: Harvested rainwater use across the region (current state and 2050 reference state)

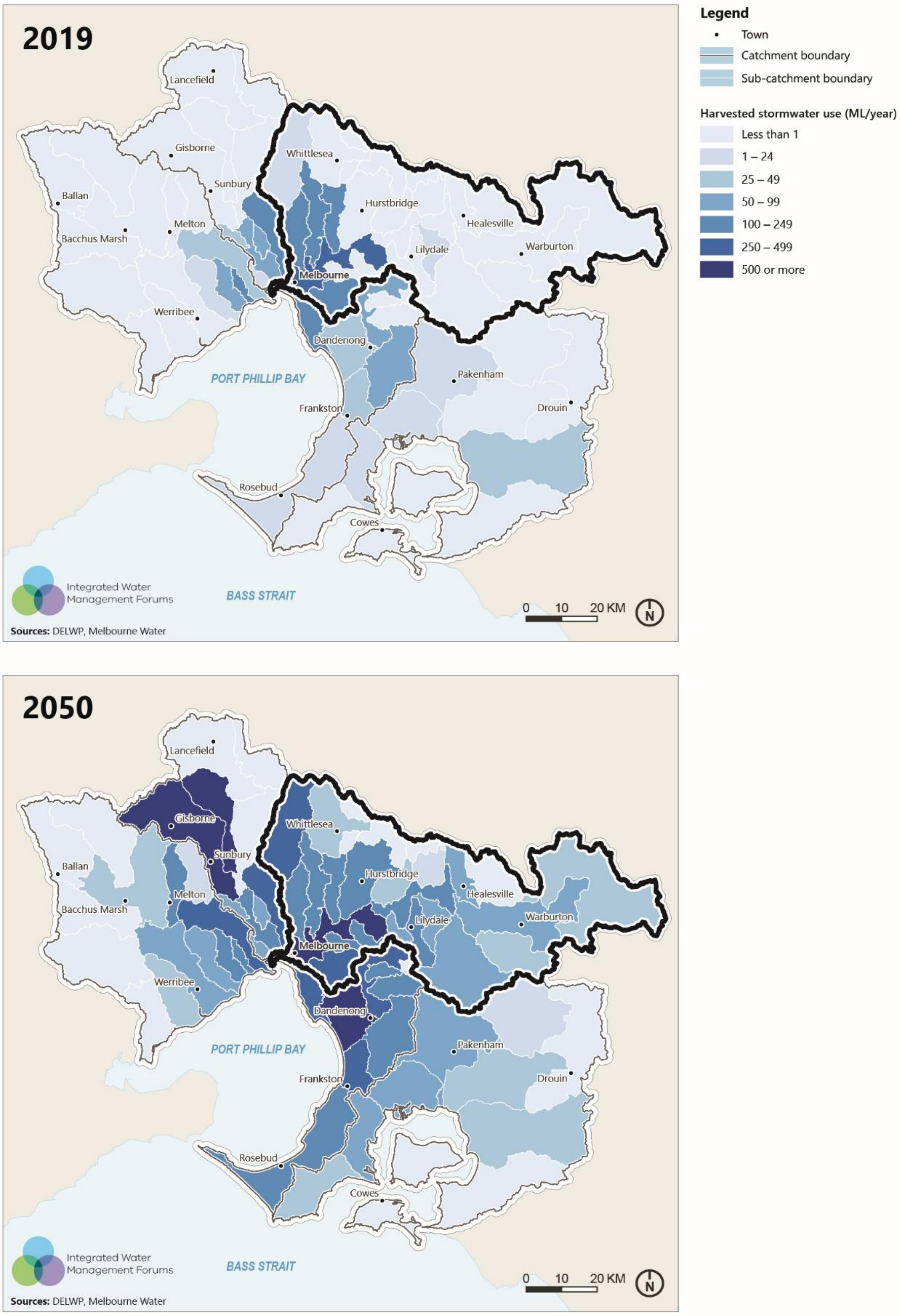

Figure 17: Harvested stormwater use across the region (current state and 2050 reference state)

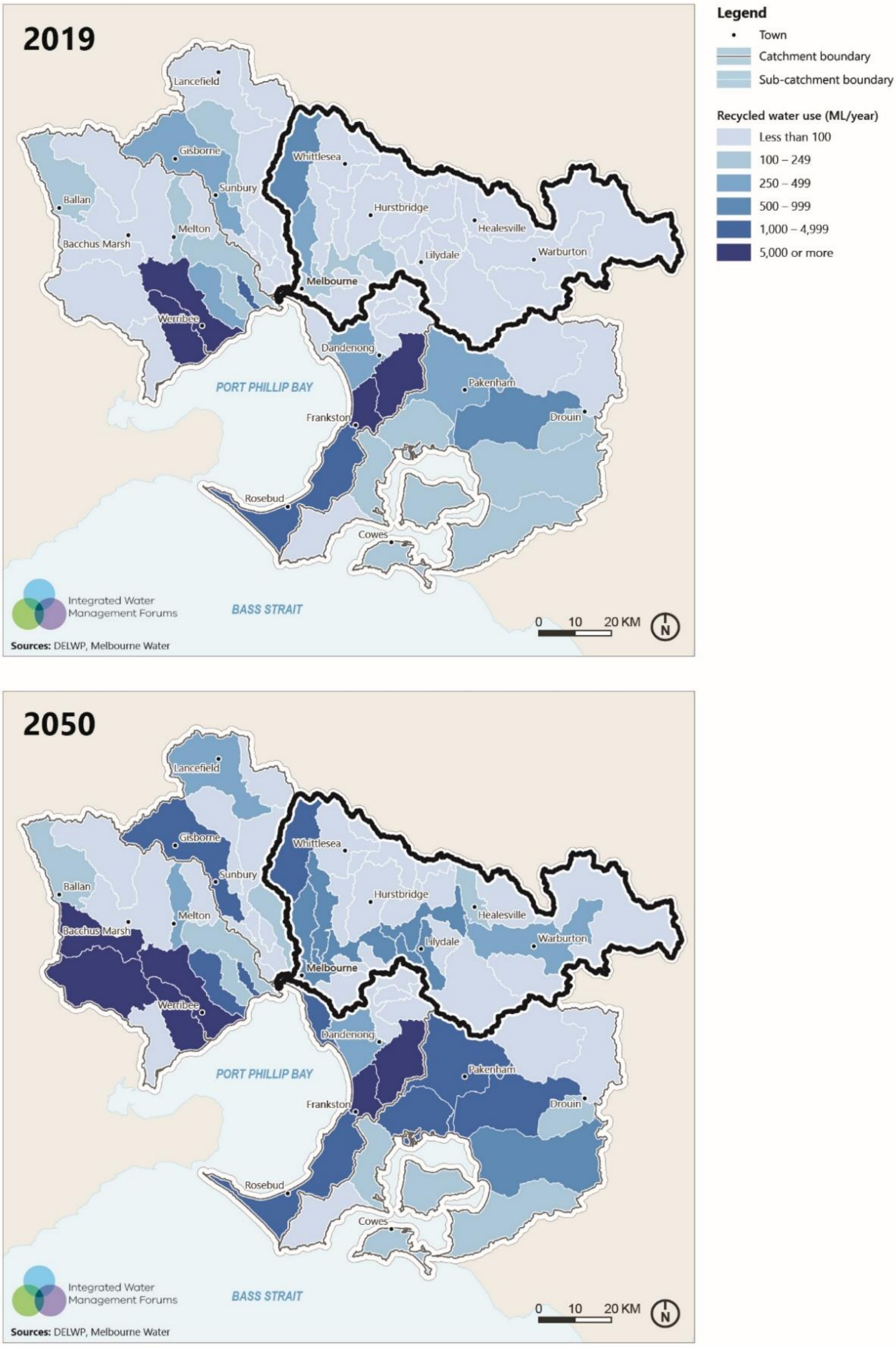

Figure 18: Recycled water use across the region (current state and 2050 reference state)

Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 18: Indicators and Measures for Strategic Outcome 1

Indicators	Measures
1.1 Decrease potable water use	a. Litres/per person/day residential potable water use b. ML/year non-residential potable water use
1.2 Increase use of fit-for-purpose water sources	a. Percent of total water use which is provided from alternative water sources b. ML/year of alternative water sources that substitutes potable mains water supply

Indicator 1.1: Decrease potable water use

Measure 1.1a: Litres/per person/day residential potable water use

By understanding residential potable water use on a per person basis, we can learn more about how communities use water, and track our progress towards the aim of prioritising potable water for potable uses, and alternative water for all other uses. It tells us how potable water use in the home is changing through behaviour change, water efficiency measures and replacement of non-potable water demands with alternative sources.

Table 19: Measure overview

Measure 1.1a: Litres/per person/day residential potable water use												
Indicator type	Leading											
Desired State Target Scale	Regional											
Measure performance and targets												
l/p/d	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	**172**		175		166		175		168		197	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	**135**	**124**	139	130	144	133	141	130	143	131	135	124
Desired State	To be confirmed by the Greater Metropolitan Melbourne Urban Water System Strategy 2022											

Table 20: Data and assumptions

Data source/s
Potable water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water, Central Highlands Water. Provided December 2019 - March 2020. Spatial Economics (2018) Land use projections: Greater Metropolitan Melbourne 2016-2051. Provided by State Government of Victoria.

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Key assumptions

Refer to Background Appendix A: Water and Pollutant Balance Analysis

Population totals were also aggregated to Local Government Areas and sub-catchments. Residential demands in litres/person/day was calculated by converting the annual use to a daily use and dividing by the relevant population total where sufficient data for both demand and population was available to report this indicator.

It should be noted that this measure is calculated for the metropolitan region as a whole, which extends beyond the reporting area under the T155 campaign (which includes the service areas of City West Water, South East Water and Yarra Valley Water). It also extends temporally to 2030 and 2050.

Current State

Decreasing potable water use has been a focus in recent times, particularly during the Millennium Drought. Historical residential use data shows a substantial drop in water use during the drought, which has largely been maintained. It should be noted that regularly reported per capita potable water use is based on data from the major three retailer service areas in Melbourne, and averaged at 162l/p/d in 2018/2019. The average across the five Catchment areas, which also includes the Western Water service area and parts of the service areas of Western Port Water, Barwon Water, South Gippsland Water, Central Highlands Water and Gippsland Water is higher at 172l/p/d based on 2018/2019 residential potable water use data.

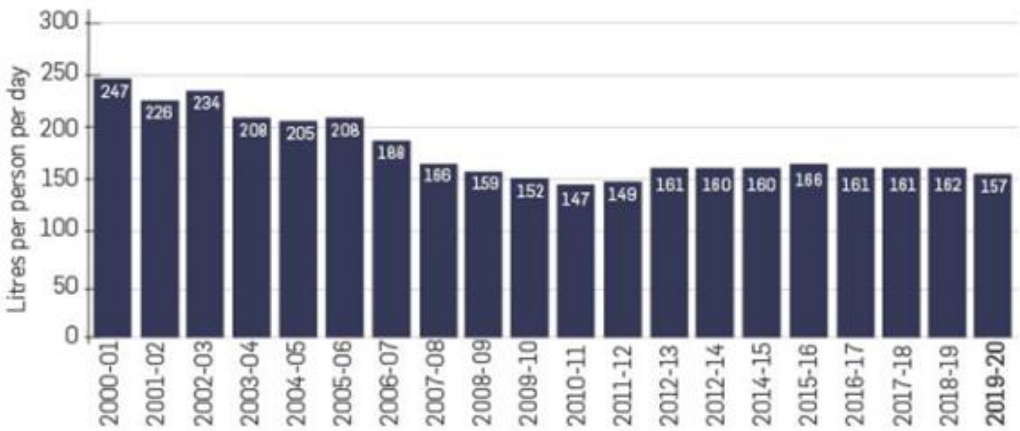

Figure 19: Historical residential water use per capita (for the service area of the three major metropolitan retailers only)[38]

Internationally, per capita consumption varies significantly. Factors such as attitudes toward water conservation, population density, dwelling types and outdoor watering levels, structure of the urban water sector and how supply and demand are managed all play a role, Due to these factors, these numbers are not directly comparable. Some examples of the variation in potable water use (l/p/d) are:

- Melbourne (2018/19): 162
- Copenhagen: 104
- UK: 140-150
- Los Angeles: 428
- Singapore: 140, targeting 130 by 2030.

[38] Melbourne Water (2020). Melbourne's Water Outlook 2020.

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Performance across the Catchment

The more urbanised areas of the Yarra Catchment nearer the city centre generally show lower potable water use per person, however most sub-catchments showed per person use above the State Government's target for 155 litres per person per day. Potable water use in some of the rural sub-catchments in Whittlesea and in the Yarra Ranges was lower on a per person basis. This most likely reflects that some of the population in this area does not have access to the potable water network, or have substantial rainwater harvesting systems for their properties.

Future Reference State

The reference state provides spatial projections that are aligned with future residential potable water use developed by the major water corporations across the Catchments. The projections consider future changes in water efficiency and development trends along with committed alternative water supplies and they are considered to represent the business as usual outlook. However, it is worth noting that substantive work on water efficiency implementation and community awareness is required to underpin these projections.

These projections have been spatially distributed to account for where growth and infill development is expected to occur. The residential projections forecast a substantial decrease in potable water use due to a combination of factors:

- Increasing proportion of new housing stock (and new bathrooms and kitchens whereby old and inefficient fixtures and fittings are replaced)
- Changes in community behaviour
- Advances in technology and appliance efficiency
- Uptake of alternative water sources for a wider range of end uses
- Increasing density of housing.[39]

As can be seen in the figure below, these projections anticipate an average across the Greater Metropolitan Melbourne Region of approximately 130l/p/d for residential use by 2050.

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[39] City West Water (2016). Urban water strategy: Demand Forecasting Working Group Report.

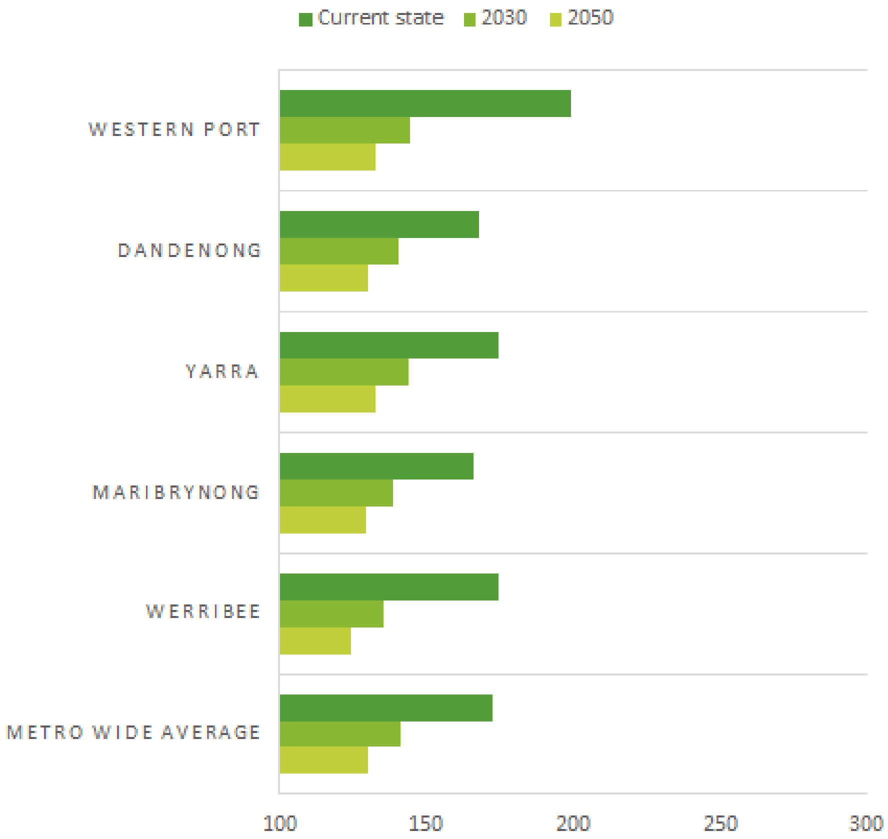

Figure 20: Residential potable water use on a per person per day basis

Performance across the Catchment

Under the future reference state we see overall decreases in potable water use per person overall, but with substantial spatial variation. In the Northern Growth Area we see relatively low per person potable water use predicted due to greater water efficiencies in new homes and reduced average home sizes. Potable water use is further lowered by the use of recycled water in these areas. In most established areas, we will see a reduction in per person water use due to gradual renewal associated with infill development and from future efficiencies and changes in water use expected in existing homes.

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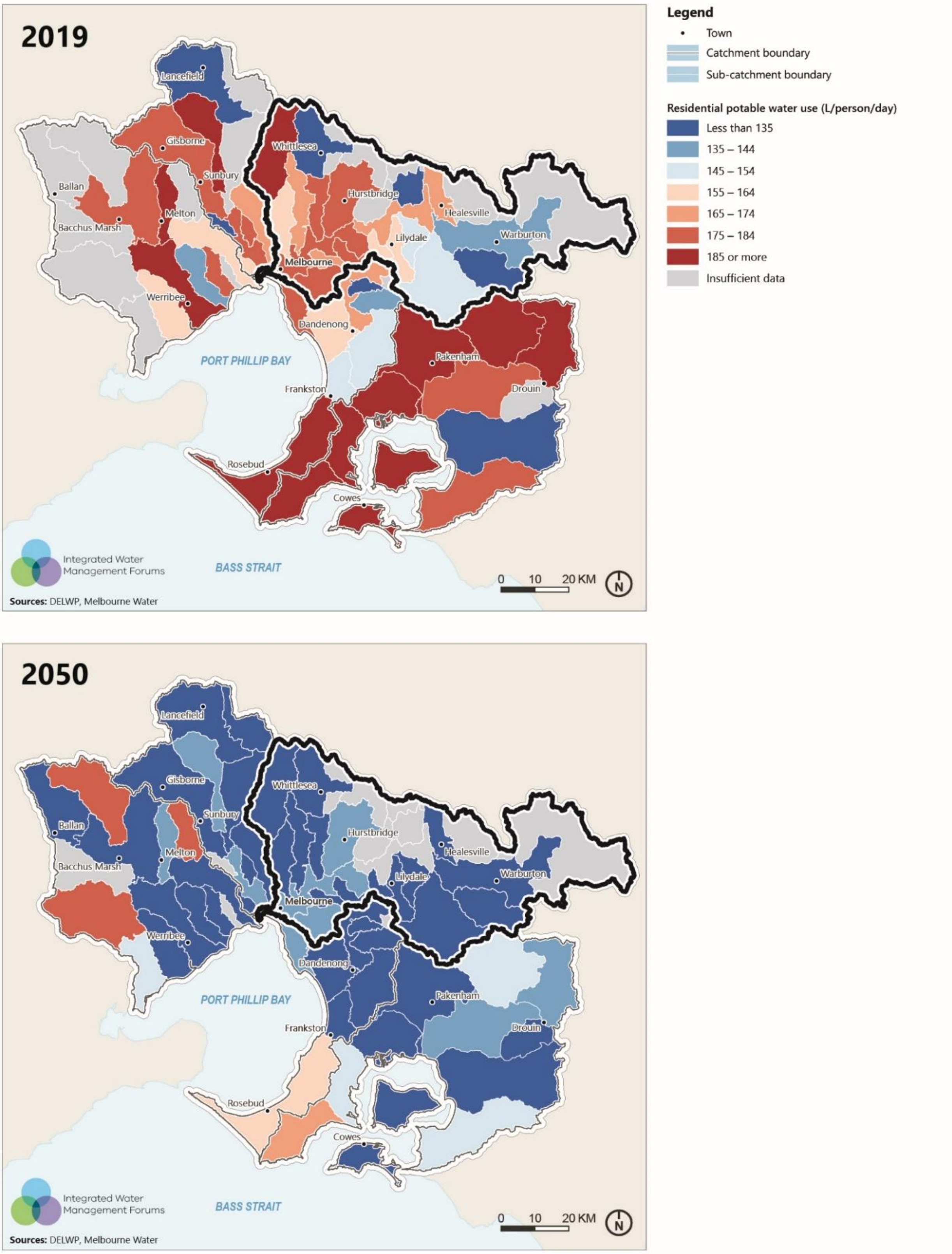

Figure 21: Measure 1.1a Litres/per person/day residential potable water use (current state and 2050 reference state)

Future Desired State

Existing targets and referenceable evidence

The Target 155 campaign is a key educational and community engagement tool in the metropolitan area which directly promotes a target of 155l/p/d which the community can check on their water bills. Further to this, 'Water for a future thriving Melbourne'[40] set out projections for residential water use of 150 litres per person per day by 2022. No long-term targets are identified in the strategy, but a projection graph is included in the strategy that projects a continuing decrease in potable water use on a per person basis. Work currently underway to inform the Greater Metropolitan Melbourne Urban Water System Strategy is considering possible future goals for residential water use. Some councils have IWM strategies in place which present community, non-residential or council based potable water use targets based on their goals and projections.[41]

It is important to highlight the difference between the purpose and use of the targets that will be included in this Plan, and those communicated to the community. Targets considered here are long-term goals for the Catchment IWM Forums, while the Target 155 campaign is a community-facing communication tool which may be revised in the future to assist in the implementation of longer-term goals for the region.

Possible future interventions

There are a range of interventions that could be delivered in existing and new homes to reduce residential potable water use. These broadly fall into the following categories:

- Water efficient fixtures and appliances
- Behaviour change, water literacy and incentives
- Alternative water supplies, including the provision of recycled water, stormwater or rainwater in place of potable supplies.

Improvements in water efficiency and potable water use reduction are a consistent focus of water corporations, though investment in programs has varied over time, peaking during the Millennium Drought. The potential for improvement varies across the region and depends on a range of factors. A review of residential water end uses in Melbourne highlighted that:

> "There remains significant potential for saving water through behaviour change, showerhead replacement, toilet replacement, changeover of washing machine stock, repair of dripping taps and toilet cisterns. By these measures there is a potential 45 GL per annum saving that could be made, equating to approximately 10% of Melbourne's total annual usage." [42]

The major Metropolitan Melbourne water corporations are currently exploring a household level target of 100l/p/day as a voluntary water efficiency program. The 100 l/p/d target reflects a climate conscious era and embraces next generation water efficiency measures. It is believed to be achievable with the use of known water efficiency measures (see diagram below) and doesn't rely on the provision of alternative water resources beyond those mandated under the reference state. Achievement of this target depends on uptake and funding of these initiatives; these will slowly infiltrate into houses and the timeframe and uptake is difficult to project.

[40] Melbourne Water, City West Water, Yarra Valley Water and South East Water (2017). Water for a Future-Thriving Melbourne. Available at: https://www.melbournewater.com.au/sites/default/files/2017-10/Water-for-future-thriving-Melbourne_0.pdf

[41] In the Melbourne Water service area sustained improvements in water use have been seen reducing from 245 litres per day in 2001 to 157L/p/d in 2019/20. In 2015-16, it was 166 L/p/d, in 2018-19 was 162 litres per person per day, one litre higher than in 2017-18 and 2016-17.

[42] N. Siriwardene, J. Do, A. Radion, J. Westcott (2019) Where is water being used in Melbourne households? Residential End Use Measurement Study (REUMS) insights.

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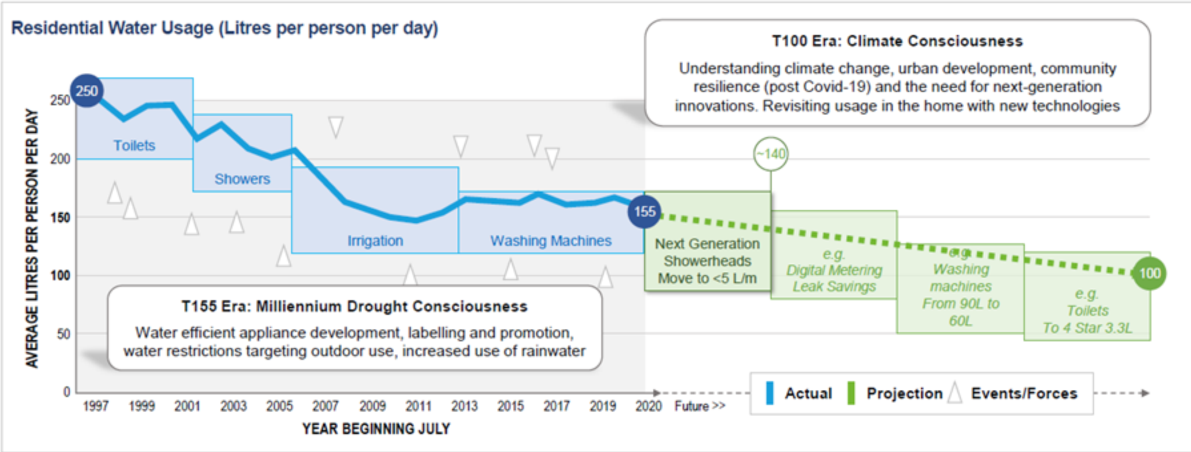

Figure 22: Possible pathway to 100l/p/d[43]

A review of international best practice highlighted that Australia is still regarded as a front-runner in water efficient practices and programs following the Millennium Drought, and innovative and new approaches adopted internationally primarily related to the use of online tools, social media and digital meters (and related technologies), which have the potential to generate information to inform decisions, and to help utilities reach and effectively engage with customers.[44] While some innovative and new approaches to water efficiency were identified there were no ground-breaking 'silver bullet' solutions for improving water use efficiency.

Improvements in water literacy have been shown to increase water savings and a recent study showed that water literacy in Victoria is relatively low,[45] suggesting there is ground to be gained here. However, behaviour change and water literacy initiatives have varying impact and can be difficult to measure. A review of interventions designed to change behaviour also highlighted that impacts may not be long term:

> "Effects may last several months but seem to dissipate over time. Median reduction of 3% over time vis 4.4% straight way. Ongoing intervention increased longer term reduction to 6%. Moderate reductions could be achieved with only 1-3 interventions often."[46]

Accordingly, consistent investment in water efficiency and behaviour change programs are needed, which needs to also adapt to utilise social media and new technologies. Wide-spread smart metering has been explored as an option for Victoria, and has shown to reduce residential water use elsewhere by 3-12%.[47]

In cost terms, water efficiency and behaviour change measures that reduce potable water demand have been consistently shown to be more cost-effective than water supply augmentations or alternative water supplies. The cost savings are also of direct benefits to the community and are realised through reductions in water bills (and also in energy bills in the case of hot water).

[43] Yarra Valley Water (2020). New Horizons 2030: Introducing the next generation shower head. Presentation November 2020.
[44] Aither (2019). International scan of water efficiency: International scan and possible options for Victoria. DELWP.
[45] Smart Approved WaterMark (2019). Australia's Relationship with Water. Available at: https://smartwatermark.org/research/australias-relationship-water/
[46] Ehret, P.J., Hodges, H.E., Kuehl, C., Brick, C., Mueller, S. and Anderson, S.E. (2020). Systematic review of household water conservation interventions using the information–motivation–behavioural skills model. *Environment and Behaviour*, 53(5), pp.485-519.
[47] Aither (2019). International scan of water efficiency: International scan and possible options for Victoria. DELWP.

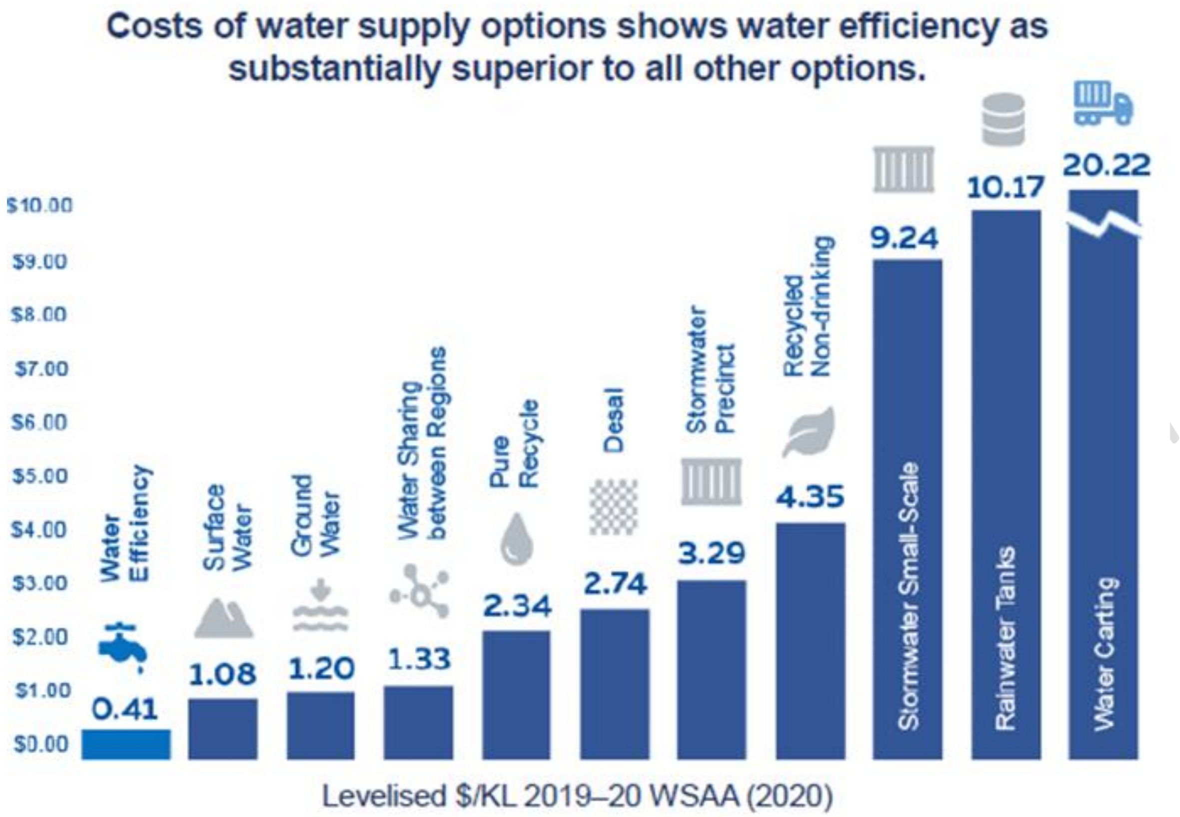

Figure 23: Levelised cost of various water supply and demand management options[48]

A number of residential water efficiency actions are being explored. These include water efficiency behaviour change campaigns (including harnessing new technologies to encourage behaviour change), water efficiency standards regarding the sale of water using fixtures and appliances and standards for new developments and incentives to encourage replacement of inefficient appliances, such as inefficient showerheads, in existing dwellings.

Desired State target recommendations

The rationale and discussion from this Plan is being considered through the development of the Greater Metropolitan Melbourne Urban Water System Strategy (GMMUWSS) along with ongoing modelling of future residential demands. Accordingly, the regional target for this measure will mirror the recommendations of that strategy.

[48] WSAA (2020). All options on the table: Urban water supply options for Australia. Available at: https://www.wsaa.asn.au/publication/all-options-table-urban-water-supply-options-australia

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Measure 1.1b: ML/year non-residential potable water use

While it is useful to understand residential water use on a per person basis, this isn't the case for non-residential water use, which is concentrated in town centres and industrial locations. This measure helps us to understand where the hot-spots are for non-residential potable water use, and therefore where we can prioritise initiatives to increase access to alternative supplies or increase efficiency of water use.

Table 21: Measure overview

Measure 1.1b: ML/year non-residential potable water use												
Indicator type	Lagging (reporting-only)											
Desired State Target Scale	N/A											
Measure performance and targets												
GL/yr	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	111		17		16		43		27		7	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	124	151	23	31	17	20	46	54	29	33	10	13

Table 22: Data and assumptions

Data source/s
Potable water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water, Central Highlands Water. Provided December 2019 - March 2020. Spatial Economics (2018) Land use projections: Greater Metropolitan Melbourne 2016-2051. Provided by State Government of Victoria.
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis

Current State

Non-residential potable water use in the Greater Metropolitan Melbourne Region currently makes up 27% of the total potable water use. This includes use of potable water by businesses and industry, as well as by local councils for activities like the irrigation of open space with potable water.

Performance across the Catchment

Total non-residential potable water use aligns closely with the density of urban development, with the highest usage nearer to the city centre, in the most urbanised areas.

Future Reference State

The reference state provides spatial projections that are aligned with future non-residential potable water use developed by the major water corporations across the Catchments. These have been spatially distributed to account for where growth and infill development is expected to occur. The current non-residential demand for the Greater Metropolitan Melbourne Region is predicted to increase by 36% by 2050 under the reference state. However, compared with residential demand, changes in non-residential demand are more difficult to

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predict, with changes expected due to changes of use (e.g. increasing focus on logistics rather than manufacturing with a lower water use).

As can be seen in the figure below, these projections anticipate a Melbourne average of 180l/p/d for residential and non-residential use combined by 2050.

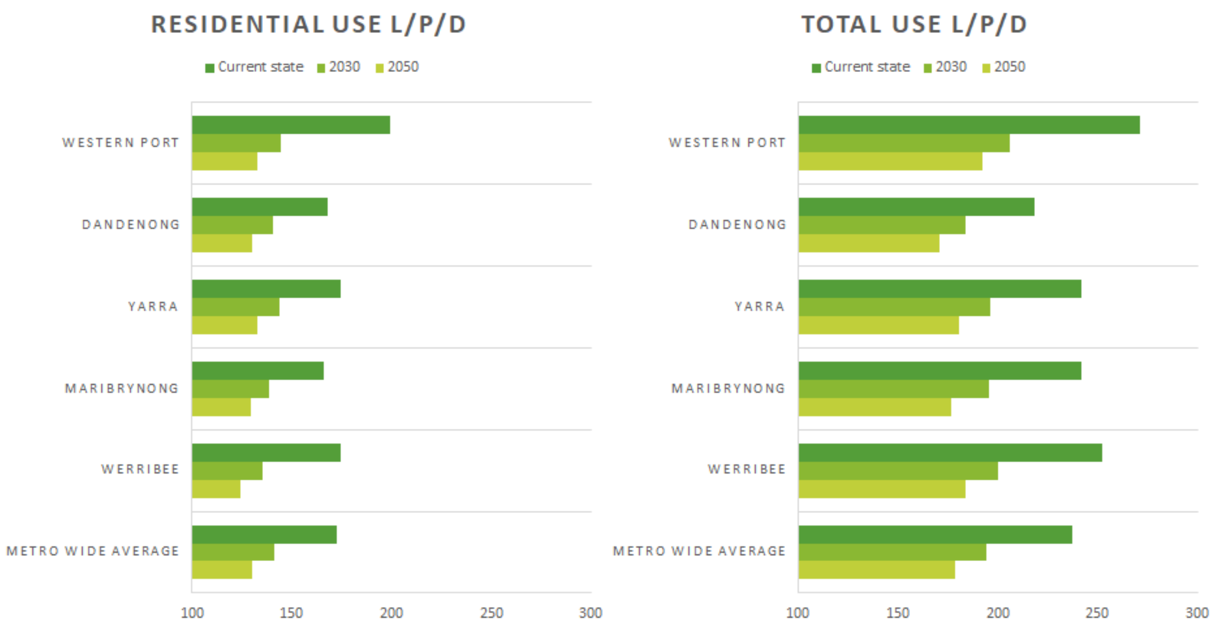

Figure 24: Residential and total (including non-residential) potable water use on a per person per day basis

Performance across the Catchment

As the area grows we will see new non-residential water demands from commercial and industrial properties as well as open space demands. Non-residential water demands are generally expected to increase over time, due to a hotter, drier climate requiring higher irrigation, intensification of land use and general growth.

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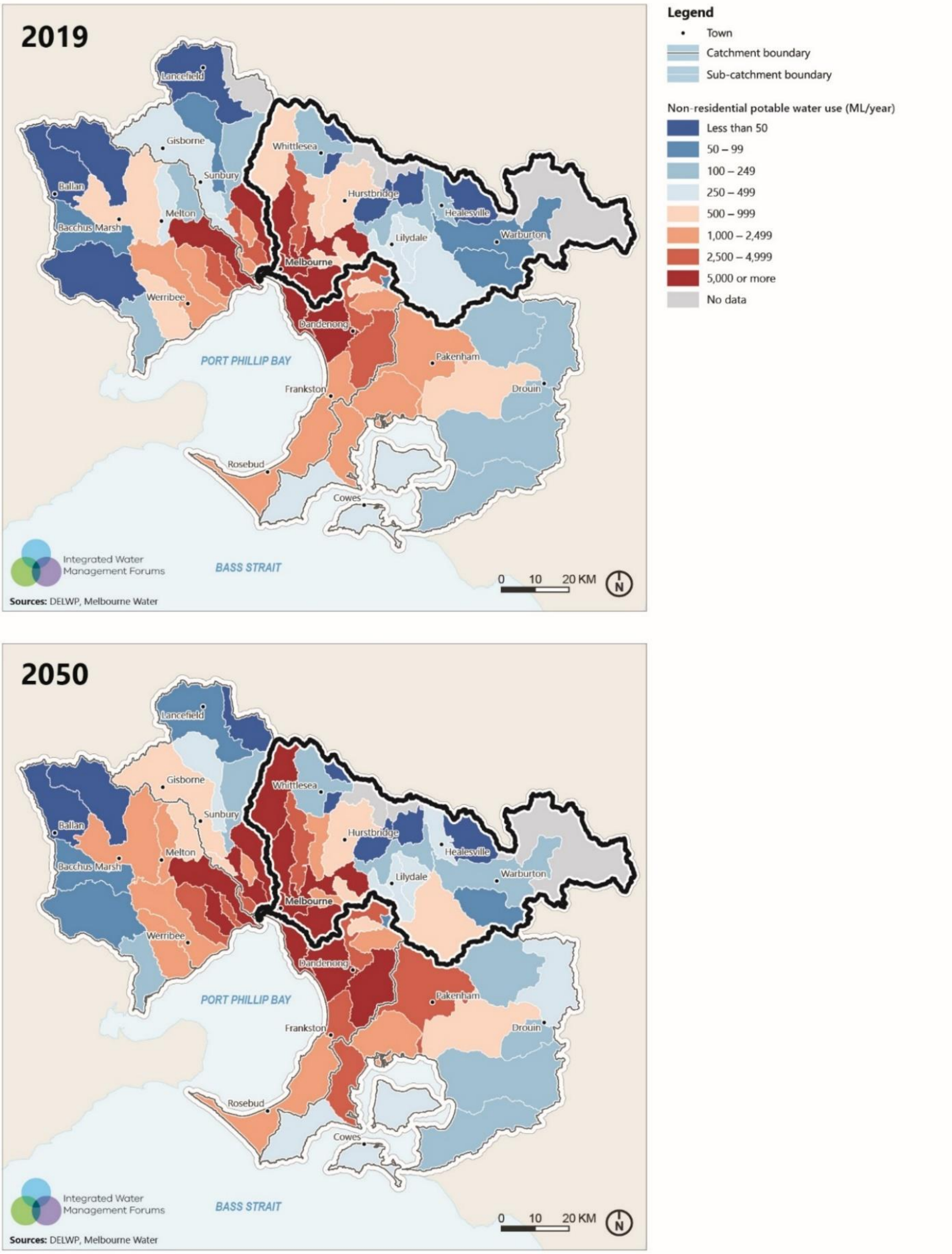

Figure 25: Measure 1.1b ML/year non-residential potable water use (current state and 2050 reference state)

Future Desired State

Existing targets and referenceable evidence

'Water for a future thriving Melbourne' set out projections for total water use (residential and non-residential):

> *By 2022, we are forecasting demands of:*
>
> *- 230 litres per person per day for total drinking water use across Melbourne*
>
> *- 150 litres per person per day for residential drinking water use across Melbourne.*

Projections have not been expressed specifically for GL/year of non-residential potable water use, as this is instead expressed as part of the total l/p/d on a Melbourne-wide scale.

Possible future interventions

Given the variation in how water is used in the non-residential sector, both in the amounts and quality needed, and the possible variation in land uses over time, the possible interventions are also highly variable and often opportunistic. Water corporations have been working with non-residential users and targeting major users to identify opportunities, and it's likely that the 'easy-wins' have already been gained. A number of non-residential water efficiency actions are being explored. These include providing better information and behaviour change support tailored to specific non-residential business types or end uses (i.e. cooling towers) and incentives to encourage greater uptake of digital metering and alternative water for irrigating public open spaces.

Desired State target recommendations

Targets have not been recommended for this measure, recognising the future uncertainty linked to non-residential use patterns and locations. Instead, this has been nominated as a lagging indicator for ongoing monitoring and review.

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Indicator 1.2: Increase use of fit-for-purpose water sources

Measure 1.2a: Percent of total water use which is provided from alternative water sources

This measure tracks the overall water use that is provided from alternative water sources, including recycled water, greywater, rainwater and urban stormwater. This is compared to total water use, which is made up of alternative water use, plus potable water use, groundwater use and river water use. It represents all uses of water in the metropolitan area, including agricultural users. The methods and data used to estimate water use are described further in Background Appendix A: Water and Pollutant Balance Analysis. By understanding the full water use picture, we can track our overall progress in matching alternative water use for fit-for-purpose demands.

Table 23: Measure overview

Measure 1.2a: Percent of total water use which is provided from alternative water sources												
Indicator type	Lagging											
Desired State Target Scale	N/A											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	**12.5**		34.2		2.7		2.7		14.3		6.2	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	**16.8**	**18.2**	36.8	37.3	8.4	9.1	6.7	8.8	16.8	17.7	14.6	16.3

Table 24: Data and assumptions

Data source/s
Potable water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water. Provided December 2019 - March 2020.
Groundwater licence and metered use data (2018/2019 Financial Year). Provided by Southern Rural Water. Provided March 2020.
Southern Rural Water (2019) Local Water Reports 2018/2019 for the Werribee-Maribyrnong Basin and Bunyip-Mornington Peninsula Basin.
Surface water licence and metered use data (2018/2019 Financial Year). Provided by Southern Rural Water and Melbourne Water. Provided March 2020.
Recycled water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water, Central Highlands Water.
State Government of Victoria (2020) health.vic website: Class A Water Recycling Schemes. Accessed March 2020. Available: https://www2.health.vic.gov.au/public-health/water/alternative-water-supplies/class-a-recycled-reclaimed-water
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide a summary of rainwater, stormwater and greywater use for council facilities and public spaces. Conducted February-March 2020.
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis

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Current State

Water use data for the current state has provided insight into the total water portfolio for the region. Based on this data, alternative water resources make up 13% of total water use for the Greater Metropolitan Melbourne Region. It should be noted that the total water use data does not include runoff harvested from rural land (farm dams).

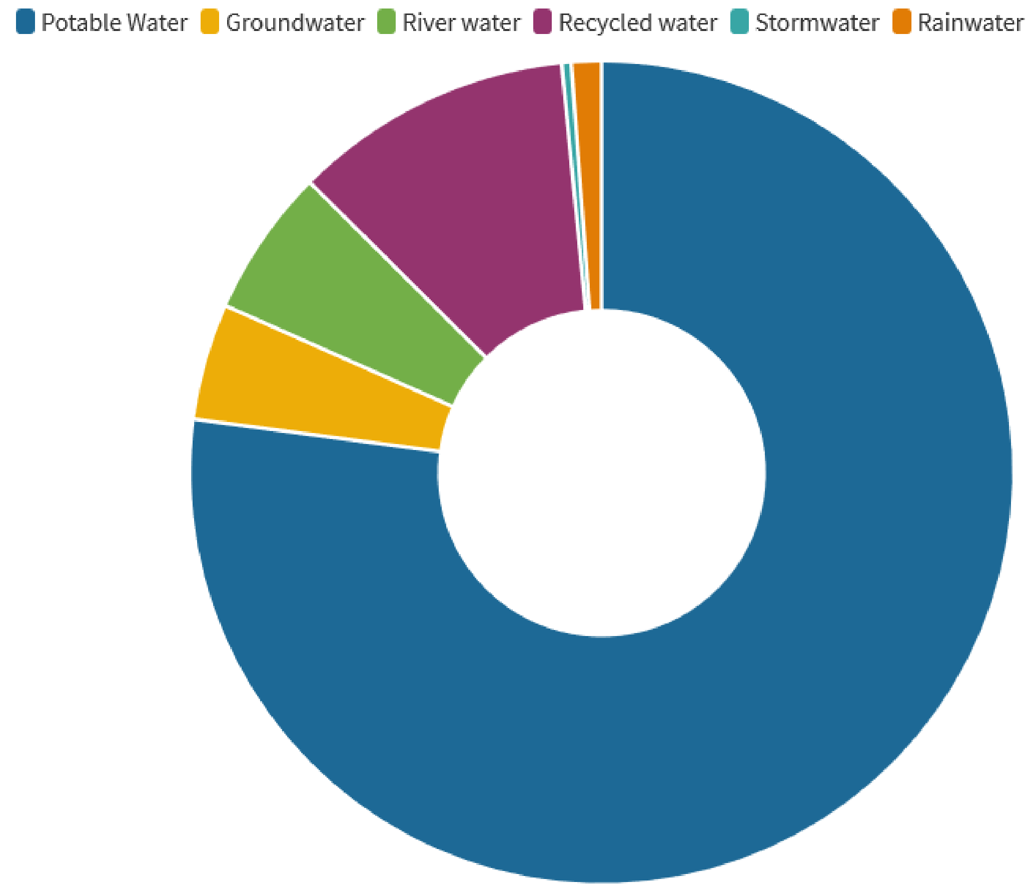

Figure 2: Current mix of water use across the Greater Metropolitan Melbourne Region

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Performance across the Catchment

The Yarra Catchment showed a geographical split in terms of the proportion of total water use provided by an alternative water supply. The more rural areas around Whittlesea and in the Yarra Ranges showed the highest proportions, largely due to low potable demands and relatively high rainwater harvesting. Urban areas which don't have access to recycled water generally show a base level of rainwater harvesting and some recycled water use which contributes around 2-5% of total use in most cases.

Future Reference State

As presented in the figure below, the reference state projects a significant increase in alternative water use by 2050, resulting in a 5% increase in the overall share in the water resource portfolio, even as water use grows overall. As this indicator presents the total use, including alternative water use for purposes that don't replace potable supply (e.g. agriculture, water used within treatment processes).

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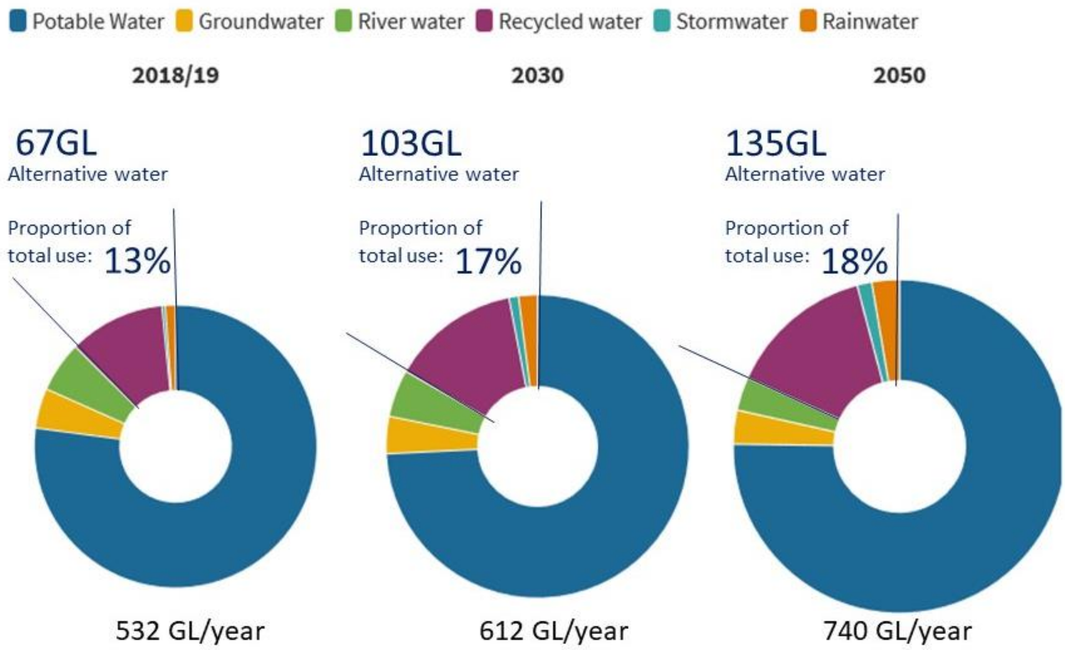

Figure 26: Current and future projections of total water use and alternative water use as a proportion

Performance across the Catchment

The alternative water resource portfolio in the Yarra Catchment is expected to increase substantially through the roll out of recycled water in the Northern Growth Corridor and through the take up of rainwater tanks in other new developments. The planned stormwater harvesting at Kalkallo also adds to the local alternative resource portfolio.

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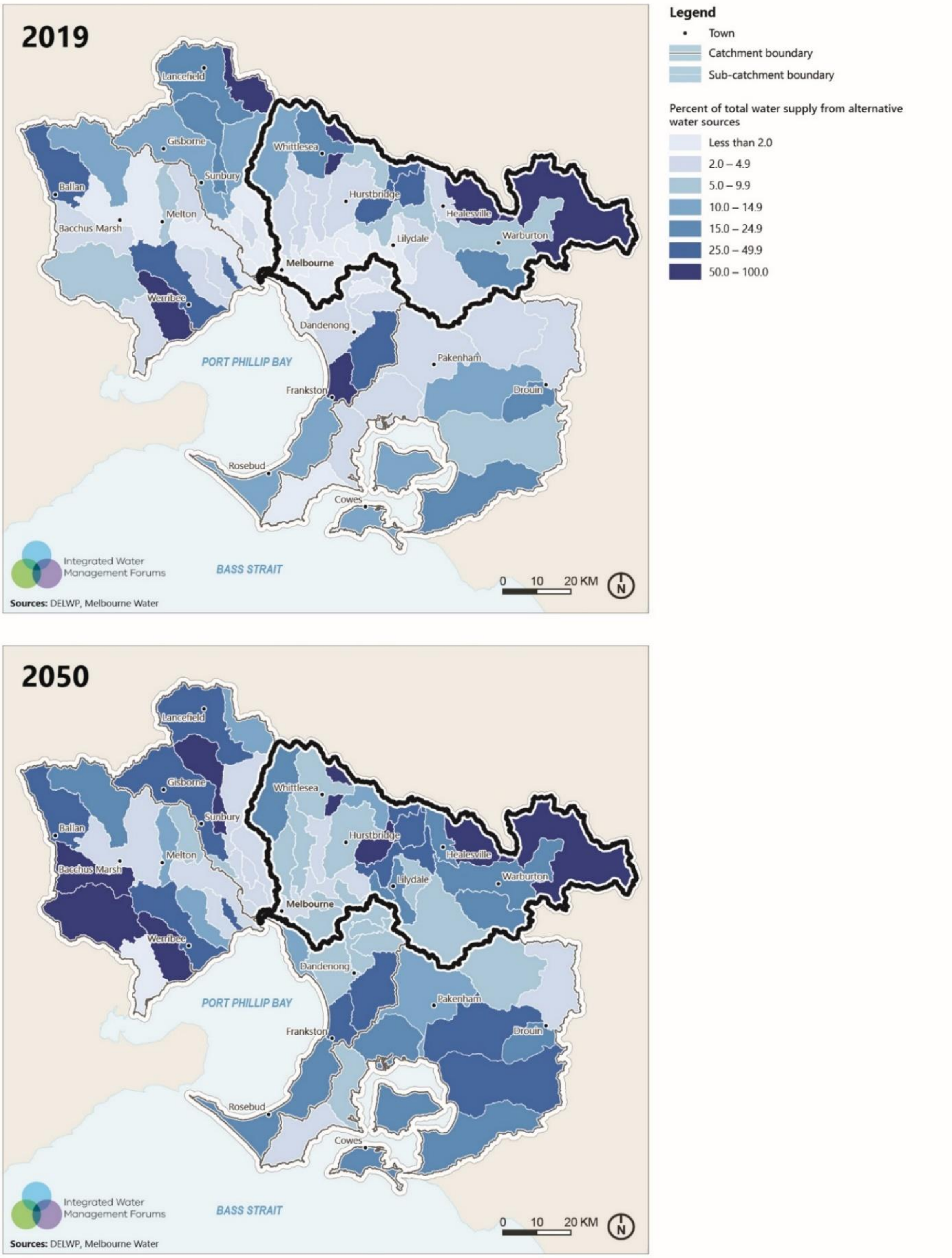

Figure 27: Measure 1.2a Percent of total water use which is provided from alternative water sources (Current and 2050 Reference state)

Future Desired State

Existing targets and referenceable evidence

While there is broad support for diversification of water resources to aid long-term resilience, there are no specific targets in existing strategies that frame alternative water use as a proportion of total use. Targets for increases in alternative water use to substitute potable water use have been set out (which are discussed under 1.2b).

Possible future interventions

A range of alternative water schemes could be delivered in the future, at all scales. Major foreseeable alternative water projects (beyond those included in the reference state) have been identified by stakeholders and appraised to provide some indication of the foreseeable potential within the timeframe of this Plan. These are summarised in Background Appendix B: Collaborative Plan Development Process.

Desired State target recommendations

Targets have not been recommended for this measure, as an ideal percentage of alternative supply for the region could not be adequately defined from an outcome perspective. Outcome-based targets have been set for related measures that consider alternative water use for specific end uses including 1.2b (potable substitution), 7.1a (agriculture), and 5.2 (open space irrigation). Instead, this measure has been nominated as a lagging indicator for ongoing monitoring and review.

Measure 1.2b: ML/year of alternative water sources that substitutes potable mains water supply

It is important to understand the total amount of alternative water we are using and how this changes over time. This measure specifically quantifies the alternative water that is substituting a use which would otherwise be supplied by potable water. This measure does not include alternative water use for agricultural purposes which may have otherwise utilised other non-potable water sources such as groundwater or been less intensive, and it does not include alternative water use for irrigation which would have otherwise not have occurred using potable water. This helps us to recognise the impact that alternative water use is having on preserving and protecting our high-quality potable water resources.

Table 25: Measure overview

Measure ML/year of alternative water sources that substitutes potable mains water supply parameters												
Indicator type	Leading											
Desired State Target Scale	Region (2030 and 2050), Catchment (2030)											
Measure performance and targets												
GL/yr	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	18		5		1		5		6		2	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	35	55	6	9	4	6	10	18	10	16	4	7
Desired State	53	150	16	N/A	6	N/A	14	N/A	11	N/A	6	N/A

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Table 26: Data and assumptions

Data source/s
Surface water licence and metered use data (2018/2019 Financial Year). Provided by Southern Rural Water and Melbourne Water. Provided March 2020.
Recycled water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water
State Government of Victoria (2020) health.vic website: Class A Water Recycling Schemes. Accessed March 2020. Available: https://www2.health.vic.gov.au/public-health/water/alternative-water-supplies/class-a-recycled-reclaimed-water
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide a summary of rainwater, stormwater and greywater use for council facilities and public spaces. Conducted February-March 2020.
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis
It is assumed that all use of rainwater and stormwater use substitutes potable use. It is assumed that all agricultural use of recycled water does not substitute for potable use.

Current State

Data collected as part of the current state demonstrated that there are alternative supplies (recycled water, stormwater and rainwater) substituting 18.4GL/year of potable supply.

Performance across the Catchment

The Yarra Catchment showed strong performance in urban areas against this indicator, with rainwater, stormwater and recycled water use substituting for potable supply to homes and businesses. Elevated performances can be seen in sub-catchments where significant stormwater harvesting has been implemented, such as Moreland, Darebin, Manningham, Banyule, Whittlesea and Monash. Elevated recycled water use is also evident in the Northern Growth Corridor, where recycled water is being provided to homes.

Future Reference State

This measure is predicted to increase substantially under the reference state due to delivery of recycled water supplies to the majority of new growth areas, stormwater harvesting schemes for green space irrigation, and an expected large uptake of rainwater tanks in infill developments to meet new stormwater management requirements under the recent changes to the VPPs of Amendment VC154. In total, under the reference state, the alternative water supplies that substitute potable supply increases to 57GL/year in 2050.

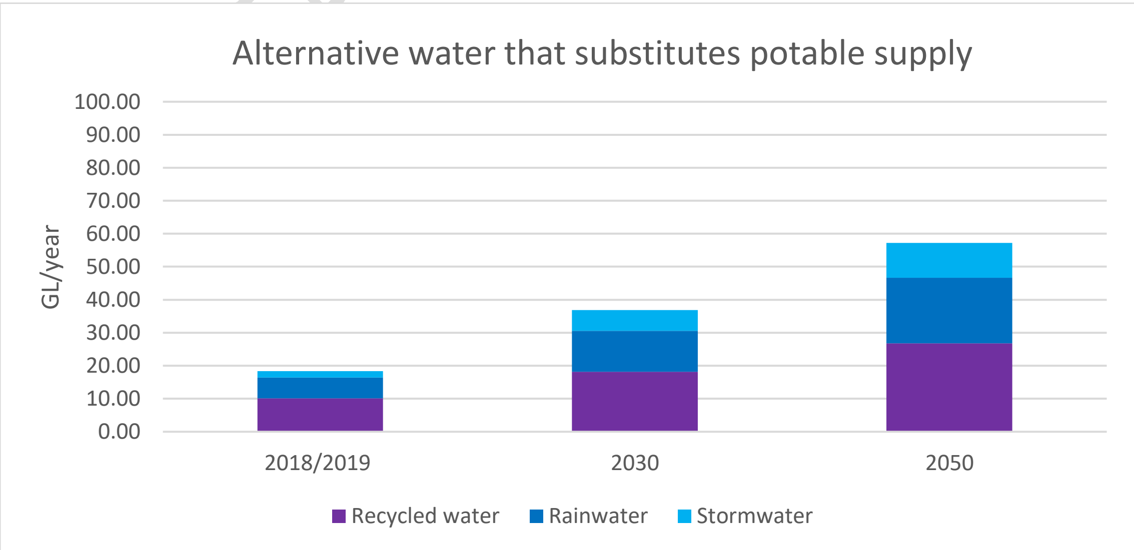

Figure 28: The contribution of alternative water supplies which substitute potable supply under the current state and future reference state.

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Performance across the Catchment

Changes in alternative supplies which substitute potable supply are largely focussed in areas where new homes and active open spaces receive alternative supplies of either recycled water or rainwater.

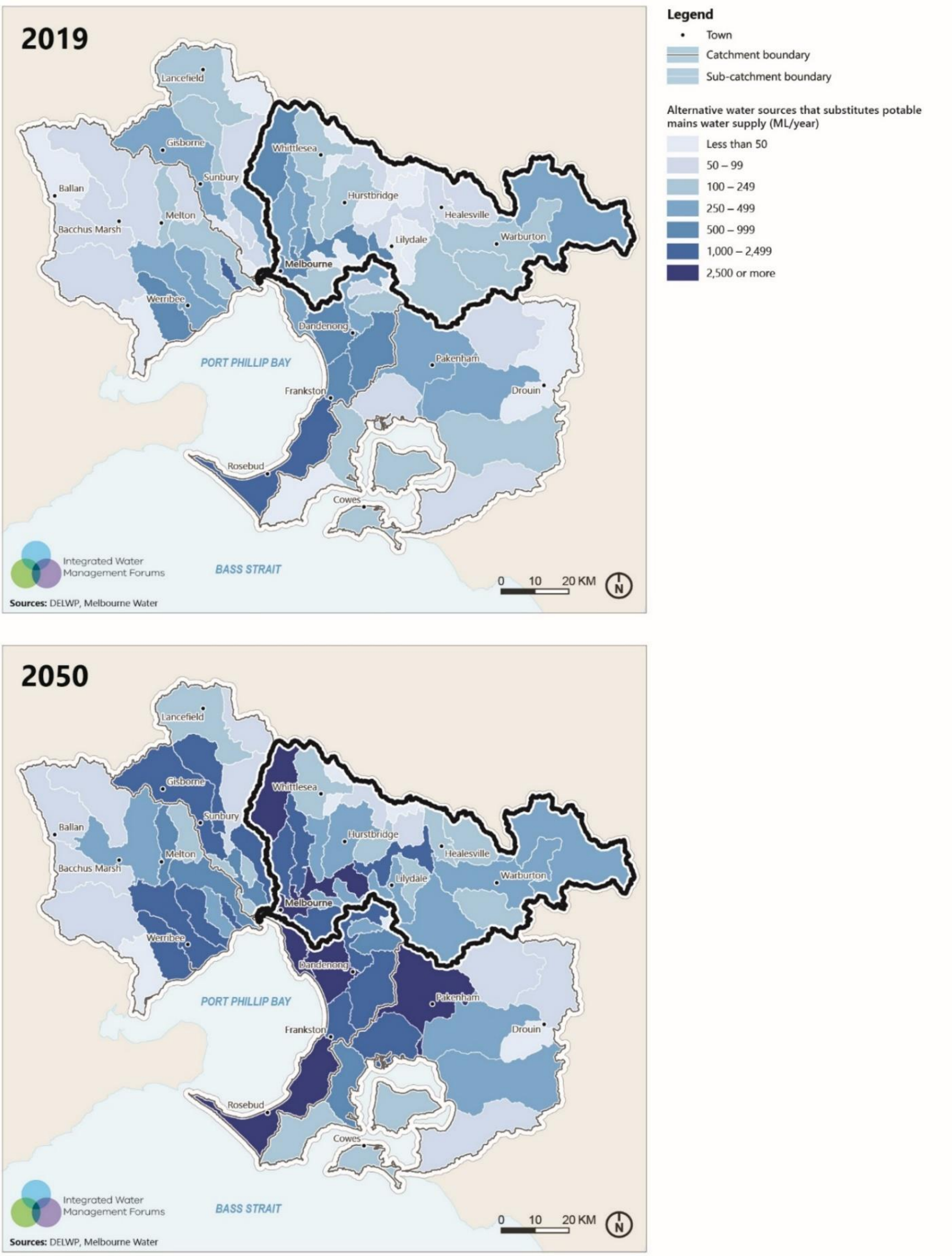

Figure 29: Measure 1.2b ML/year of alternative water sources that substitutes potable mains water supply (Current and 2050 Reference state)

Future Desired State

Existing targets and referenceable evidence

The Water for a future thriving Melbourne strategy sets out an action within the areas serviced by the three largest water corporations:

> *"We forecast the delivery of 25 GL per year of alternative water by 2065 in line with our current plans. Our aim is to contribute up to a further 40 GL per year where business cases demonstrate value to our communities."* [49]

The Melbourne Water System Strategy also includes a target to:

> *"Collaborate through integrated water management forums and plans to deliver up to 80 GL/yr (subject to further investigation) from diverse sources of water instead of the water supply system by 2065."* [50]

This is set against an evidence base within the strategy that compares supply and demand forecasts for potable water in the Melbourne Water supply area. This provides important context for the target. The figure below shows the three supply and demand scenarios presented in the strategy.

The incremental change (medium growth in water demands and medium climate change) and rapid change (higher growth in water demands and high climate change) scenarios show a potential projected shortfall in supply in 2043 and 2028 respectively. The shortfall is then predicted to increase to 100GL by 2065 and 450GL by 2065 respectively. Alternative water resources could play a role in addressing potential shortfalls, and therefore these projections and their breadth of uncertainty are important evidence for the framing of a 2050 target.

It is also worth noting that the supply modelling of the Melbourne potable water system used in these scenarios assumed that:

- The existing environmental water reserve will remain in place in the future, including the additional 8 GL/yr committed to the Thomson River.
- The Victorian Desalination Project could be operated at its full capacity in the future – up to 150 GL/yr.

Accordingly, where alternative supplies can substitute potable supplies there may also be potential to change these conditions (where desirable).

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[49] Melbourne Water, City West Water, Yarra Valley Water and South East Water (2017). Water for a Future-Thriving Melbourne. Available at: https://www.melbournewater.com.au/sites/default/files/2017-10/Water-for-future-thriving-Melbourne_0.pdf
[50] Melbourne Water (2017). Melbourne Water System Strategy. Available at: https://www.melbournewater.com.au/about/strategies-and-reports/melbourne-water-system-strategy

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Figure 30: Three key scenarios of supply and demand used during the development of the Melbourne Water System Strategy (2017) this strategy: low change scenario (top), incremental change scenario (middle), and rapid change scenario (bottom)[51]

Possible future interventions

A range of alternative water schemes could be delivered in the future, at all scales and serving a range of end uses. A set of major foreseeable alternative water projects (beyond those included in the reference state) have been identified by stakeholders and appraised to provide some indication of the foreseeable potential within the timeframe of this Plan. These are summarised in Background Appendix A: Water and Pollutant Balance Analysis. These were considered when the Future Desired State targets were developed for this measure.

[51] Melbourne Water (2017) Melbourne Water Systems Strategy. Available at: https://www.melbournewater.com.au/about/strategies-and-reports/melbourne-water-system-strategy

Desired State target recommendations

2050 Regional Target

As the climate changes and the population of the region grows, future modelling of supply and demand shows there could be future shortfalls, meaning we need to enhance Melbourne's potable water supply portfolio or reduce demand. By delivering 150GL/year of alternative water supplies by 2050 that will substitute potable water supplies, we will significantly reduce the risk of future shortfalls by diversifying our water supplies.

By integrating much greater use of recycled water, rainwater and stormwater, we can diversify our water supplies and build resilience to climate change and population growth while also delivering other benefits by harnessing resources for fit-for-purpose uses that might otherwise be wasted. These additional benefits driven through the substantive use of alternative water supply can include:

- Driving the potential for more generous yet sustainable use of water to enhance our local landscapes and improve amenity, heat wave resilience and community health
- Protecting and enhancing our local waterways and Port Phillip Bay and Western Port
- Reducing local nuisance flooding
- Enabling improvements to be made to environmental flow regimes in flow-stressed waterways.

There are a range of opportunities to deliver alternative water supplies, and the exact road map to meet the target will need to be defined through rigorous option testing and integrated planning, to ensure the best outcomes are delivered to the community and the environment.

2030 Catchment Targets

The 2030 target for the Catchment is 14GL/year for this measure, which represents a fundamental step-change in the rate at which we are delivering alternative water schemes. The target is recommended based on foreseeable opportunities that take advantage of the planned growth in the Catchment, and to optimise local water portfolios.

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Strategic Outcome 2 - Effective and affordable wastewater systems

Providing effective and affordable wastewater systems in the region is the remit and responsibility of water corporations and Melbourne Water, and various performance indicators are already tracked to monitor and drive progress. The indicators and measures selected for the Catchment-scale IWM plans focus on how IWM could stimulate a step-change in the utilisation of wastewater resources to transition towards a circular economy.

The case for change

Wastewater infrastructure

The majority of the Catchment's wastewater is transferred to the Western Treatment Plant or the Eastern Treatment Plant, which are managed by Melbourne Water. However, there are also nine local wastewater treatment plants managed by Yarra Valley Water. The wastewater drainage network extends across the urbanised areas of the Catchment, however some rural areas are not serviced by a centralised wastewater system and rely on local treatment systems like septic tanks.

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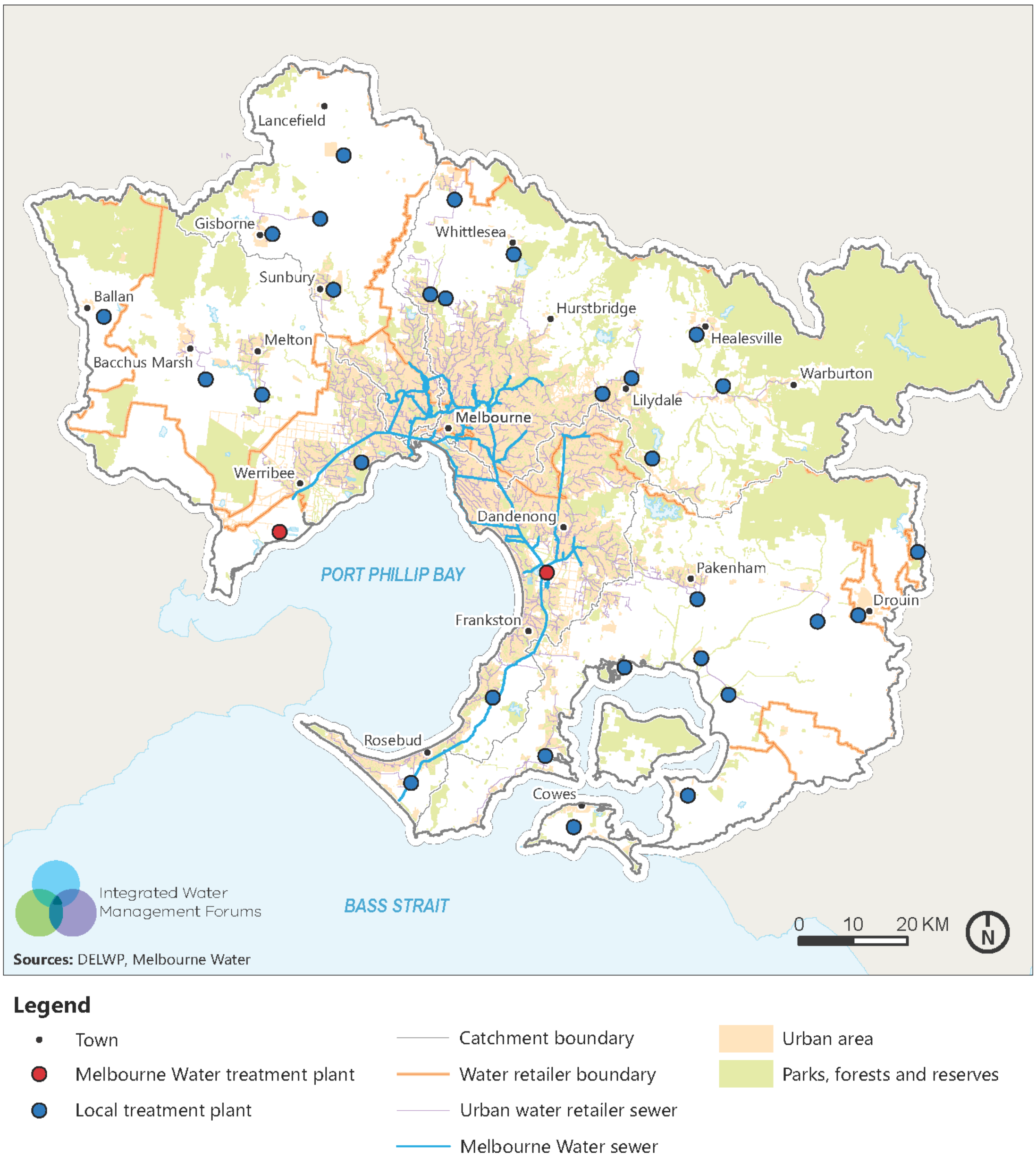

Figure 31: Major wastewater drainage infrastructure across the region

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Wastewater generation

Wastewater generation is related to the use of water within homes and businesses which is then transferred to the sewerage system. Wastewater generation will increase under the future reference state as water use increases with a growing population and a drier climate. The figure below shows the relative wastewater generation in each sub-catchment. It should be noted that in many cases wastewater is transferred to other Catchments for treatment or reuse.

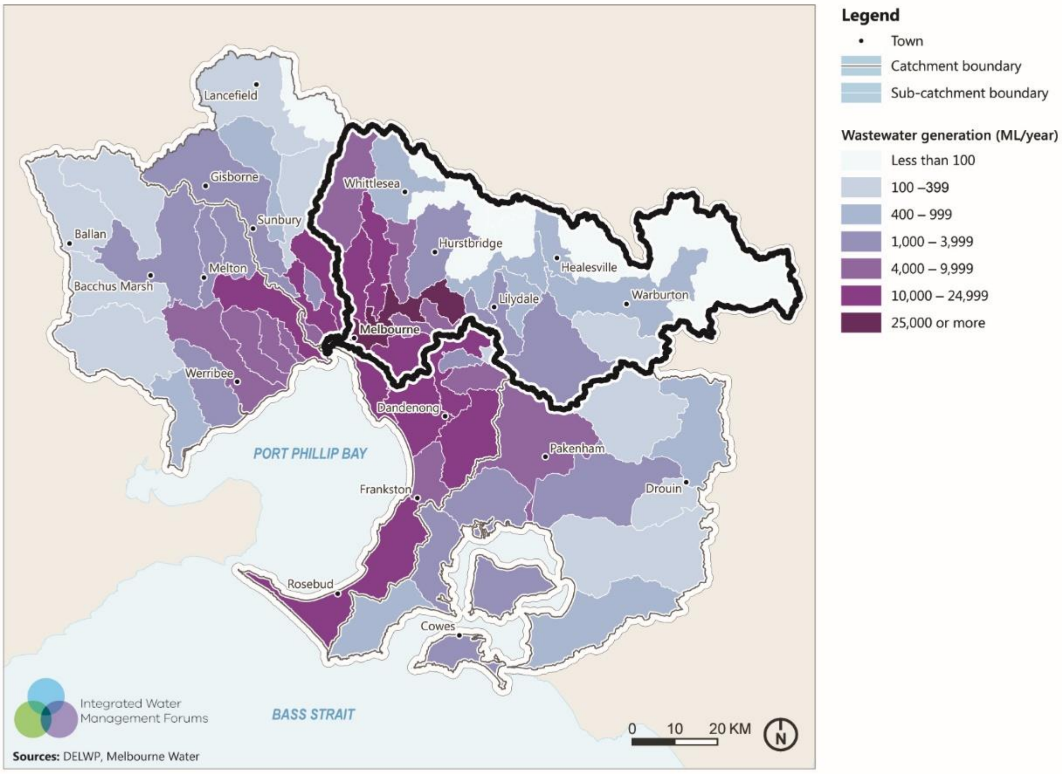

Figure 32: Current wastewater generation across the region

Wastewater treatment and reuse

A proportion of treated wastewater is released to waterways and marine environments, and often contains large quantities of nutrients and other pollutants that can adversely impact environmental health. Some local treatment plants discharge (at least irregularly) to waterways that ultimately flow to Port Phillip Bay.

The Melbourne Sewerage Strategy recognises the need to transition from a largely linear 'treat and discharge' system to a 'resource recovery' system that exemplifies the circular economy. In an ever more resource constrained world, resource recovery and contributing to the circular economy will become increasingly important. Wastewater resources that can be harnessed to provide value to communities locally include recycled water as an alternative water resource, renewable energy, and biosolids. Recognising the potential impacts of treated wastewater discharges on waterways, a number of inland wastewater treatment plants have reuse schemes in place to reduce environmental impacts and meet Environment Protection Authority Victoria (EPA) discharge licence requirements.

As the population grows, wastewater inflows into treatment plants will also increase. Recycled water use is also expected to increase under the future reference state, as committed recycled water schemes will utilise greater volumes of treated wastewater from plants. This will occur particularly where plants are servicing the growth areas, such as the Sunbury, Parwan and Melton Treatment Plants which will be connected to create the new Western Irrigation Network, and the expanded rural recycled water schemes from Pakenham, Lang Lang and Longwarry Treatment Plants in the south east. New decentralised recycled water treatment plants will also be built to service developments within urbanised areas at Fisherman's Bend and Aquarevo.

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Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 27: Indicators and Measures for Strategic Outcome 2

Indicators	Measures
2.1 Increase use of resources recovered from wastewater to stimulate a circular economy	a. ML/year of recycled water delivered to customers b. Percent of nitrogen recovered at treatment facilities for beneficial use c. Percent of carbon recovered at treatment facilities for beneficial use

Indicator 2.1: Increase use of resources recovered from wastewater to stimulate a circular economy

Measure 2.1a: ML/year of recycled water delivered to customers

This measure monitors the amount of recycled water being harnessed for beneficial use. The measures align with reporting required by water authorities to measure recycled water delivered to customers, and excludes use of recycled water for irrigation of land owned by water authorities as a method of discharge. The measure gives insight into the use of recycled water to support communities through the supply of an alternative water resource.

Table 28: Measure overview

Measure ML/year of recycled water delivered to customers parameters												
Indicator type	Leading											
Desired State Target Scale	Regional											
Measure performance and targets												
GL/yr	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	44		30		1		1		10		2	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	62	82	38	51	1	1	4	7	12	14	8	10
Desired State	85	230	Catchment scale targets have not been set for this measure, recognising the need to coordinate across catchment boundaries to match demands with recycled water supplies.									

Table 29: Data and assumptions

Data source/s
Recycled water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water, Central Highlands Water.
State Government of Victoria (2020) health.vic website: Class A Water Recycling Schemes. Accessed March 2020. Available: https://www2.health.vic.gov.au/public-health/water/alternative-water-supplies/class-a-recycled-reclaimed-water
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide a summary of recycled water schemes. Conducted February-March 2020.
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis.

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Current State

Data collected as part of the current state demonstrated that 44GL/year of recycled water is supplied to customers across the region.

Performance across the Catchment

Recycled water use in the Yarra Catchment is concentrated in the Northern Growth Areas in Whittlesea and Hume, where recycled water is provided to residential customers. The lower Yarra River sub-catchment also benefits from a large private recycled water scheme for the Melbourne Cricket Ground and Yarra Park.

Future Reference State

This measure is predicted to increase to 82GL by 2050 (62GL by 2030) under the future reference state, largely due to the roll out of recycled water supply in growth areas and significant increases in supplies to agriculture via the Western Irrigation Network and expansions of the supply network in the South East.

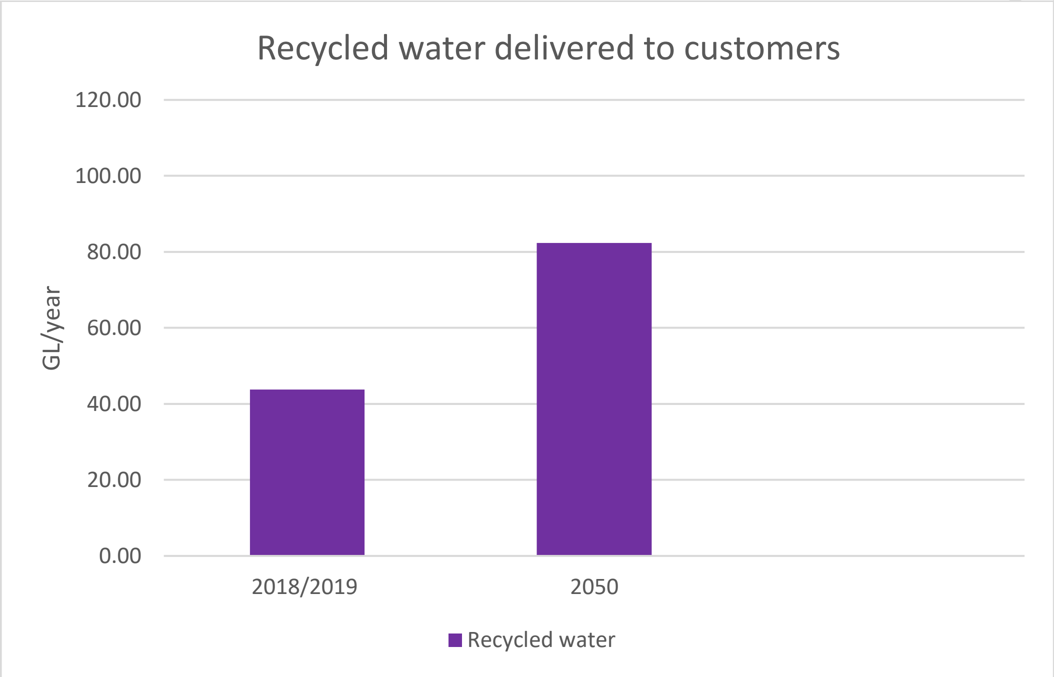

Figure 33: Recycled water use by customers under the current state and future reference state (GL/year)

Performance across the Catchment

Expansion of recycled water provision to new homes in the Northern Growth Corridor and sewer mining to supply recycled water to Fisherman's Bend is the major change in recycled water provision forecast under the future reference state.

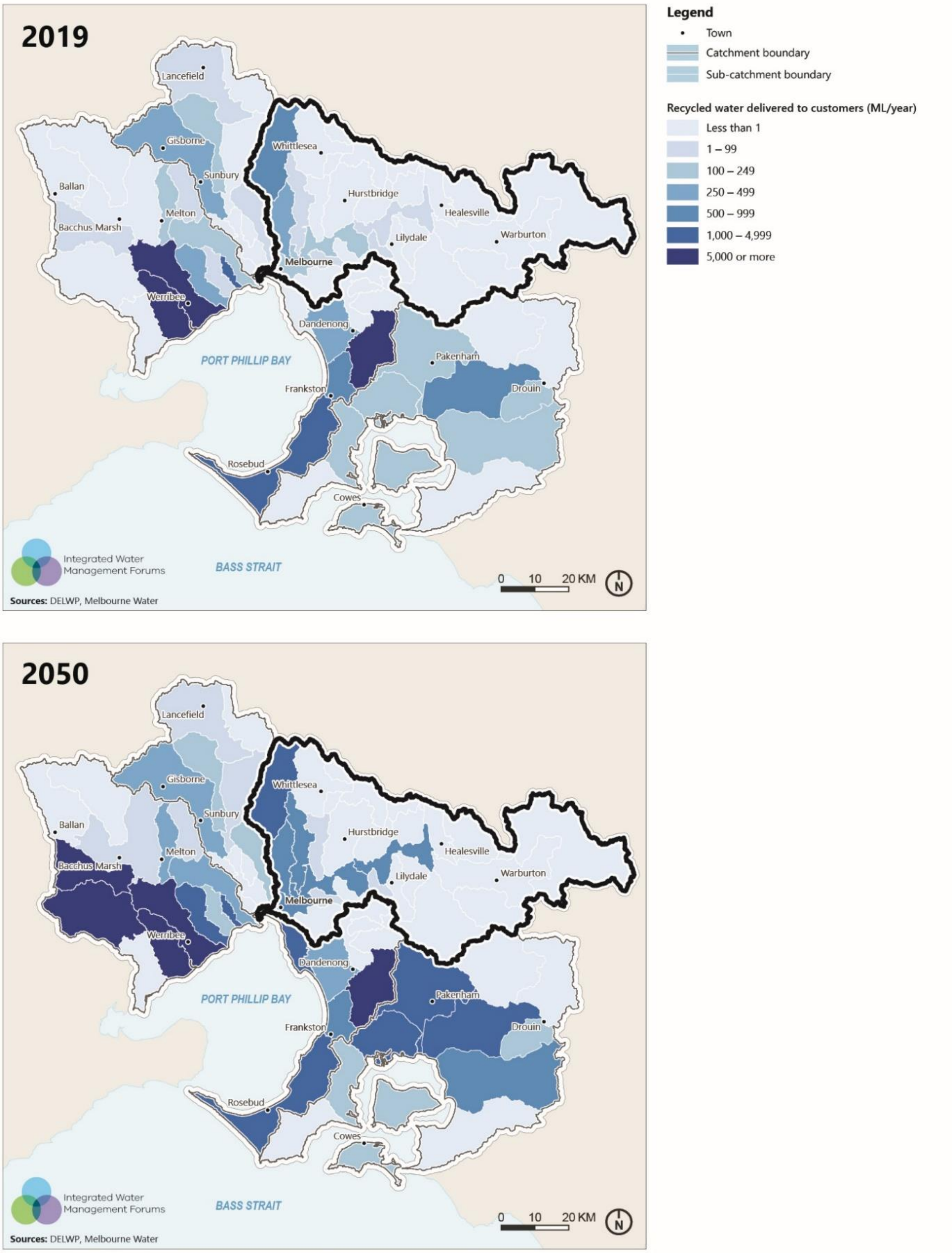

Figure 34: Measure 2.1a ML/year of recycled water delivered to customers (Current and 2050 Reference State)

Future Desired State

Existing targets and referenceable evidence

As discussed in the Strategic Outcome 1 chapter, there are various existing targets for alternative water supply for potable substitution. The Melbourne Sewerage Strategy sets out a specific target for recycled water use more broadly:

> *An additional 50 GL/year of water from the sewerage system is beneficially reused in an economically viable way by 2040 to support MWSS goals.*[52]

The Sewerage Strategy also sets out that:

> *By 2070, Melbourne's metropolitan water industry will see the key features of our sewerage system helping to achieve the following Goals:*
>
> *…*
>
> ***Leveraging resources****: Melbourne will be recognised as a world leader in advancing the circular economy through our commitment to beneficially using 100% of our water and resources while ensuring affordability for current and future generations of Melburnians.*

This goal is overarching and is not specifically a time-bound target in the Sewerage Strategy. It is also notable that the Sewerage Strategy goal is for 100% beneficial use, which is slightly different to measure as it includes internal reuse in wastewater treatment plants, and irrigation of land owned by the water authority.

Possible future interventions

A range of recycled water schemes could be delivered in the future. A set of major foreseeable alternative water projects (beyond those included in the reference state) have been identified by stakeholders and appraised to provide some indication of the foreseeable potential within the timeframe of this Plan. These are summarised in Background Appendix B: Collaborative Plan Development Process. These were considered when the Desired State targets were developed for this measure.

Desired State target recommendations

2050 Regional Target

A target of 230GL/year has been set for 2050 across the region. It is recommended as a target range, to ensure a variety of options can be explored to drive the most effective and beneficial outcomes. This represents a pathway towards achieving 100% beneficial use by 2070.

Recycled water is an under-utilised resource that is largely generated independent of weather conditions (unlike stormwater) and has significant potential to underpin Melbourne's water security. In achieving this target, the Greater Metropolitan Melbourne Region will be a world leader in advancing the circular economy and will be on track to be beneficially using 100% of our water and resources by 2070 while ensuring affordability for current and future generations of Melburnians.

The opportunities to deliver recycled water to end users are more deliverable in areas near wastewater treatment plants or networks, however, there are significant transfer networks in place and these are expanding, including the committed connections between Sunbury, Melton (Surbiton Park), and Parwan (Bacchus Marsh) wastewater treatment plants to service the new Parwan Balliang Irrigation District via the Western Irrigation Network. Expansion of the networks from the two major wastewater treatment plants (Western Treatment Plant and Eastern Treatment Plant) offer significant potential, as do the expansion of local networks from inland treatment plants in the Werribee, Maribyrnong, Yarra and Western Port Catchments in particular.

[52] Melbourne Water (2018). Melbourne Sewerage Strategy. Available at: https://www.melbournewater.com.au/about/strategies-and-reports/melbourne-sewerage-strategy

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2030 Regional Target

The 2030 target for the region is 85GL/year for this measure, which represents a major uplift in recycled water use. The target is recommended based on foreseeable opportunities in each Catchment that take advantage of planned growth, expansion of existing networks to support local irrigation and new and enhanced agricultural schemes in Werribee, Yarra and Western Port.

Measure 2.1b: Percent of nitrogen recovered at treatment facilities for beneficial use

This measure has been chosen to enable tracking of the level of recovery and/or reuse of one of the more valuable components of wastewater; nitrogen, no matter whether it is embedded in biosolids, recycled water or some other future product. This approach has not been taken by the industry to date. Instead, the focus has been on minimising impacts on the environment. The measure acknowledges the inherent value within a product that could generate benefits through reuse. Furthermore, this approach allows flexibility in how these resources are utilised rather than driving reuse of a specific product.

Table 30: Measure overview

Measure 2.1b: Percent of nitrogen recovered at treatment facilities for beneficial use parameters												
Indicator type	Leading											
Desired State Target Scale	Region (Weighted Average by inflow)											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	8		10		24		2		3		23	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	6	6	10	8	15	11	2	1	3	2	15	13
Desired State	N/A	94										

Table 31: Data and assumptions

Data source/s
Wastewater treatment data by plant (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water, Central Highlands Water.
Key assumptions
Data collated by water corporations and provided directly for each wastewater treatment plant, following guidelines for calculation outlined by Melbourne Water (summarised below). A weighted average of the performance of the treatment plants in each sub-catchment has been calculated.

Guidelines for nitrogen recovery calculation (developed by Melbourne Water)

- The methodology used NGERS reporting wherever possible.
- Parameters are mass loads i.e. flow x concentrations, tonnes per year
- Nitrogen is measured by the sum of TKN + NO2 + NO3 unless otherwise stated.
- Nitrogen Reuse is the sum of:
  1. Biosolids: Nitrogen content delivered to agricultural users
  2. Recycled water: Nitrogen content used in delivery to agricultural users
  3. Biodiversity: Nitrogen content used to upkeep wetlands biodiversity

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- It is noteworthy that only recycled water use by agriculture is included in the beneficial use calculation, as Nitrogen and Carbon play a valuable role here in soil health and productivity, while nutrients in recycled water utilised for indoor uses will be returned to the wastewater system after use. Recycled water for beneficial reuse via irrigation of public open space and private gardens wasn't included in the calculation methodology for simplicity during this baselining phase, but could be included to improve the data set in the future.

Current State

The results are highly variable across the region and were dependent on the specific treatment plant with an average of 13.1% for nitrogen recovery on a per plant basis and 7.5% on a weighted average basis. On a water authority basis (see average plant performance and the weighted average performance per authority in the table below) the performance against these indicators is highly variable, with some water authorities recording very low values. In some cases, performance is systemic to the setup of the wastewater system. For example, very low resource recovery is recorded across Yarra Valley Water wastewater treatment plants (often 0%) where sludge is transferred to Melbourne Water plants and could be reused at that point.

Table 32: Nitrogen recovery performance by retailer (plant average and weighted average)

Average plant performance by Water Authority	**% N recovered for beneficial use**	
	Average by plant	Weighted average by inflow
Melbourne Water	5.5	6.2
Yarra Valley Water	2.2	2.3
South East Water	30.8	25.1
City West Water	32.0	32.0
Western Water	12.4	22.8
Central Highlands Water (Ballan only)	12.5	12.5
Gippsland Water (Drouin and Neerim South only)	0.8	0.9
Western Port Water (Cowes and Kings Rd only)	1.9	2.9
Whole region	**13.1**	**7.5**

However, given the large proportions of the region's wastewater treated at the Western Treatment Plant (52%) and the Eastern Treatment Plant (35%), the weighted average for the region (by inflows) is closely tied to the performance of these two plants. No significant change occurs under the reference state, though a few plants will benefit from additional recycled water use for agricultural supply.

Performance across the Catchment

The majority of wastewater treatment plants in the Yarra Catchment recorded zero beneficial use of nitrogen. Wallan treatment plant recorded the highest level with 10%, while Whittlesea and Lilydale plants recorded around 5%.

Future Reference State

Under the future reference state, there are relatively minor changes expected in these measures, with the largest changes being driven through increased recycled water use for agriculture on the rural fringes of the region.

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Future Desired State

Existing targets and referenceable evidence

The Melbourne Sewerage Strategy sets out a long-term goal for 100% resource recovery and aims to establish diverse markets for '*resource recovery products that could include biosolids, nutrients, methane, heat, energy, and recycled water to add resilience to the sewerage system'*, however no specific dates or interim targets have been set.

Possible future interventions

There will be different types of opportunities and challenges for different wastewater treatment plants in increasing beneficial reuse. The influencing factors include scale of the plant, types of treatment processes used, location (and access to agricultural end-uses, presence of a waste to energy facility etc). A range of possible interventions were identified through conversations with specialists from water authorities across the Greater Metropolitan Melbourne Region, including:

- **Increasing the use of biosolids and recycled water for agricultural purposes:** This will help to increase recovery, but there will be limitations based on the concentration of nitrogen in the existing outputs of the plants and the amounts lost in those processes. Making substantial gains may require a re-think of treatment processes and plant designs for some plants. At the moment, plant design is optimised to meet various requirements, including environmental requirements for licenced discharges. These drive the design, and a knock-on effect is the potential for resource recovery. For example, a plant that has nitrogen for discharge to a waterway or sensitive environment will often remove a lot of Nitrogen in the process as Nitrous Oxide. It is then lost to the atmosphere, and it isn't possible to recover it for beneficial use without completely re-thinking the processes used. Equally, a plant that is designed to produce Class A recycled water for reuse may be designed to use chlorine disinfection as part of the process, which relies on low concentrations of ammonia being present, therefore driving the removal of nitrogen earlier in the process. Currently, wastewater treatment plants that utilise lagoon treatment and produce lower class recycled water have an advantage in terms of resource recovery, as there are still high concentrations of nutrients in the recycled water and biosolid products, meaning that reuse of end-products will have a significant impact on the percentage of inflow resources recovered. However, there is also likely to be an upper limit to recovery as there will be a limiting resource load within recycled water which can still be effectively applied to land.
- **Utilising new resource recovery methods:** Often the viability of resource recovery from water is limited by the low concentration of the elements in the water. As part of an investigation into the reduction of greenhouse gas emissions, of which Nitrous Oxide is a key contributor, Melbourne Water is investigating the use of zeolites to absorb nitrogen, allowing higher nitrogen concentration streams to be created where advanced industrial processes can be used for extraction. This example highlights the dual benefit of some possible interventions whereby resources could be recovered while reducing greenhouse gas emissions. However, this is an emerging technology at this stage.

Desired State target recommendations

2050 Regional Target

A regional target has been developed which is a weighted average, recognising the dominance of the Western Treatment Plant and Eastern Treatment Plant in terms of impact. The targets are therefore based on analysis that has been undertaken of the potential of those two plants by Melbourne Water.

The proposed 2050 target of 94% is based on the concept of a major paradigm shift in how we manage, or 'treat', sewage. Currently, treatment paradigms are based on seeing nitrogen as a contaminant which need to be reduced to make the water safe for environmental discharge. The mechanisms used to reduce nitrogen generally involve removing them from the water by converting them into other forms such as nitrogen gas. These transformations of nitrogen are a source of Scope 1 GHG emissions. Melbourne Water is conducting a study which looks at reimagining how we manage, or 'treat', sewage with the goal of minimising Scope 1 GHG emissions. With this goal in mind, a conceptual treatment approach is proposed which removes nitrogen through more direct extraction rather than transformation. In addition to reducing Scope 1 GHG emissions, this novel treatment system would change the mechanisms for nitrogen recovery. The nitrogen would effectively be extracted from the sewage without transformation and be available as a fertiliser product. The treated water product would have little in the way of Nitrogen in it for recovery and so the recycled water

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targets are not so relevant once this happens. There would be no biosolids stream other than the solids stream used for energy generation.

Based on the approach above the predicted possible recovery performance for ETP & WTP are summarised below. Nitrogen recovery increases significantly as the nitrogen is being extracted and valued directly as a recovered product. For the 2050 target it is suggested that nitrogen recovery is achieved as fertiliser rather than recycled water so that it is completely removed from the system, and therefore the total recovery would be 94%.

Table 33: Potential nitrogen recovery for WTP and ETP[53]

Plant	ETP					WTP				
Recovery mechanism/channel	Energy	Biosolids	Recycled Water	Fertilizer	Total	Energy	Biosolids	Recycled Water	Fertilizer	Total
Current (2018)	0%	0%	2%	0%	2%	0%	1%	5%	0%	6%
Current potential under current treatment paradigm	0%	5%	26%	0%	31%	0%	7%	42%	0%	49%
Future potential under new treatment paradigm	0%	0%	4%	94%	98%	0%	0%	4%	94%	98%

2030 Regional Target

A target has not been set for 2030. Scenario testing conducted by Melbourne Water, summarised in the table above, shows that a weighted average performance (between ETP and WTP) of 42% recovery could be achieved under a ‘current potential’ scenario where the existing nitrogen recovery mechanisms and channels are maximised. Specifically:

- All recycled water is used for irrigation requiring either significant expansion or development of new reuse schemes. A minimum Western Treatment Plant nitrogen discharge to Port Phillip Bay is also recognised as being beneficially recovered.
- Biogas production is optimised and all biogas produced is used to generate renewable electricity (i.e. no lost biogas or flaring to atmosphere).

Typically, wastewater treatment infrastructure is renewed over a 20-30 year horizon. Given there are various pathways that could be taken to drive greater beneficial use, and that some may involve replacement or addition of treatment processes, a 2030 target has not been fixed. Instead the 2050 target has been set to drive innovation and improvements to processes at key investment milestones.

Measure 2.1c: Percent of carbon recovered at treatment facilities for beneficial use

This measure has been chosen to enable tracking of the level of recovery and/or reuse of one of the more important components of wastewater; carbon, no matter whether it is embedded in biosolids, recycled water, biogas or some other future product. This approach has not been taken by the industry to date and instead of focussing on minimising impacts on the environment it acknowledges the inherent value within a product that could generate benefits through reuse. Furthermore, this approach allows flexibility in how these resources are utilised rather than driving reuse of a specific product.

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[53] Provided by Melbourne Water.

Table 34: Measure overview

Measure 2.1c: Percent of carbon recovered at treatment facilities for beneficial use parameters												
Indicator type	Leading											
Desired State Target Scale	Region (Weighted Average by inflow)											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	17		19		12		0.1		15		9	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	13	12	18	15	7	5	0	0	14	12	6	5
Desired State	N/A	67										

Table 35: Data and assumptions

Data source/s
Wastewater treatment data by plant (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Western Port Water, Central Highlands Water.
Key assumptions

Data collated by water corporations and provided directly for each wastewater treatment plant, following guidelines for calculation outlined by Melbourne Water (summarised below). A weighted average of the performance of the treatment plants in each sub-catchment has been calculated.

Guidelines for nitrogen recovery calculation (developed by Melbourne Water)

- The methodology used NGERS reporting wherever possible.
- Parameters are mass loads i.e. flow x concentrations, tonnes per year
- Carbon is measured by using COD as a representative surrogate unless otherwise stated.
- Carbon Reuse is the sum of:
  1. Biosolids: Carbon content delivered to agricultural users
  2. Biogas: Carbon content in biogas
  3. Recycled water: Carbon content used in delivery to agricultural users
  4. Biodiversity: Carbon content used to upkeep wetlands biodiversity
- It is noteworthy that only recycled water use by agriculture is included in the beneficial use calculation, as Nitrogen and Carbon play a valuable role here in soil health and productivity, while nutrients in recycled water utilised for indoor uses will be returned to the wastewater system after use.

Current State

The results are highly variable across the region and were dependent on the specific treatment plant with an average of 9.1% for carbon recovery on a per plant basis and 16.5% on a weighted average basis. On a water authority basis (see average plant performance and the weighted average performance per authority in the table below), the performance against these indicators is highly variable, with some water authorities recording very low values. In some cases, performance is systemic to the setup of the wastewater system. For example, very low resource recovery is recorded across Yarra Valley Water wastewater treatment plants (often 0%) where sludge is transferred to Melbourne Water plants and could be reused at that point.

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Table 36: Carbon recovery performance by retailer (plant average and weighted average)

Average plant performance by Water Authority	% C recovered for beneficial use	
	Average by plant	Weighted average by inflow
Melbourne Water	15.8	16.3
Yarra Valley Water	0.1	0.1
South East Water	17.4	35.6
City West Water	51.0	51.0
Western Water	7.9	12.5
Central Highlands Water (Ballan only)	11.7	11.7
Gippsland Water (Drouin and Neerim South only)	0.8	0.8
Western Port Water (Cowes and Kings Rd only)	0.6	0.2
Whole region	**9.1**	**16.5**

However, given the large proportions of the region's wastewater treated at the Western Treatment Plant (52%) and the Eastern Treatment Plant (35%), the weighted average for the region (by inflows) is closely tied to the performance of these two plants. No significant change occurs under the reference state, though a few plants will benefit from additional recycled water use for agricultural supply.

Performance across the Catchment

The majority of wastewater treatment plants in the Yarra Catchment recorded zero beneficial use of carbon. Wallan treatment plant recorded the highest level with 1%.

Future Reference State

Under the reference state, there are relatively minor changes expected in these measures, with the largest changes being driven through increased recycled water use for agriculture on the rural fringes of the region.

Future Desired State

Existing targets and referenceable evidence

The Melbourne Sewerage Strategy sets out a long-term goal for 100% resource recovery and aims to establish diverse markets for '*resource recovery products that could include biosolids, nutrients, methane, heat, energy, and recycled water to add resilience to the sewerage system*', however no specific dates or interim targets have been set.

Possible future interventions

There will be different types of opportunities and challenges for different wastewater treatment plants in increasing beneficial reuse. The influencing factors include scale of the plant, types of treatment processes used, location (and access to agricultural end-uses, presence of a waste to energy facility etc). A range of possible interventions were identified through conversations with specialists from water authorities across the metropolitan region, including:

- **Increasing the use of biosolids and recycled water for agricultural purposes:** This will help to increase recovery, but there will be limitations based on the concentration of carbon in the existing outputs of the plants and the amounts lost in those processes. Making substantial gains may require a re-think of treatment processes and plant designs for some plants.
- **Increasing and optimising biogas recovery:** Carbon recovery becomes more possible with Anaerobic Digestion processes in place, and the utilisation of Biogas. However, Anaerobic digestion is often not feasible at smaller plants, and while it enables more carbon recovery, it is also more energy intensive (increasing carbon emissions at source). Accordingly, there is a need to think at a systems level and avoid perverse outcomes.

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Desired State target recommendations

2050 Regional Target

A regional target has been developed which is a weighted average, recognising the dominance of the Western Treatment Plant and Eastern Treatment Plant in terms of impact. The targets are therefore based on analysis that has been undertaken of the potential of those two plants by Melbourne Water.

The proposed 2050 target of 67% is based on the concept of a major paradigm shift in how we manage, or 'treat', sewage. Currently, treatment paradigms are based on seeing carbon a contaminant which need to be reduced to make the water safe for environmental discharge. The mechanisms used to reduce carbon generally involve removing carbon from water and turning it into other forms such as carbon dioxide or methane. While methane is generally recovered as biogas, some of it is lost to the atmosphere where it is not collected as carbon dioxide. These transformations of carbon are a source of Scope 1 GHG emissions. Melbourne Water are conducting a study which looks at reimagining how we manage, or 'treat', sewage with the goal of minimising Scope 1 GHG emissions. With this goal in mind, a conceptual treatment approach is proposed which removes carbon through more direct extraction rather than transformation. In addition to reducing Scope 1 GHG emissions, this novel treatment system would change the mechanisms for carbon recovery. The Carbon would be recovered as a solids stream which is recovered as renewable energy. The treated water product would have little in the way of Carbon in it for recovery and so the recycled water targets are not so relevant once this happens. There would be no biosolids stream other than the solids stream used for energy generation.

Based on the approach above the predicted possible recovery performance for ETP & WTP are summarised below. Carbon recovery does not increase substantially to 2050 as it is still utilising energy as the recovery mechanism and this has some inefficiencies. If the Carbon was used as a product itself the recovery would be greater.

Table 37: Potential carbon recovery for WTP and ETP[54]

Plant	ETP					WTP				
Recovery mechanism/channel	Energy	Biosolids	Recycled Water	Fertilizer	Total	Energy	Biosolids	Recycled Water	Fertilizer	Total
Current (2018)	13%	0%	0%	0%	13%	15%	3%	0%	0%	18%
Current potential (2030)	19%	40%	0%	0%	59%	29%	24%	0%	0%	53%
Future potential (2050)	67%	0%	0%	0%	67%	67%	0%	0%	0%	67%

2030 Regional Target

A target has not been set for 2030. Scenario testing conducted by Melbourne Water, summarised in the table above, shows that a weighted average performance (between ETP and WTP) of 55% recovery could be achieved under a 'current potential' scenario where the existing carbon recovery mechanisms and channels are maximised. Specifically:

- All recycled water is used for irrigation requiring either significant expansion or development of new reuse schemes.
- Biogas production is optimised and all biogas produced is used to generate renewable electricity (i.e. no lost biogas or flaring to atmosphere).

Typically wastewater treatment infrastructure is renewed over a 20-30 year horizon. Given there are various pathways that could be taken to drive greater beneficial use, and that some may involve replacement or addition of treatment processes, a 2030 target has not been fixed. Instead the 2050 target has been set to drive innovation and improvements to processes at key investment milestones.

[54] Provided by Melbourne Water.

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Strategic Outcome 3 - Existing and future flood risks are managed to maximise outcomes for the community

Flooding can have major impacts on communities and businesses, and needs to be considered as part of an IWM approach. To date, flood risk management has often been managed separately from the rest of the water cycle, but there are many ways in which flood risk management initiatives can deliver multiple benefits to the water cycle, and in which other stormwater management and greening initiatives can reduce flood risk.

The case for change

Managing flood risk from stormwater drainage systems and waterways falls within the existing remit and responsibilities of Melbourne Water and local councils. However, the way we measure and evaluate flood risk is changing to be more outcome focussed. The Flood Management Strategy for Port Phillip and Westernport drives this new approach.[55] The indicators and measures for this Plan have been developed to align and complement indicators and goals in the draft Flood Strategy and also recognise that through IWM, we can create multi-functional solutions that reduce flood risk while also supporting recreation, greening, stormwater treatment and the provision of alternative water supplies.

Types of flooding and interactions with IWM

There are different types of flooding, and the impact that IWM can have on each differs. The most significant impacts of flooding in the region are from flooding of stormwater drainage systems, both local systems (managed by Councils) and regional systems (managed by Melbourne Water). These drainage systems built as part of early developments were not designed to hold the volumes of water we now know can flow through our landscape. When there is more runoff than underground drains or designated overland flow paths can accommodate, water can spill into surrounding land, flooding roads and properties. Accordingly, IWM initiatives can help to reduce flooding from drainage systems by retaining water in the landscape or through the creation of more storage in urban Catchments. This could be in the form of retarding basins, tanks or permeable soils. To enhance other IWM outcomes, those storages can be multi-functional, providing opportunities for stormwater harvesting, recreation and amenity.

Flooding also occurs from waterways, often in the lower areas of a Catchment. Riverine flooding is impacted by runoff from both rural and urban areas, and initiatives that reduce or slow runoff to waterways on a large scale can have an impact on waterway flooding.

The third type of flooding is coastal flooding, where areas are inundated by tides and rising sea levels. IWM can help us better prepare for coastal flooding, by designing landscapes to accommodate flooding.

Flood risk areas

While riverine flooding occurs near waterways across the region, stormwater flooding from drainage systems is concentrated in established urban areas. Recently developed areas have employed improved drainage systems and integrated infrastructure like retarding basins to reduce flood risk.

However, as Melbourne's population grows flood risk is likely to increase in established areas, as infill development and general urbanisation creates more impervious areas, increasing runoff and potentially overwhelming some drainage systems. Expected changes in climate will have an even greater impact on flood risk and associated damages. While the future climate is expected to be drier, more intense rainstorms and continuing rises in sea level are likely to exacerbate flooding.

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[55] Melbourne Water (2021). Draft Flood Management Strategy Port Phillip and Westernport 2021-31. Released March 2021.Available at: https://www.melbournewater.com.au/about/strategies-and-reports/flood-management-strategy-port-phillip-and-westernport#refresh

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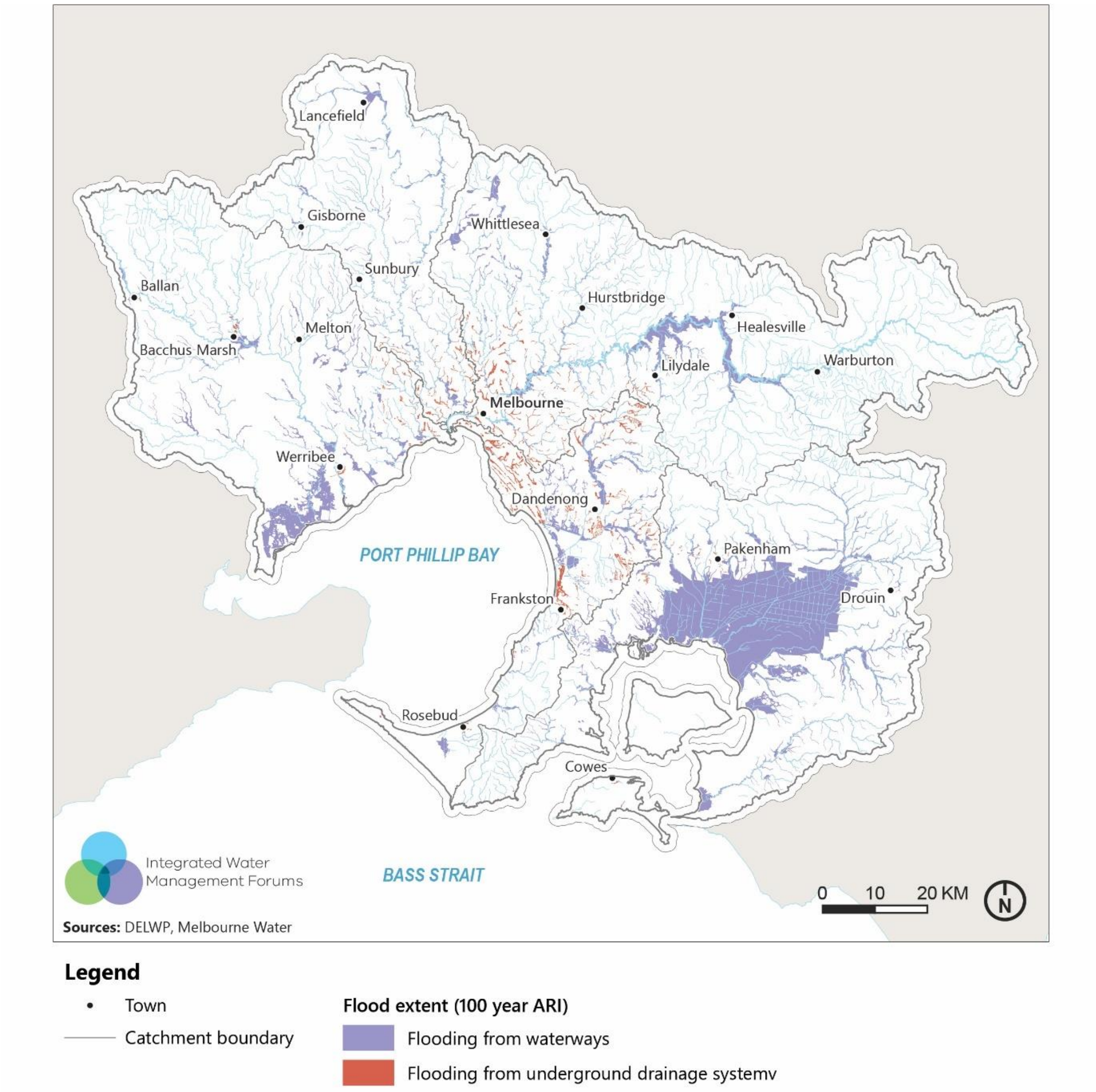

Figure 35: Flooding extent across the region

Stormwater flooding is prevalent in urban areas of the Yarra Catchment. The ongoing development and growth of suburbs in the Catchment contributes higher volumes of stormwater during periods of heavy rain, impacting the waterway health of the Yarra River and its tributaries.

Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 38: Indicators and Measures for Strategic Outcome 3

Indicators	Measures
3.1 Reduce flooding impacts on communities	Dollar ($) reduction in Annual Average Damage (AAD) delivered by flood management initiatives
3.2 Increase surface runoff storage created through multifunctional assets	Cubic metres of effective flood storage volume created as part of multi-functional assets
3.3 Increase cross-consideration of flood mitigation and integrated water management	Percent of projects that cross-consider IWM and flood mitigation opportunities as part of their design

Indicator 3.1: Reduce flooding impacts on communities

Measure 3.1: Dollar ($) reduction in Annual Average Damage (AAD) delivered by flood management initiatives

This measure considers progress in reducing the estimated Annual Average Damage (AAD) from flooding in the Greater Metropolitan Melbourne Region through flood mitigation measures which may include physical interventions, policy changes or education. It is baselined against the AAD estimation that was completed in 2020 to inform the refresh of the Port Phillip and Western Port Regional Flood Strategy.

The AAD approach has been employed in the previous two Flood Strategies to estimate the probability-weighted average cost of flooding. The AAD approach is built on economic inputs that quantify flood damage in monetary terms. The derivation and assumptions of economic inputs are described for the following categories of flood damage:

- Direct damages - physical damages to buildings (residential and commercial/industrial), property and roads.
- Indirect damages - tangible economic costs of disruption of day-to-day activities. This includes loss of public services, emergency responses and transport disruptions.
- Intangible damages - Non-infrastructure and unpriced impacts to human life, social memorabilia and flora and fauna.

The AAD considers damage from flooding of assets managed by Melbourne Water, local councils and property owners. Within the Port Phillip and Western Port region, responsibility for drainage activities is broadly divided between local and regional authorities as follows:

- Smaller Catchments (generally less than 60ha) are deemed to provide a local drainage service. Local governments typically manage the local drainage networks within these smaller Catchments and work with Melbourne Water to provide flood protection and manage stormwater quality. At the time of writing this delineation of responsibilities is being reviewed through the Melbourne Urban Stormwater Institutional Arrangements (MUSIA) process.
- Larger Catchments (generally 60ha and greater) are deemed to provide a regional drainage service. Melbourne Water is generally responsible for owning and maintaining regional drainage infrastructure in these large Catchments.
- Individual property owners are responsible for stormwater drainage systems within their property boundaries.

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Table 39: Measure overview

Measure 3.1: Dollar ($) reduction in Annual Average Damage (AAD) delivered by flood management initiatives parameters												
Indicator type	Leading											
Desired State Target Scale	Catchment (2030) and Regional (2050)											
Measure performance and targets												
$millions	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	N/A		N/A		N/A		N/A		N/A		N/A	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	20	61	2	6	2	5	6	16	9	29	2	5
Desired State	37-102	408	3-13	N/A	4	N/A	10	N/A	9-64	N/A	11	N/A

Table 40: Data and assumptions

Data source/s
Melbourne Water (2021) Port Phillip and Western Port Regional Flood Strategy (Draft). Jacobs (2020) Melbourne's Flood Risk: Assessment of average annual damage.
Key assumptions
Reduction in AAD is measured against a zeroed 2020 baseline. For the purposes of the reference state estimation, it is assumed that an AAD reduction of $10.23million is achieved in every 5-year period to 2050 (echoing the draft Flood Management Strategy target that uses the same 5-year investment rate to 2030), resulting in a total AAD reduction of $61.38 million by 2050 due to flood management activities. No data regarding future investments and likely impact was available from Councils or for private property owners, so these possible future investments are not included in the reference state. It should be noted that investments will also deliver benefits beyond the 5-year period for example for the expected life of the asset which is on average 30 years.

Current State

Given that Measure 3.1 considers reductions in AAD made against the 2020 baseline, the current state for this measure is zero.

The 2020 baseline estimate of AAD for the Melbourne region was $735.5 million, made up of $294.2 million related to Melbourne Water managed Catchments and $441.3 million related to Council managed Catchments. Of this total, 44% of the AAD is intangible, 13% is indirect, and 44% is direct damage (predominantly to residential buildings and properties).

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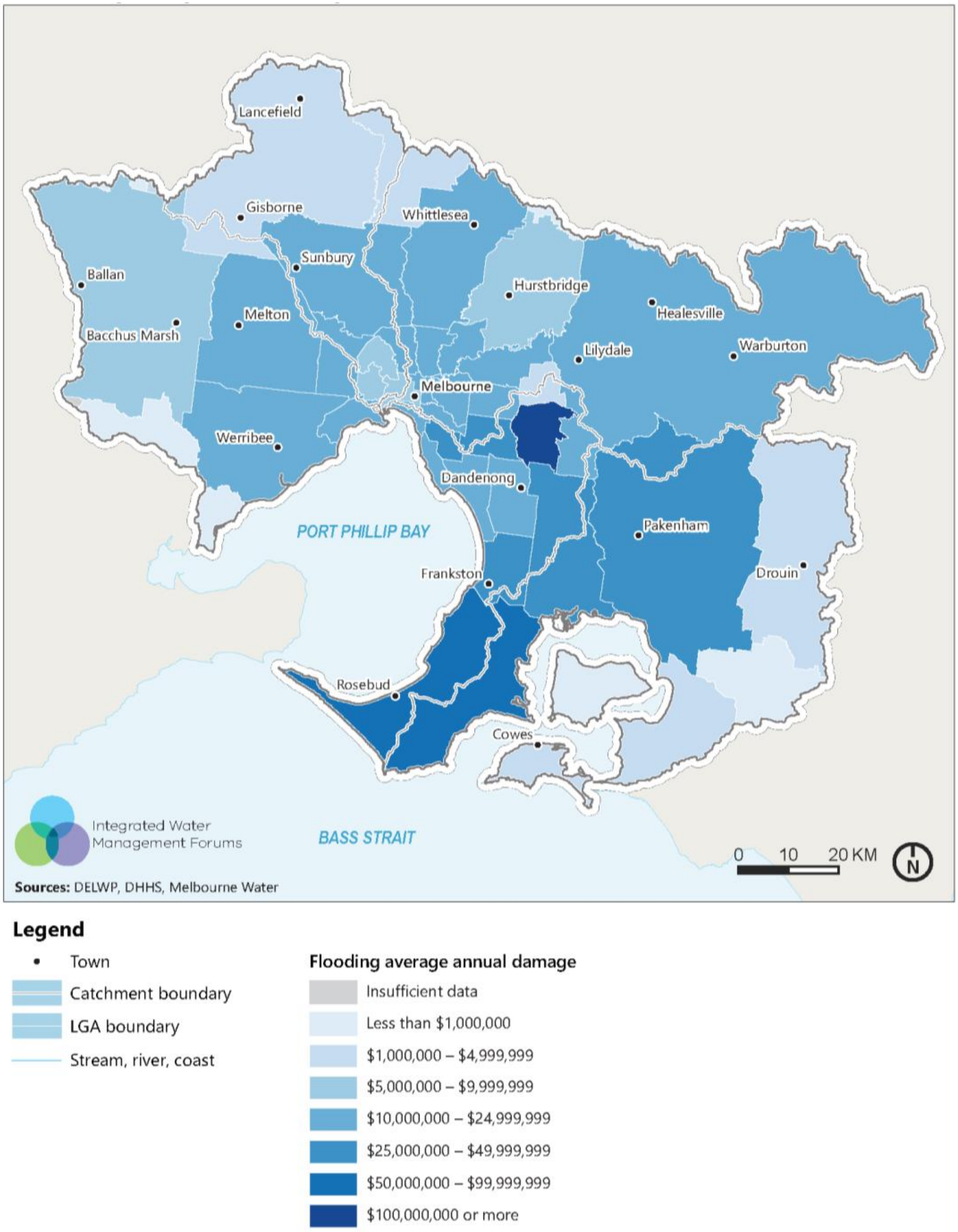

Figure 36: Current (2020) Average Annual Damage across the region

Future Reference State

Damage related to flooding is expected to increase in the future due to the impacts of climate change and urban consolidation (increased imperviousness). Climate change is likely to increase rainfall intensity, potentially leading to increases in flood damages. Urban consolidation from both development in growth areas and infill development in existing areas will increase impervious surfaces and also increase flood risk. However, incremental building replacement also reduces flood risk gradually in the long term provided that planning controls are in place. The future impact of these two factors on AAD has been estimated, and is summarised in the table below.

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Table 41: Projected changes in AAD due to climate change and urban consolidation

	2030	2050
Expected change in AAD due to climate change		
Average Annual Damage ($M)	974	1088
Increase from 2020	32%	48%
Expected increase in AAD baseline due to urban consolidation		
Average Annual Damage ($M)	839	821
Increase from 2020	14%	12%
Expected combined increase		
Average Annual Damage ($M)	1,078	1,174
Increase from 2020	47%	60%

For the purposes of the reference state estimation, it is assumed that an AAD reduction of $10.23 million is achieved in every 5-year period to 2050 (echoing the draft Flood Management Strategy target that uses the same 5-year investment rate to 2030), resulting in a total AAD reduction of $61.38 million by 2050 due to flood management activities. No data regarding future investments and likely impact was available from Councils or for private property owners, so these possible future investments are not included in the reference state. It should be noted that investments will also deliver benefits beyond the 5-year period for example for the expected life of the asset which is on average 30 years.

Performance across the Region

The draft Flood Management Strategy does not define where future investments will be made geographically to reduce AAD, as this is yet to be determined through action planning. For the purpose of this Plan, it is assumed that future investments would be distributed across the major Catchments following the distribution of existing AAD, which is as shown in the table below.

Table 42: Distribution of current Average Annual Damage (AAD) by Catchment, %

Werribee	Maribyrnong	Yarra	Dandenong	Western Port
10%	8%	26%	48%	9%

Future Desired State

Existing targets and referenceable evidence

The draft Flood Management Strategy includes a 2030 target for AAD reduction against the 2020 baseline. This is a reduction in AAD of $20.46 million, which is equivalent to the projected impact of the forecast Melbourne Water investments in flood risk mitigation set out in the 2021-2026 Waterways and Drainage Investment Plan

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(doubled to reflect two sets of 5-year investments). This investment trajectory has also been used to estimate the future reference state.

Melbourne Water has undertaken analysis to estimate the likely impact of Melbourne Water investments for the next 5 years outlined in the 2021-2026 Waterways and Drainage Investment Plan on AAD, as summarised in the table below.

Table 43: Anticipated reduction in AAD from the Waterways and Drainage Investment Plan

Component	$ Investment (over 5 years)	Estimated effective lifespan of investment	AAD reduction (over 5 years)
Land Use Planning	Undefined	30+ years	$7.13m
Flood Mitigation Works	$98.1m	50+ years	$2.1m
Education & Warnings	$18.8m	5+ years	$1m
Total	**$116.9m**		**$10.23m**

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Possible future interventions

As discussed in the previous section, investments and consequent impacts have been projected for the 2021-2026 period, and this has underpinned the reference state projection to 2050. Melbourne Water's future interventions are likely to fall under the same three broad categories of land use planning, flood mitigation works, and education and warnings, but the interventions and their impact are likely to vary. For example:

- The relationship between investments and a reduction in AAD can be difficult to anticipate, and is likely to vary greatly between areas, initiatives and over time. Some measures may also not fully affect AAD reductions until much later.
- The effectiveness of capital works interventions is likely to change over time as the 'low hanging fruit' are taken, and more expensive interventions remain. Consequently, the level of investment is likely to require an increase to maintain the same reduction in AAD. Large infrastructure projects are becoming more expensive and technically difficult to deliver because of increasing urbanisation and the nature of some high flood risk areas (former swamp land).
- Some interventions, such as planning controls and policy changes, will require relatively low investment but could have a significant impact. However, these are likely to have longer lead times and the impacts may not be seen for some time.
- This estimate only considers the impact of planned Melbourne Water investments, and does not account for the impact of potential council investments in the 5 year period, as the impact of these has not been estimated due to lack of available data. However, data gathering on the impact of council investments is a focus of the Flood Strategy MERI plan, and could improve over time.

The draft 2021 Flood Strategy sets out a range of possible actions and interventions that could be used to improve flood management, and to reduce the AAD. Possible interventions include:

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- **Land use planning**: This includes improved mapping and risk-based planning processes, more streamlined planning scheme amendments, planning for climate change, and upstream planning controls to reduce runoff.
- **Flood mitigation works**: The draft Flood Management Strategy commits partners to working together to find the right solution to high priority flooding problems in the region. This may include the delivery of infrastructure at a variety of scales and the piloting of innovative approaches.
- **Education and warnings**: Improved community empowerment to enable them to respond and recover from flooding through, engagement, better information and the provision of flood warnings.

Desired State target recommendations

2050 Regional Targets

A 2050 target of a reduction of $408 million in AAD has been set for the region which seeks to negate the increases expected due to both climate change and urban consolidation, thereby ensuring that the impacts of flooding in the region do not significantly increase in the future.

2030 Catchment Targets

Catchment based targets have been derived for 2030, with the aim of focussing local action and bringing together efforts from Melbourne Water, Councils and the community. However, it is recognised that there is still much work to be done regarding data, processes and procedures to streamline modelling and reporting processes, and to focus investment on priority areas. Accordingly, the 2030 targets outlined in the plan will be tested and confirmed through subsequent action plan development. The interim 2030 target for the Catchment is a reduction in AAD of $10 million for this measure, with the exact figure to be confirmed through further investigations.

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Indicator 3.2: New surface runoff storage created through multi-functional assets

Measure 3.2: Cubic metres (m3) of effective flood storage volume created as part of multi-functional assets

While flood risk management initiatives are not new, and have been delivered by Melbourne Water and local councils for many years, this measure seeks to understand how well we are integrating flood mitigation through an IWM process by delivering multi-functional assets that also provide flood storage.

This measure does not seek to assess the relative effectiveness of the flood management techniques, though it is assumed that assets are designed for flood management benefit and located accordingly. Instead it focuses on understanding how much IWM infrastructure also provides flood storage. The unit of the measure is the effective storage volume, defined as the storage capacity that is available at the beginning of a major rainfall event, measured in cubic metres. Flood management initiatives that would contribute to this indicator include:

- smart rainwater tanks with a release system linked to rainfall forecast
- rainwater tanks with a dedicated storage volume for detention
- combined stormwater harvesting and flood storage schemes (e.g. a shared major underground storage).

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Table 44: Measure overview

Measure 3.2: Cubic metres (m3) of effective flood storage volume created as part of multi-functional assets parameters												
Indicator type	Lagging (reporting-only)											
Desired State Target Scale	N/A											
Measure performance and targets												
‘000 m^3	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	**106**		34		1		10		61		1	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	No change is expected under the reference state.											

Table 45: Data and assumptions

Data source/s
Smart rainwater tanks with a release system linked to rainfall forecast.
Iota. Pers comm. March 2020: Smart rainwater tanks are an emerging technology. There are pilot projects in place in Casey, Glen Eira, Melbourne, Yarra Ranges and Frankston. Current estimated storage capacity provided.
Rainwater tanks with a dedicated storage volume for detention.
No data available. Rain consulting. Pers comm, March 2020: Many councils have an OSD (on-site detention) policy, however most OSD locations and specifics are poorly recorded and rarely inspected. It is also unknown how many of these OSD assets are multi-functional.
Combined stormwater harvesting and flood storage schemes (e.g. a shared major underground storage)
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide information about stormwater harvesting schemes that also provide flood mitigation. Conducted February-March 2020.
Key assumptions
Projects were spatially allocated to the primary sub-catchment in the urbanised area of the LGA where the specific location was unknown.
An average depth of 1.5m assumed for storages within retarding basins.

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Current State

Based on data available there is over 100,000 cubic metres of effective flood storage built into multi-functional assets that also harvest rainwater or stormwater for local reuse.

Performance across the Catchment

Multi-functional IWM assets providing flood storage were only recorded in some of the more urbanised sub-catchments, perhaps reflecting drivers in those areas to alleviate pressure on local drainage systems. There is a general lack of data regarding the storage capacity of these multi-functional IWM assets.

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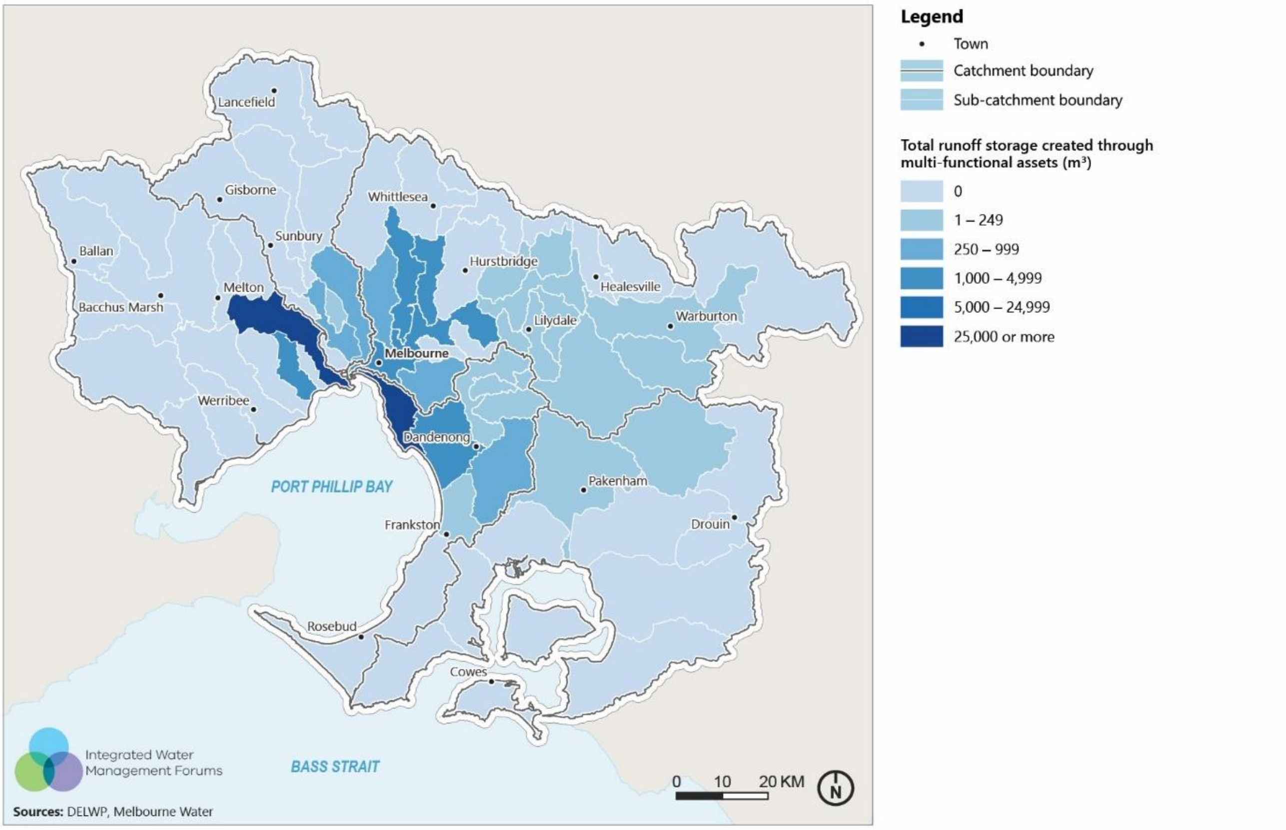

Figure 37: Effective flood storage created through multi-functional assets

Future Reference State

While the current state recorded some progress to date against this indicator, most examples were either pilot projects or opportunistic projects. There is no existing commitment to deliver more multi-functional flood storage under current policy. Accordingly, no change is expected in this measure under the reference state.

Future Desired State

Existing targets and referenceable evidence

There are no known existing targets for flood storage created as part of multi-functional assets.

Possible future interventions

This measure currently includes three specific interventions which have the potential to be 'scaled up' and included in areas where rainwater or stormwater harvesting is proposed and where distributed storage is likely to significantly reduce flood risk. These solutions are likely to be particularly pertinent in existing areas where drainage systems have become undersized due to the impacts of gradual infill and decreasing permeability in the Catchment.

Desired State target recommendations

Targets have not been recommended for this measure, recognising the need to establish better data reporting and to take an outcome approach to the integration of effective storage where it is most needed. Instead, this has been nominated as a lagging indicator for ongoing monitoring and review. A target can potentially be set at a later point in time.

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Indicator 3.3: Increase cross-consideration of flood mitigation and other aspects of integrated water management

Measure 3.3: Percent of priority projects that cross-consider flood mitigation and other aspects of integrated water management as part of their design

This measure is designed to drive a change in practice and build stronger interrelationships between flood management and other aspects of IWM, including opportunities to harvest rainwater or stormwater and to create multi-functional blue-green assets that improve amenity and community well-being. In the calculation of the percentage, this measure includes:

- priority IWM projects that consider flood mitigation as part of their design; and
- priority flood mitigation and drainage projects that consider broader IWM opportunities as part of their design.

Table 46: Measure overview

Measure 3.3: Percent of priority projects that cross-consider flood mitigation and other aspects of integrated water management as part of their design parameters												
Indicator type	Leading											
Desired State Target Scale	Catchment											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	No data available											
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	No data available											
Desired State	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 47: Data and assumptions

Data source/s
No data available at the time of writing. It is proposed that data is gathered forthwith for priority projects through the following reporting mechanisms: • Priority IWM projects would report through the Project Reporting Tool as part of regular project reporting by the Catchment Forums. • Priority flood mitigation and drainage projects could report through mechanisms to be defined as part of the Flood Strategy Monitoring, Evaluation, Reporting and Improvement (MERI) (to be confirmed).

Current State

No data was available for this measure, so no baseline has been established.

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Future Reference State

No data was available for this measure, and it has not been projected.

Future Desired State

Desired State target recommendations

2050 Catchment Targets

A target of 100% has been set for all Catchments for 2050, with the aim of driving a step-change in practice that better integrates flood mitigation with IWM and vice versa. This will ensure that opportunities are taken to drive multiple benefits through interventions delivered in the Catchments.

2030 Catchment Targets

A target of 100% has been set for all Catchments for 2030, with reporting of the measure focussing on priority projects with existing or proposed reporting mechanisms in place.

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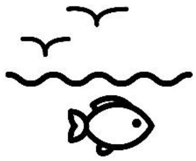
Strategic Outcome 4 – Healthy and valued waterways and marine environments



An understanding of the health of our waterways and marine environments is crucial to IWM as they interact with many parts of the water cycle and are important community and environmental resources. This strategic outcome explores how IWM can improve the health of our waterways and bays. It also explores the impacts of the use of river catchments for water supplies and how we are improving the amount of water available for the environment in waterways.

The case for change

The health of the waterways and bays in the region is a key focus for Melbourne Water in its waterway management and catchment management role. Minimising impacts and enhancing the health of these assets is also within the responsibility of councils and water authorities in the area.

Waterway health

The Healthy Waterways Strategy is a collaborative strategy which has compiled significant knowledge and data around the waterways in the region.[56] The Strategy sets a vision for the future of the health of these waterways through considering the impact of future developments. It has identified sets of indicators and targets that are key to both ecological and community values associated with waterways.

Data associated with the current habitat suitability for macroinvertebrates shows the most habitat degradation is in urbanised areas. In keeping with this finding, it is also predicted that as new areas urbanise and become more impervious, changes to runoff patterns and volumes will cause irreparable damage to some waterways, especially in headwater tributaries on the edge of the Melbourne urbanised area. The expected change is shown in the figures below.

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[56] Melbourne Water (2018) Healthy Waterways Strategy 2018-2028. Available at: https://www.melbournewater.com.au/about/strategies-and-reports/healthy-waterways-strategy

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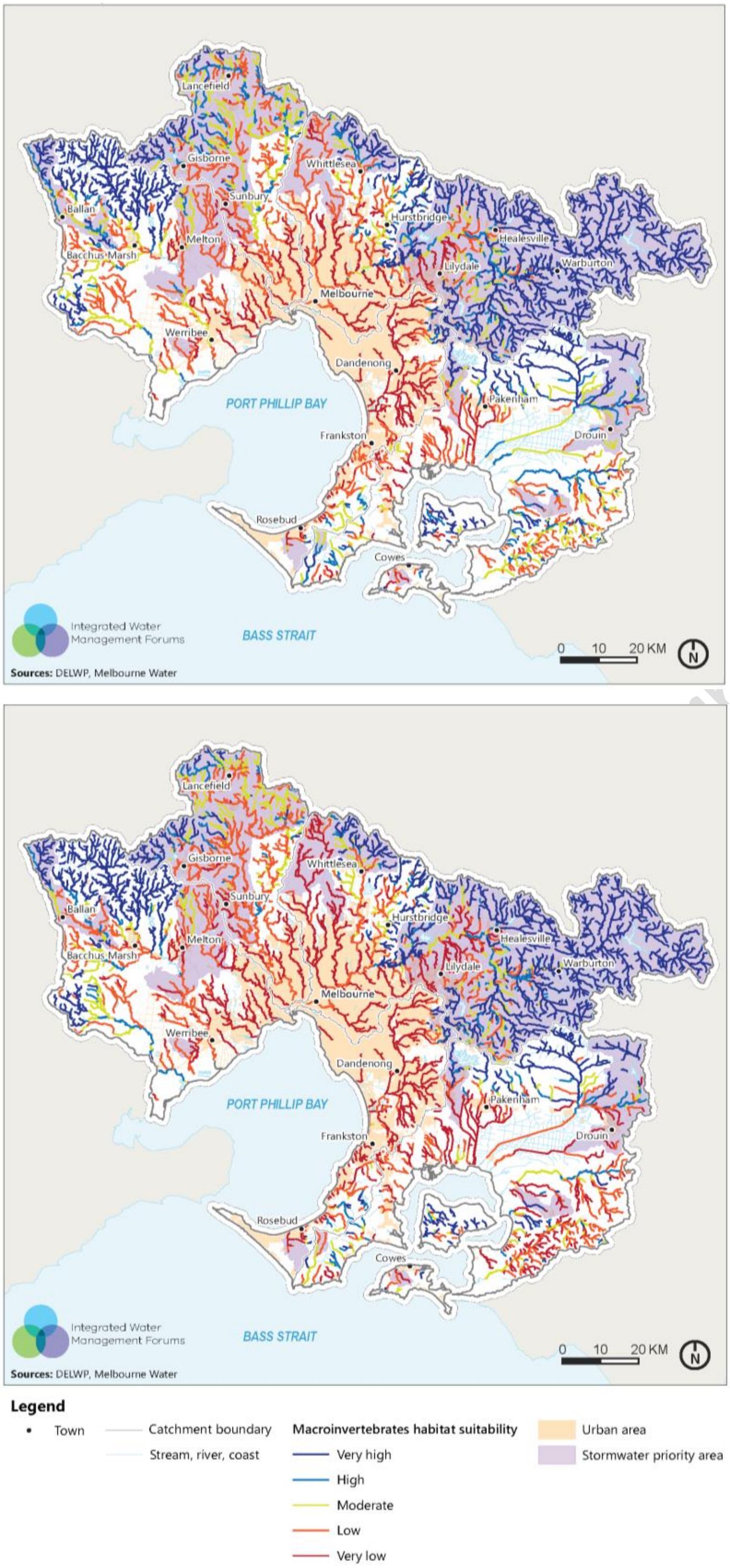

Figure 38: Waterway health across the region (macroinvertebrates) currently and projected in 2070 with anticipated impacts of development

The Yarra Catchment contains an array of significant and biologically diverse waterways ranging from expansive rivers with variable flows to small ephemeral creeks and streams. All major waterways in the

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Catchment eventually join the Yarra River, the largest river in Victoria. The Yarra flows 242 km from its origins in the forested Yarra Ranges National Park, located in north-eastern Victoria on the southern slopes of the Great Dividing Range. The river winds its way through the Greater Metropolitan Melbourne Region, finally meeting the Maribyrnong River at the northernmost entry to Port Phillip Bay.

The Yarra River holds high cultural, social, economic and environmental value. It is designated as a Victorian Heritage River Area between Warburton, in the Catchment's central east area, and Warrandyte, 24 km northeast of Melbourne. Other notable waterways in the Catchment include the O'Shannassy River, Little Yarra River, Woori Yallock Creek, Watts River, Plenty River, as well as the Merri Creek and Darebin Creek.

In general, the water quality in the upper reaches of the Yarra Catchment is good, however water quality for waterways located in urbanised and industrial areas within the mid and lower Catchment declines significantly. Stormwater is one of the major sources of pollution to waterways in the region, transporting elevated levels of nitrogen and other nutrients, sediment and litter into Port Phillip Bay. Above average rainfall during 2016-2017 and associated runoff resulted in a slight decline in overall water quality in the Yarra Catchment.

According to the 2016-2017 environmental report card for the Catchment's waterways developed by the EPA, Melbourne Water and DELWP under the Yarra and Bay Action Plan (2012-2017), approximately 43 per cent of waterways in the Yarra Catchment are in very poor condition, with just over 3 per cent rated as near-natural and high quality. Over one quarter of waterways in typically rural areas on the urban fringe of the Catchment are in good condition, meeting Victorian water quality standards.

Changes to stormwater flows to waterways

The Healthy Waterways Strategy recognises the significant impact of urban stormwater flows on waterways and sets out priority areas where greater harvesting or infiltration of stormwater is desirable to minimise the impact of excess urban stormwater flows to waterways. The highest quality waterways from an ecological perspective are located in the north-east section of the Yarra Catchment, and in the north-west parts of the Werribee and Maribyrnong Catchments. These priority areas primarily cover urban growth areas and areas where it is possible to rehabilitate waterways if runoff directly discharged to waterways can be substantially reduced by 70-90%.

Total runoff (ML/year) from each sub-catchment is shown in the figures below for the current and future reference state. Under the future reference state, stormwater flows are largely unabated in new development areas, with minor flow reductions (typically 5-25%) due to the implementation of wetlands and the installation of rainwater tanks on some homes. Stormwater flows are also expected to increase in established areas as infill development intensifies imperviousness.

Proportion of runoff which is 'urban excess'

It is important to recognise that runoff (stormwater) from highly impervious urban areas (stormwater) is potentially much more harmful to the receiving environment than natural runoff. Rainfall on urban areas is often channelled immediately to drainage systems, and prevented from soaking into the ground or evaporating, and making its way to waterways in much less time, leading to a concentration of larger, faster flows. Accordingly, when considering the total runoff from an area, it is important to consider the 'urban excess' or the runoff which is generated which would not naturally exist and is due to the impacts of urbanisation.

The source Catchments model used to estimate runoff from the sub-catchments in the region (see Appendix A: Water and Pollutant Balance) was run again with 100% grassland land use, to predict runoff without the impacts of urbanisation. The difference between this and the runoff modelled for the current and future reference state Catchments provides an estimate of 'urban excess'. The table below summarises the results for the major Catchments.

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Table 48: Runoff generated and proportion which is urban excess in the five Catchments in the current and future reference state[57]

	Runoff generated (GL/yr)		Urban excess %	
	2019	**2050**	**2019**	**2050**
Werribee	233	319	37%	48%
Maribyrnong	229	274	35%	37%
Yarra	1836	1772	15%	20%
Dandenong	370	411	54%	58%
Westernport	1150	1225	15%	19%
Region	3818	4001	22%	28%

The current proportion of runoff which is urban excess is 22%, which amounts to 866GL/year of runoff. The highest proportion of urban excess is seen in Dandenong, the most urbanised Catchment, followed by Werribee and Maribyrnong Catchments. The proportion of runoff which is urban excess is expected to increase in all Catchments, as existing urban areas intensify and new development areas are constructed, thereby increasing impervious surfaces. The urban excess predicted for the region by 2050 is 1,148GL/year, an increase of 283GL/year.

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[57] Based on results from the Source Catchments model and factored to represent an equivalent MUSIC estimation of runoff generation (to enable comparison with removal estimations).

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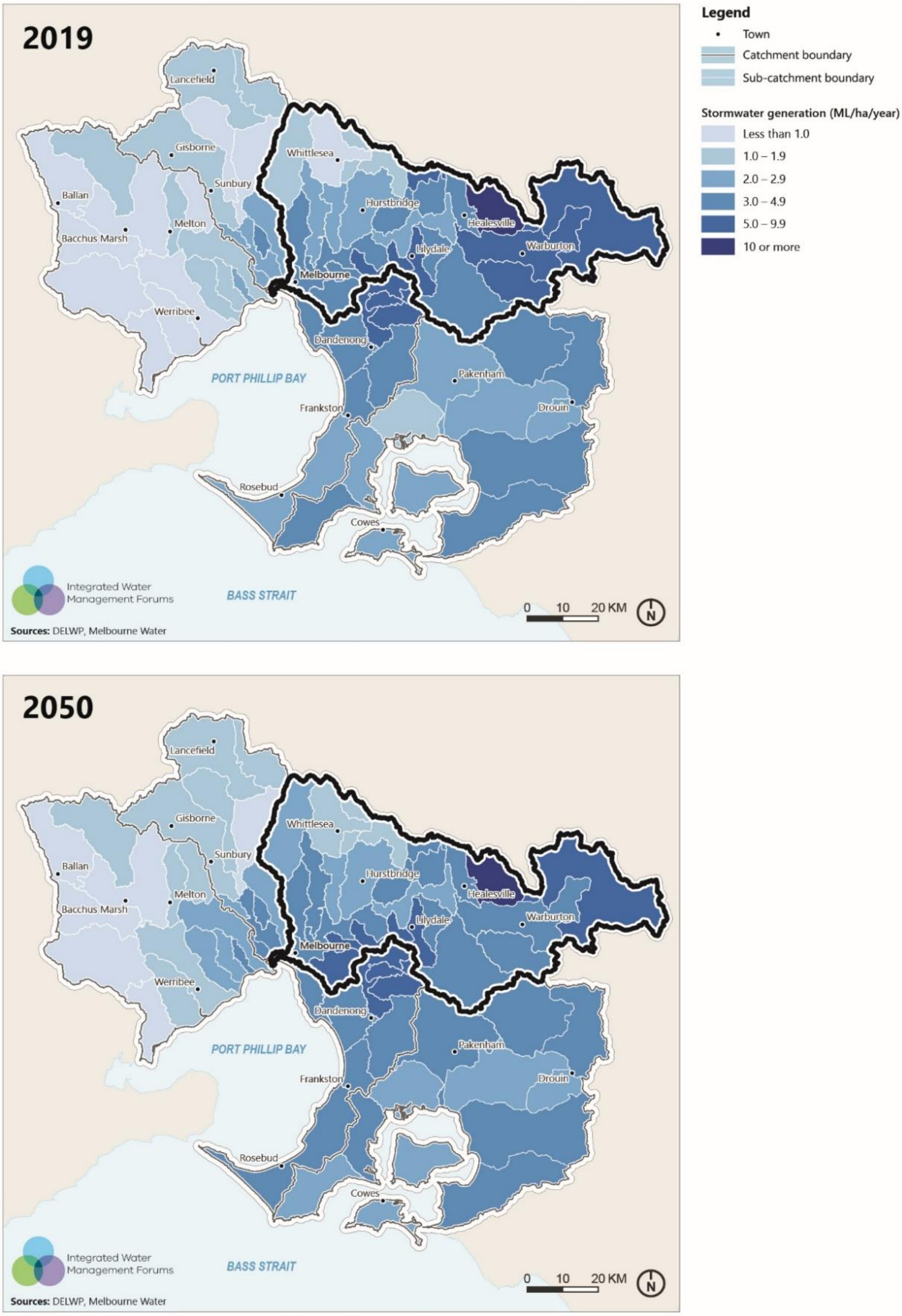

Figure 39: Runoff from each sub-catchment, expressed as ML/ha/year (current and future reference state)

Port Phillip Bay and Western Port Health

The health of Port Phillip Bay and Western Port are crucial to the Metropolitan Melbourne Region and to Victoria more broadly. Essential for tourism, recreation and habitat, protecting and improving the water quality of the bays is a key objective for IWM. Port Phillip Bay and Western Port are especially sensitive to pollutants such as nutrients and sediment.

Despite the 4 million people living near its 333km coastline, Port Phillip Bay is generally in good health, offering high water quality and an abundance of marine flora and fauna. Along the coast, water quality tends to be lower than in the protected marine parks within the bay, and this is largely related to urban and rural influences on stormwater runoff to the bay.

The reduction of nutrients, including nitrogen, is paramount for the sustained health of Port Phillip Bay, as is the reduction of pathogens and litter. Increasing nutrients and other pollutants will cause poor water quality during wet periods, potentially resulting in more frequent temporary closures of popular beaches.[58] Stormwater is a major source of these pollutants, entering the bay directly and via local waterways. Treated wastewater discharges from wastewater treatment plants, particularly the Western Treatment Plant in the Werribee Catchment, are also major contributors of nutrients to the bay. It is considered that Port Phillip Bay is approaching its environmental limit for nutrients, and the Environmental Management Plan for the Bay has set out targets to effectively annul any new nitrogen discharges to the Bay that will be created as the city grows and changes.

Superficially similar to Port Phillip Bay, Western Port is more complex than its western neighbour, with a greater tidal range, extensive intertidal mudflats, and two large islands (Phillip Island and French Island). The tidal flats are cut by deep channels, with several Catchments draining (some artificially connected) into the north-eastern and eastern parts of the bay. All of this makes for complex oceanographic circulation. Much of its coastline is fringed by mangroves and saltmarshes, and there are extensive seagrass meadows on mudflats and below the low tide level. Nutrient transfer via stormwater and wastewater discharges to the bay are a focus but sediment has been identified as the key indicator of the health of Western Port,[59] and it is believed Western Port Bay is highly sensitive to any further discharges of sediment, so no future increases should be made to sediment loads entering the Bay.

Pollutants in runoff generated in Catchments

Pollutants including nutrients and sediment are carried with runoff into the waterways. As described in Appendix A: Water and Pollutant Balance Analysis, a Source Catchments model has been created that predicts the runoff volumes and associated pollutants generated within the Catchments, and the subsequent losses as water moves through the Catchments and the waterways to the Bays. The figures below show the estimation of Total Suspended Solids (TSS) and Total Nitrogen (TN) generated within the Catchments under the current and future reference states on a per hectare basis. The composition of pollutants in runoff depends on a number of factors. Rural areas can show high concentrations of nutrients due to fertiliser use. The pollutants generated in the five Catchments is shown in the table below.

Table 49: Pollutants generated in the five Catchments in the current and future reference state[60]

	TSS generated (ktonnes/yr)		TN generated (tonnes/yr)	
	2019	**2050**	**2019**	**2050**
Werribee	36	40	542	728
Maribyrnong	30	37	432	525
Yarra	56	64	2194	2485
Dandenong	29	33	1381	1566
Westernport	359	372	3804	4173
Region	510	547	8353	9476

[58] Melbourne Water (2017). Port Phillip Bay Environmental Management Plan 2017-2027. Available at: https://www.marineandcoasts.vic.gov.au/coastal-programs/port-phillip-bay
[59] Melbourne Water (2011). Understanding the Western Port Environment: A summary of current knowledge and priorities for future research. Available at: https://www.melbournewater.com.au/sites/default/files/2018-02/Understanding_the_Western_Port_Environment_0.pdf
[60] Based on results from the Source Catchments model and factored to represent an equivalent MUSIC estimation of runoff generation (to enable comparison with removal estimations).

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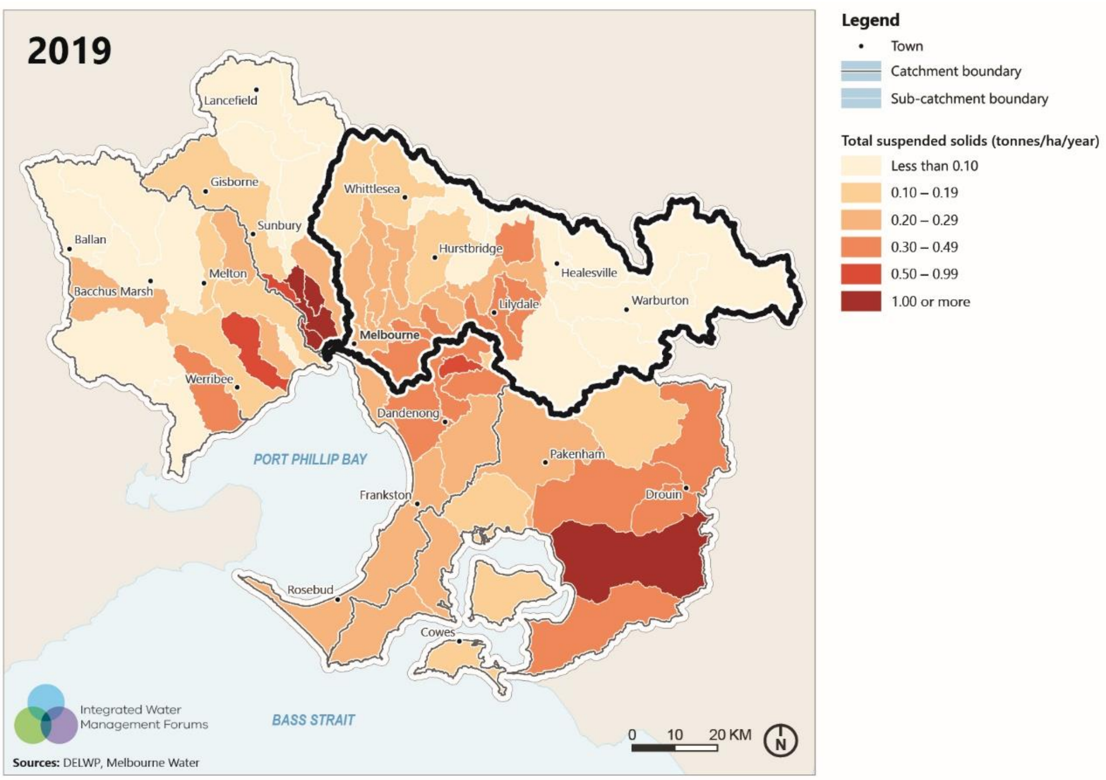

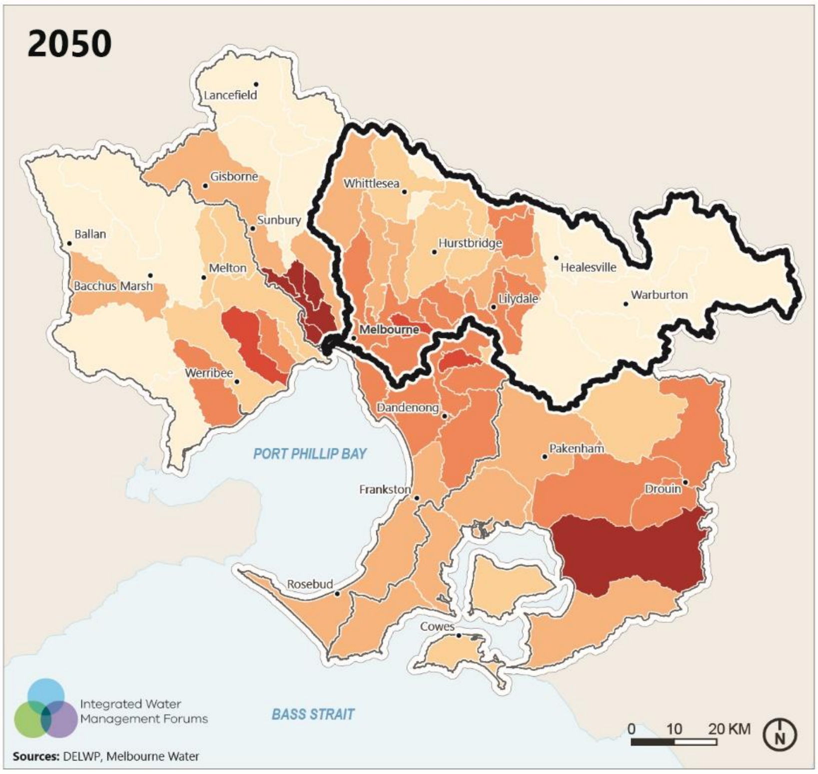

Figure 40: Total suspended solids generated in the Catchment per ha of land (MUSIC approximation from Source Catchments estimate)

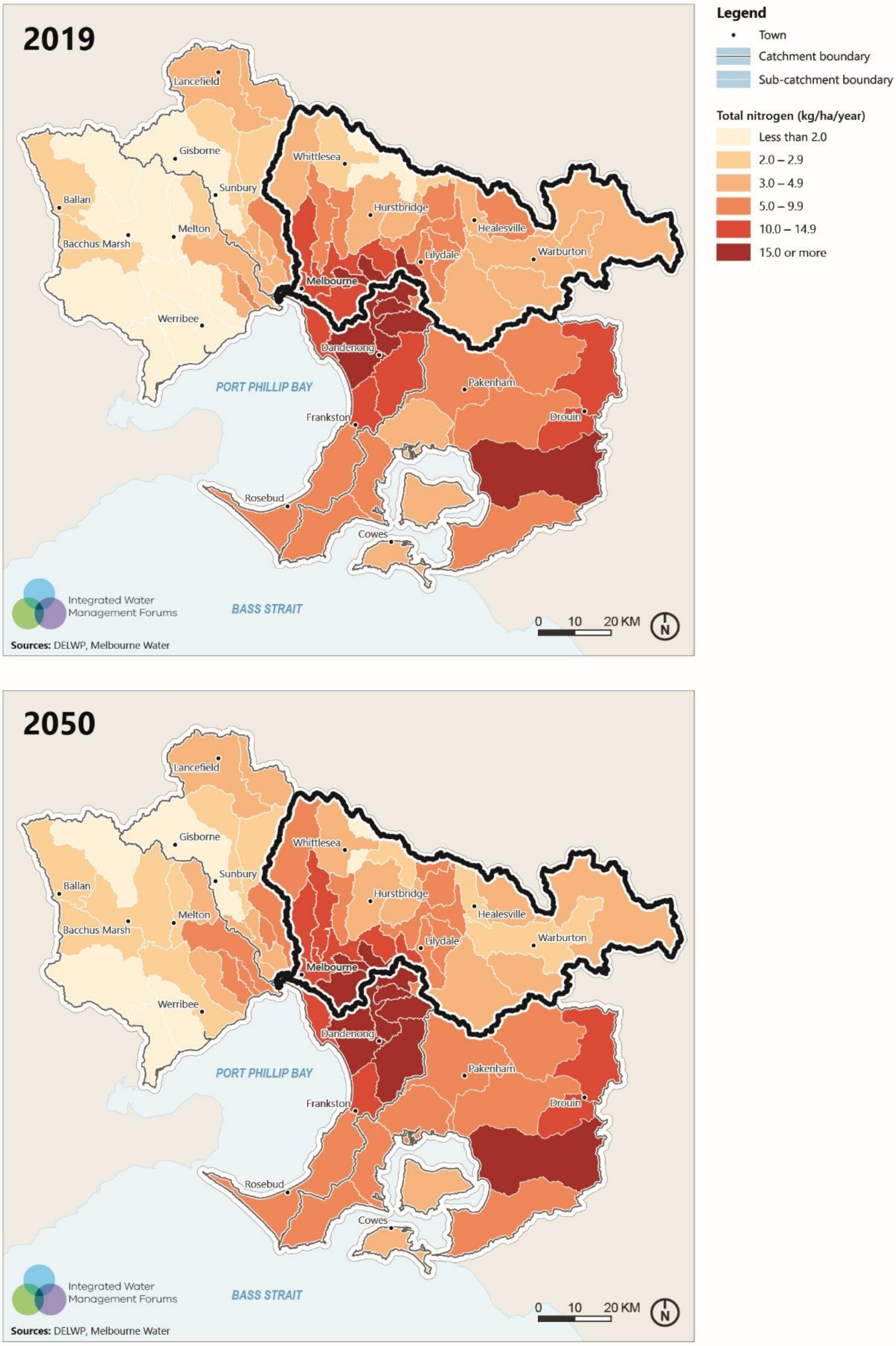

Figure 41: Total nitrogen generated in the Catchment per ha of land (MUSIC approximation from Source Catchments estimate)

Removal of pollutants from runoff

IWM contributes to the removal of pollutants from runoff through various initiatives, including:

i. Urban stormwater treatment;
ii. Rainwater and stormwater harvesting;
iii. Waterway revegetation; and
iv. Rural land improvements.

The impacts of each of these initiatives are discussed in the sections below.

Urban stormwater treatment

It is recognised that there is a pressing need to maintain and improve stormwater treatment within Catchments to improve the quality of water entering our bays.[61] The delivery and maintenance of stormwater treatment devices, also known as Water Sensitive Urban Design (WSUD) assets, is the responsibility of both local councils and Melbourne Water. The delivery of WSUD in established areas is anticipated to continue as councils continue to invest in improvements to stormwater management. WSUD is also anticipated to increase under current policy requirements for new development, with major wetland assets expected across the growth areas under Drainage Schemes coordinated by Melbourne Water.

Our ability to control and treat disparate sources of stormwater is dependent on the active management and maintenance of these stormwater treatment assets. A major audit of stormwater treatment assets across the Greater Metropolitan Melbourne Region highlighted that 25% of the assets surveyed were failing, while 50% were underperforming and required significant maintenance or improvement.[62] Accordingly, performance of WSUD has been reduced by 50% in both the current state and future reference state. Further information on projection assumptions is available in Background Appendix A: Water and Pollutant Balance Analysis.

The following figures show the removal of pollutants (TSS and TN) currently achieved by urban stormwater treatment and the projection into the future under the reference state.

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[61] Melbourne Water (2017). Port Phillip Bay Environmental Management Plan 2017-2027.Available at: https://www.marineandcoasts.vic.gov.au/coastal-programs/port-phillip-bay
[62] Melbourne Water (2017). Living Rivers WSUD Asset Audit. Available at: https://www.melbournewater.com.au/sites/default/files/LivingRivers-WSUD-asset-audit.pdf

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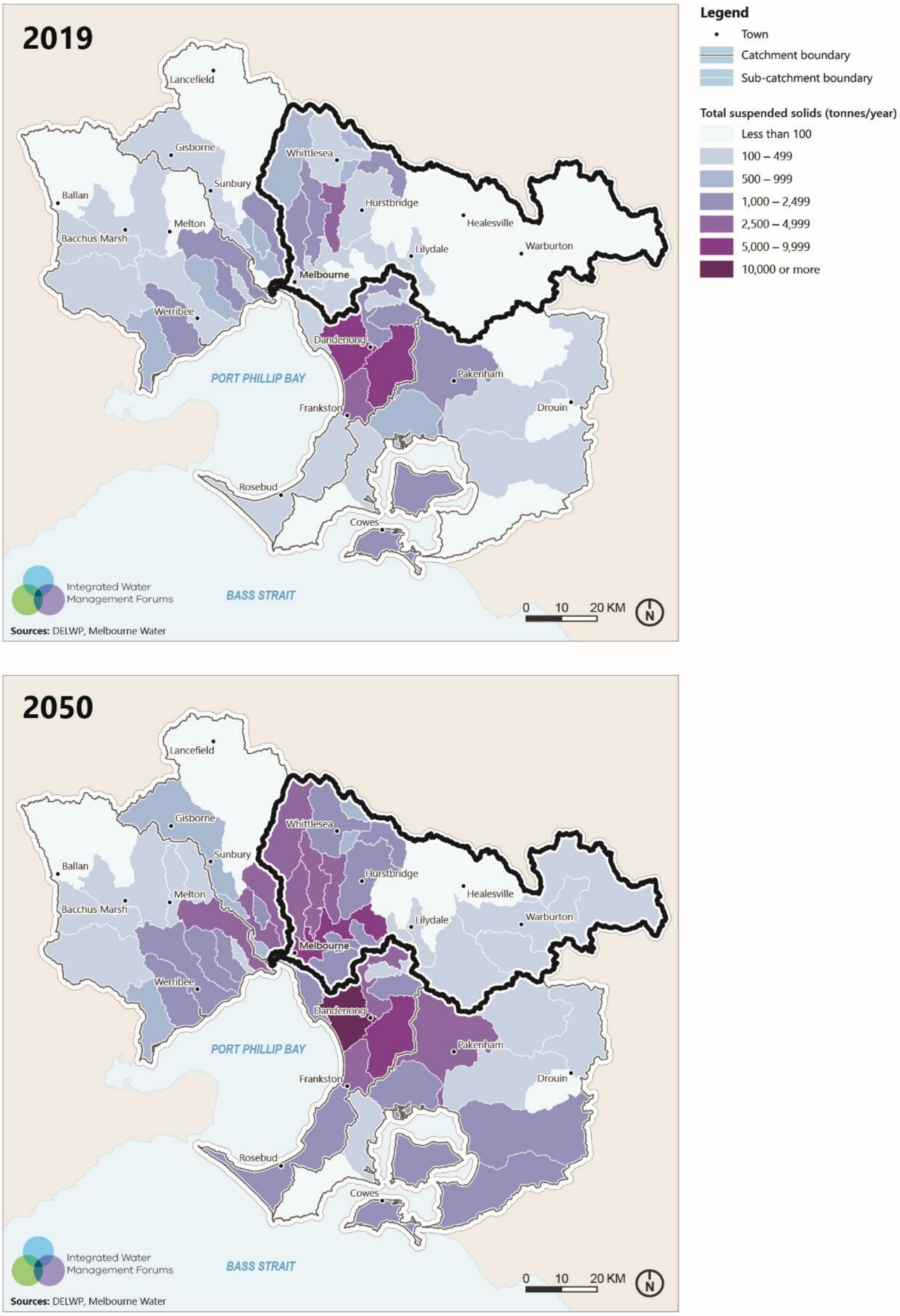

Figure 42: Total suspended solids removed through urban stormwater treatment (current and future reference state)

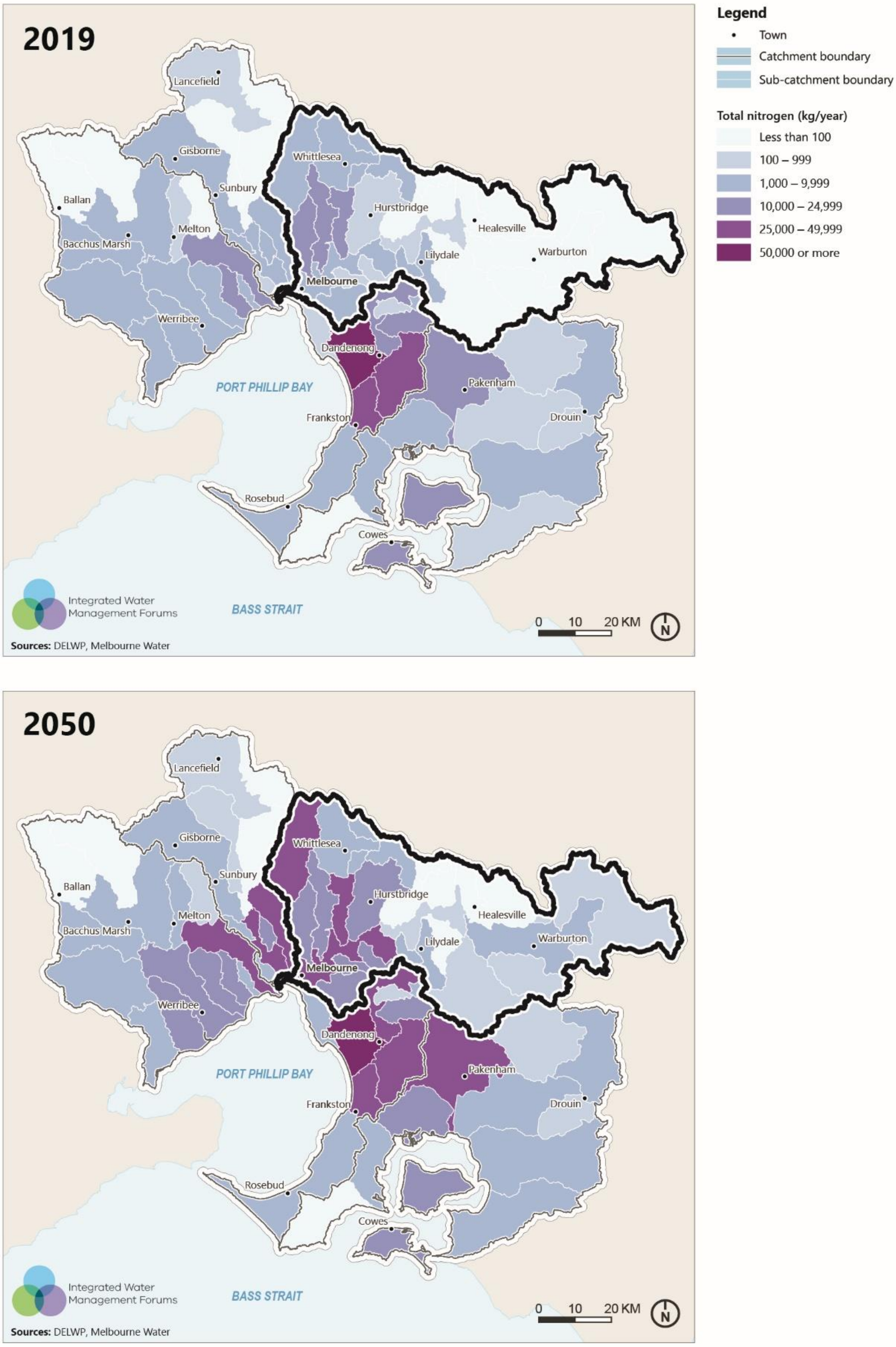

Figure 43: Total nitrogen removed through urban stormwater treatment (current and future reference state)

Rainwater and stormwater harvesting

As discussed under Strategic Outcome 1, the future reference state includes increases in rainwater and stormwater harvesting in some areas. The removal of urban runoff through harvesting also leads to a reduction in pollutants entering receiving environments. The assumptions underpinning these projections is discussed in Background Appendix A: Water and Pollutant Balance.

Waterway revegetation

Under the Healthy Waterways Strategy, waterways have been prioritised for revegetation. These priority waterway sections are located in both urban and rural areas, recognising both the ecological and community value that riparian planting can add to waterways. Under existing Melbourne Water programs investments are made in waterway revegetation and erosion control across Melbourne. It is assumed that this investment program continues under the future reference state at the current rate, distributed evenly across the priority waterways for revegetation.

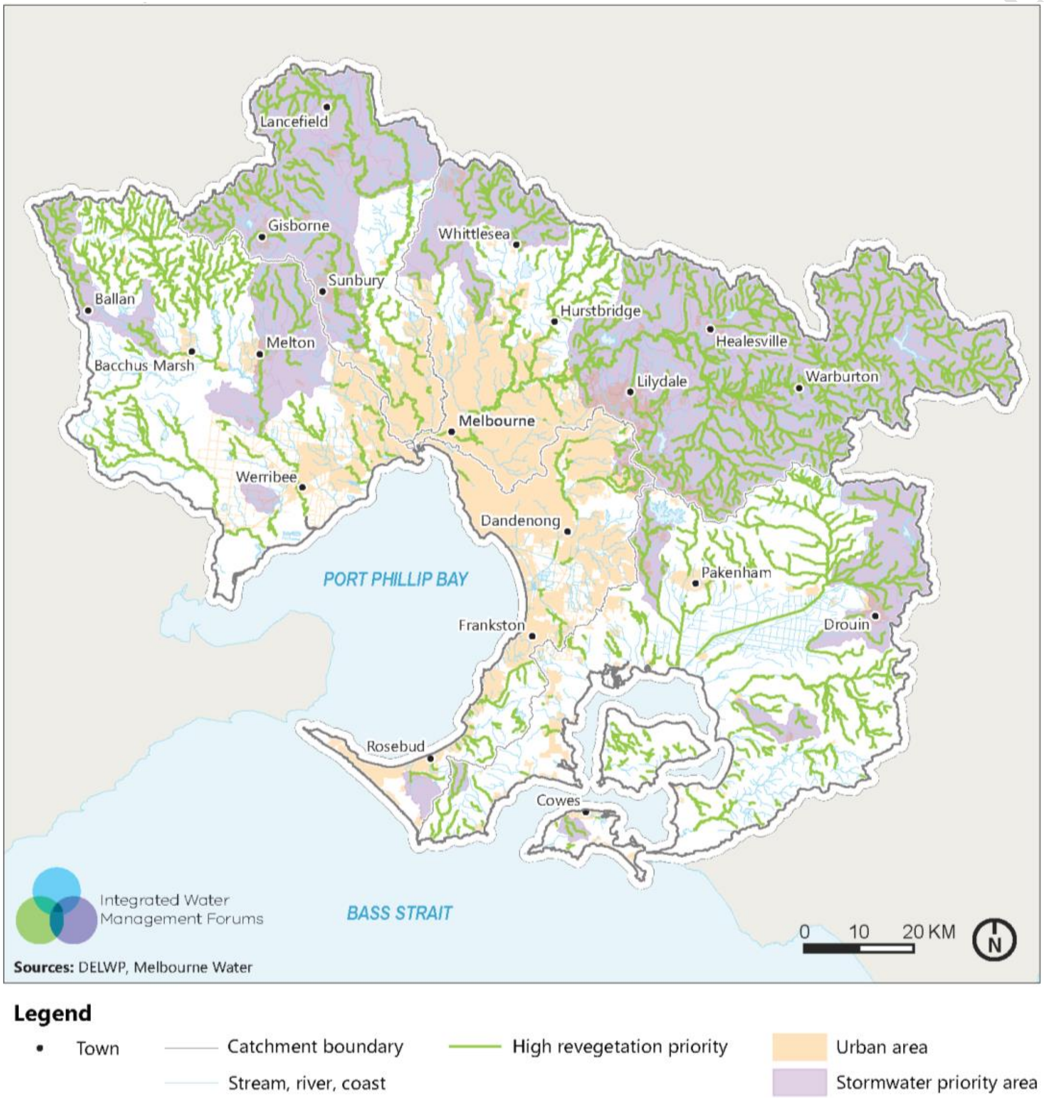

Figure 44: Waterway health across the region (priority revegetation)

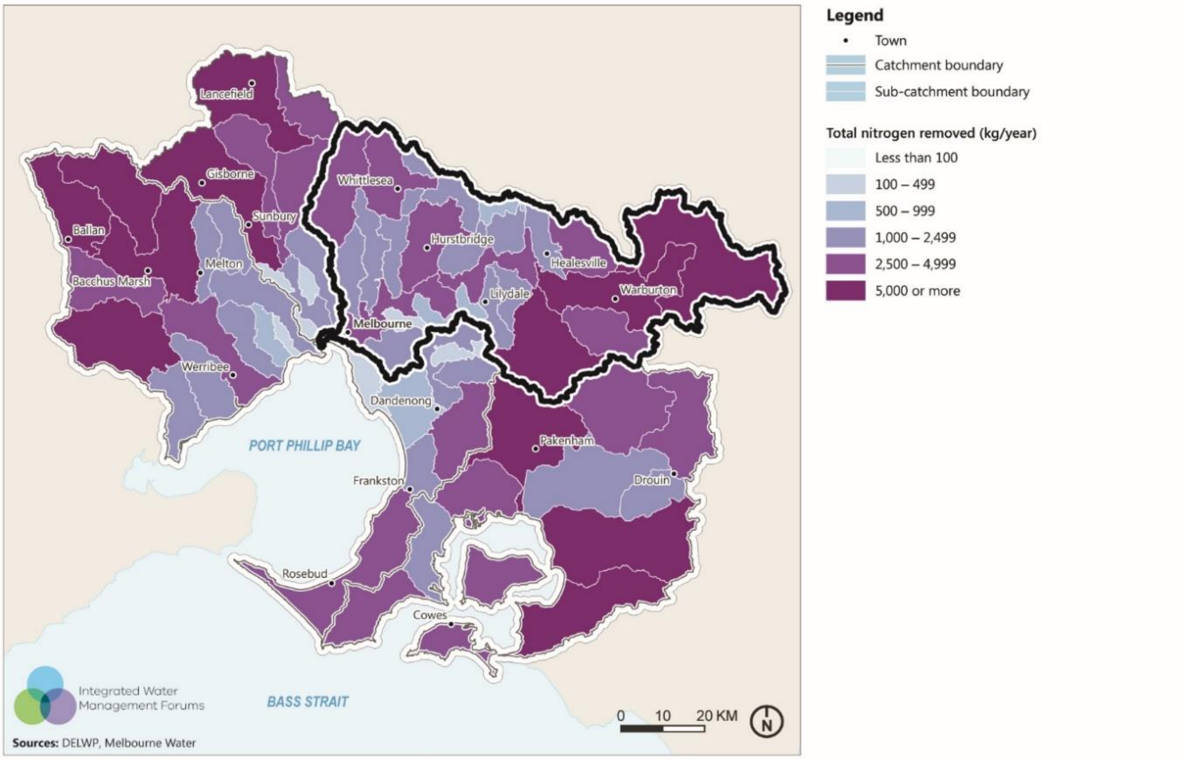

Figure 45: Total nitrogen removed through waterway revegetation (kg/year)

Rural land improvements

Melbourne Water's rural land program works with rural land owners to improve runoff quality and to reduce the generation of pollutants at source. It is assumed to continue under the reference state at the same pace. The figure below shows the spatial distribution of pollutant removals anticipated to be removed by the rural land improvement program under the future reference state.

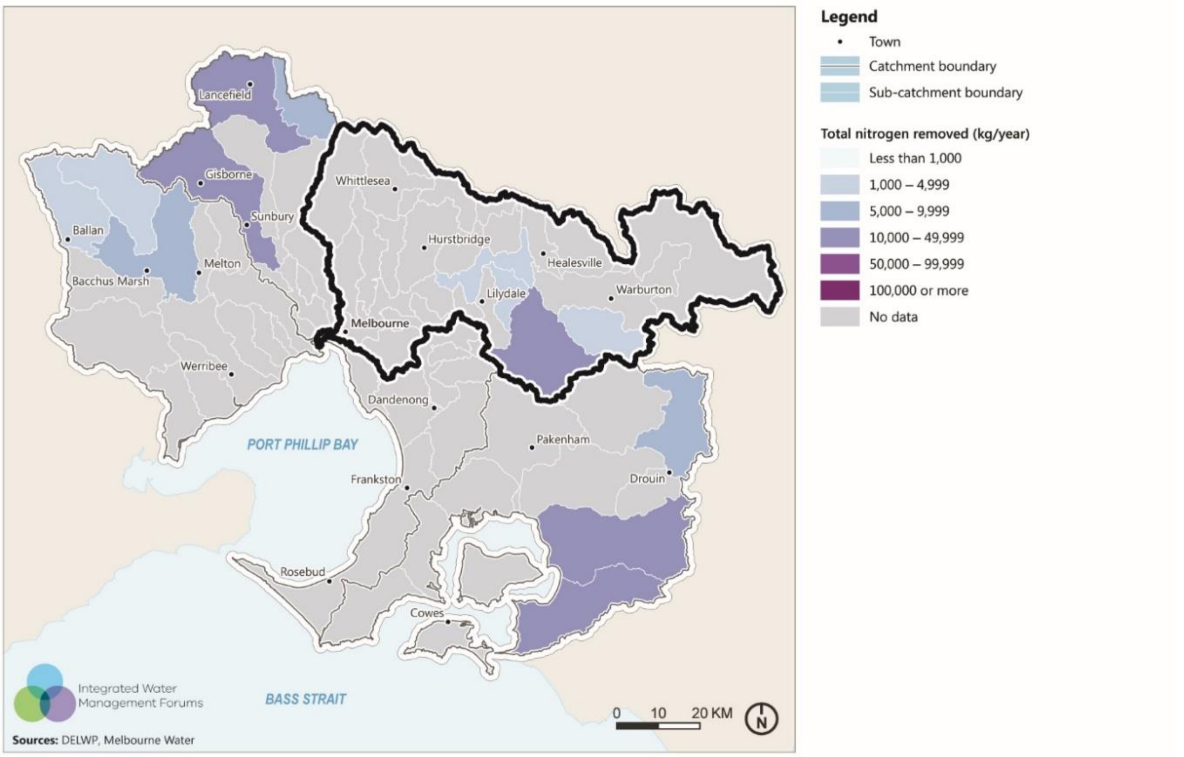

Figure 46: Total nitrogen removed through rural land management (kg/year)

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Pollutants from treated wastewater discharges

Pollutants also enter the environment via treated wastewater discharges from wastewater treatment plants. The pollutant loads entering the environment from wastewater discharges arising from wastewater treatment plants in each catchment are summarised in the table below.

Table 50: Pollutants generated in the five Catchments in the current and future reference state[63]

	TSS released to the environment (tonnes/yr)		TN released to the environment (tonnes/yr)	
	2019	**2050**	**2019**	**2050**
Werribee	2668	3426	2987	3838
Maribyrnong	7	10	13	15
Yarra	10	10	43	43
Dandenong	123	141	1876	2154
Westernport	8	11	32	45
Region	2817	3598	4952	6095

However, the significance of these discharges in terms of the impact on the receiving environment depends on where the discharge occurs and the sensitivity of the receiving environment. The wastewater discharges to the key types of receiving environments are summarised in the table below.

	TSS released to the environment (tonnes/yr)		TN released to the environment (tonnes/yr)	
	2019	**2050**	**2019**	**2050**
Direct discharges to Port Phillip Bay	2668	3426	2987	3838
Discharges to waterways draining to Port Phillip Bay	17	21	56	58
Direct discharges to Bass Strait	130	148	1901	2179
Discharges to waterways draining to Western Port	1	4	7	19

Pollutants released to waterways within the catchments, then travel down waterways where various losses occur, meaning that the pollutant load reaching Port Phillip Bay or Western Port is significantly reduced. The most significant impact of wastewater-derived pollutants on Port Phillip Bay is from the Western Treatment Plant, which discharges directly to the bay.

Environmental flows in waterways

Some of the major waterways in the region have been modified or highly impacted by the use of river water for major water supplies and for agricultural diversions and extractions. This changes the natural flow in the river, in terms of both the volume and timing of flows. This has resulted in a need for environmental water to protect and enhance ecological and habitat values in the waterways. The environmental water reserve consists of water

[63] Based on results from the Source Catchments model and factored to represent an equivalent MUSIC estimation of runoff generation (to enable comparison with removal estimations).

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held in environmental entitlements, along with other water in the system that can contribute to environmental outcomes, such as passing flows, and ‘above cap’ water. The environmental entitlements are the only ‘guaranteed’ water for the environment, with the other aspects being dependent on rainfall and flows in the river in any given year. These are likely to be increasingly impacted by a changing climate in the future, which is predicted to reduce stream flows.

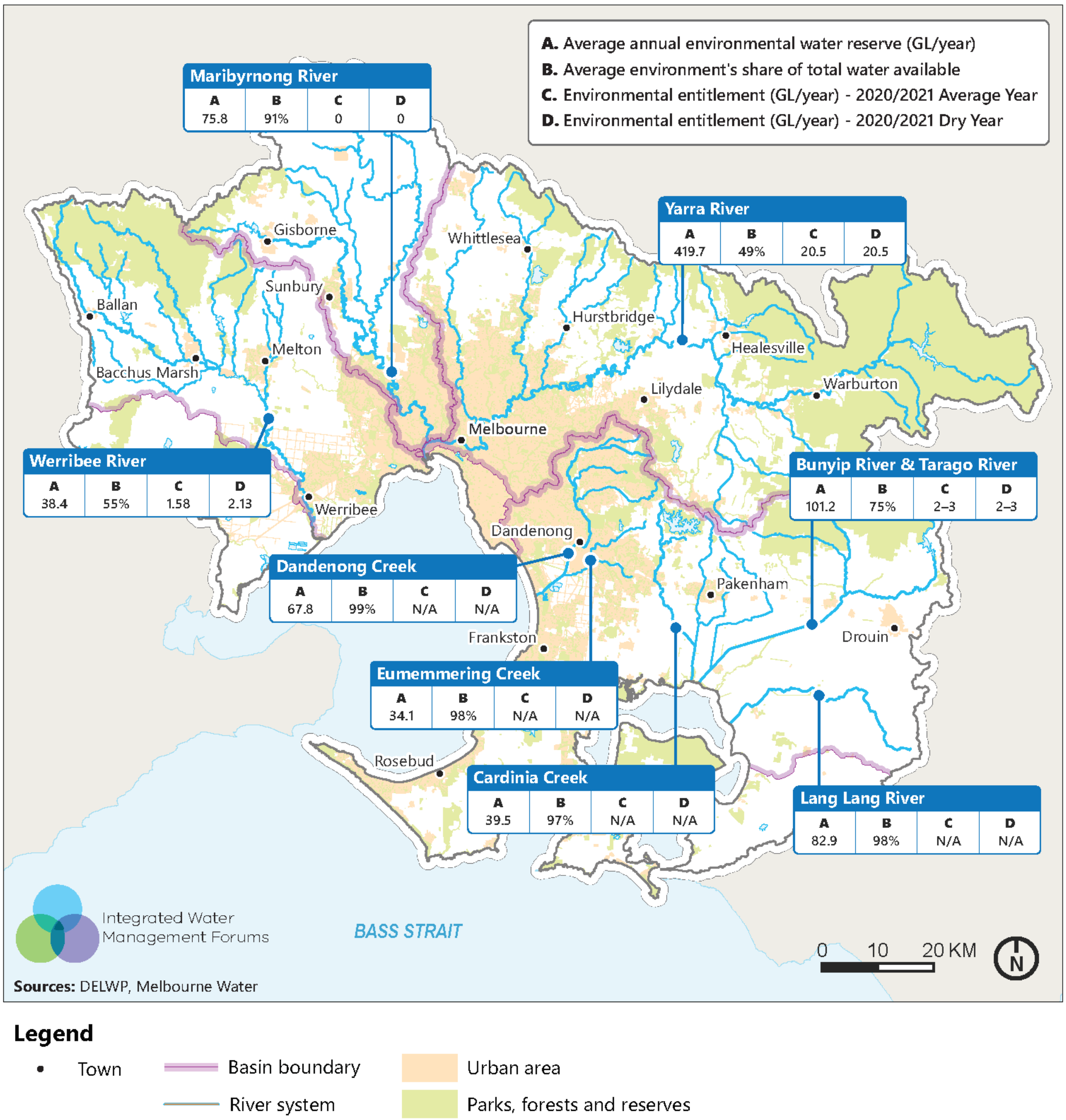

Figure 47: Environmental flows to waterways

The Long Term Water Resource Assessment for the Werribee, Maribyrnong, Yarra and Bunyip-Tarago Catchments in the region provides an average estimate of the share of water currently available to the environment based on the ‘current climate’ and on a ‘future climate’.[64] The environment’s share of water is lowest in the Werribee and Yarra Rivers (55% and 49% respectively), however only a small portion of this share is held in the environmental entitlements. Where alternative water resources can substitute for potable or river water uses, there are future opportunities to add to the environmental water reserve and achieve both environmental and community outcomes. The expected changes in the environment’s share of water due to climate change is shown in the table below.

[64] DELWP (2020). Long Term Water Resource Assessment. Available at: https://www.water.vic.gov.au/planning/long-term-assessments-and-strategies/ltwra

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Table 51: Change in Environment's Share of Flows

Catchment	Environment's share under current climate (GL/yr)	Environment's share under current climate (% of total)	Environment's share under future climate (GL/yr)	Environment's share under future climate (% of total)	Catchment
Werribee	38.4	55%	-12.5 (-33%)	50%	Werribee
Maribyrnong	75.8	91%	-17.2 (-23%)	90%	Maribyrnong
Yarra	419.7	49%	-163.8 (-39%)	42%	Yarra
Bunyip-Tarago	101.2	75%	-20.1 (-20%)	73%	Bunyip-Tarago

Under the future reference state, it is assumed that there is no further allocation of water to the environmental reserve due to IWM initiatives. As a result, the water available to the environment will decrease, with the changes being most marked in the Yarra and Werribee Catchments.

Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 52: Indicators and Measures for Strategic Outcome 4

Indicators	Measures
4.1 Reduce the total urban stormwater runoff volume discharged to receiving waters	ML/yr of mean annual runoff volume reduction; reported with proportion attributed to harvesting, infiltration and evaporation/evapotranspiration
4.2 Decrease pollutants discharged to receiving waters	a. Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters; reported with proportion attributed to urban runoff, rural runoff, wastewater discharges and stream frontage/in-stream sources b. kg/year mean annual Total Nitrogen (TN) prevented from discharging to receiving waters; reported from urban runoff, rural runoff, wastewater discharges and stream frontage/in-stream sources
4.3 Increase environmental benefit to waterways through addition of water to the environmental water reserve, which is of an appropriate quality, magnitude, duration and timing	Additional ML/yr of water allocated to environmental water reserve that increases environmental benefits in waterways

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Indicator 4.1: Reduce the total urban stormwater runoff volume discharged to receiving waters

Measure 4.1: ML/yr of mean annual runoff volume reduction

This measure focuses on stormwater volume reductions, reflecting the desire to reduce the adverse impact that intense and consistent urban stormwater discharges have on waterways. Urban stormwater runoff includes all runoff from “developed” areas as a result of rainfall, including townships within rural areas. The overarching measure is the reduction in mean annual volume, which is also reported with proportions of surface runoff being harvested, infiltrated or lost to evaporation to align with Healthy Waterways Strategy indicators for stormwater runoff reductions.

Table 53: Measure 4.1 overview

Measure 4.1: ML/yr of mean annual runoff volume reduction parameters												
Indicator type	Leading											
Desired State Target Scale	Region, Catchment, Sub-catchment											
Measure performance and targets												
GL/yr	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	22		4		2		6		8		2	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	38	59	7	10	5	8	12	20	12	18	3	5
Desired state	70	197	12	46	8	23	21	71	11	19	18	38

Table 54: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide information on their WSUD assets, rainwater use and stormwater use. Conducted February-March 2020. Surface water licence and metered use data (2018/2019 Financial Year). Provided by Southern Rural Water and Melbourne Water. Provided March 2020.
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis

Current state

Total reductions in flow (i.e. due to rainwater harvesting, stormwater harvesting and infiltration and evapotranspiration associated with stormwater treatment and WSUD practices) for each Catchment were assessed and collated to determine the current state performance.

Performance across the Catchment

Performance varied across the Yarra Catchment but generally the inner, more urbanised areas showed a higher performance, with significant areas of stormwater treatment assets and rainwater tanks. The Yarra Ranges area also performed well.

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Future reference state

The graph below allows for comparison between current and 2050 expected flow reduction performances as a percentage of the total runoff generated in the Catchments, with significant uplifts expected in some Catchments due to increased harvesting and ongoing investments in WSUD.

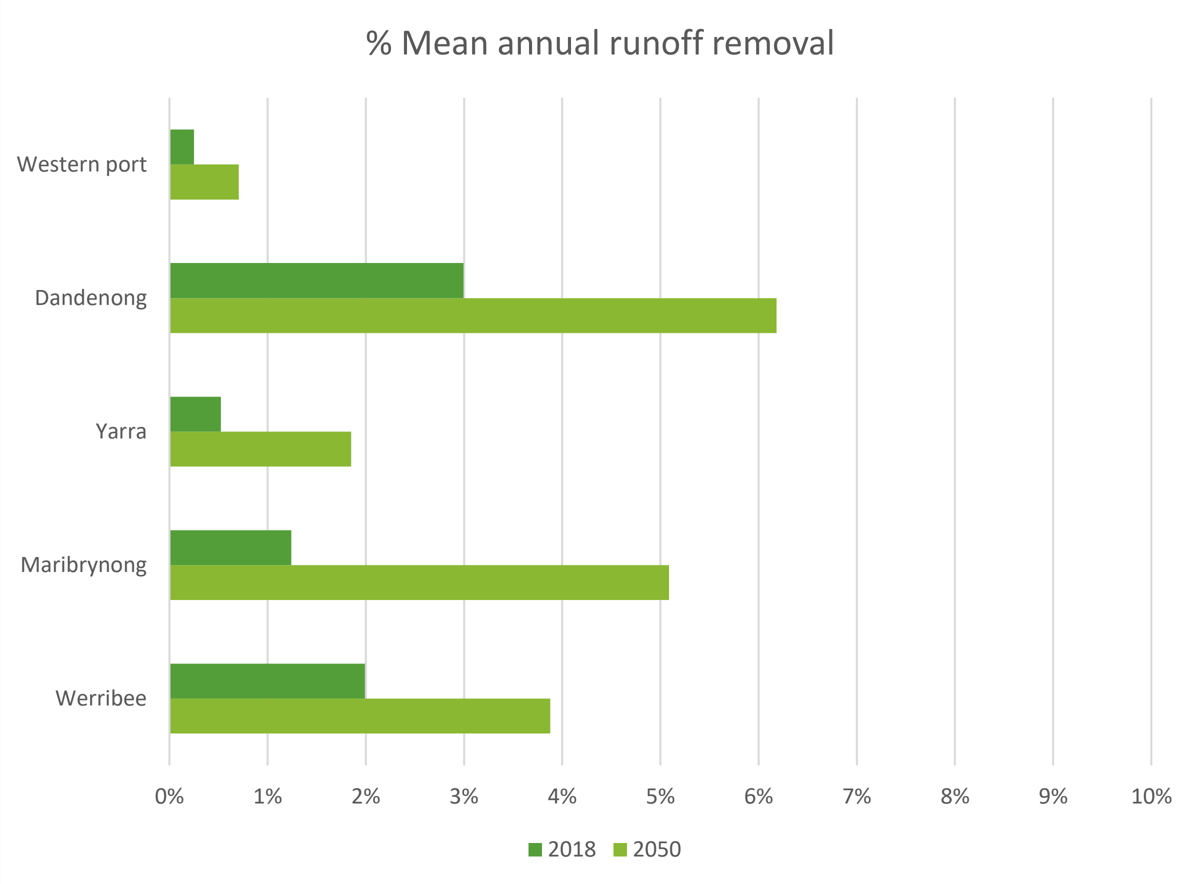

Figure 48: Flow reductions as a percentage of total runoff generated in the Catchments[65]

Proportionally, the majority of flow reduction is being achieved through harvesting, and predominantly rainwater harvesting. A substantial uplift is expected in rainwater harvesting under the changes to VC154 which require best practice stormwater treatment in a greater range of developments, meaning that infill developments will most likely adopt rainwater tanks as a preferred method of achieving pollutant reduction targets. The majority of both existing rainwater harvesting and also new rainwater harvesting under the reference state is located in established areas (delivered through infill development), and only a small portion is predicted within stormwater harvesting priority areas designated by the Healthy Waterways Strategy.

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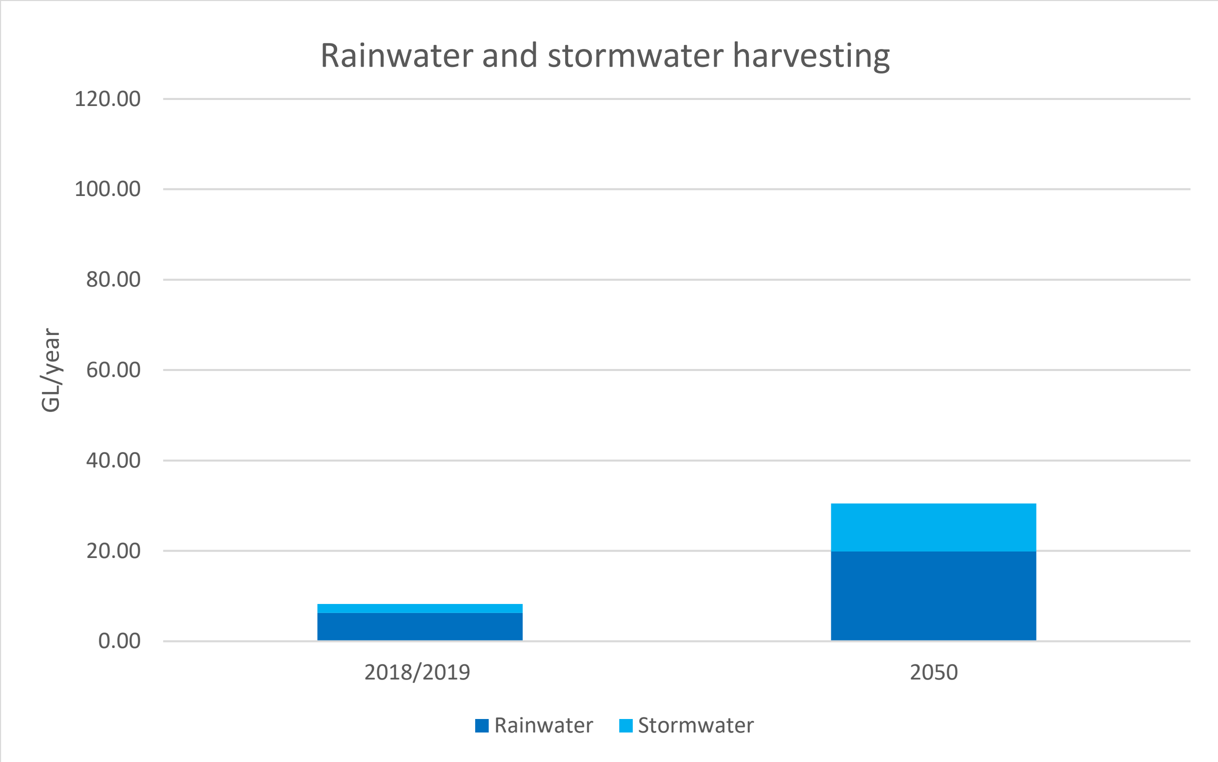
[65] Note that these percentage reductions are compared with the total amount of runoff generated rather than just the runoff from developed areas. The total amount of runoff for each sub-catchment has been estimated using the Source Catchment's model. Flow removals estimated using MUSIC have been factored by 0.47 to align with the source estimate. The calibration factor has been derived by comparing runoff generated from per hectare of impervious area in Source and MUSIC. Source includes different assumptions about how runoff is generated, but also represents directly connected impervious area, while MUSIC uses total impervious area.



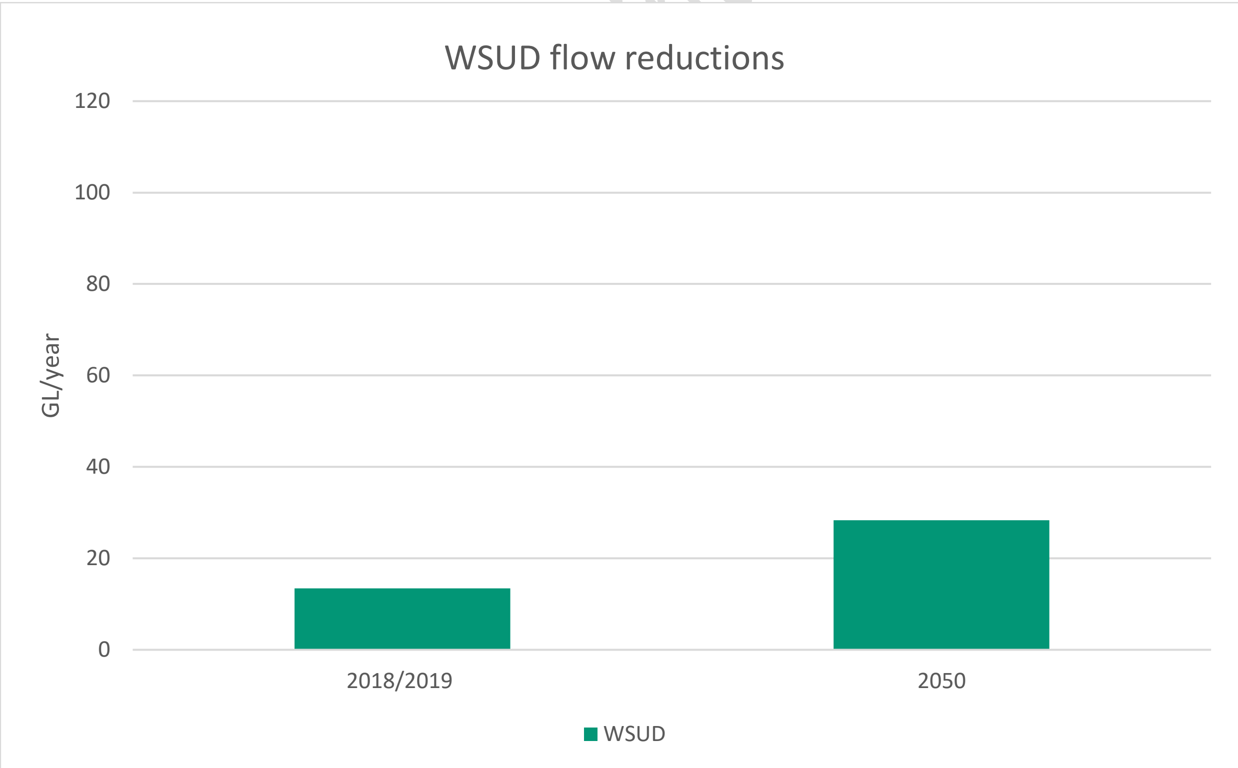


Figure 49: Expected flow reductions (GL/year) across the region as a whole due to harvesting (top) and WSUD infiltration and evapotranspiration (bottom).

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Performance across the Catchment

Under the future reference state, larger amounts of runoff are removed before entering waterways due to increases in rainwater and stormwater harvesting, and increased delivery of WSUD assets which act to hold and infiltrate stormwater runoff.

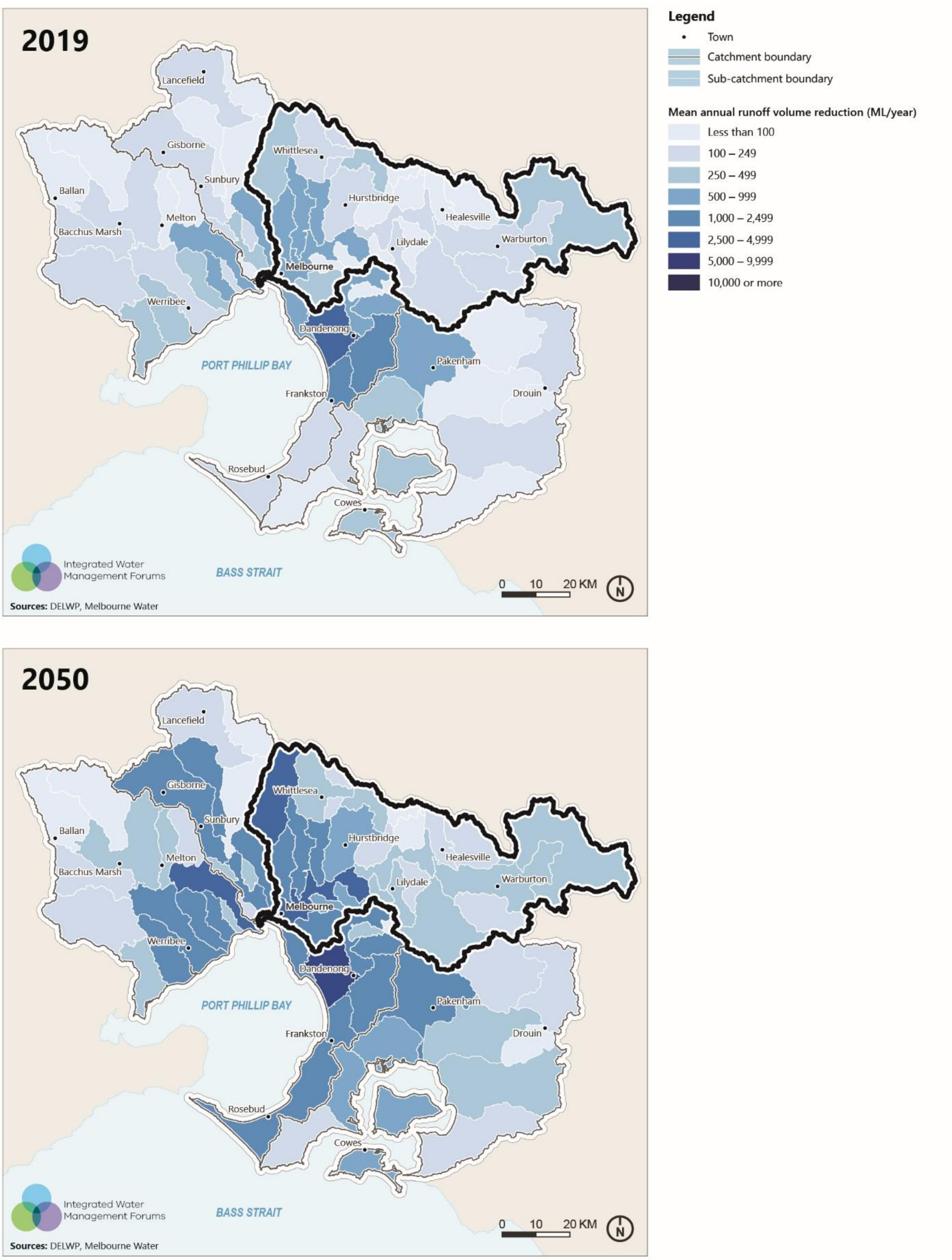

Figure 50: Measure 4.1 ML/yr of mean annual runoff volume reduction (current state and 2050 reference state)

Future desired state

Existing targets and referenceable evidence

The Healthy Waterways Strategy and the associated co-designed Catchment programs for each of the major Catchments includes stormwater harvesting and infiltration targets in priority areas where flow reductions are particularly important to protect and enhance waterway health (‘stormwater priority areas’). These targets are expressed as a ML/year rate for hectare of new impervious area and as a ML/year (based on the expected full build-out of impervious areas within the sub-catchment). These targets aim to substantially reduce runoff entering waterways in spatially defined ‘stormwater priority areas’ by reducing flows through harvesting and infiltration to closely mirror pre-development levels. Through a prioritisation process, these areas were identified and are predominantly on the edges of the existing urban extent of Melbourne, where new development is likely to have the greatest impact on waterways, and where existing waterways are in the best condition. Targets have been set in these areas on a ML/year basis, but are broadly equivalent to an 80% reduction in runoff in most cases.

The EPA is also currently reviewing the Urban stormwater best practice environmental management guidelines (BPEM),[66] which are referenced in the VPPs. The review is to reflect current scientific knowledge and industry practice regarding the harmful effects of stormwater, including harm from stormwater flow. The Draft urban stormwater management guidance released for consultation at the end of 2020 was developed based on a review of available science that highlights urban runoff volume entering waterways as a key metric to work with to improve waterway outcomes. Through its very nature, flow reductions also drive pollutant reductions, but also drive broader benefits to flow regimes, habitat preservation and erosion reduction. The draft guidance proposes a 50-90% reduction in annual runoff volume from new development in priority areas, which are to be defined by the Catchment manager – in Melbourne, it is expected these would align with those outlined in the Healthy Waterways Strategy. Outside of those areas, the draft guidance proposes a 25% reduction in runoff volumes from new developments.

Possible future interventions

The most effective ways to reduce flows to reduce mean annual runoff from new developments, both in an infill context and in greenfield developments has been explored by both Melbourne Water and the EPA as part of their target development for this indicator. In an infill development context, a 25% flow reduction can largely be achieved through the introduction of rainwater harvesting in most contexts where the roof makes up the majority of the impervious site area, but may need to be supplemented through the introduction of additional measures to locally infiltrate or evaporate runoff.

For large greenfield developments, there are likely to be more opportunities to achieve flow reductions at a either the property and street scale, or at a regional scale, through either harvesting or infiltration activities. The costs and the feasibility of these opportunities varies based on the site-specific context, but larger flow reduction targets are generally more feasible where a regional harvesting scheme can be put in place.[67]

Desired state target recommendations

2050 Catchment Target

The Catchment target for this measure aims to protect and enhance our valued waterways for future generations to enjoy, by ensuring that we are take opportunities to reduce runoff from impervious areas, and mimic natural flows in the areas where it matters most. The ‘urban excess’ proportion of runoff is anticipated to increase by 85GL/year by 2050. The regional target aims to remove the majority of that increase in targeted locations where our waterways are most vulnerable to flow increases. The target is made up of three components:

The Healthy Waterways Strategy (HWS) 2050 targets for flow reduction in stormwater priority areas are maintained for the relevant sub-catchments.

[66] EPA (2020). Urban stormwater management guidance. Available at: https://www.epa.vic.gov.au/for-business/find-a-topic/prevent-water-pollution/urban-stormwater-management-guidance#about-our-draft-urban-stormwater-management-guidance

[67] Based on preliminary modelling by Melbourne Water and EPA.

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In all other areas where impervious surfaces will be increased through development, a 25% reduction in flow is incorporated in the target. This seeks to lessen future impacts on waterways in established areas to sustain functional ecosystems to support healthy population of frogs, fish, and other aquatic life while also supporting key amenity and recreation values.

A further collective reduction target is allocated at a Catchment level, which will be prioritised across the Catchment by the Forums. Priorities could be (a) enhanced flow reductions for new developments and (b) disconnecting existing areas in high value areas within sub-catchments that aren't HWS priority areas.

2030 Catchment Target

The 2030 Catchment target has been derived based on (a) foreseeable opportunities to reduce flow associated with new impervious areas, and (b) projected development in the stormwater priority areas and in infill areas.

2050 and 2030 Sub-Catchment Targets

The Catchment targets for this measure have been disaggregated from Catchment level to sub-catchment level. As a proportion of the Catchment target for 2050 is yet to be prioritised at a sub-catchment level, the disaggregated values represent the two components which should be regarded as the minimum target in each sub-catchment:

a. The Healthy Waterways Strategy 2050 targets for flow reduction in stormwater priority areas are maintained for the relevant sub-catchments.

b. In all other areas where impervious surfaces will be increased through development, a 25% reduction in flow is incorporated in the target. This seeks to lessen future impacts on waterways in established areas to sustain functional ecosystems to support healthy population of frogs, fish, and other aquatic life while also supporting key amenity and recreation values.

These minimum targets are presented in the table and figure below.

Table 55: Disaggregated minimum targets for sub-catchments for measure 4.1

Catchment	Sub Catchment	Minimum target (GL/year)		Catchment	Sub Catchment	Minimum target (GL/year)	
		2030	2050			2030	2050
Western Port	Bass River	0.04	0.14	Maribyrnong	Maribyrnong River	0.14	0.45
Dandenong	Bayside	0.13	0.41	Yarra	Merri Creek Lower	0.37	1.18
Dandenong	Blind Creek	0.11	0.36	Yarra	Merri Creek Upper	9.03	29.13
Maribyrnong	Boyd Creek	0.03	0.11	Maribyrnong	Moonee Ponds Creek	0.38	1.23
Yarra	Brushy Creek	1.09	3.50	Western Port	Mornington Peninsula North-Eastern Creeks	0.47	1.50
Western Port	Bunyip Lower	0.14	0.44	Western Port	Mornington Peninsula South-Eastern Creeks	0.04	0.13
Western Port	Bunyip River Middle and Upper	0.03	0.10	Dandenong	Mornington Peninsula Western Creeks	0.31	1.01
Western Port	Cardinia, Toomuc, Deep and Ararat Creeks	3.82	12.31	Yarra	Mullum Mullum Creek	0.11	0.34
Werribee	Cherry Creek	0.09	0.30	Yarra	Olinda Creek	0.53	1.70
Dandenong	Corhanwarrabul, Monbulk and Ferny Creeks	0.41	1.31	Werribee	Parwan Creek	0.02	0.08

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Western Port	Dalmore Outfalls	1.19	3.84
Dandenong	Dandenong Creek Lower	0.56	1.82
Dandenong	Dandenong Creek Middle	0.40	1.28
Dandenong	Dandenong Creek Upper	0.22	0.70
Yarra	Darebin Creek	1.99	6.41
Maribyrnong	Deep Creek Lower	0.30	0.96
Maribyrnong	Deep Creek Upper	1.12	3.60
Yarra	Diamond Creek (Rural)	0.13	0.42
Yarra	Diamond Creek (Source)	0.01	0.04
Maribyrnong	Emu Creek	1.30	4.20
Dandenong	Eumemmerring Creek	1.16	3.75
Western Port	French and Phillip Islands	0.20	0.66
Yarra	Gardiners Creek	0.52	1.68
Maribyrnong	Jacksons Creek	3.44	11.10
Dandenong	Kananook Creek	0.08	0.26
Western Port	King Parrot and Musk Creeks	0.87	2.80
Yarra	Koonung Creek	0.15	0.47
Werribee	Kororoit Creek Lower	3.96	12.77
Werribee	Kororoit Creek Upper	0.31	0.99
Western Port	Lang Lang River	0.13	0.42
Werribee	Laverton Creek	0.43	1.38
Werribee	Lerderderg River	0.01	0.02
Werribee	Little River Lower	0.02	0.05
Werribee	Little River Upper	0.02	0.06
Yarra	Little Yarra River and Hoddles Creek	0.12	0.39
Werribee	Lollypop Creek	1.23	3.96
Yarra	Plenty River (Source)	0.00	0.00
Yarra	Plenty River Lower	0.21	0.67
Yarra	Plenty River Upper	0.21	0.67
Werribee	Skeleton Creek	0.79	2.55
Maribyrnong	Steele Creek	0.08	0.27
Yarra	Steels and Pauls Creek (Rural)	0.01	0.03
Yarra	Steels and Pauls Creek (Source)	0.01	0.02
Maribyrnong	Stony Creek	0.05	0.15
Yarra	Stringybark Creek	0.17	0.54
Western Port	Tarago River	1.27	4.10
Maribyrnong	Taylors Creek	0.05	0.17
Werribee	Toolern Creek	1.05	3.40
Yarra	Watsons Creek	0.03	0.09
Yarra	Watts River (Rural)	0.18	0.59
Yarra	Watts River (Source)	0.00	0.00
Werribee	Werribee River Lower	1.60	5.17
Werribee	Werribee River Middle	0.32	1.02
Werribee	Werribee River Upper	0.34	1.10
Yarra	Woori Yallock Creek	0.31	1.00
Yarra	Yarra River Lower	0.72	2.33
Yarra	Yarra River Middle	1.46	4.70
Yarra	Yarra River Upper (Rural)	0.28	0.90
Yarra	Yarra River Upper (Source)	0.00	0.00

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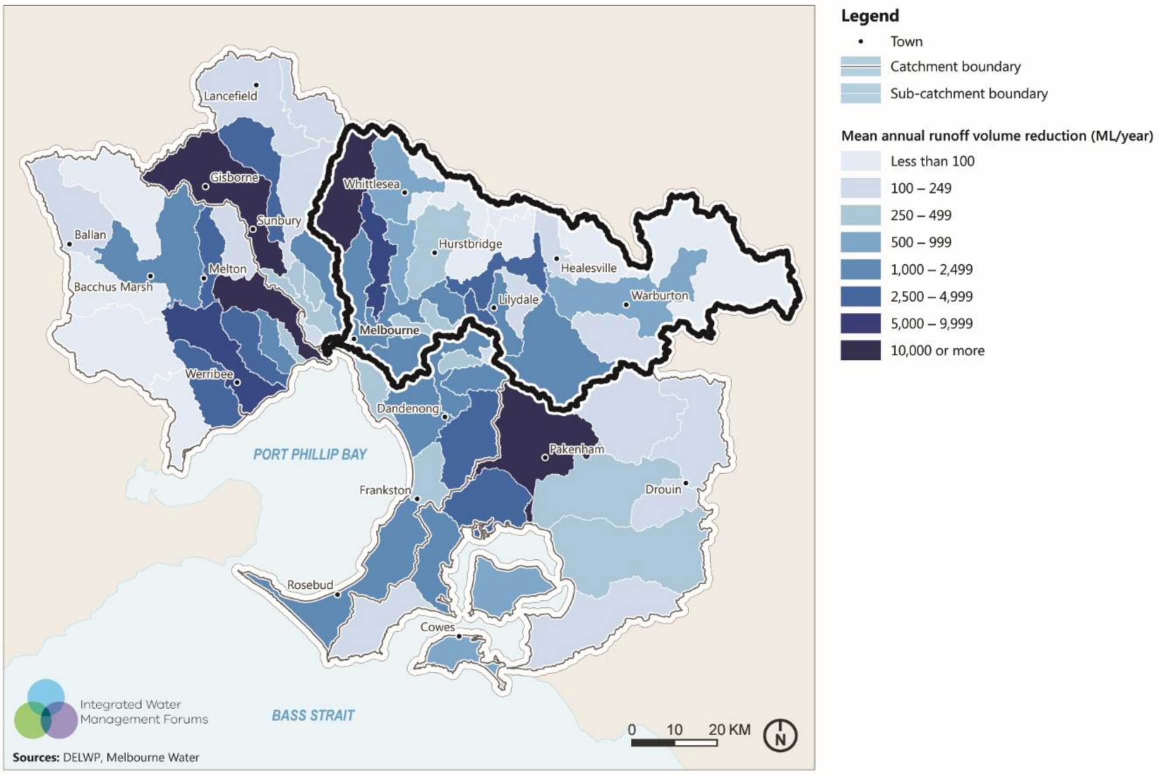

Figure 51: Relative flow reduction targets between sub-catchments

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Indicator 4.2: Decrease pollutants discharged to receiving waters

Measure 4.2a: Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters

This measure focuses on how well we are employing water management techniques to improve water quality by measuring the reduction in a key pollutant transferred to receiving environments: Total Suspended Solids (TSS). It combines data relating to initiatives that remove pollutants, including:

i. urban runoff management (including WSUD, rainwater and stormwater harvesting)

ii. wastewater treatment

iii. other pollutant removal initiatives (including rural land management and waterway rehabilitation).

It should be noted that with albeit much lower concentrations compared with nutrients, treated wastewater also contributes sediments (measured as TSS) to the environment.

Table 56: Measure overview

Measure 4.2a: Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters parameters												
Indicator type	Leading											
Desired State Target Scale	Bay (Port Phillip Bay and Western Port)											
Measure performance and targets												
ktonnes/yr removed[68]	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	205		82		6		16		79		21	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	253	313	100	120	10	18	29	44	89	98	25	32
Desired State	Desired state targets are defined by pollutants entering the Bays as defined by SEPP (Waters). These are reflective of no net increase in TSS loads compared to baseline loads (2018 for Western Port and 2017 for Port Phillip Bay).											

Table 57: Data and assumptions

Data source/s
Refer to Background Appendix A: Water and Pollutant Balance Analysis
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis

Current state

In terms of TSS removal from receiving waters, the majority is achieved through wastewater treatment, however the proportions vary significantly in the Catchments. The wastewater pollutant removal share of the total is highest in the Werribee Catchment and the Dandenong Catchment where the Western Treatment

[68] The regional and catchment totals have been adjusted to ensure no more than 100% removal can occur in a sub-catchment (with double treatment).

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Plant and the Eastern Treatment Plant are located. Though it is notable that the Eastern Treatment Plant's receiving water is Bass Strait, which does not have the same sensitivity to pollutants as the Bays.

Table 58: Components of TSS reduction (tonnes/year) in each catchment – Current State

	Current State pollutant removal breakdown - TSS (tonnes/year) and % of catchment total							
	Rainwater and stormwater harvesting		WSUD		Rural land improvements and waterway revegetation		Wastewater treatment	
Werribee	339	0%	6680	8%	31	0%	75324	91%
Maribyrnong	393	7%	3300	58%	190	3%	1763	31%
Yarra	2308	14%	7888	48%	782	5%	5349	33%
Dandenong	1786	2%	15994	20%	0	0%	61353	78%
Westernport	600	3%	5750	27%	12562	59%	2209	10%
Region	5425	3%	39611	19%	13565	7%	145998	71%

Performance across the Catchment

The largest reductions in TSS are achieved by distributed stormwater treatment devices across the Catchment. Particularly high stormwater treatment can be seen in the inner north urban areas.

Future reference state

Under the future reference state, the largest increases in TSS removal are anticipated from increases in urban stormwater management, as councils are anticipated to continue to deliver WSUD initiatives, while stormwater and rainwater harvesting are projected to increase significantly. Ongoing rural land management and waterway rehabilitation will also continue to make contributions, under the assumption that these programs continue at a similar rate to the current state. A comparison between the removals of TSS from runoff is shown in the figure below. Increased recycled water use under the reference state will also aid removals from wastewater, but the majority of removal occurs in the treatment process itself, rather than through recycling.

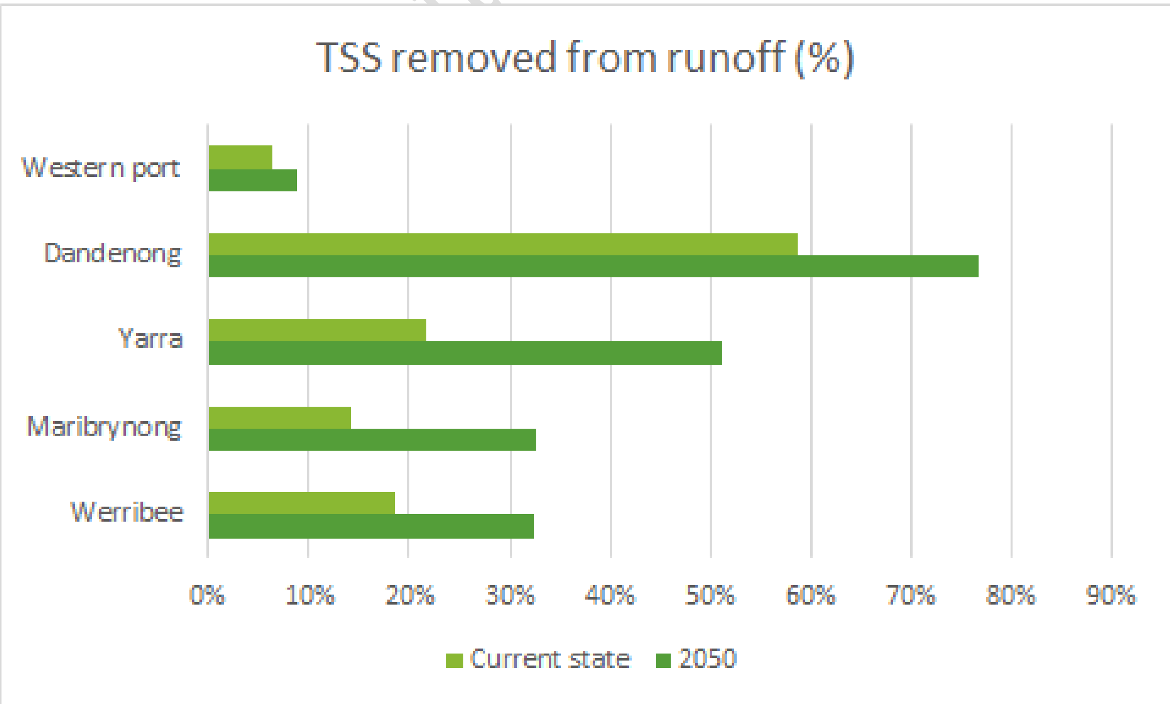

Figure 52: Percentage reduction in TSS achieved through stormwater treatment, stormwater and rainwater harvesting and rural land and waterway improvements compared with pollutants generated in Catchments.

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A summary of the components of the anticipated removal and resulting change in the residual pollutants entering the environment is provided below.

Table 59: Components of TSS reduction (tonnes/year) in each catchment – 2050 Reference State

	2050 Reference State pollutant removal breakdown - TSS (t/year) and % of catchment total							
	Rainwater and stormwater harvesting		WSUD		Rural land improvements and waterway revegetation		Wastewater treatment	
Werribee	851	1%	11822	10%	642	1%	106798	89%
Maribyrnong	1131	6%	9714	54%	1300	7%	5701	32%
Yarra	5300	12%	26561	60%	1537	3%	11067	25%
Dandenong	3898	4%	21516	22%	3	0%	72830	74%
Westernport	1397	4%	12199	38%	14211	44%	4579	14%
Region	12577	4%	81811	26%	17693	6%	200974	64%

Table 60: Residual TSS entering environment (at or near source) in the current state and 2050 future reference state

	Residual TSS entering local environment (tonnes/year)					
	From runoff		From wastewater discharges		Total	
	2019	2050	2019	2050	2019	2050
Werribee	28630	26923	2668	3426	31299	30349
Maribyrnong	26580	25089	7	10	26587	25099
Yarra	45085	31069	10	10	45096	31080
Dandenong	11290	7368	123	141	11413	7510
Westernport	340272	344410	8	11	340280	344421
Region	451857	434859	2817	3598	454674	438458

Performance across the Catchment

Under the reference state, removal of TSS will increase due to the positive impacts of increased delivery of WSUD, wastewater treatment, rural land improvements and waterway revegetation. However, as discussed in the background section, the baseline generation of sediment will also change due to the impacts of population growth and climate change, and accordingly the impact on the pollutant loads entering the environment is a more modest decrease overall. In the Yarra Catchment, the majority of change in TSS removal is expected in urbanised areas through the introduction of WSUD assets.

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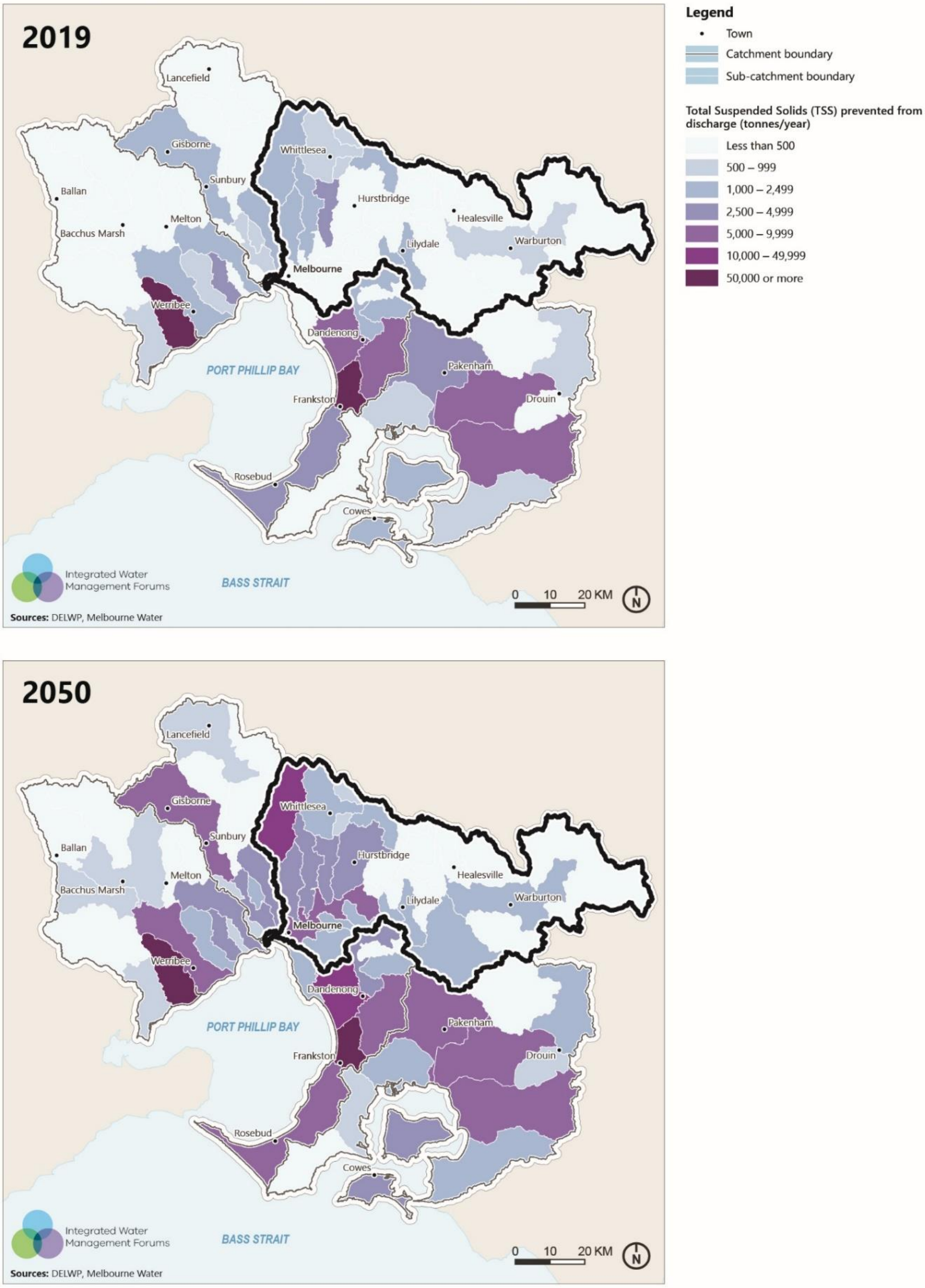

Figure 53: Measure 4.2a Tonnes/year mean annual Total Suspended Solids (TSS) prevented from discharging to receiving waters (current state and future reference state)

Future Desired State

Existing targets and referenceable evidence

The desired state for this measure must consider the scale and location at which the impacts are felt. There are existing pollutant load targets in place for the Port Phillip Bay and Western Port receiving environments. There are also targets that are required at a development scale, and waterway specific targets. All are described below.

Port Phillip Bay Targets

Increased sediments (and associated sediment bound toxicants) is recognised as a significant threat to the Bay, and accordingly targets have been set for TSS. Modelled increases in loads to Port Philip Bay showed more persistent algal blooms and poor water quality at beaches, which would have the potential to reduce tourism contribution to the economy by at least $68 million per year and reduce the value of enjoyment derived by locals and tourists from visiting the Bay by $39 million per year.[69]

SEPP (Waters) sets pollutant load targets to protect the beneficial uses of Port Phillip Bay, for the period 2017 to 2027:

> 1(a) annual pollutant loads entering Port Phillip Bay from the surrounding waterways must not exceed the following ranges –
>
> > (ii) 60,000 to 70,000 tonnes of total suspended solids.
>
> Measures to achieve the targets set out in subclause (1) include ensuring that during the relevant period –
>
> 2(c) the contribution of the Yarra and Maribyrnong rivers do not exceed 70% of the annual total suspended sediment loads discharging into Port Phillip Bay.

The Port Phillip Bay Environmental Management Plan 2017-2027 aims to 'Ensure sediment loads do not exceed current levels and pollutant loads are reduced where practicable'. It aims to achieve this goal through three key actions:

- Effectively maintain existing stormwater infrastructure and programs to mitigate loads to the Bay, or secure via equivalent means.
- Prevent increases in nutrient loads from wastewater systems and where practicable reduce loads of other pollutants.
- Ensure all urban and rural land use effectively controls impacts from stormwater and runoff, and that controls are in place to manage increases in loads.

Western Port Targets

SEPP (Waters) sets out requirements for the period 2018-2028 for TSS:

- The average annual TSS load entering Western Port must not exceed 28,000 tonnes; AND
- There must be a 15% decrease in the TSS concentration in the East Arm segment from an annual mean of 40 mg/L to 34 mg/L by 2028.

Furthermore, 'Understanding the Western Port Environment 2018' provides a summary of research findings from the Western Port Environment Research Program 2011-2017 and priorities for future research.[70] Based on research to date, it highlights that:

- For sediment:
  - The relevant proportions of sediment entering the bay are from Cardinia creek 12%; Bunyip River 31%, Lang Lang River 41% and Bass River 16%.
  - Resuspension of sediment by tides and waves is the primary short-term driver of the light climate within Western Port. The light climate affects seagrass condition and extent by modifying growth rate and mortality.

[69] EPA (2020) Background information: Draft Urban Stormwater Management Guidance Consultation Guide. Available at: https://www.epa.vic.gov.au/about-epa/publications/1829

[70] Melbourne Water (2018). Understanding the Western Port Environment: A summary of current knowledge and priorities for future research. Available at: https://www.melbournewater.com.au/sites/default/files/2018-02/Understanding_the_Western_Port_Environment_0.pdf

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- The primary sediment inputs into Western Port (measured as TSS) are rivers (stream bank and gully erosion) and coastal bank erosion. Some sediment is redistributed, mostly from the Upper North Arm, in a clockwise direction around French Island.
- Catchment sediment supply appears to be below a historical peak but is no longer declining, with an estimated mean-annual suspended solid delivery into Western Port of 23.8 kt/year (since 1980).
- Managing sediment supply at or below current levels may help improve water clarity in coming decades.

Waterway targets

The Healthy Waterways Strategy does not set water quality objectives based on pollutant loads specifically, but sets targets for stormwater harvesting in priority areas (discussed above) along with targets for a range of actions including revegetation and rural land management initiatives. SEPP (Waters) sets out a variety of environmental quality indicators and objectives for major waterways but these are expressed as concentrations within the waterways rather than total pollutant loads. A strategy to define and meet these waterway-based targets is under consideration by Melbourne Water.

Development scale targets

Under the VPPs many developments must design urban stormwater systems to meet BPEM objectives. This means developments must reduce levels of certain substances compared to the typical urban annual load by 80% for TSS. These objectives are currently under review. The Draft urban stormwater management guidance (October 2020) propose no change to pollutant targets, but add flow reduction targets.

Possible future interventions

The interventions to reduce pollutant loads are largely known, and further delivery of initiatives such as urban and rural stormwater management and wastewater treatment improvements are likely to form the focus of future interventions.

The impact of interventions on receiving waters depends on a number of factors, including:

- The receiving water of interest
- The location and type of intervention
- The connections between the intervention and receiving water.

For example, as demonstrated in the diagram below, we can consider pollutant load reductions made by a WSUD asset at a local scale, by considering loads generated by a development, loads removed, and residual loads then leaving a site. This is common practice using MUSIC or STORM modelling for new developments. However, if we wish to understand how much that WSUD asset will reduce pollutants entering a bay downstream, we must also consider pollutant losses that occur as the stormwater moves through the landscape, and within the waterway before it reaches the bay. These losses will depend on a number of factors, meaning that the impact of the same intervention in different locations in the Catchment will have a different impact on the bay.

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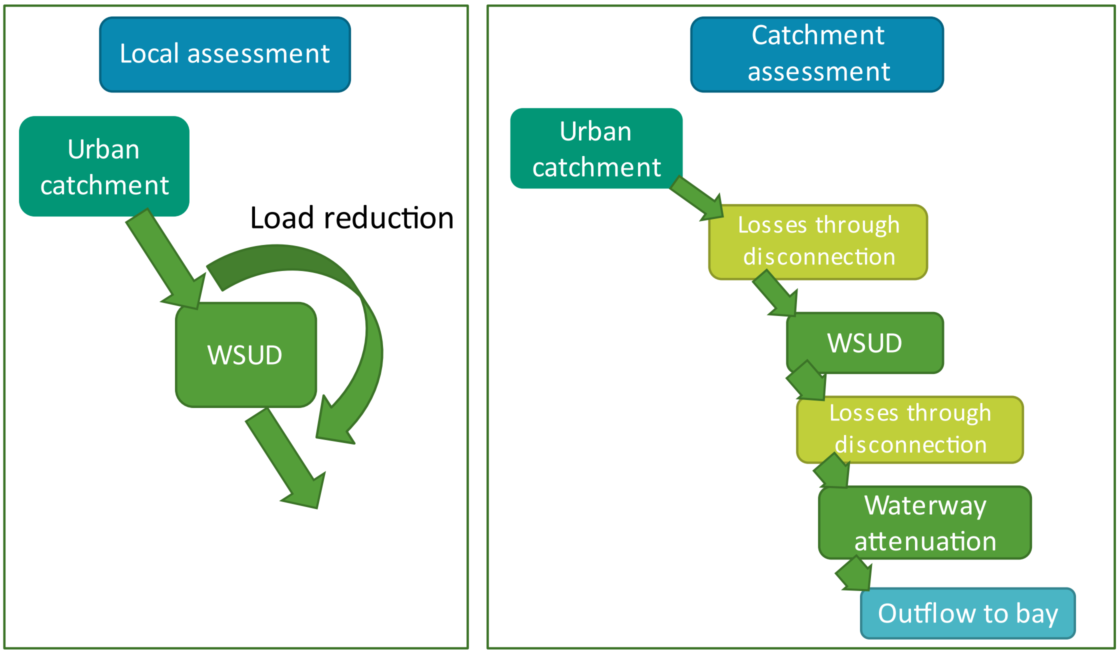

Figure 54: Example of the difference between load reduction estimation at a local scale and modelling of load reduction to a bay at Catchment scale.

A Source Catchments model has been developed and calibrated to flow and pollutant volumes recorded in waterways and in the two bays (see Appendix A: Water and Pollutant Balance Analysis for future detail). The model seeks to represent in-stream processes and losses to better understand how runoff moves through the Catchment, and the total pollutant loads that are transferred to the bays at the bottom of the Catchments. The model has been set up to predict current and future runoff generated within the Catchments, and the corresponding flows and pollutant loads to the bays. The table below shows the modelled pollutant loads entering the two bays and the estimated pollutant removals achieved locally. It shows the modelled TSS loads entering the bays are currently meeting the SEPP (Waters) targets and are predicted to meet the targets under the reference state. It demonstrates that increases in the estimated removal of pollutants through interventions at source are much greater than the pollutant reduction experienced at the bay outlets. This is due to losses occurring in the Catchment and in the waterways, but also due to changes in the impacts of population growth and climate change on the total TSS load being generated in the future (meaning more removal is needed to offset new pollutant loads).

Table 61: Comparison of modelled TSS loads to Bays compared to estimated load removals within Catchments draining to those Bays

	Port Phillip Bay		**Western Port**	
	Modelled kt/year entering bay[71]	Estimated kt/year removed by in-Catchment interventions (at or near source)	Modelled kt/year entering bay[72]	Estimated kt/year removed by in-Catchment interventions (at or near source)
Current State	51	120	28	25
Future Reference State	36	195	27	33

[71] The Source Catchment model for the future reference state includes a high level approximation of future interventions for the reference state across the Catchments.
[72] The sediment entering Western Port has been modelled separately using a Dynamic Sednet model. These figures represent those results. An estimate of the 2050 performance has been estimated based on the proportional difference between the Source Catchments and the SEDNET model.

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Desired State target recommendations

2050 and 2030 Bay Targets

Based on discussions with waterway and bay health experts from Melbourne Water, the 2030 targets for this indicator align with the existing SEPP (Waters) targets for pollutants entering Port Phillip Bay and Western Port as these are scientifically developed targets and the best available evidence at the time of writing. 2050 targets have not been set at this stage.

As the relationship between removal of pollutants at or near source and the pollutant load entering the bay depends on a range of factors, the correlation of interventions and their impact on the targets will need to be tested and monitored using a Catchment scale model over time.

The SEPP (Waters) targets for the bays are reflective of no net increase in TSS loads compared to baseline loads (2018 for Western Port and 2017 for Port Phillip Bay). However, in the future, pollutant loads will increase with urbanisation. Accordingly, at a local level it is prudent to ensure that any new pollutant loads generated are largely removed through interventions to ensure there is no increase in pollutants entering the bays compared with current conditions.

2050 and 2030 Sub-Catchment Targets

It is desirable to also set sub-catchment based targets which relate to the sensitivity of local waterways to pollutants and the opportunities available to drive pollutant reduction. However, at the time of writing there was a lack of evidence to define specific targets for waterway reaches. Melbourne Water is beginning work to consider possible targets for concentrations of pollutants in waterway reaches.

It is worth nothing that targets for measure 4.1 are set at a sub-catchment scale, which will inherently drive the removal of pollutants from urban runoff, and also captures the broader impacts of erosion and flow regime disturbance caused by urban excess runoff.

Measure 4.2b: kg/year mean annual Total Nitrogen (TN) prevented from discharging to receiving waters

This measure focuses on how well we are employing water management techniques to improve water quality by measuring the reduction in a key pollutant transferred to receiving environments: Total Nitrogen (TN). It combines data relating to initiatives that remove pollutants, including:

i. urban runoff management (including WSUD, rainwater and stormwater harvesting)

ii. wastewater treatment

iii. other pollutant removal initiatives (including rural land management and waterway rehabilitation).

Table 62: Measure overview

Measure 4.2b: kg/year mean annual Total Nitrogen (TN) prevented from discharging to receiving waters parameters						
Indicator type	Leading					
Desired State Target Scale	Bay scale (Port Phillip Bay and Western Port)					
Measure performance and targets						
tonnes/yr removed[73]	**Region**	**Werribee**	**Maribyrnong**	**Yarra**	**Dandenong**	**Western Port**

[73] The regional and catchment totals have been adjusted to ensure no more than 100% removal can occur in a sub-catchment (with double treatment).

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Current state	20377		11136		310		937		7567		428	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	23633	29173	12164	14754	592	1057	1372	2092	8757	10352	748	917
Desired State	Desired state targets are defined by pollutants entering the Bays as defined by SEPP (Waters). These targets are reflective of no net increase of TN loads compared to baseline loads (2018 for Western Port and 2017 for Port Phillip Bay).											

Table 63: Data and assumptions

Data source/s
Refer to Background Appendix A: Water and Pollutant Balance Analysis
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis

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Current state

In terms of TN removal from receiving waters, the majority of the removal of nutrients is achieved through wastewater treatment (raw wastewater TN inflows minus wastewater TN loads released to the environment), accounting for 98% of the TN removal in the region. However, good wastewater treatment reflects modern standards of living in a developed city and therefore these levels of removal are very much expected in current times, and will occur into the future. In terms of removals achieved from runoff, the majority of the impact we are making is due to the delivery of WSUD (stormwater treatment initiatives), as shown in the figure below.

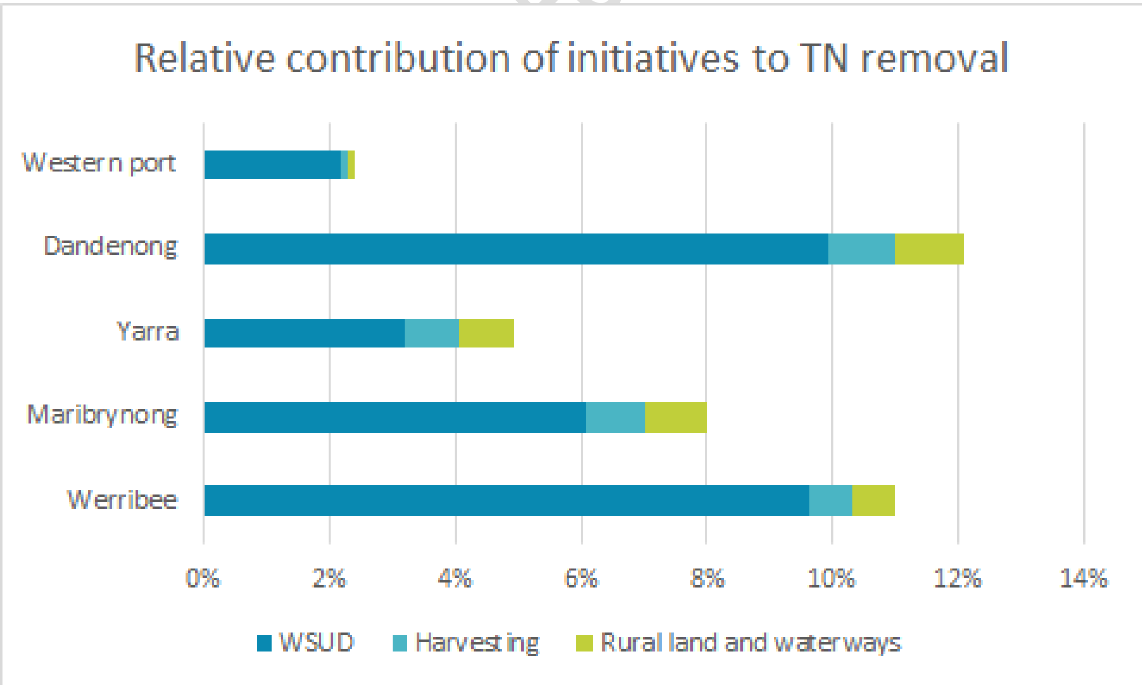

Figure 55: Relative contribution of various interventions to TN reductions in runoff

Table 64: Components of TN reduction (tonnes/year) in each catchment – Current State

	Current State pollutant removal breakdown - TN (tonnes/year) and % of catchment total							
	Rainwater and stormwater harvesting		WSUD		Rural land improvements and waterway revegetation		Wastewater treatment	
Werribee	4	0%	60	1%	0	0%	11072	99%
Maribyrnong	4	1%	22	7%	1	0%	283	91%
Yarra	19	2%	63	7%	1	0%	853	91%
Dandenong	15	0%	166	2%	0	0%	7387	98%
Westernport	5	1%	46	11%	39	9%	339	79%
Region	47	0%	356	2%	40	0%	19934	98%

Performance across the Catchment

The largest reductions in TN are achieved by the wastewater treatment plants in the north and east of the Catchment, but there is also a substantial amount of removal achieved by distributed stormwater treatment devices across the Catchment.

Future reference state

Under the future reference state, the largest increases in TN removal are anticipated from increases in urban stormwater management, as councils are anticipated to continue to deliver WSUD initiatives, while stormwater and rainwater harvesting are projected to increase significantly. Ongoing rural land management and waterway rehabilitation will also continue to make contributions, under the assumption that these programs continue at a similar rate to the current state. A comparison between the removals of TN from runoff is shown in the figure below. Increased recycled water use under the reference state will also aid removals from wastewater, but the majority of removal occurs in the treatment process itself, rather than through recycling.

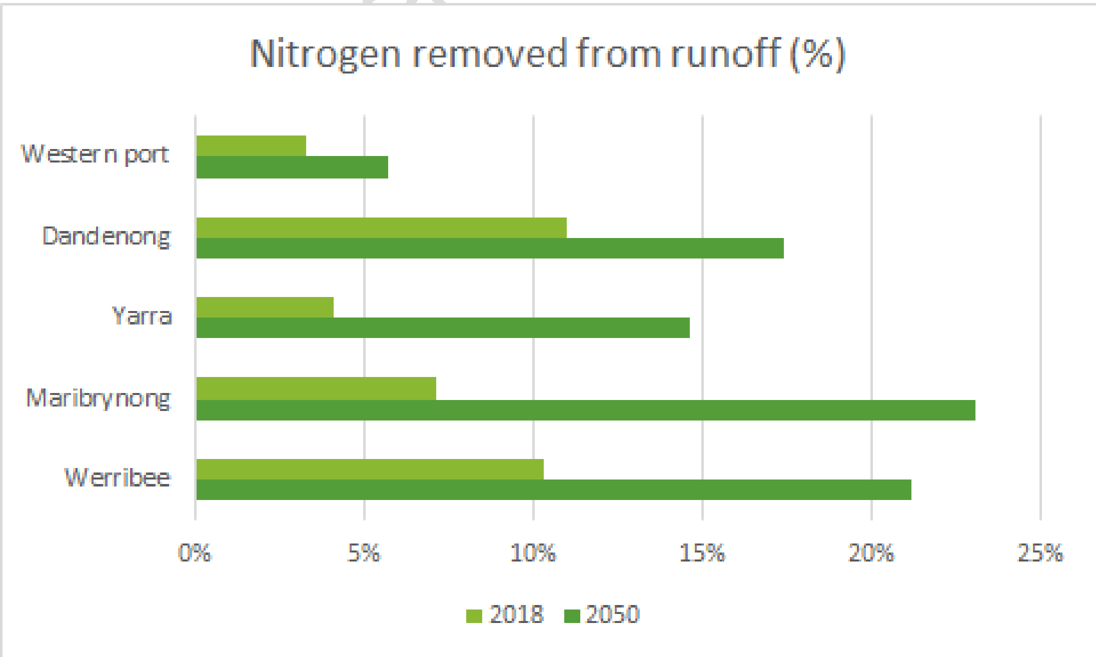

Figure 56: Percentage reduction in TN achieved through stormwater treatment, stormwater and rainwater harvesting and rural land and waterway improvements compared with pollutants generated in Catchments.

A summary of the components of the anticipated removal and resulting change in the residual pollutants entering the environment is provided below.

Table 65: Components of TN reduction (tonnes/year) in each catchment – 2050 Reference State

	2050 Reference State pollutant removal breakdown - TN (tonnes/year) and % of catchment total							
	Rainwater and stormwater harvesting		WSUD		Rural land improvements and waterway revegetation		Wastewater treatment	
Werribee	11	0%	101	1%	49	0%	14594	99%
Maribyrnong	19	2%	60	6%	40	4%	940	89%
Yarra	55	3%	221	11%	79	4%	1737	83%
Dandenong	39	0%	253	2%	10	0%	10049	97%
Westernport	13	1%	83	9%	99	11%	722	79%
Region	136	0%	718	2%	277	1%	28042	96%

Table 66: Residual TN entering environment (at or near source) in the current state and 2050 future reference state

	Residual TSS entering local environment (tonnes/year)					
	From runoff		From wastewater discharges		Total	
	2019	2050	2019	2050	2019	2050
Werribee	479	568	2987	3838	3466	4405
Maribyrnong	405	406	13	15	418	421
Yarra	2111	2129	43	43	2153	2172
Dandenong	1201	1263	1876	2154	3078	3417
Westernport	3714	3979	32	45	3747	4024
Region	7910	8345	4952	6095	12862	14440

Performance across the Catchment

Under the reference state, removal of TN will increase due to the positive impacts of increased delivery of WSUD, wastewater treatment, rural land improvements and waterway revegetation. However, as discussed in the introductory section, the baseline generation of nitrogen will also change due to the impacts of population growth and climate change, meaning the total TN entering the environment is expected to remain similar overall but still increase. In the Yarra Catchment, the majority of change in TN removal is expected through improvements to runoff.

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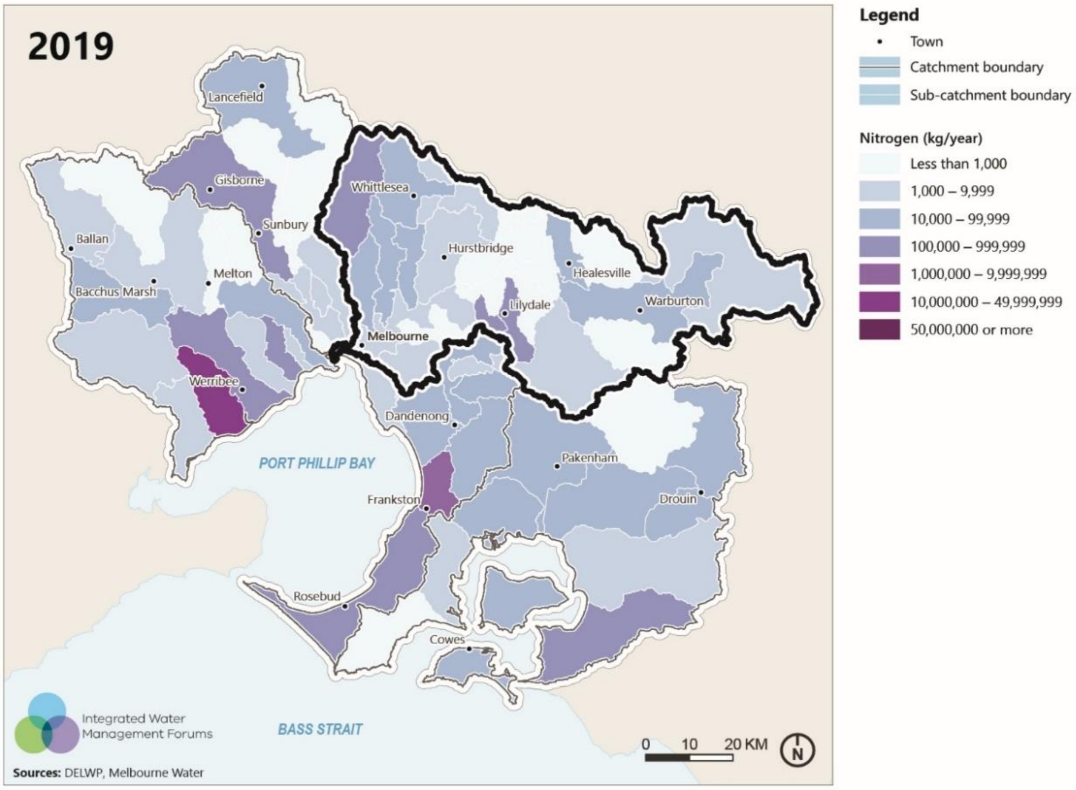

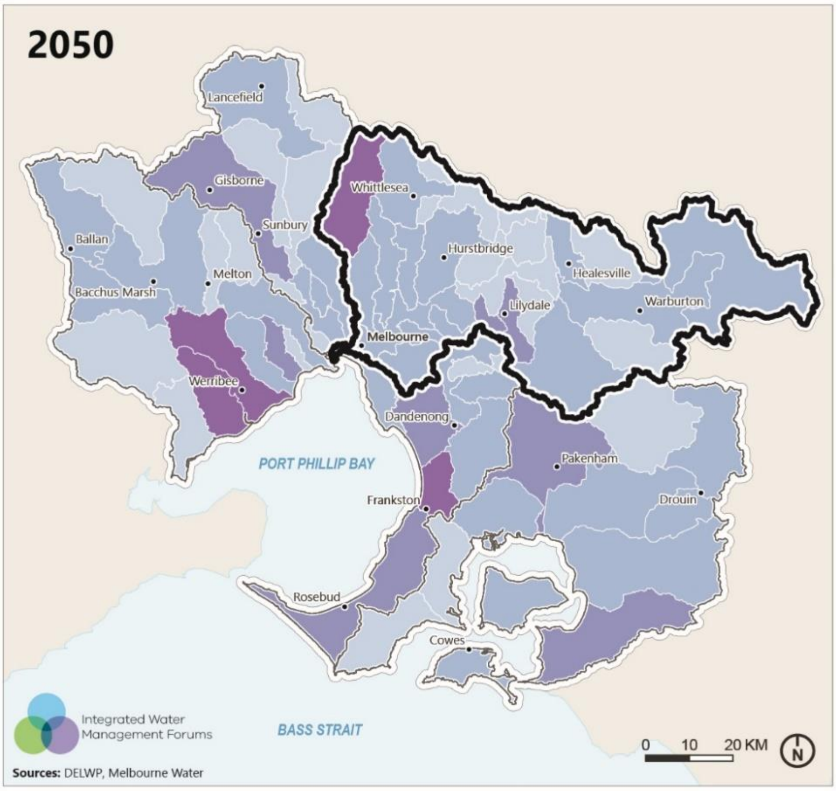

Figure 57: Measure 4.2b. kg/year mean annual Total Nitrogen (TN) prevented from discharging to receiving waters (current state and future reference state)

Future Desired State

Existing targets and referenceable evidence

The desired state for this measure must consider the scale and location at which the impacts are felt. There are existing pollutant load targets in place for the Port Phillip Bay and Western Port receiving environments. There are also targets that are required at a development scale, and waterway specific targets. All are described below.

Port Phillip Bay Targets

Nutrient enrichment is recognised as significant threats to the Bay, and accordingly targets have been set for total nitrogen (TN). Modelled increases in loads to Port Philip Bay showed more persistent algal blooms and poor water quality at beaches, which would have the potential to reduce tourism contribution to the economy by at least $68 million per year and reduce the value of enjoyment derived by locals and tourists from visiting the Bay by $39 million per year.[74]

SEPP (Waters) sets pollutant load targets to protect the beneficial uses of Port Phillip Bay, for the period 2017 to 2027:

> 1(a) annual pollutant loads entering Port Phillip Bay from the surrounding waterways must not exceed the following ranges –
>
> > (i) 1,500 to 2,200 tonnes of total nitrogen; and
>
> 1(b) annual loads of total nitrogen from the Western Treatment Plant must not exceed 3,100 tonnes during the period (based on a rolling three-year average).
>
> Measures to achieve the targets set out in subclause (1) include ensuring that during the relevant period –
>
> 2(a) seasonal loads of total nitrogen do not adversely impact on the denitrification efficiency of Port Phillip Bay or increase the risk of nuisance algal blooms; and
>
> 2(b) there is no net increase in annual loads of total nitrogen discharging directly into Port Phillip Bay, or into waterways in the Port Phillip Bay Catchment, from sewage treatment plants (both existing and proposed); and
>
> 2(c) the contribution of the Yarra and Maribyrnong rivers do not exceed 70% of the annual total nitrogen and total suspended sediment loads discharging into Port Phillip Bay.

The Port Phillip Bay Environmental Management Plan 2017-2027 aims to 'Ensure nutrient loads do not exceed current levels and pollutant loads are reduced where practicable'. It aims to achieve this goal through three key actions:

- Effectively maintain existing stormwater infrastructure and programs to mitigate loads to the Bay, or secure via equivalent means.
- Prevent increases in nutrient loads from wastewater systems and where practicable reduce loads of other pollutants.
- Ensure all urban and rural land use effectively controls impacts from stormwater and runoff, and that controls are in place to manage increases in loads.

Western Port Targets

SEPP (Waters) does not set targets for TN for Western Port. 'Understanding the Western Port Environment 2018'provides a summary of research findings from the Western Port Environment Research Program 2011-2017 and priorities for future research. [75] Based on research to date, it highlights that the 'Preliminary nitrogen budget estimates suggest that Catchment derived nitrogen loads do not accumulate within the water column. This is likely to be largely associated with substantial exchange of water with Bass Strait during each tidal cycle.'

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[74] EPA (2020) Background information: Draft Urban Stormwater Management Guidance Consultation Guide. Available at: https://www.epa.vic.gov.au/about-epa/publications/1829

[75] Melbourne Water (2018). Understanding the Western Port Environment: A summary of current knowledge and priorities for future research. Available at: https://www.melbournewater.com.au/sites/default/files/2018-02/Understanding_the_Western_Port_Environment_0.pdf

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Waterway targets
The Healthy Waterways Strategy does not set water quality objectives based on pollutant loads specifically, but sets targets for stormwater harvesting in priority areas (discussed above) along with targets for a range of actions including revegetation and rural land management initiatives. SEPP (Waters) sets out a variety of environmental quality indicators and objectives for major waterways but these are expressed as concentrations within the waterways rather than total pollutant loads. A strategy to define and meet these waterway-based targets is under consideration by Melbourne Water.

Development scale targets
Under the VPPs many developments must design urban stormwater systems to meet BPEM objectives. This means developments must reduce levels of certain substances compared to the typical urban annual load by 45% for TN. These objectives are currently under review. The Draft urban stormwater management guidance (October 2020) propose no change to pollutant targets, but add flow reduction targets.

Possible future interventions

The interventions to reduce pollutant loads are largely known, and further delivery of initiatives such as urban and rural stormwater management and wastewater treatment improvements are likely to form the focus of future interventions.

The impact of interventions on receiving waters depends on a number of factors, including:

- The receiving water of interest
- The location and type of intervention
- The connections between the intervention and receiving water.

For example, as demonstrated in the diagram below, we can consider pollutant load reductions made by a WSUD asset at a local scale, by considering loads generated by a development, loads removed, and residual loads then leaving a site. This is common practice using MUSIC or STORM modelling for new developments. However, if we wish to understand how much that WSUD asset will reduce pollutants entering a bay downstream, we must also consider pollutant losses that occur as the stormwater moves through the landscape, and within the waterway before it reaches the bay. These losses will depend on a number of factors, meaning that the impact of the same intervention in different locations in the Catchment will have a different impact on the bay.

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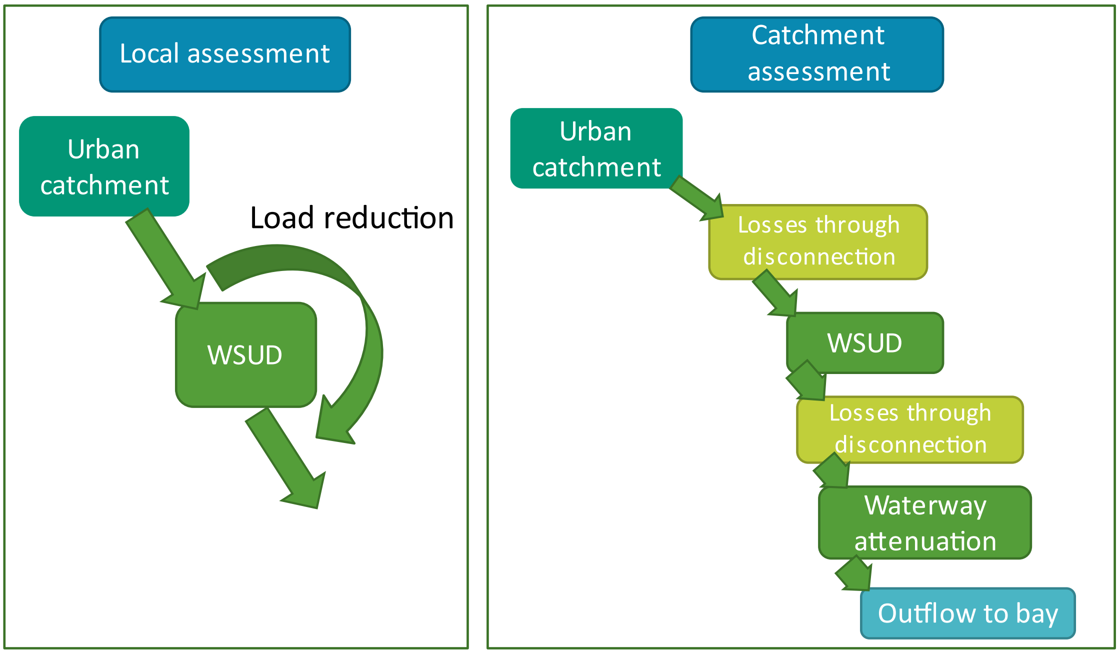

Figure 58: Example of the difference between loan reduction estimation at a local scale and modelling of load reduction to a bay at Catchment scale.

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A Source Catchments model has been developed and calibrated to flow and pollutant volumes recorded in waterways and in the two bays (see Appendix A: Water and Pollutant Balance Analysis for future detail). The model seeks to represent in-stream processes and losses to better understand how runoff moves through the Catchment, and the total pollutant loads that are transferred to the bays at the bottom of the Catchments. The model has been set up to predict current and future runoff generated within the Catchments, and the corresponding flows and pollutant loads to the bays. The table below shows the modelled pollutant loads entering the two bays and the estimated pollutant removals achieved locally. It shows the modelled TN loads entering the bay are currently meeting the SEPP (Waters) targets and are predicted to meet the targets under the reference state. It demonstrates that increases in the estimated removal of pollutants through interventions at source are much greater than the pollutant reduction experienced at the bay outlet. This is due to losses occurring in the Catchment and in the waterways, but also due to changes in the impacts of population growth and climate change on the total TN load being generated in the future (meaning more removal is needed to offset new pollutant loads).

Table 67: Comparison of modelled TSS loads to Bays compared to estimated load removals within Catchments draining to those Bays

	Port Phillip Bay		**Western Port**	
	Modelled t/year entering bay[76]	Estimated t/year removed by in-Catchment interventions (at or near source)	Modelled t/year entering bay[77]	Estimated t/year removed by in-Catchment interventions (at or near source)
Current State	4179	12068	1127	241
Future Reference State	5040	16427	1213	369

Desired State target recommendations

2050 and 2030 Bay Targets

Based on discussions with waterway and bay health experts from Melbourne Water, the 2030 targets for this measure align with the existing SEPP (Waters) targets for pollutants entering Port Phillip Bay and Western Port as these are scientifically developed targets and the best available evidence at the time of writing. 2050 targets have not been set at this stage.

As the relationship between removal of pollutants at or near source and the pollutant load entering the bay depends on a range of factors, the correlation of interventions and their impact on the targets will need to be tested and monitored using a Catchment scale model over time.

The SEPP (Waters) targets for the bays are reflective of no net increase in TN loads compared to baseline loads (2018 for Western Port and 2017 for Port Phillip Bay). However, in the future, pollutant loads will increase with urbanisation. Accordingly, at a local level it is prudent to ensure that any new pollutant loads generated are largely removed through interventions to ensure there is no increase in pollutants entering the bays compared with current conditions.

2050 and 2030 Sub-Catchment Targets

It is desirable to also set sub-catchment based targets which relate to the sensitivity of local waterways to pollutants and the opportunities available to drive pollutant reduction. However, at the time of writing there was a lack of evidence to define specific targets for waterway reaches. Melbourne Water is beginning work to consider possible targets for concentrations of pollutants in waterway reaches, which can be considered when these targets are made available.

[76] The Source Catchment model for the future reference state includes a high level approximation of future interventions for the reference state across the Catchments.
[77] The Source Catchment model for the future reference state includes a high level approximation of future interventions for the reference state across the Catchments.

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It is worth nothing that targets for measure 4.1 are set at a sub-catchment scale, which will inherently drive the removal of pollutants from urban runoff, and also captures the broader impacts of erosion and flow regime disturbance caused by urban excess runoff.

Indicator 4.3: Increase environmental benefit to waterways through addition of water to the environmental water reserve, which is of an appropriate quality, magnitude, duration and timing

Measure 4.3: Additional ML/yr of water allocated to environmental water reserve that increases environmental benefits in waterways

This measure explores the impact of IWM on the provision of environmental flows, which are important for waterways where natural flow patterns have been significantly altered by bulk water supply or irrigation diversions. Here, the measure can be used to understand how IWM can increase allocations of water for environmental benefit through substitution or supplementation of allocations from an alternative water source.

Table 68: Measure overview

Measure 4.3: Additional ML/yr of water allocated to environmental water reserve that increases environmental benefits in waterways parameters												
Indicator type	Leading											
Desired State Target Scale	Region, Catchment											
Measure performance and targets												
GL/yr	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	0		0		0		0		0		0	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	3.1	3.1	0	0	0	0	0	0	0	0	0	0
Desired state	To be defined by the CGRSWS											

Table 69: Data and assumptions

Data source/s
Melbourne Water (2020) Environmental Water Entitlements. Pers. Comm with Lidia Harvey.
Key assumptions
Future reference state includes: • Approximately 2GL as a result of the Werribee Irrigation District and Bacchus Marsh Irrigation District modernisation works. The location of where this allocation will be held is still to be confirmed. • 734ML of high reliability and 361ML of low reliability water has been allocated to the environmental water reserve from the Werribee agricultural college. The allocation will be held at Melton Reservoir.

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Current State

This measure is baselined against current state; therefore the current state value is 0.

Future reference state

New allocations to the environmental water reserve are expected in the Werribee Catchment under the reference state. No changes have been identified in the other Catchments.

Future desired state

For the major waterways, targets for an increase to the environmental water reserve have been set out through several strategies, and most recently by the Healthy Waterways Strategy. These have been summarised below.[78]

Shortfall source	Use of shortfall figure	Shortfall volume (GL/ year)			
		Werribee	M'nong	Yarra	Tar./Bun.
2005 Central Region Sustainable Water Strategy Catchment recovery targets	Previous SWS target (recovery post-SWS)	6 (2.2[1])	3 (0)	20 (17)	3 (3)
2018 Melbourne Water Healthy Waterways Strategy E-Water recovery performance objectives	2030 target	7	5	10	1
2018 Melbourne Water Healthy Waterways Strategy Long term shortfall (bottom of target range)	2050 target (low)	10	10	15	1
2018 Melbourne Water Healthy Waterways Strategy Long term shortfall (top of target range)	2050 target (high) Aspirational target	20	20	25	5

* New modelling for the Yarra, Maribyrnong and Werribee shortfalls will be available in ~3 months (November 2020).

[1] 2.2GL recovered consists of water shares bought by MW (734ML High Reliability and 361 ML Low Reliability Water) and EE of 10% of inflows in Merrimu reservoir, and a maximum of 15 ML/day into Melton Reservoir. The EE is estimated to yield 550ML/year on average.

Figure 59: Summary of existing targets

Long term shortfall ranges (2050 low-high targets) have been set out in the Healthy Waterways Strategy. The Yarra and Tarago/Bunyip values have taken into account the range of figures that have been calculated from the recent studies undertaken (in 2017) using a combination of climate scenarios (such as current baseline climate, 2040 median climate, 2065 median climate). The Werribee and Maribyrnong values have taken into account the range of figures calculated for all reaches in the system (in 2017) using the 'step climate change record'. This does not include storage provision and is in addition to the current Entitlement (i.e. there is no entitlement in the Maribyrnong so the new range represents the new shortfall whereas the Yarra has 17GL existing so the 15-25 is in addition to the 17GL).

The strategy also sets out recovery 10-year performance targets based on the assumption that recovery will be greatest early in the Strategy, as the 'easiest/simplest' recovery options are implemented. Due to this, the targets have been 'front loaded' with more recovery early, and less recovery as time progresses. These performance objectives are recovering volumes to maintain the current level of service for environmental flows. These volumes would maintain current condition, not improve environmental conditions.

Possible future interventions

A variety of interventions could be delivered to increase the environmental water reserve. This could include provision of alternative water resources to substitute users who currently rely on water from the river system, thereby allowing a transfer of allocations to be made.

Desired state target recommendations

Targets for environmental water are currently being considered in detail as part of the development of the Central and Gippsland Region Sustainable Water Strategy (CGRSWS). Targets for this Plan will mirror targets set in the CGRSWS.

[78] Provided by Melbourne Water.

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Strategic Outcome 5 – Healthy and valued urban and rural landscapes

This strategic outcome explores the impact that IWM can have on urban and rural landscapes. Water itself is an important part of the landscape and can also support and enhance the health of vegetation and green spaces, helping to provide greater amenity, better opportunities for recreation, improved ecological value and localised cooling that gives relief to communities during hot weather. By supporting landscapes with alternative water supplies, it is also possible to enhance resilience during droughts where potable water supplies may be restricted, and to opportunistically harness local alternative supplies to provide water to landscapes that may not otherwise receive irrigation.

The case for change

The landscapes of Greater Melbourne are extremely diverse and include a variety of natural landscapes, agricultural areas, and formal public open space. Green space and vegetation are crucial to the resilience and sustainability of all areas, but this need is particularly pertinent in built-up urban areas where large populations depend on local green spaces for amenity, recreation and natural cooling. Integration and linking of vegetation and habitat in urban areas is also essential to the health of ecosystems.

As Melbourne continues to grow it will be important to continue to retain and enhance vegetation in the urban environment and to provide high quality open spaces. The changing climate further reinforces the importance of healthy landscapes. More frequent and intense heat waves, together with declining rainfall and water resource availability, highlights the need for IWM to create and support greening in our cities. Irrigation demands are also expected to increase in the future to support existing green spaces, as rainfall decreases and evapotranspiration increases.

IWM planning can enable the incorporation of green-blue infrastructure that works to provide multiple benefits, both greening urban areas with trees and open space, while servicing these areas with alternative water supplies. These actions can work to increase tree canopy cover, reduce the urban heat island effect, and provide higher quality open space for community use.

Water held in the local landscape

Comparing rainfall and runoff from sub-catchments gives us some insight into how much water is held in the local landscape, either returning to soils and flowing through to groundwater aquifers or returning to the atmosphere through evaporation or evapotranspiration (via vegetation). The figure below shows the difference between rainfall and runoff in each Catchment, representing the losses that occur in the sub-catchment due to evaporation, infiltration and evapotranspiration.

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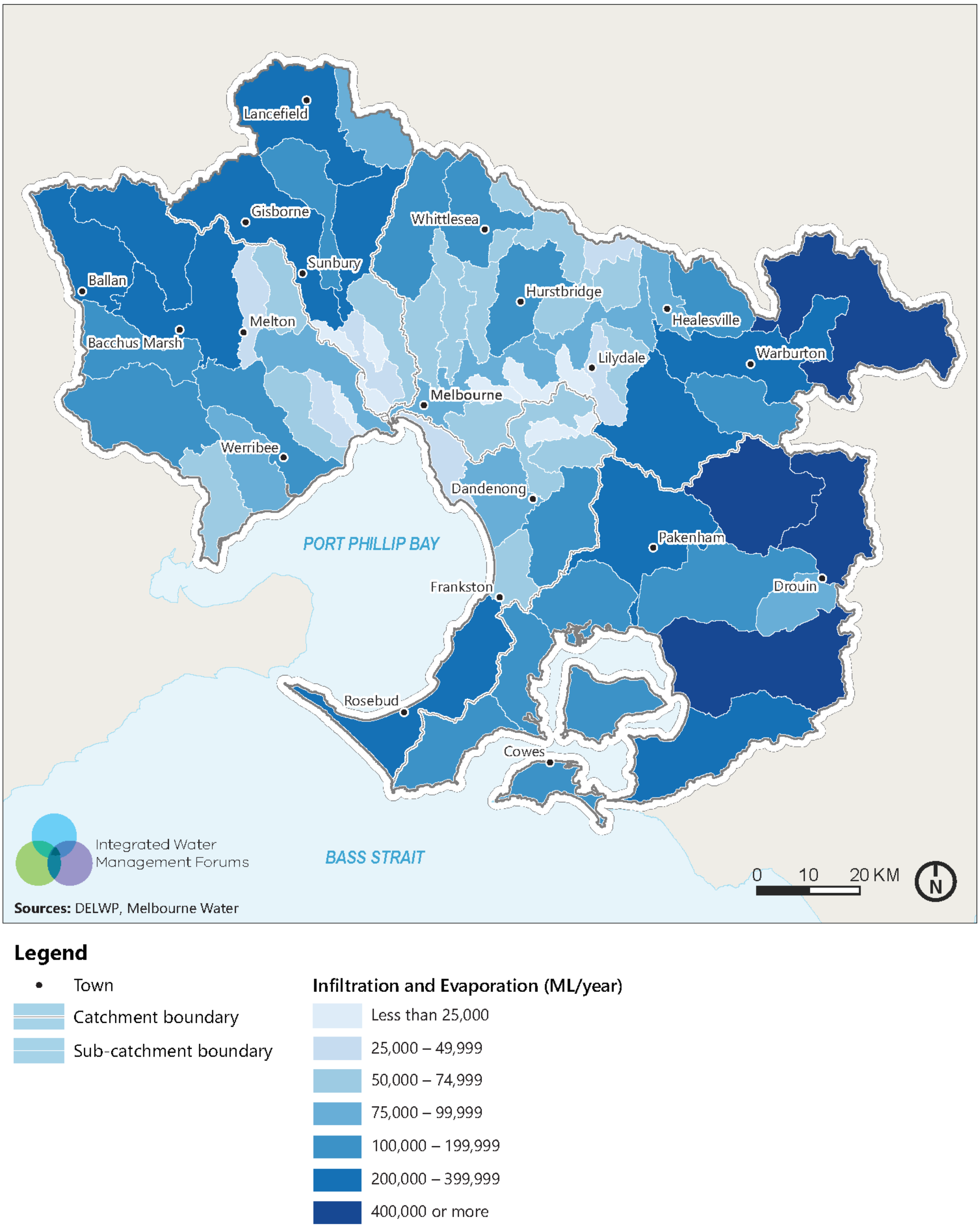

Figure 60: Evaporation, infiltration and evapotranspiration.

Trees and vegetation in the urban environment

The benefits of urban ecosystems and the metropolitan urban forest have been well established, with tree canopy cover becoming a key metric for liveability and resilience.[79] Beyond providing critical ecological services, the integration of trees and other vegetation in our urban environments can help to improve social cohesion and connection to Country, provide shade and cooling, support physical and mental well-being, and contribute other socio-economic benefits such as reduced energy costs. High resolution mapping is available

[79] Nature Conservancy and Resilient Melbourne (2019). Living Melbourne: our metropolitan urban forest. Available at: https://resilientmelbourne.com.au/living-melbourne/

which provides a baseline for urban vegetation across the urban areas of the Catchments, with precise measures of tree, shrub and grass cover at a land parcel level that can be tracked over time.[80]

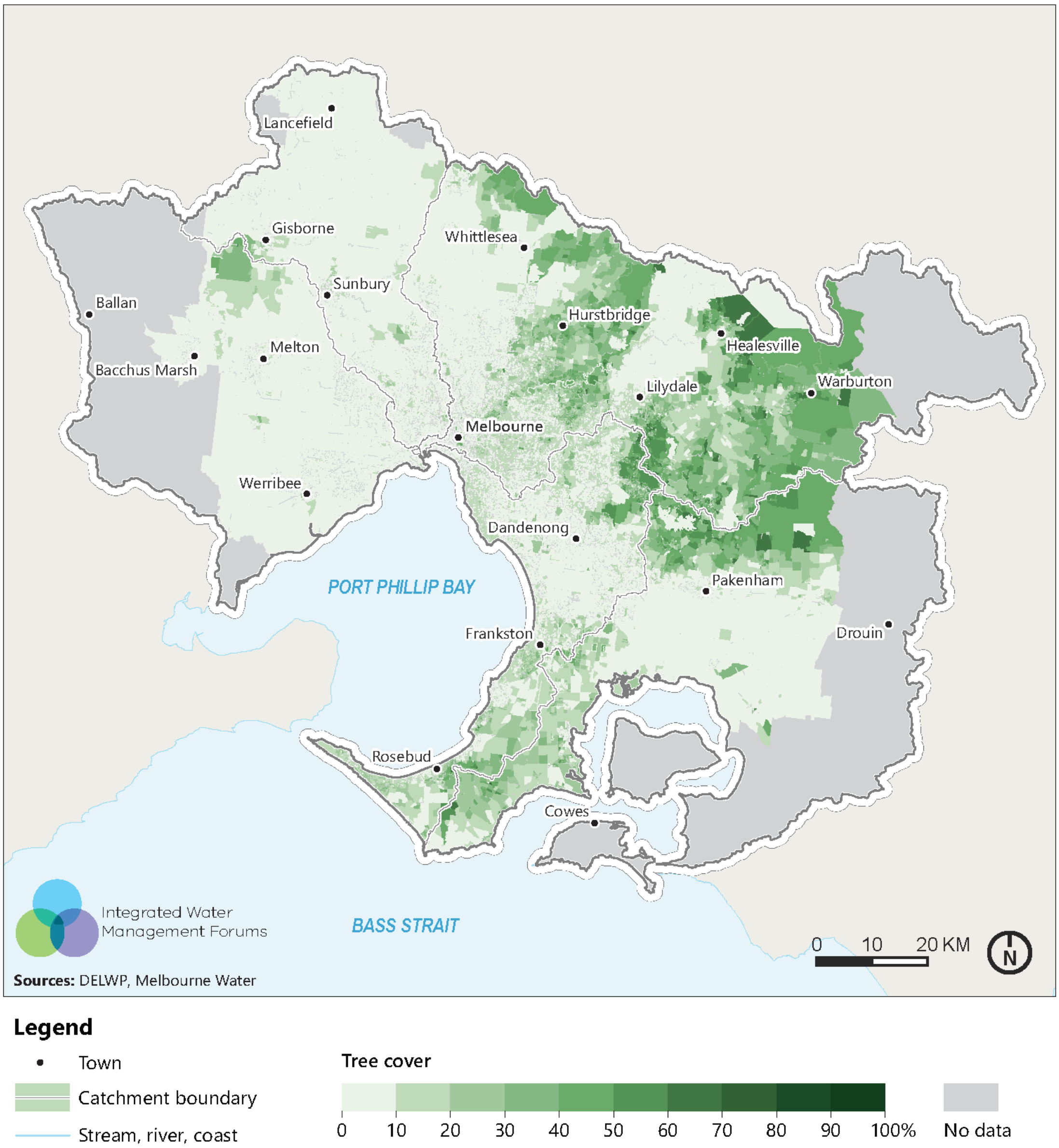

Figure 61: Tree canopy cover across the region.

Tree canopy cover is highest in the Yarra Catchment where vegetation is lush and widespread, with parts of the Western Port and Dandenong Catchments also presenting pockets of higher canopy cover. Key challenges can be identified across the Werribee and Maribyrnong Catchments where tree canopy is limited in the most part to under 10% of the Catchment, and where conditions are drier, meaning that access to water becomes essential to increase and sustain tree canopy cover.

A study of future development across Metropolitan Melbourne has estimated changes in tree cover under a 'business-as-usual' scenario for development to accommodate future population change.[81] The changes are shown in the figure below.

[80] Mapping undertaken by DELWP and Melbourne Water in 2018. The vegetation cover data was produced using CSIRO's Urban Monitor. The Urban Monitor provides a three-dimensional spatial representation of vegetation at 20cm resolution. It uses stereo photogrammetry to compare the height of identified vegetation though a digital surface model, relative to a ground elevation model, and estimates vegetation height. Images were captured in summer 2014 and summer 2018.
[81] CRC for Water Sensitive Cities (2020) Greening and cooling Melbourne: Future scenarios. Produced for DELWP.

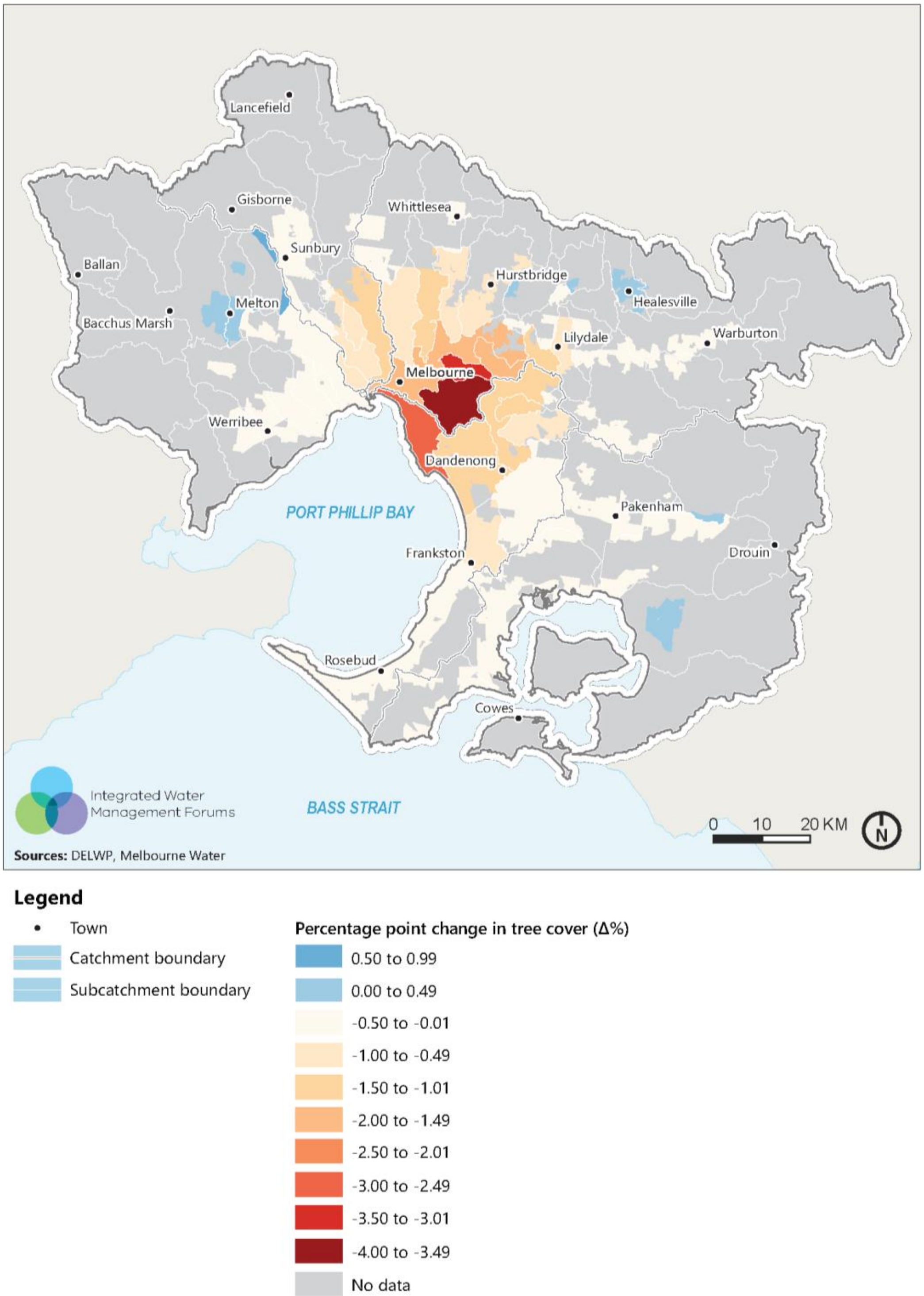

Figure 62: Anticipated changes in tree cover due to future development (2018-2051)

Open space

Public open space plays an important role in maintaining urban liveability, providing the community with a setting for a range of recreational opportunities as well as supporting local ecosystems. Open space is diverse in nature, including parklands, gardens, sporting ovals, conservation spaces, active transport routes, and other vegetated areas, which can be enjoyed passively or through active sports and recreational activities.

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Different types of public open space have been mapped for the Greater Metropolitan Melbourne Region.[82] Several large passive recreation areas can be observed in the Werribee and Western Port Catchments, being Werribee Park and Royal Botanical Gardens of Cranbourne, with smaller areas distributed across other Catchment areas. Organised recreation areas are similarly distributed across the Catchments, the largest identifiable area being Albert Park managed by Parks Victoria. Services and utilities areas are also shown, which are an important open space for water management as they are often associated with drainage infrastructure, providing a direct opportunity for water management to deliver quality public open space.

Existing open space assets are carefully managed by local government, ensuring they are maintained and irrigated appropriately to meet community needs. Drought conditions and water restrictions in the past have meant that in recent years local governments and water corporations have sought to secure alternative water supplies for open space irrigation, with initiatives to date primarily focusing on the irrigation of sporting fields. Recognising the importance of water in supporting the health and useability of open space, the potential role of alternative water sources being utilised to irrigate passive open spaces like parks and gardens is being emphasised.[83]

Under the current state, a proportion of open space is provided with irrigation to support vegetation needs and the creation of greener spaces. Active open space (e.g. sports grounds and playing fields) are the most commonly irrigated spaces, though in most cases, there are still active open spaces that are unirrigated in most council areas. The maps below show the reported estimates of areas of active and passive open space in each council area that are irrigated by any water source (including potable irrigation).[84] This can be compared with indicators 5.2a and 5.2b, which show the percentage of active and passive open space supported by irrigation from alternative sources.

As Melbourne grows, there is a need to plan for additional open space to service the community, both within urban renewal and precinct structure planning scenarios in identified growth areas. There is an opportunity through strategic planning to locate and integrate alternative water supply schemes to support open space irrigation. Specific standards are set in structure planning to ensure open space is sized and distributed appropriately. Accordingly, we expect to see both active and passive open space areas increase in growth areas under the future reference state. While open space areas are unlikely to change greatly in this future state, the irrigation demand is likely to change with a hotter, drier climate.

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[82] Victorian Environmental Assessment Council (2011). Public open space categories in the entire metropolitan Melbourne area. The State of Victoria.
[83] See for example, DELWP (2017). Planning a Green-Blue City. Available at: https://www.water.vic.gov.au/__data/assets/pdf_file/0029/89606/Green-blue-Infrastructure-Guidelines-Feb17.pdf
[84] The council survey gathered data regarding areas irrigated. This has been converted to a percentage using the total open space areas available from VEAC. See indicators 5.2a and 5.2b for details of data used.

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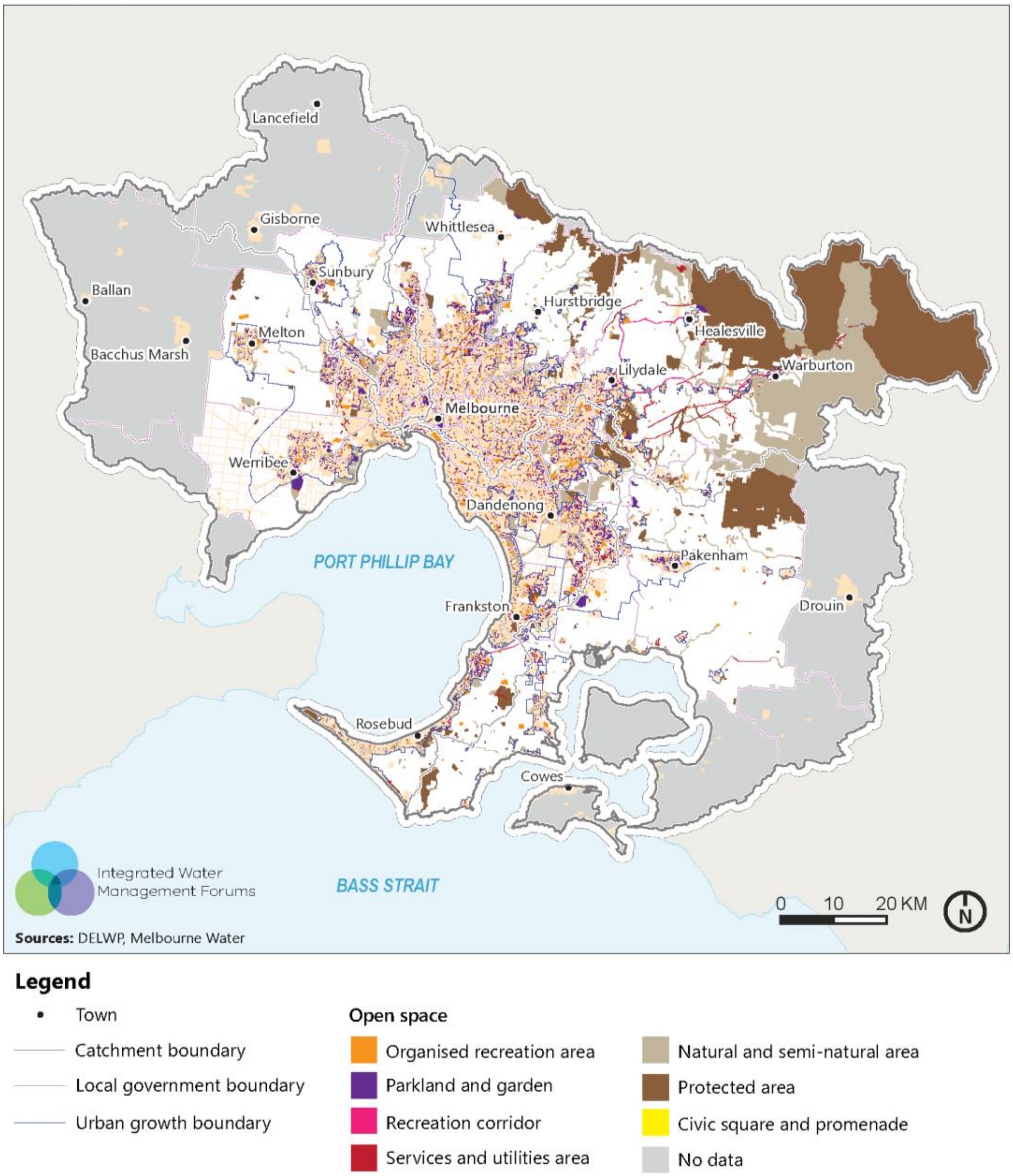

Figure 63: Map of open space across the region

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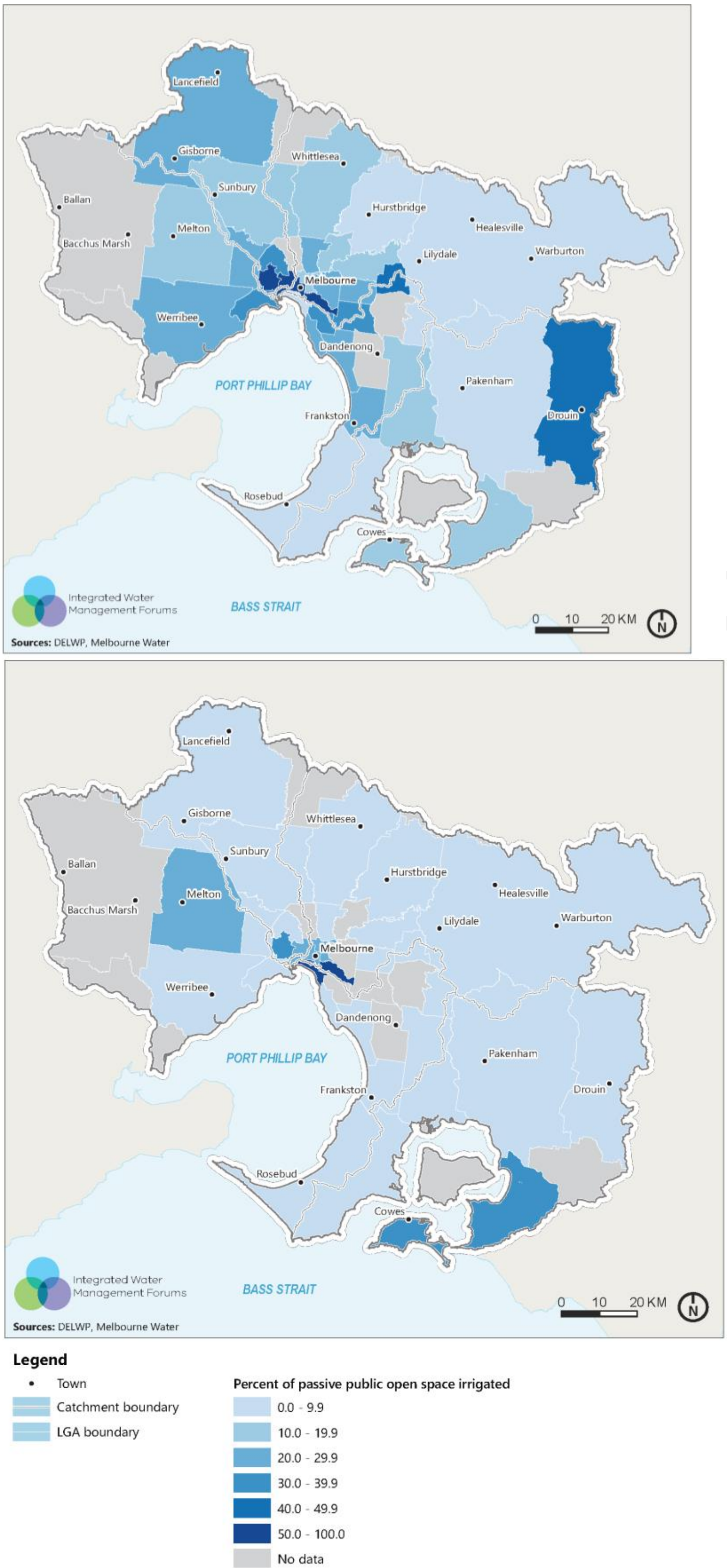

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Figure 64: Active (top) and passive (bottom) open space irrigation (by any source)

Urban heat

Heat waves and high temperatures pose a significant threat to both vegetation and human health. Temperatures in urban areas tend to be significantly higher as a result of increased impervious surfaces and reduced vegetation, leading to the presence of urban heat islands where temperatures are higher than average air temperature across the city. Urban heat can be particularly impactful on vulnerable populations such as the elderly and young children, and is a useful measure for prioritising actions to address urban heat. Adapting our cities to mitigate the impacts of urban heat through better integration of trees and greening is a key action in Plan Melbourne, recognising the importance of this for both liveability and resilience.[85]

Significant research has been undertaken at local and regional levels to better understand urban heat and the role that vegetation, tree cover and irrigated green spaces can play in its reduction.[86] Water in the environment provides natural cooling through evaporation, and further supports local cooling by increasing evapotranspiration in vegetation, and enhancing canopy cover and shade.[87]

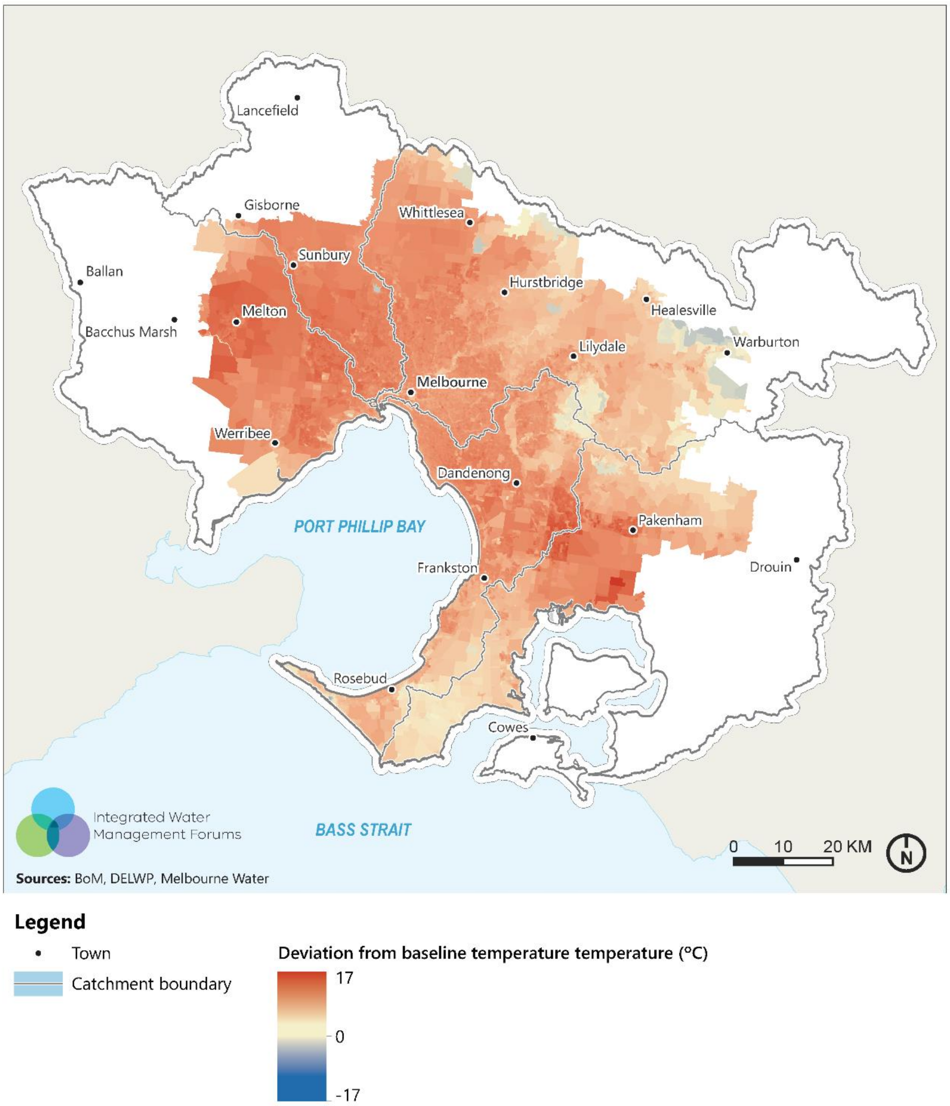

Figure 65: Urban heat map (2018).

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85 State Government of Victoria (2017). Plan Melbourne 2017-2050. Direction 6.4 Make Melbourne cooler and greener.

86 For example, Jacobs, S.J., Gallant, A.J., Tapper, N.J. and Li, D. (2018). Use of cool roofs and vegetation to mitigate urban heat and improve human thermal stress in Melbourne, Australia. *Journal of Applied Meteorology and Climatology*, 57(8), pp.1747-1764. Open access, available at: https://journals.ametsoc.org/view/journals/apme/57/8/jamc-d-17-0243.1.xml

87 Broadbent, A.M., Coutts, A.M., Tapper, N.J., Demuzere, M. and Beringer, J. (2018). The microscale cooling effects of water sensitive urban design and irrigation in a suburban environment. *Theoretical and Applied Climatology*, 134(1), pp.1-23.

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In recent years, some councils across the five Catchment areas have individually mapped local urban temperatures, with the State Government releasing comprehensive urban heat mapping for Greater Metropolitan Melbourne in 2019.[88] The urban heat map confirms the presence of significant areas of heat retention across the five Catchment areas. Lower baseline temperatures associated with highly vegetated areas can be observed in the Western Port and Yarra Catchments, with small pockets observed in the Dandenong Catchment and towards the fringes of the Werribee and Maribyrnong Catchment areas.

The heat vulnerability Index provides an overview of the vulnerability of populations to extreme heat events, based on heat exposure, sensitivity and adaptive capability. The highest levels of vulnerability can be observed in the west, within the Werribee and Maribyrnong Catchment areas, and the south east, primarily within the Western Port Catchment. Brimbank and Casey exhibit the highest rating followed by interface (urban-rural) councils in these Catchments. The Yarra Catchment demonstrates the lowest overall vulnerability with Boroondara and Stonnington rating lowest in this area. The Dandenong Catchment reflects more homogenous average ratings, with Kingston rating lowest in this area.

Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 70: Indicators and Measures for Strategic Outcome 5

Indicators	Measures
5.1 Increase provision of alternative water sources for tree irrigation	Percent of trees on public land that are provided with irrigation with water from an alternative water supply
5.2 Increase provision of alternative water sources for adequate irrigation of public open spaces	a. Percent of the total area of active public open space (sports fields and organised recreation) supported by an alternative water source b. Percent of the total area of passive public open space (parkland and gardens) supported by an alternative water source
5.3 Reduce urban heat for the purposes of enhancing human thermal comfort	Degree Celsius reduction in land surface temperature attributed to IWM in urban areas

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[88] State Government of Victoria (2019). Mapping and analysis of vegetation, heat and land use. Available: https://www.planning.vic.gov.au/policy-and-strategy/planning-for-melbourne/plan-melbourne/cooling-greening-melbourne/mapping-and-analysis-of-vegetation,-heat-and-land-use

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Indicator 5.1: Increase provision of alternative water sources for tree irrigation

Measure 5.1: Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply

Trees located on public land, such as in streets and public open space, are sometimes provided with irrigation to support their health and growth. This indicator measures the percentage of trees that receive irrigation (beyond a two-year establishment period) from an alternative water source (recycled water, greywater, rainwater and urban stormwater). Irrigation could be provided through a formal irrigation system or passively through redirection of stormwater from a road or adjacent paved surfaces.

Table 71: Measure overview

Measure 5.1: Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply parameters												
Indicator type	Leading											
Desired State Target Scale	Catchment, LGA											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	2.3		2.6		2.9		2.0		1.6		2.6	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	2.7	3.5	3.0	3.8	3.4	4.4	2.2	2.6	1.9	2.3	3.1	4.2
Desired state	12	23	14	30	10	26	8	21	11	23	11	23

Data source/s

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide the typical percentage of trees on public land which are provided with irrigation (beyond establishment) with water from an alternative water source (e.g. passive irrigation from stormwater runoff or active irrigation from stormwater or recycled water). Conducted February-March 2020.

Key assumptions

In the future reference state, council clusters (see Appendix A) were assembled to project future performance, based on a factoring of existing delivery rates. An average percentage of trees irrigated with alternative water was calculated for each council cluster. Blanks were excluded from averages. For gaps in the data, the average for the cluster was used as the baseline for the current state. Absolute percentage increases were added to the current state baseline levels to obtain reference states for 2030 and 2050, as per the table below.

Inner metro councils	Suburban councils	Growth area councils	Outer metro councils
Apply a 1% absolute percentage increase per decade to each LGA and sub-catchment in this cluster.	Hold the historical percentage of trees irrigated with alternative water constant for each LGA and sub-catchment in this cluster.	Apply a 1% absolute percentage increase per decade to each LGA and sub-catchment in this cluster.	Hold the historical percentage of trees irrigated with alternative water constant for each LGA and sub-catchment in this cluster.

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Current state

The current percentage of trees on public land provided with irrigation from alternative sources was estimated by councils in the Council Survey (February 2020). Overall, the average percentage of trees supported by an alternative water source was 2.3%, with the average showing little variation between the major Catchment areas. There was more variation by the type of council cluster, with inner metro council areas showing a higher proportion. Indeed, when broken down by council cluster, inner metro councils were found to exhibit the highest percentage of street trees irrigated with alternative water sources (~3%) followed by suburban councils, outer metro councils (~2%) and growth area councils (<1.5%).

Performance across the Catchment

The Yarra Catchment sustains a number of diverse landscapes where alternative water supplies can support tree health. These range from densely populated areas in the inner city to newer developments further out on the fringe. The highest percentage of trees irrigated by alternative water supplies was recorded for the City of Banyule at 10%, with 5% recorded for each of the inner-city areas of Port Phillip, Glen Eira and Yarra. The majority of councils in the Catchment reported that less than 1% of trees are supported by an alternative water source.

Future reference state

Under the future reference state, it was assumed that increases in irrigation of trees with alternative sources would be focussed on inner metro council and growth council areas, with a 1% increase every decade in these areas. This resulted in an anticipated overall uplift to 3.5% of trees across the region being supported by an alternative source by 2050. The anticipated performance by council area under the reference state can be viewed here. In terms of the total number of street trees, under the reference state it is assumed that the current numbers of street trees are maintained in existing areas and a new street tree is delivered for every new home in a growth area. When assessed by council cluster, it is expected that the percentage of trees irrigated with an alternative water source will be highest in inner metro councils (~6% by 2050), followed by growth area councils (~4%), suburban councils and outer metro councils (~2%).

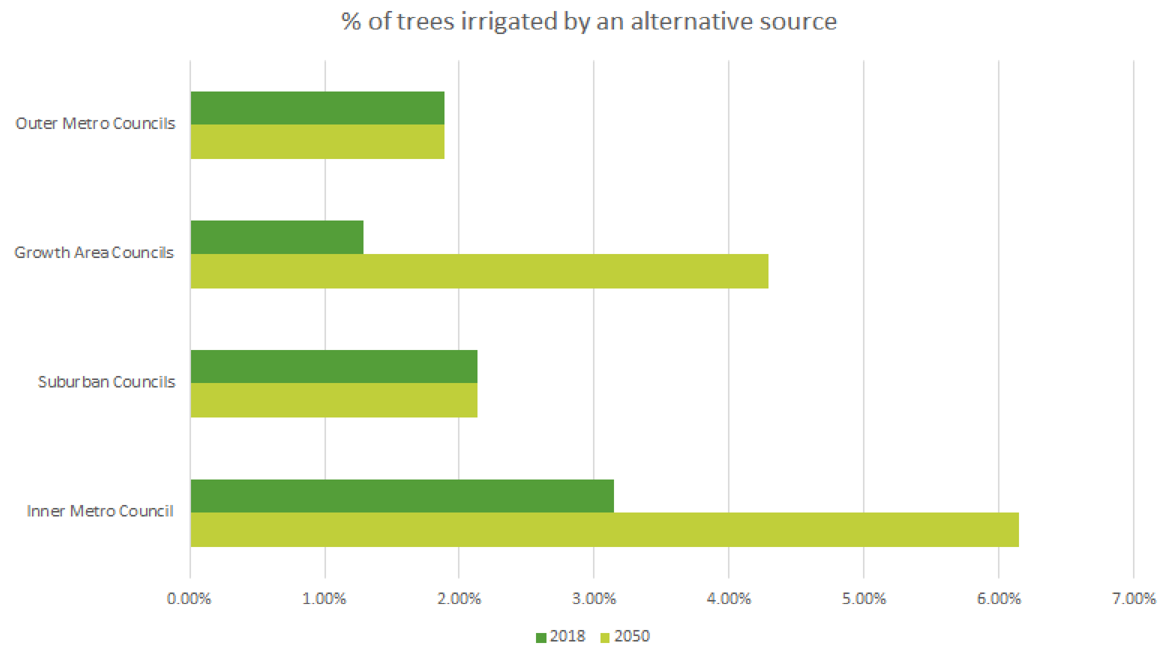

Figure 66: Percentage of trees supported by an alternative water source in the current and reference 2050 state for the four council clusters.

Performance across the Catchment

Most councils in the Yarra Catchment are not expected to increase the percentage of trees irrigated with alternative water sources in the future reference state for 2030 and 2050. Increases are expected for the Cities of Whittlesea (from 0.5% to 3.5%), Yarra (from 5% to 8%), Moreland (from 2% to 5%) and Hume (from 1% to

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4%). The City of Banyule is expected to maintain its high percentage of trees irrigated by alternative water supplies at 10%. By area, the Yarra Catchment is expected to be amongst the lowest performers due to low irrigation rates among outer metropolitan councils (Yarra Ranges Shire, Nillumbik Shire).

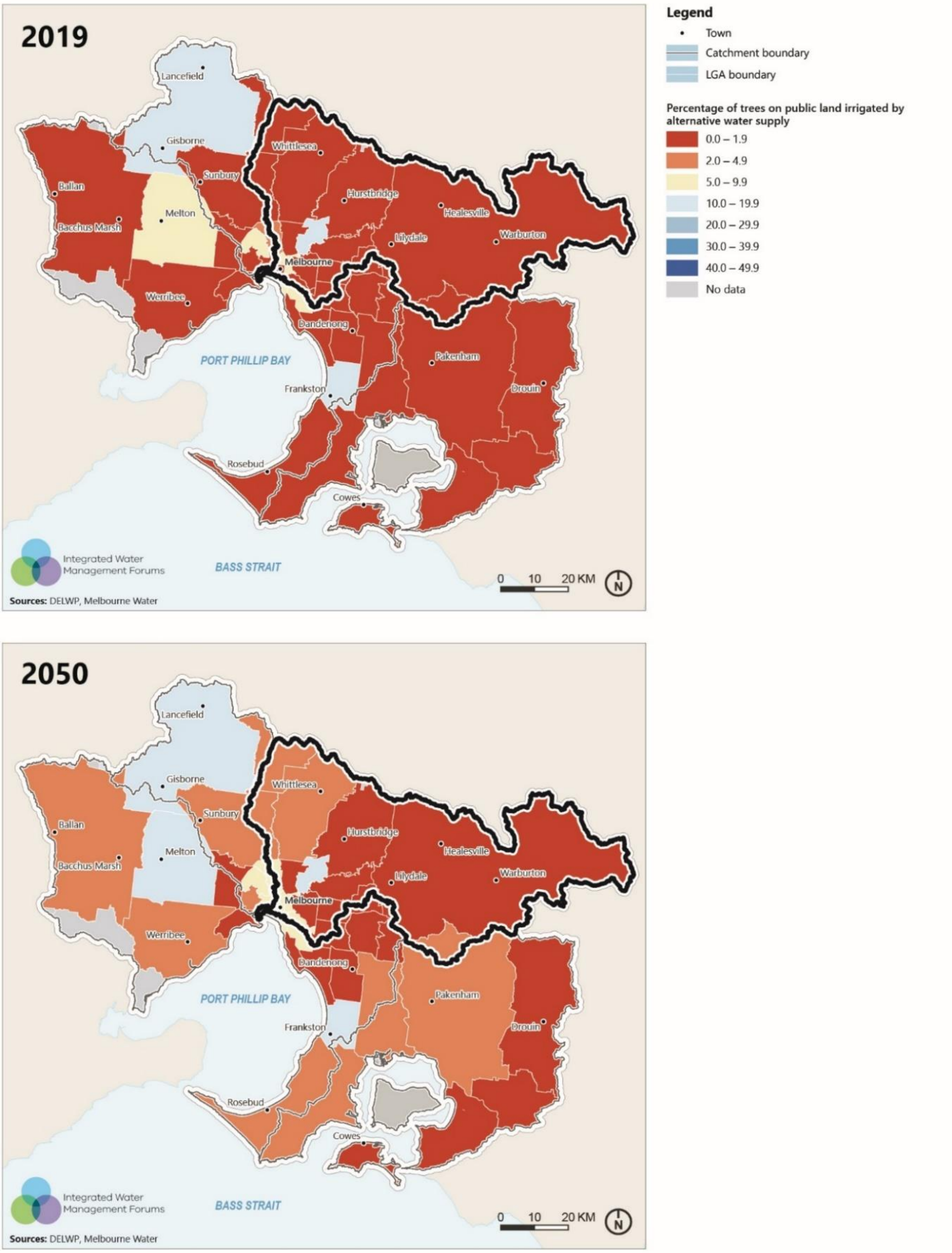

Figure 67: Measure 5.1. Percent of street trees that are supported with permanent (active or passive) irrigation from an alternative water supply (current state and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

Increasing tree canopy cover across the region has been recognised as a key objective to benefit health, biodiversity and resilience. Water will play a key role in supporting this objective. Living Melbourne puts forward targets to increase canopy cover across the Greater Metropolitan Melbourne Region,[89] specified by sub-area as shown in the figure below.

The Living Melbourne targets apply to tree canopy as a whole across public and private land, but the principles underpinning the target stress that action is important in both areas and a limit of 70% of the additional canopy should be achieved on public land. Many councils also have set targets for increased canopy cover on public land.

Region	Local government authorities	Existing 2015		Target 2030		Target 2040		Target 2050	
		Total % tree canopy	Total % tree canopy & shrubs	Total % tree canopy	Total % tree canopy & shrubs	Total % tree canopy	Total % tree canopy & shrubs	Total % tree canopy	Total % tree canopy & shrubs
Western	Brimbank, Hobsons Bay, Maribyrnong, Melton, Moonee Valley, Wyndham	4	15	9	20	14	25	20	30
Northern	Banyule, Darebin, Hume, Mitchell, Moreland, Nillumbik, Whittlesea	12	24	17	29	22	34	27	39
Inner	Melbourne, Port Phillip, Yarra	13	18	18	23	23	28	28	33
Southern	Casey, Frankston, Greater Dandenong, Kingston, Cardinia, Mornington Peninsula	16	34	21	39	26	44	30	50
Inner South-East	Bayside, Boroondara, Glen Eira, Stonnington	22	39	24	44	27	49	30	50
Eastern	Knox, Manningham, Maroondah, Monash, Whitehorse, Yarra Ranges	25	44	27	49	29	50	30	50

Figure 68: Living Melbourne canopy targets

Possible future interventions

While there is a wealth of ongoing work focussing on canopy cover increase across the Greater Metropolitan Melbourne Region, there are no specific targets for irrigation of trees, or any objectives related to the use of alternative water sources for tree irrigation. However, it is worth recognising that in a changing climate, provision of water will be essential to tree health, and the provision of irrigation can also increase tree canopy size (see graph below) and double the growth rate.[90] A recent examination of the resilience of trees to climate change identified that a substantial proportion of trees in Melbourne would not be able to survive future climates.[91] Tree populations were examined across 10 local government areas in Melbourne, and 54% of trees were found to be at risk under a business-as-usual scenario.[92] To manage this risk, provision of irrigation is flagged as a key strategy to improve survival rates.

[89] The Nature Conservancy and Resilient Melbourne (2019). Living Melbourne: our metropolitan urban forest. Available at: https://resilientmelbourne.com.au/living-melbourne/

[90] Grey, V. et al (2018) Establishing street trees in stormwater control measures can double tree growth when extended waterlogging is avoided. Available: https://www.researchgate.net/publication/325768839_Establishing_street_trees_in_stormwater_control_measures_can_double_tree_growth_when_extended_waterlogging_is_avoided

[91] Clean Air and Urban Landscapes Hub (2017). Risks to Australia's urban forest from climate change and urban heat. Available at: https://nespurban.edu.au/wp-content/uploads/2018/11/CAULRR07_RisksAustralianUrbanForest_Oct2017.pdf

[92] Average of total number of trees classified as 'yellow', 'orange' or 'red' level risk, reflecting that the temperature is warmer than 80%, 90% or 97.5% of the locations where this species is found under a future climate (RCP8.5) scenario.

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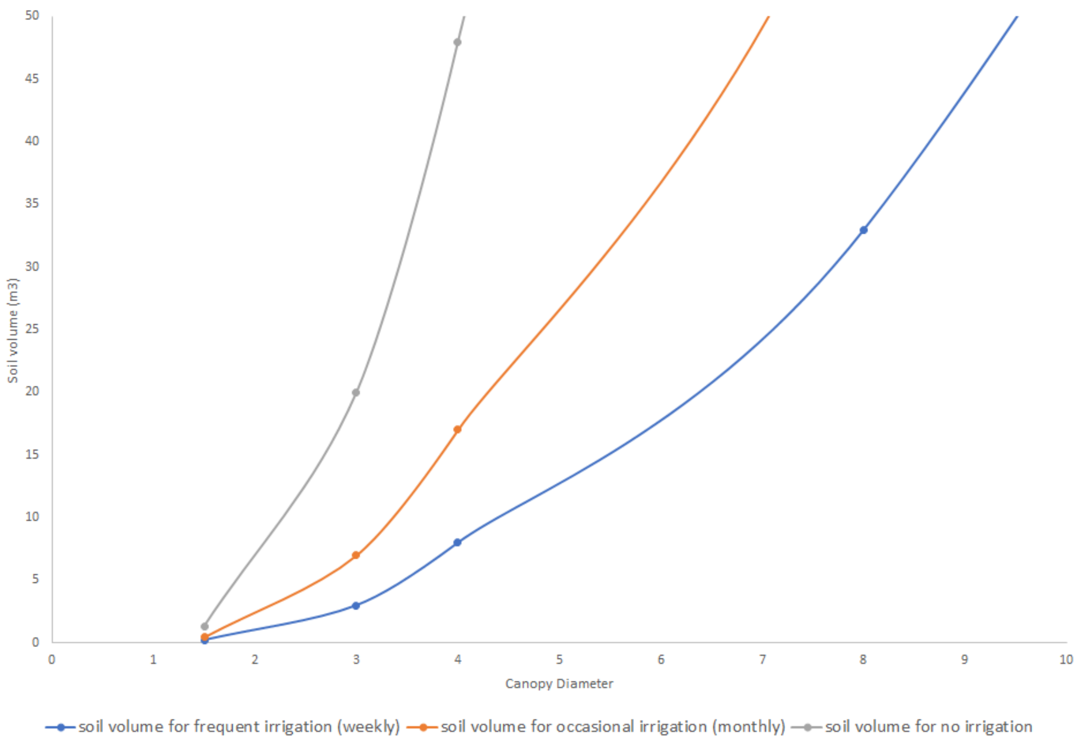

Figure 69: Relationship between soil volume, canopy and tree diameter[93]

Desired state target recommendations

2050 Target

The target for tree irrigation using alternative sources will drive a change in practice across the region that will support our healthy, thriving street trees in a sustainable way. Provision of irrigation, whether that is passive irrigation from adjacent runoff, or permanent active irrigation systems using recycled water, will support both existing and new trees in the anticipated future hotter, drier climates, where more than half of our tree population is expected to struggle without support. By also designing an environment for new trees where water is more consistently available, we will create healthier and larger tree canopies with a longer life span, which will provide shade, habitat, amenity and natural cooling for communities. The targets anticipate Living Melbourne targets being achieved and supporting at least 50% of new street trees in growth areas and 25% of replacement trees and new trees planted in existing areas with irrigation from either stormwater runoff or recycled water.

2030 Catchment Target

The 2030 Catchment targets have been derived based on foreseeable opportunities to provide irrigation to trees, particularly in growth and redevelopment areas.

2050 and 2030 Local Government Area Targets

The Catchment targets for this measure have been disaggregated from Catchment level to local government area level. The disaggregation assumes that Living Melbourne targets being achieved and that at least 50% of new street trees in growth areas and 25% of replacement trees and new trees planted in existing areas will be supported with irrigation from either stormwater runoff or recycled water. These targets are presented in the table and figure below.

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[93] E2Designlab based on Hitchmough J (1994). 'Roof gardens and other landscapes involving finite volumes of artificial soils', Hitchmough J (ed) Urban landscape management. Sydney, Inkata Press.

Table 72: Disaggregated minimum targets for local government areas for measure 5.1

Local Government Area	Target (%)		Local Government Area	Target (%)	
	2030	2050		2030	2050
Banyule	8	22	Melton	17	37
Bass Coast	11	23	Mitchell	14	30
Baw Baw	11	23	Monash	8	19
Bayside	8	21	Moonee Valley	9	24
Boroondara	8	21	Moorabool	14	30
Brimbank	9	24	Moreland	9	22
Cardinia	10	23	Mornington Peninsula	8	22
Casey	22	40	Nillumbik	8	22
Darebin	8	22	Port Phillip	8	22
Frankston	9	23	South Gippsland	6	15
Glen Eira	8	21	Stonnington	9	25
Greater Dandenong	10	24	Whitehorse	8	19
Hobsons Bay	9	23	Whittlesea	15	28
Hume	12	30	Wyndham	17	34
Kingston	9	22	Yarra	8	22
Knox	8	20	Yarra Ranges	8	19
Macedon Ranges	10	26			
Manningham	8	19			
Maribyrnong	9	24			
Maroondah	8	19			
Melbourne	9	22			

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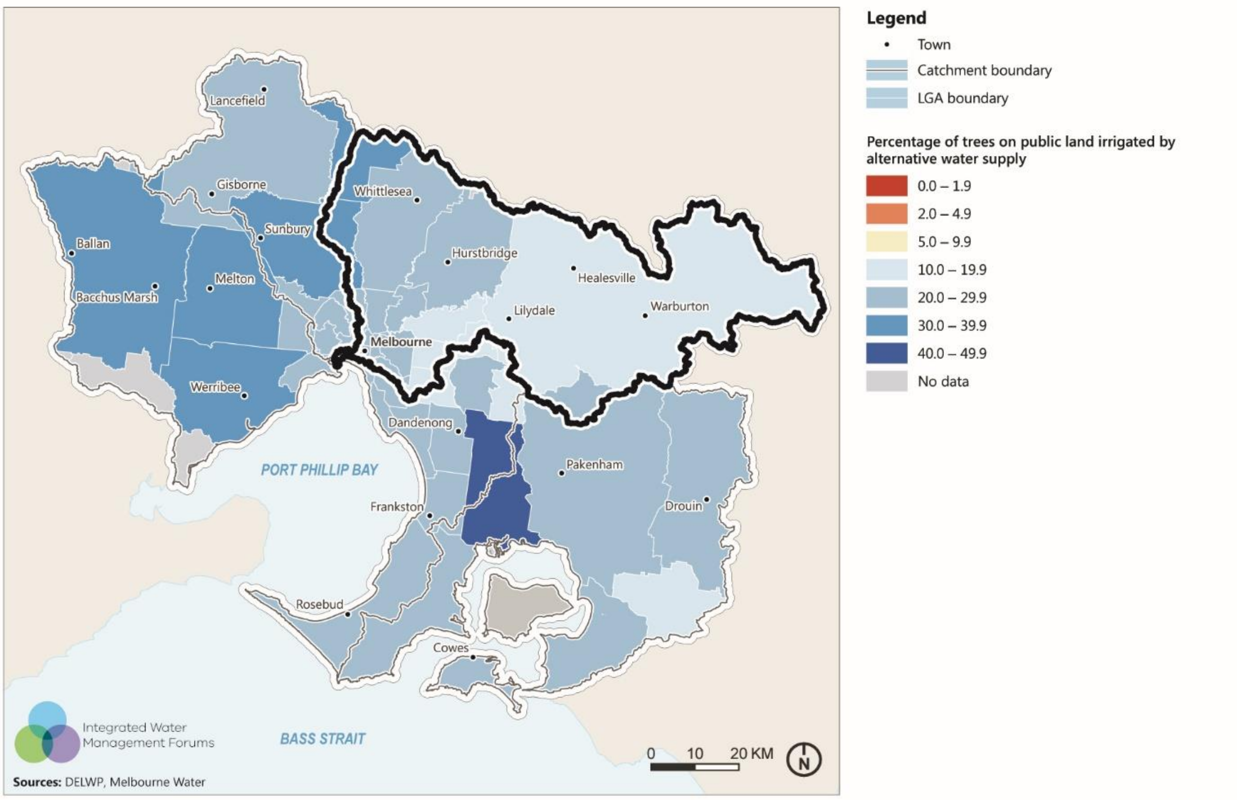

Figure 70: Measure 5.1 targets disaggregated to LGA

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Indicator 5.2: Increase provision of alternative water sources for adequate irrigation of public open spaces

Measure 5.2a: Percent of the total area of active public open space (sports fields and organised recreation) supported by an alternative water source

Active open space refers to open space that primarily provides a setting for formal structured sporting activities. These open spaces are commonly provided with irrigation to ensure playing surfaces are safe and attractive. This indicator measures the percentage of active open space that receives adequate irrigation from an alternative water source (recycled water, greywater, rainwater and urban stormwater) to maintain a functional level of service.

Table 73: Measure overview

Measure 5.2a: Percent of the total area of active public open space (sports fields and organised recreation) supported by an alternative water source parameters												
Indicator type	Leading											
Desired State Target Scale	Region, Catchment, LGA											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	6.7		9.9		10.4		4.4		4.8		4.0	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	14	39	10	29	14	30	14	51	17	36	7	30
Desired state	19	48	22	50	20	54	18	50	19	45	14	40

Table 74: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide the area of active open space supported by irrigation from alternative water sources (stormwater, recycled water, greywater). Conducted February-March 2020. Victorian Environmental Assessment Council (2011) Public open space categories in the entire metropolitan Melbourne area. The State of Victoria.
Key assumptions
• Percentage calculated based on VEAC totals for 'organised recreation areas'. Total open space areas for council areas outside of the metropolitan boundary interpreted from publicly available open space strategies. • Projections of stormwater harvesting and recycled water supplies to open space are described in Appendix A: Water and Pollutant Balance Analysis. • Calculations for active open space irrigated with stormwater harvesting assumes stormwater harvesting meets 60% of irrigation demands. • Active open space supported by recycled water assumes all new active open space in PSPs with mandated recycled water are irrigated solely with recycled water. Spatial analysis was used to calculate the overlap between areas of greenspace within PSPs and mandated recycled water areas. Of new green space area, 60% assumed active open space and 40% passive open space. • Percentage calculated based on total active open space supported by both stormwater harvesting (council-led and major projects) and recycled water (new active open space in PSPs) divided by total active open space (new areas in PSPs added to base supply).

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Current state

Council data gathered through the council survey shows that irrigation of open spaces with alternative sources is substantially higher for active open spaces than passive open spaces. This trend is also reflected in irrigation generally (from all water sources). The proportion of active open space that is irrigated ranged significantly across councils, but was generally highest in the inner metro councils (over 50% irrigated). Of the total area of irrigated active open space, less than 15% is irrigated by alternative water sources in inner metro councils and less than 5% in all other council clusters.

Performance across the Catchment

There is a wide range of variability in the use of alternative water supplies for the irrigation of active open space across the Yarra Catchment, with data lacking for some areas including the Cities of Glen Eira, Yarra and Moreland. The average performance of the Yarra Catchment is similar to the Greater Metropolitan Melbourne Region average. The highest percentage is recorded by Maroondah with 30.9% of its active open space irrigated by alternative water supplies, followed by the City of Melbourne with 20.2%.

Future reference state

Increases in active open space irrigated with alternative sources under the future reference state are anticipated to be delivered through stormwater harvesting schemes and recycled water supply in new growth areas. There is a strong desire for councils to utilise alternative water supplies to future proof active open spaces for their communities through the irrigation of sporting ovals and fields. The figure below shows the average performance of each council cluster under the current and future (2050) reference state for the percentage of active open space supported by irrigation from alternative sources. It is expected that, on top of current state figures, there will be a further ~20% increase in open active space irrigated by alternative water sources in outer metro councils; 25% in growth area councils and inner metro councils; and ~40% in suburban councils under the future reference state.

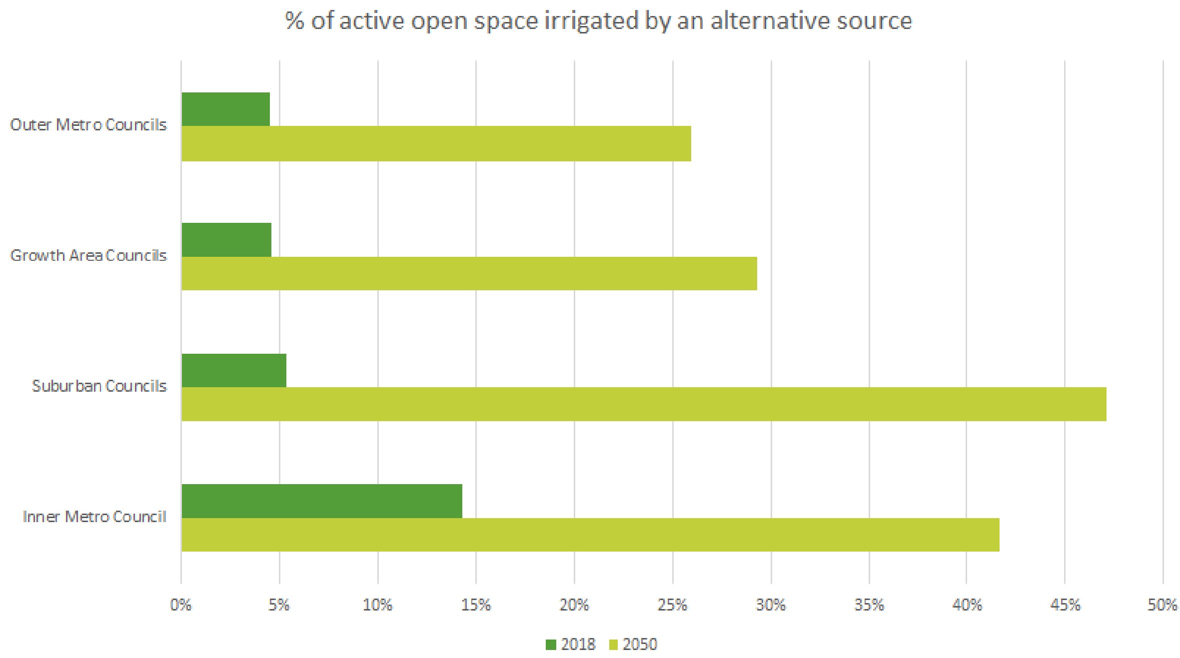

Figure 71: Current and reference state performance for measure 5.2a by council cluster

Performance across the Catchment

Councils across the Yarra Catchment are predicted to see significant uplifts in active open space irrigation driven by a combination of recycled water in growth areas (e.g. City of Whittlesea and Mitchell Shire) and stormwater harvesting in suburban councils.

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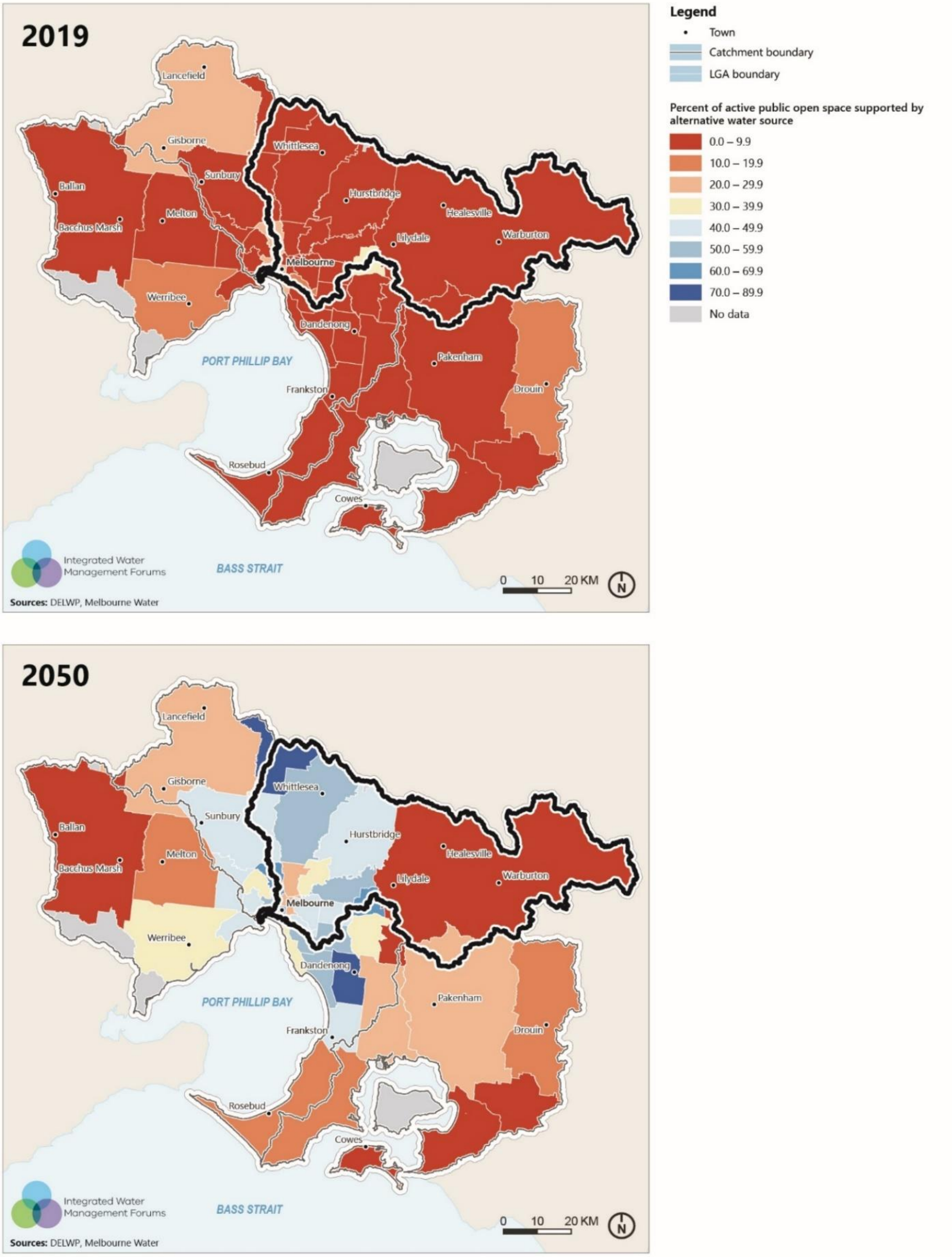

Figure 72: Measure 5.2a Percent of the total area of active public open space (sports fields and organised recreation) supported by an alternative water source (current state and 2050 reference state)

Future desired state

Existing targets and referenceable evidence

There are no known targets in existing Melbourne-wide strategies that focus on irrigation of active spaces. However, some councils have set 5- or 10-year targets based on predicted needs or opportunities, primarily for active open space.

Melbourne Water recently completed a study that considered the future irrigation of open space across Melbourne.[94] As part of the study, a range of future scenarios were considered where the irrigation of different types of open space may change. As part of these scenarios, different councils across the region were interviewed to understand the drivers and ambitions to increase or diversify irrigation of open space. These interviews identified differences in drivers between different councils.

Figure 73: Selection of feedback from various councils on the future of open space irrigation

Possible future interventions

Interventions that will increase irrigation of active open space with alternative sources depend on the location and cluster of demands. Recycled water supply depends on the availability of recycled water in the area, and there are a significant number of opportunities near existing or proposed recycled water networks to be explored. Stormwater harvesting is generally a more adaptable approach to different locations, though it depends on access to a drainage system with a suitable Catchment size (and yield) to make it viable. Rainwater harvesting from large adjacent roofs can also be feasible in some circumstances.

It is worth noting that the future reference state anticipates significant uptake of stormwater harvesting for open space irrigation, particularly in the suburban council cluster. This could be delivered for active or passive open spaces.

Desired state target recommendations

2050 Catchment Target

The Catchment target for irrigation of active open space is 50%. The Yarra Catchment includes urbanised areas with high urban heat vulnerability and low rainfall, meaning there is a clear case for increased irrigation of open spaces to benefit the community. By supporting this proportion of active open spaces with irrigation, modelling has shown that we will reduce the average land surface temperature across a LGA by up to 5 degrees Celsius on an extreme heat day. A reduction of that magnitude directly reduces heat mortality and adverse health impacts. Added to this, increased irrigation will support sport and recreation and provide amenity value for local communities, all while utilising alternative water resources that can be drawn on during drought without depleting our precious potable water supplies. The catchment target has been

[94] Melbourne Water (2020). Water for greening and cooling.

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disaggregated to an LGA level (see below), where the greatest focus is on the local government areas with the highest urban heat vulnerability, particularly City of Hume, City of Whittlesea and Mitchell Shire.

2030 Catchment Target

The 2030 Catchment targets have been derived based on foreseeable opportunities to provide open space irrigation using alternative sources, particularly in growth areas. These targets are presented in the table and figure below.

2050 and 2030 Local Government Area Targets

The Catchment targets for this measure has been disaggregated from Catchment level to LGA level. The targets have been apportioned between LGAs based on the Heat Vulnerability Index,[95] relative to the Catchment average, with higher risk areas receiving higher targets. These targets are presented in the table and figure below.

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Table 75: Disaggregated minimum targets for local government areas for measure 5.2a

Local Government Area	Target (%)		Local Government Area	Target (%)	
	2030	2050		2030	2050
Banyule	17	47	Melton	29	65
Bass Coast	14	40	Mitchell	22	60
Baw Baw	14	40	Monash	18	46
Bayside	12	27	Moonee Valley	19	50
Boroondara	9	26	Moorabool	20	46
Brimbank	29	70	Moreland	21	59
Cardinia	16	46	Mornington Peninsula	15	37
Casey	23	59	Nillumbik	12	34
Darebin	21	59	Port Phillip	14	33
Frankston	24	57	South Gippsland	14	40
Glen Eira	15	36	Stonnington	11	29
Greater Dandenong	33	79	Whitehorse	16	42
Hobsons Bay	20	47	Whittlesea	29	81
Hume	27	72	Wyndham	24	56
Kingston	23	56	Yarra	14	38
Knox	19	46	Yarra Ranges	16	45
Macedon Ranges	13	36			
Manningham	16	43			
Maribyrnong	20	53			
Maroondah	17	43			
Melbourne	15	40			

[95] DELWP (2018) Heat Vulnerability Index. Source: Sun, C, Hurley, J, Amati, M, Arundel, J, Saunders, A, Boruff, B & Caccetta, P 2019, *Urban Vegetation, Urban Heat Islands and Heat Vulnerability Assessment in Melbourne, 2018*, Clean Air and Urban Landscapes Hub, Melbourne, Australia.

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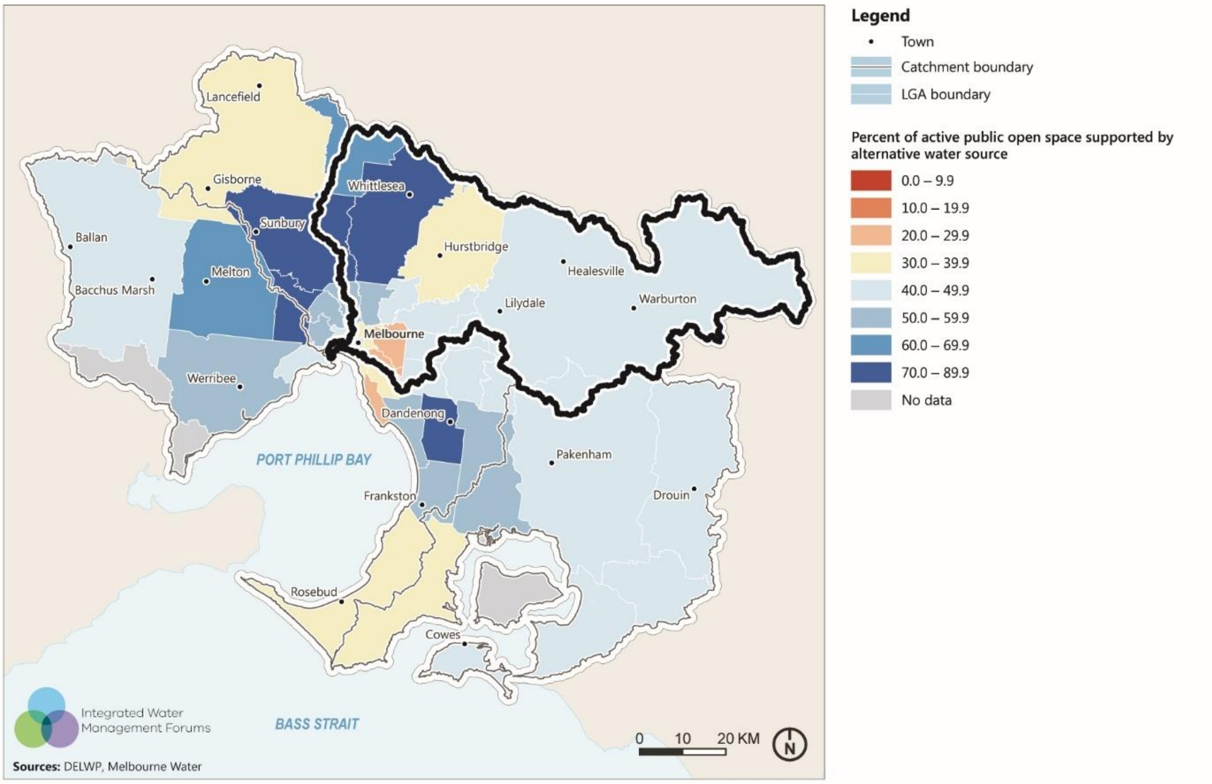

Figure 74: Measure 5.2a targets disaggregated to LGA

Measure 5.2b: Percent of the total area of passive public open space (parkland and gardens) supported by an alternative water source

Passive open space refers to open space that primarily provides a setting for informal play and physical activity, relaxation and social interaction. These open spaces are sometimes provided with irrigation to support amenity. This indicator measures the percentage of passive open space that receives adequate irrigation from an alternative water source (recycled water, greywater, rainwater and urban stormwater) to maintain a functional level of service.

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Table 76: Measure overview

Measure 5.2b: Percent of the total area of passive public open space (parkland and gardens) supported by an alternative water source parameters												
Indicator type	Leading											
Desired State Target Scale	Region, Catchment, LGA											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	2		7		2		0.1		0.1		0.6	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	1	1	6	5	1	1	0.1	0.1	0.1	0.1	0.02	0.02

Desired state	6	28	9	25	16	54	2	30	4	10	9	25

Table 77: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide the area of active open space supported by irrigation from alternative water sources (stormwater, recycled water, greywater). Conducted February-March 2020. Victorian Environmental Assessment Council (2011) *Public open space categories in the entire metropolitan Melbourne area*. The State of Victoria.
Key Assumptions
Percentage calculated based on VEAC totals for 'parkland and garden' and 'services and utilities areas'. Total open space areas for council areas outside of the metropolitan boundary interpreted from publicly available open space strategies. No additional passive open space irrigation for reference state in 2030 or 2050, but new passive open space from PSPs added to the total area, lowering the overall percentage of passive open space irrigated with alternative water compared with the current state. Passive open space assumed to be 40% of new green space in PSPs.

Current state

Council data gathered through the council survey demonstrates that irrigation of open spaces with alternative sources is substantially lower for passive than active open spaces. This trend is also reflected in irrigation generally (from all water sources). Typically, the proportion of passive open space that is irrigated is less than 10%. In terms of the proportion of passive open spaces irrigated by alternative sources, percentages are less again. Currently the highest proportions of passive open space irrigation with alternative water are in growth area councils (2.8%), followed by inner metro councils (1.2%). Suburban and outer councils showed a very low proportion (0.1% or 0.2% respectively).

Performance across the Catchment

There is limited data on the irrigation of passive open space by alternative supplies for the Yarra Catchment. The highest percentage is recorded by the Cities of Port Phillip and Yarra, at 2.54% and 2.28% respectively.

Future reference state performance

Very little change in irrigation of passive open space by alternative sources is expected under the future reference state, as it is assumed active open space will be prioritised.

Performance across the Catchment

No new irrigation of passive open space is predicted under the reference state. As a result, performance is expected to slightly decrease (minimally) in 2030 and 2050 as new passive open space areas in growth areas are added to the base.

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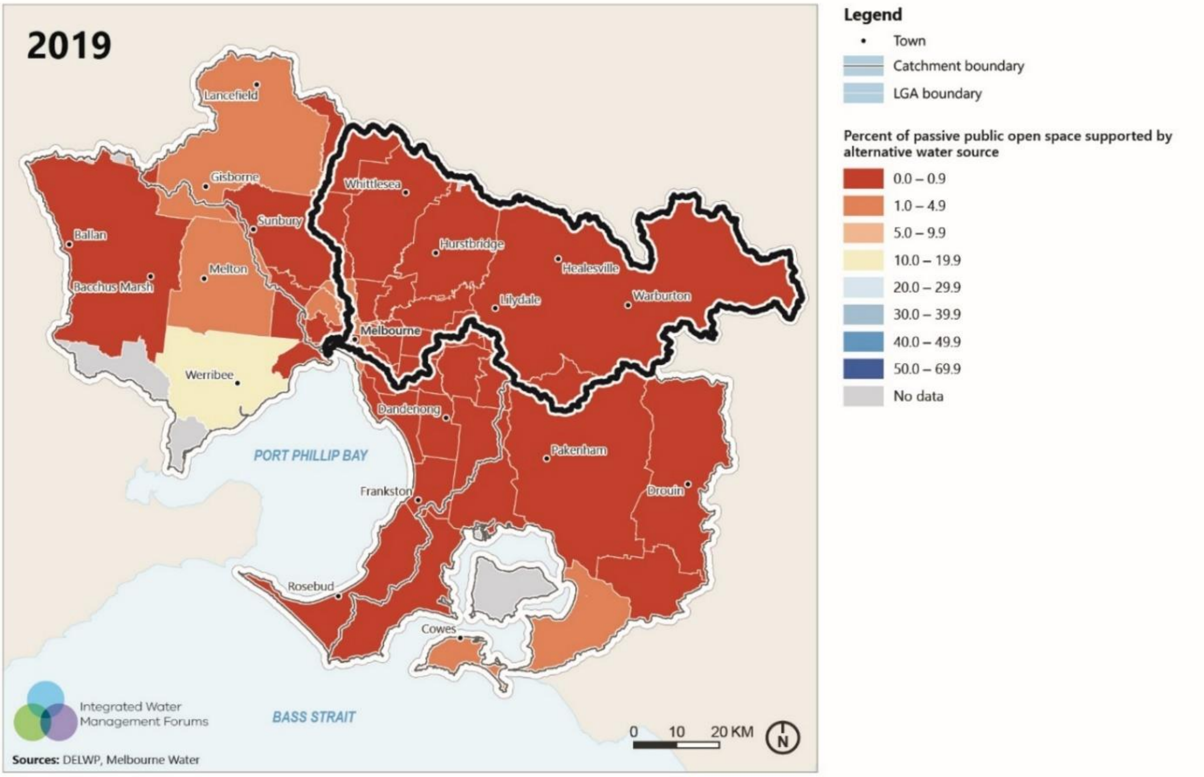

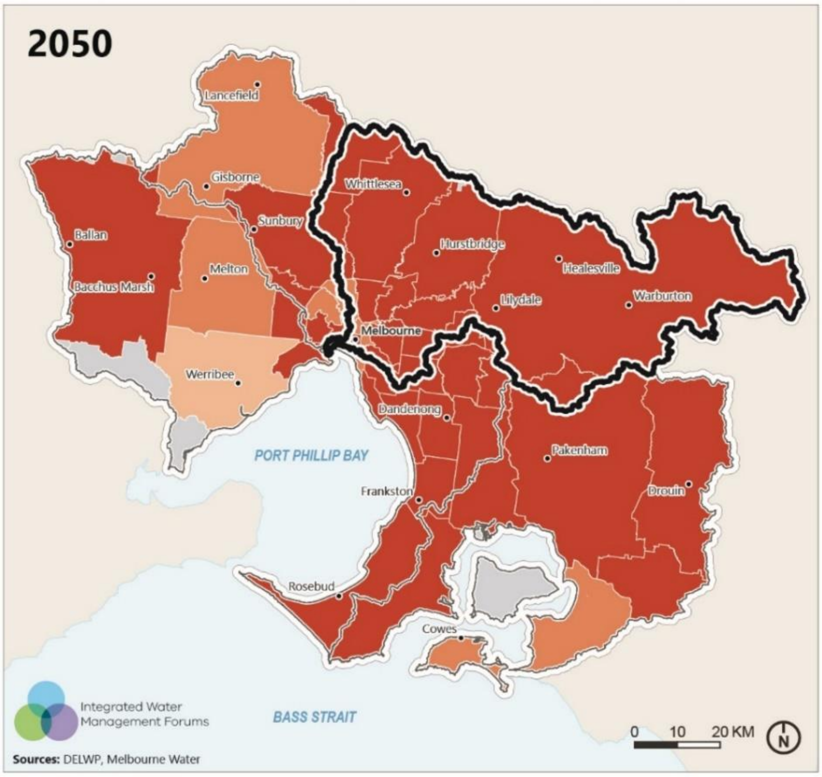

Figure 75: Measure 5.2b. Percent of the total area of passive public open space (parkland and gardens) supported by an alternative water source (current state and 2050 reference state)

Future desired state

Existing targets and referenceable evidence

There are no known targets in existing Melbourne-wide strategies that focus on irrigation of passive spaces. However, some councils have set 5- or 10-year targets for overall open space irrigation based on predicted needs or opportunities.

Melbourne Water recently completed a study that considered the future irrigation of open space across Melbourne.[96] As part of the study, a range of future scenarios were considered where the irrigation of different types of open space may change. As part of these scenarios, different councils across the region were interviewed to understand the drivers and ambitions to increase or diversify irrigation of open space. These interviews identified differences in drivers between different councils.

Possible future interventions

As discussed under measure 5.2a, interventions that will increase irrigation of passive open space with alternative sources depend on the location and cluster of demands.

It is worth noting that the future reference state anticipates significant uptake of stormwater harvesting for open space irrigation, particularly in the suburban council cluster. This could be delivered for active or passive open spaces.

Desired state target recommendations

2050 Catchment Target

The Catchment target for passive open space irrigation using alternative sources is 30%. This will ensure we take opportunities to support passive open space irrigation where it makes sense, to enrich communities by providing healthier, greener and multi-functional open spaces. Passive open spaces are often well-utilised by the community for walking, exercising, picnicking and playing. They also act as important refuges on extreme heat days and green links or biodiversity corridors are often better distributed throughout neighbourhoods than more formal active open spaces While historically most passive open space hasn't been supported by irrigation, this target recognises the growing appreciation of the many benefits this could bring to communities in targeted areas, all while utilising alternative water resources that might otherwise be wasted.

2030 Catchment Target

The 2030 Catchment targets have been derived based on foreseeable opportunities to provide open space irrigation using alternative sources, particularly in growth areas. These targets are presented in the table and figure below.

2050 and 2030 Local Government Area Targets

The Catchment targets for this measure has been disaggregated from Catchment level to LGA level. The targets have been apportioned between LGAs based on the Heat Vulnerability Index,[97] relative to the Catchment average, with higher risk areas receiving higher targets. These targets are presented in the table and figure below.

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Table 78: Disaggregated minimum targets for local government areas for measure 5.2b

Local Government Area	Target (%)		Local Government Area	Target (%)	
	2030	2050		2030	2050
Banyule	2	28	Melton	12	34
Bass Coast	9	25	Mitchell	7	43
Baw Baw	9	25	Monash	3	19

[96] Melbourne Water (2020). Water for greening and cooling.

[97] DELWP (2018) Heat Vulnerability Index. Source: Sun, C, Hurley, J, Amati, M, Arundel, J, Saunders, A, Boruff, B & Caccetta, P 2019, *Urban Vegetation, Urban Heat Islands and Heat Vulnerability Assessment in Melbourne, 2018*, Clean Air and Urban Landscapes Hub, Melbourne, Australia.

Bayside	2	6	Moonee Valley	15	50
Boroondara	1	16	Moorabool	8	23
Brimbank	16	51	Moreland	9	46
Cardinia	9	29	Mornington Peninsula	5	15
Casey	9	25	Nillumbik	1	21
Darebin	2	36	Port Phillip	3	10
Frankston	6	15	South Gippsland	9	25
Glen Eira	3	9	Stonnington	1	17
Greater Dandenong	7	17	Whitehorse	2	22
Hobsons Bay	9	26	Whittlesea	3	49
Hume	16	64	Wyndham	10	28
Kingston	5	12	Yarra	2	23
Knox	4	10	Yarra Ranges	2	27
Macedon Ranges	10	34			
Manningham	2	26			
Maribyrnong	16	53			
Maroondah	3	18			
Melbourne	6	30			

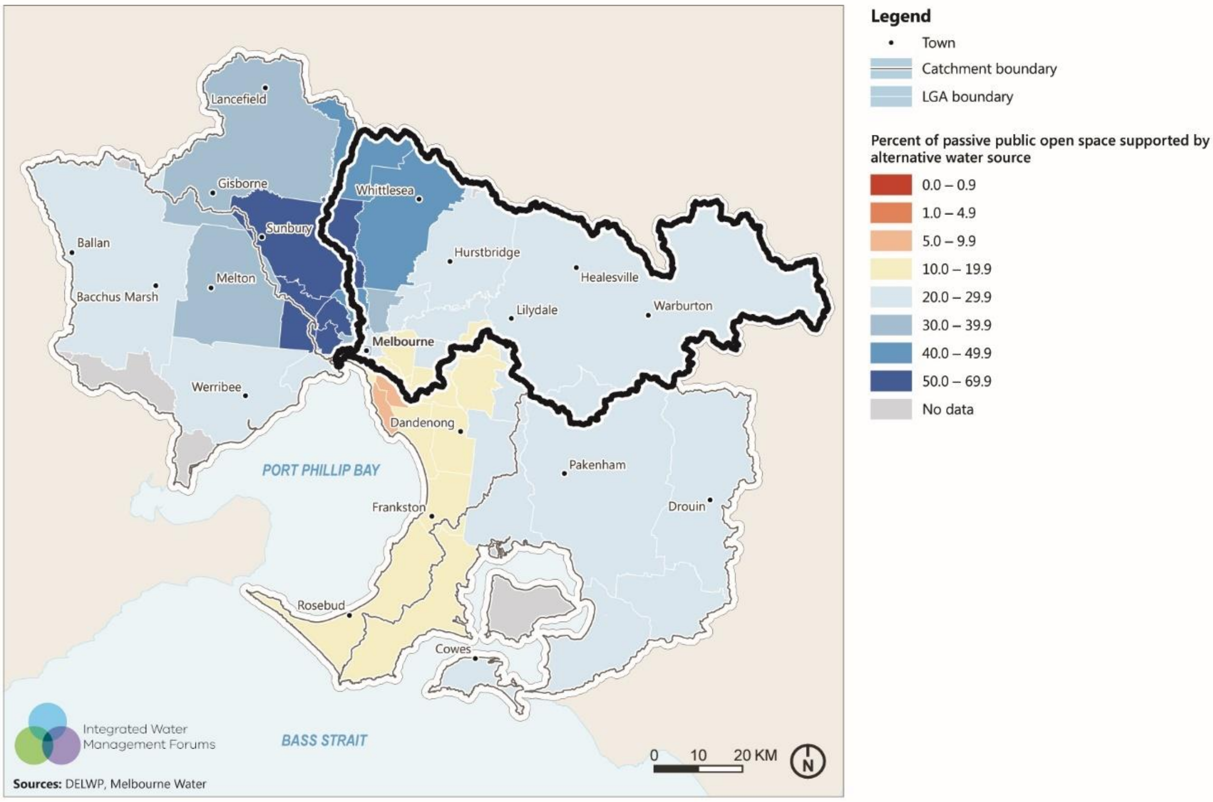

Figure 76: Measure 5.2b targets disaggregated to LGA

Indicator 5.3: Reduce urban heat for the purposes of enhancing human thermal comfort

Measure 5.3: Degree Celsius reduction in land surface temperature attributed to IWM in urban areas

Where IWM increases shade, vegetated surfaces or the presence of water in the landscape, there is the potential to reduce local air and land temperatures.

Table 79: Measure overview

Measure 5.3: Degree Celsius reduction in land surface temperature attributed to IWM in urban areas parameters												
Indicator type	Lagging											
Desired State Target Scale	N/A											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Western Port**	
Current state	**0**		0		0		0		0		0	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	No data available											

Future desired state

Existing targets and referenceable evidence

There are no known targets in existing Melbourne-wide strategies regarding the contribution that water will make to urban heat reduction.

Possible future interventions

A model has recently been developed to estimate reductions in land surface temperature due to the presence of water and irrigation based on observed reductions of various initiatives in the field.[98] Various scenarios are currently being modelled, but the data for the Greater Metropolitan Melbourne Region was not available at the time of writing.

Desired State target recommendations

It is proposed that this indicator is classified as a 'lagging' indicator, whereby it is monitored or modelled to understand the retrospective impact of IWM interventions on outcomes, but it is not specified as a leading indicator whereby a performance target is set. Models to reflect the cumulative impact of initiatives on urban heat are evolving, but it will be difficult to set or report against a target at this time. The most impactful IWM initiatives for urban heat will be irrigation of trees and open space, hence, the preceding indicators will lead change in this area.

[98] CRC for Water Sensitive Cities (2021). Water Sensitive Cities Scenario Tool. Available at: https://watersensitivecities.org.au/water-sensitive-cities-scenario-tool/

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Strategic Outcome 6 – Community values are reflected in place-based planning

This strategic outcome explores the benefits provided to local communities through effective IWM planning. Community values play an important role in defining these benefits, and measures are required to ensure they are effectively incorporated within city planning and design. Measures for this outcome are diverse and include community understanding of water and Traditional Owner perceptions around how well IWM initiatives incorporate Aboriginal values, as well as how proposed initiatives support amenity, health and well-being which are important values to all communities.

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The case for change

Traditional Owner values

Indigenous Australians have a strong cultural, spiritual and economic connection to water, gathered from the sustainable management of land, water and resources over thousands of generations. Traditional Owners have unique connections to Country throughout the Greater Metropolitan Melbourne Region, with the following three Registered Aboriginal Parties represented within the five IWM Catchment areas:

- Bunurong Land Council Aboriginal Corporation
- Wathaurung Aboriginal Corporation trading as Wadawurrung
- Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation

Water for Victoria outlines Traditional Owners and Aboriginal Victorians' role in the management of the state's water resources.[99] It includes provisions to recognise and incorporate Aboriginal values and knowledge in water planning and to support Aboriginal participation in water management.

IWM planning for each Catchment area will require the involvement of Traditional Owner groups located in that Catchment and require consideration of Aboriginal values and knowledge across all activities. Respecting the connection to Country of Traditional Owners can positively impact on health, well-being and cultural identity. Registered Aboriginal Party representatives have been included from the early stages of IWM Forum planning to ensure appropriate approaches are adopted and that all requirements are effectively met through the IWM Forum process. How incorporation of Traditional Owner values in IWM may change in the future is currently being discussed with Traditional Owner Corporation representatives.

Community understanding of the water cycle

Community understanding of the water cycle has progressively changed over recent years, with a greater acknowledgement of the role that water can play in enhancing community health and well-being, local amenity and overall urban liveability. The Millennium Drought highlighted the importance of water for communities, with water restrictions directly impacting neighbourhood amenity and bringing water use and efficiency front of mind. A national survey of Australians' water literacy in 2014 found that most Australians had good knowledge of some water issues, with 74% having a clear or general sense of how the water cycle works, 56% knowing where their drinking water comes from, and 74% understanding how water conservation practices at the individual level can affect water demand.[100] A breakdown of responses across states, however, revealed that Victorians tended to have some of the lowest levels of water knowledge. In more recent times, a greater appreciation of water management has been complemented by an increased awareness of the importance of open space and urban greening to communities.

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[99] State Government of Victoria (2018). Water for Victoria, Chapter 6. Available at: https://www.water.vic.gov.au/water-for-victoria

[100] Fielding, K., Karnadewi, F., Newton, F., & Mitchell, E. (2015). *A National Survey of Australians' Water Literacy and Water-related Attitudes*. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

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A number of stakeholders play an important role in supporting and facilitating increased community understanding and connections to the water cycle, including councils, water authorities, local Landcare groups and schools. Community engagement of these groups has enhanced community literacy around the water cycle and over time, has enabled greater participation in local placemaking initiatives. Community advocacy groups concerned with water cycle outcomes are active across all Catchments and play a key role in engaging communities at a local level. It is expected that this work will continue into the future, leading to increases in community understanding of the water cycle, water management and IWM opportunities in their communities.

Sense of place and amenity

Sense of place and satisfaction with local amenity are broad concepts that planners and local governments work hard to enhance. Water can play a significant role in enhancing amenity and local character through the integration and enhancement of blue-green infrastructure, such as waterways, wetlands, and other stormwater management assets. The impacts on natural assets unique to each Catchment can have a profound effect on a community's sense of place and drive engagement to improve local amenity. Traditionally such engagement focused on the replacement of like-for-like or maintenance of the status-quo. Today we are seeing a greater interest in the installation of blue-green infrastructure that provides multiple benefits including city greening, improved amenity and ecological services amongst others.

Generally, IWM planning has not featured heavily in urban planning or design responses to placemaking needs, in part due to limited knowledge and understanding of IWM as an approach to resolve water balance challenges created by urbanisation and deliver complementary liveability benefits.[101] However, this is changing, as the impacts of climate change are being increasingly experienced at a local level by councils and their communities, and increased urban development is shifting the focus from private green space to higher quality and climate-resilient public green space. This has contributed to the delivery of major urban greening projects such as Greening the West that seek to enhance amenity and sense of place while improving the water cycle.[102] Specific blue-green infrastructure initiatives include the development of green corridors and nature links, naturalisation of waterways, and conversion of paved space to green space. However, these project examples are disparate and are not yet commonplace across the Catchments.

Under the future reference state, we expect increased investment in urban greening, particularly the enhancement of urban forest and support of trees with alternative resources. Continued investment in WSUD assets and waterway revegetation will continue to support urban greening and amenity, albeit at relatively modest levels overall, as the impacts of urbanisation will simultaneously lead to losses in trees and green space in the private realm. Less common greening initiatives such as conversion of impervious areas to pervious green space, as well as daylighting of underground waterways, are not assumed to attract further investment under the future reference state.

Health and well-being

Greener neighbourhoods and access to quality open space, waterways, lakes and beaches have been shown to significantly improve both physical and mental health.[103] The health and well-being benefits of greening enabled by IWM are well-known, and the social and economic benefits are increasingly being evaluated as part of a holistic business case for IWM.[104] When designed well, IWM initiatives can enhance opportunities for recreation, improve amenity, connect communities with nature and naturally cool our cities. This correlates with investment in urban forests and open space, as described in Strategic Outcome 5.

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[101] Williams, D. (2020). The influence of statutory land use planning on water sensitive urban design practices. *Australasian Journal of Water Resources*, 24(1), pp.60-72.
[102] Greening the West (2021). About. Available at: https://greeningthewest.org.au/about/
[103] Kendal, D., Lee, K., Ramalho, C., Bowen, K. and Bush, J., 2016. Benefits of urban green space in the Australian context. Available at: https://minerva-access.unimelb.edu.au/bitstream/handle/11343/122914/2016-CAUL-Benefits%20of%20Urban%20Green%20Space.pdf
[104] Frontier Economics (2019). *Health Benefits from Water Centric Liveable Communities*. Water Services Association of Australia. Available at: https://www.wsaa.asn.au/publication/health-benefits-water-centric-liveable-communities

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There are strong reasons to support enhanced IWM initiatives to improve health and well-being. An assessment of the proportion of the adult population that meet physical activity guidelines demonstrates that a significant proportion do not currently meet recommended activity levels for optimal health and well-being (see the figure below). Low levels of physical activity have been correlated with the onset of disease with increased activity known to reduce depression, stress and anxiety amongst other health and wellbeing benefits.[105]

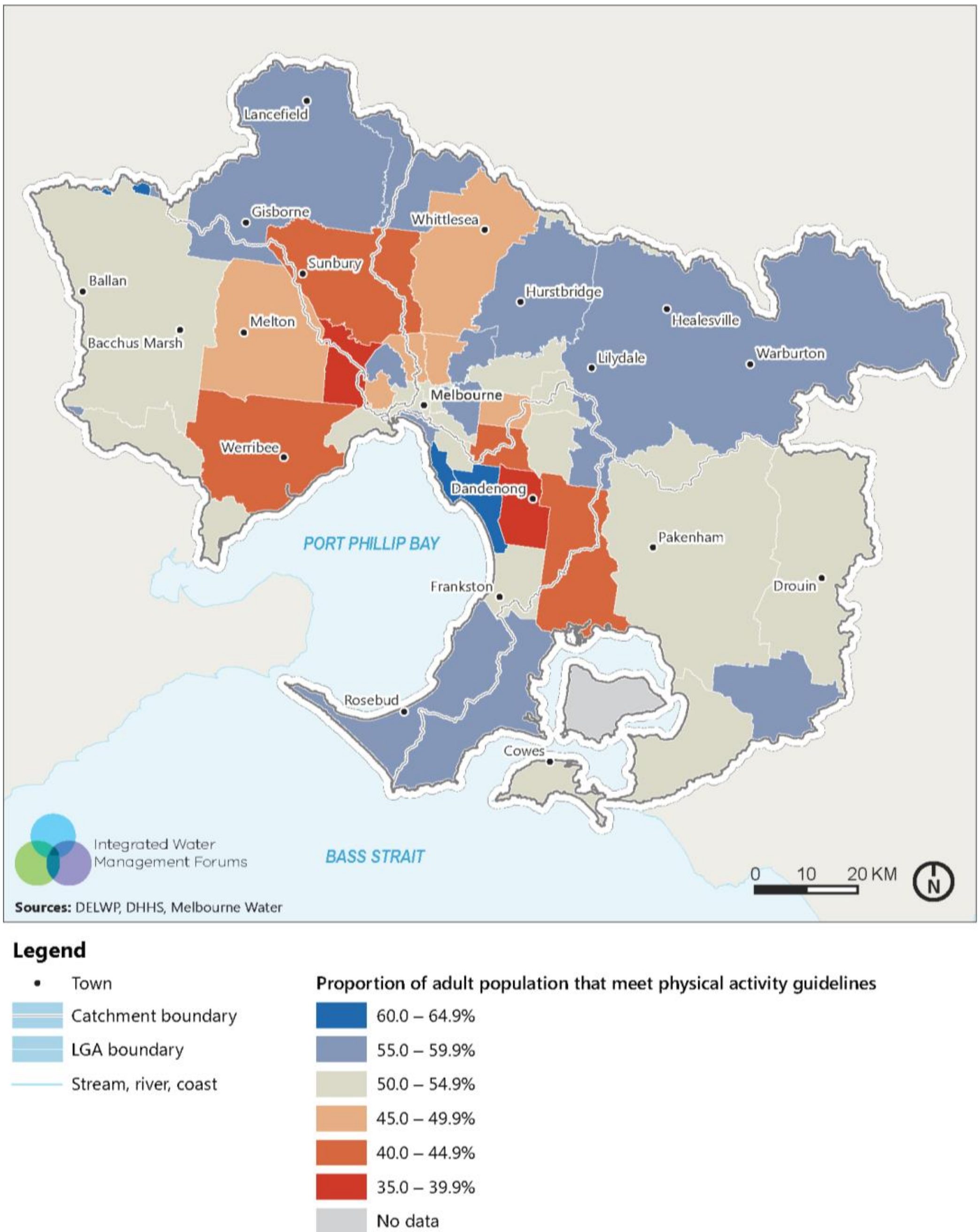

Figure 77: Proportion of adults that meet physical activity guidelines across the region.

An analysis of Catchment data for the proportion of the adult population diagnosed with anxiety or depression demonstrates that the majority of the Greater Metropolitan Melbourne Region has a diagnosis rate of over 25%. With the potential for such significant community benefits, health and well-being is a key driver for the delivery of IWM initiatives that provide multiple benefits for people and the environment.

[105] VicHealth (2010). Women's Health Atlas.

More recently, the COVID-19 pandemic has led to a growing community appreciation of the multiple health and well-being benefits that blue-green spaces in urban areas can provide. A study comparing the self-reported impacts of COVID-19 on people's lifestyles and use of green-blue infrastructure in Moscow and Perth found that both *availability* and *access* to green and blue spaces was very highly valued among urban residents in both cities, and greatly relied upon to support their well-being during the pandemic.[106] Notably, Perth respondents highly rated the importance of contact with nature for their mental well-being (97%) and physical well-being (85%). This is one of many recent investigations confirming the importance of blue-green spaces in post-COVID-19 economic recovery. These findings support arguments for greening to be a fundamental part of strategies to enhance the resilience of our cities and towns.

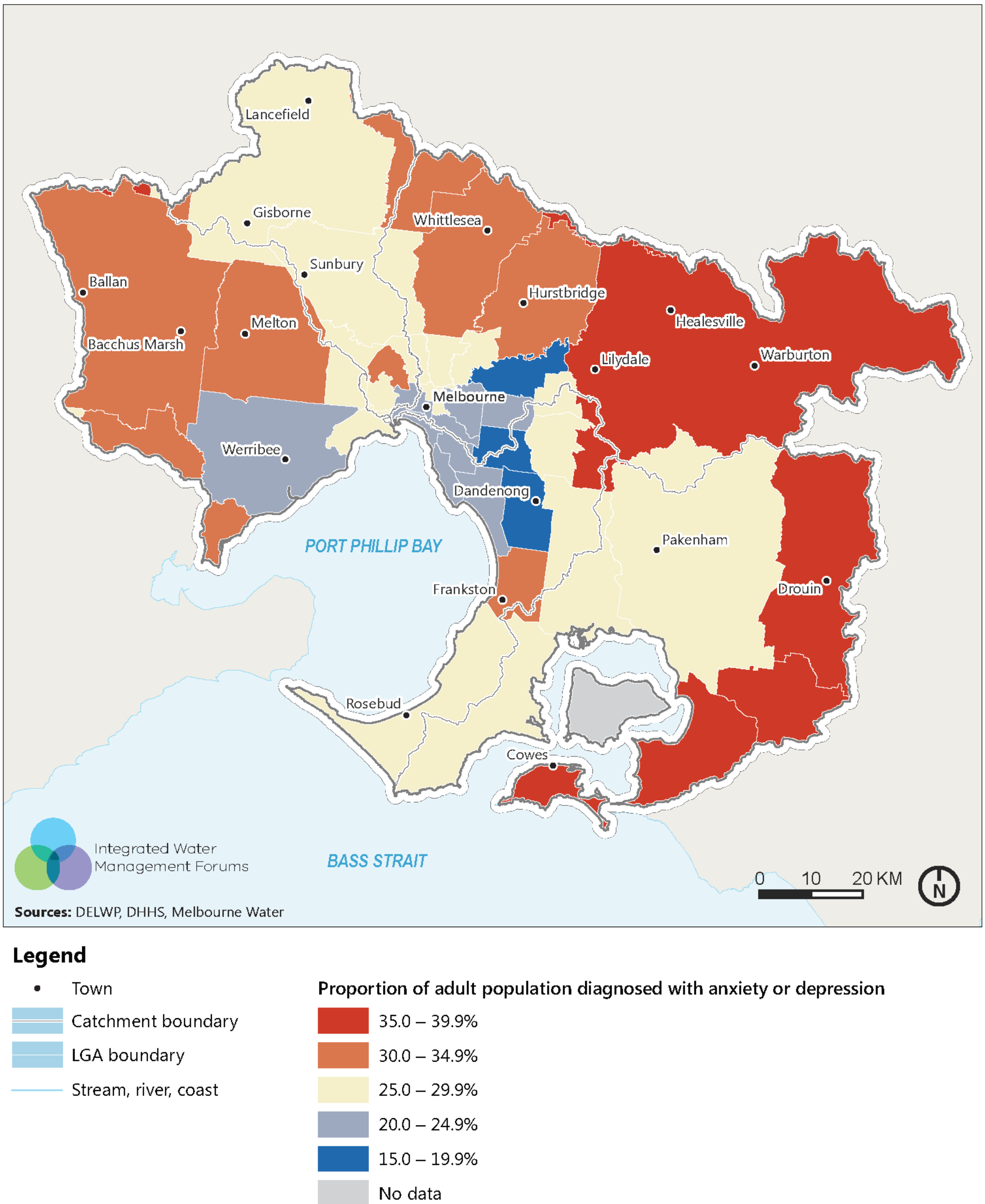

Figure 78: Proportion of adult population diagnosed with anxiety or depression across the region.

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106 Dushkova, D., Ignatieva, M., Hughes, M., Konstantinova, A., Vasenev, V. and Dovletyarova, E. (2021). Human dimensions of urban blue and green infrastructure during a pandemic. Case study of Moscow (Russia) and Perth (Australia). *Sustainability*, 13(8), p.4148. Open access, available at: https://www.mdpi.com/2071-1050/13/8/4148/htm

Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 80: Indicators and Measures for Strategic Outcome 6

Indicators	Measures
6.1: Increase the capacity of Traditional Owners to partner in IWM programs, planning, policy and project delivery, as well as the capability of other IWM partner organisations to partner with Traditional Owners in IWM programs, planning, policy and project delivery	a. Rating of Traditional Owners' capacity to partner in IWM programs, policy, planning and projects b. Rating of other IWM partner organisations' capability to partner with Traditional Owners in IWM programs, policy, planning and projects
6.2: Increase IWM's contribution to a community's sense of place, health and well-being	Hectares of blue-green infrastructure created or enhanced by integrated water management
6.3: Improve communities' connection with and understanding of the water cycle	Rating of community literacy regarding the water cycle
6.4: Increase consideration of the water cycle in town planning	Rating of whether water is a key element in city planning and design process

Indicator 6.1: Increase the capacity of Traditional Owners to partner in IWM programs, planning, policy and project delivery, as well as the capability of other IWM partner organisations to partner with Traditional Owners in IWM programs, planning, policy and project delivery

The measures for these indicators have been developed in collaboration with Traditional Owner representatives and are the subject of ongoing discussions. The *Water and Catchment Legislation Amendment Act 2019* outlines new requirements for water resource managers to recognise and involve Traditional Owners in the planning and management of waterways and Catchments. The Act ensures that Victoria's water resources and waterways are managed in a way that considers Aboriginal cultural values and uses of waterways. This amendment furthers work by the Victorian Government to ensure Aboriginal Victorians and Traditional Owners have an active and ongoing role in water and Catchments planning, as well as a strong voice to impart cultural values and knowledge in water-related policy, planning and projects.

The legislation amendment demonstrates best practice for bringing Aboriginal cultural values and traditional ecological knowledge of management of land and water resources into the planning and delivery process. However, there is still much progress to make to ensure responsible entities, including governments and water corporations, appropriately plan for and resource Traditional Owner involvement in these processes.

Measure 6.1a: Rating of Traditional Owners' capacity to partner in IWM programs, policy, planning and projects

Representatives of the Registered Aboriginal Parties in the metropolitan Catchments report unsustainable levels of demand for their interest and insight, which is impacting their *capacity* to genuinely partner in IWM as well as contribute cultural knowledge and Country expertise to numerous and wide-ranging natural resource management activities vying for their consideration. In this document, capacity refers to the amount or volume of work and the ability or power to deliver outputs. Improved coordination within and between

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agencies is required for Traditional Owner involvement to be sustainable, meaningful and mutually beneficial. Further, water resource managers must consider Traditional Owner involvement as part of their annual water resource and Catchment planning and the development and review of strategies, as well as seek to empower their organisations with the resources that Traditional Owner groups deem necessary to undertake their activities in accordance with the principles of self-determination.

Table 81: Measure overview

Measure 6.1a: Rating of Traditional Owners' capacity to partner in IWM programs, policy, planning and projects parameters												
Indicator type	Leading											
Desired State Target Scale	TBC - Pending consultation											
Measure performance and targets												
Rating	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Westernport**	
Current state	TBC – Pending outcomes of the survey											
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	TBC – Pending consultation											
Desired state	TBC – Pending consultation											

Table 82: Data and assumptions

Data source/s
A survey for tracking measures 6.1a and 6.1b was developed in consultation with Traditional Owners and was distributed in May 2021 to determine a baseline and appropriate 2030 and 2050 targets for these measures. Available: https://www.surveymonkey.com/r/MR9C9ZJ
Key assumptions
TBC – Pending consultation

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Current state

To be confirmed.

Future reference state

To be confirmed.

Future desired state

To be confirmed.

Measure 6.1b. Rating of other IWM partner organisations’ capability to partner with Traditional Owners in IWM programs, policy, planning and projects

Organisations involved in IWM have obligations to include Traditional Owners and consider Aboriginal values in their organisational activities. This measure aims to understand how Forum partner organisations’ capabilities to partner with Traditional Owners can ultimately improve the capacity of Traditional Owners to partner in IWM programs, policy, planning and projects.

Table 83: Measure overview

Measure 6.1b. Rating of other IWM partner organisations’ capability to partner with Traditional Owners in IWM programs, policy, planning and projects parameters												
Indicator type	Leading											
Desired State Target Scale	TBC - Pending consultation											
Measure performance and targets												
Rating	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Westernport**	
Current state	TBC – Pending outcomes of the survey											
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	TBC – Pending consultation											
Desired state	TBC – Pending consultation											

Table 84: Data and assumptions

Data source/s
A survey for tracking measures 6.1a and 6.1b was developed in consultation with Traditional Owners and was distributed in May 2021 to determine a baseline and appropriate 2030 and 2050 targets for these measures. Available: https://www.surveymonkey.com/r/MR9C9ZJ
Key assumptions
TBC – Pending consultation

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Current state

To be confirmed.

Future reference state

To be confirmed.

Future desired state

To be confirmed.

Indicator 6.2: Increase IWM's contribution to a community's sense of place, health and well-being

By bringing blue and green infrastructure together, we can protect and enhance the hydrological and ecological values of our urban landscapes. This provides opportunities to create places that improve community connection, health and well-being, as well as deliver broader benefits such as flood mitigation, cooler and more comfortable microclimates, and new habitats for native species.

Measure 6.2: Green-blue infrastructure created or enhanced by integrated water management as a proportion of land area (%)

This measure recognises that where green-blue infrastructure is either added or significantly enhanced,[107] it is likely to improve local amenity and sense of place, as well as the health and well-being of the community. Initiatives that would contribute to this indicator include (but are not limited to) the provision of:

i. Stormwater treatment assets that include vegetation or open water
ii. Alternative water irrigation supplies supporting public open space that wouldn't have otherwise been irrigated
iii. Alternative water irrigation supplies supporting trees that wouldn't have otherwise been irrigated
iv. Retarding basins that have been converted to useable public open space
v. Waterways or water bodies where substantial riparian planting and landscape improvement has been undertaken
vi. Waterways or drainage channels that have been naturalised (sealed base converted to a natural landscape)
vii. Drains that have been daylighted (so that water flow is along a surface channel)
viii. Large public areas where paved or impermeable surfaces haves been permanently converted to vegetated open space.

Table 85: Measure overview

Measure 6.2a: Green-blue infrastructure created or enhanced by integrated water management as a proportion of land area (%) parameters												
Indicator type	Lagging											
Desired State Target Scale	N/A											
Measure performance and targets												
%	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Westernport**	
Current state	0.59		1.05		0.29		0.20		1.27		0.13	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	0.93	1.59	1.41	2.09	0.66	1.40	0.60	1.36	1.58	2.19	0.40	0.92

[107] Enhanced beyond: a) industry best practice maintenance or b) asset rectification to meet original design intent

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Table 86: Data and assumptions

Data source/s

i. *Stormwater treatment assets that include vegetation or open water.*

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide information on their WSUD assets, rainwater use and stormwater use. Conducted February-March 2020.

ii. *Alternative water irrigation supplies supporting public open space that wouldn't have otherwise been irrigated*

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked if alternative water supplies enabled irrigation of additional open space. Conducted February-March 2020.

iii. *Alternative water irrigation supplies supporting trees that wouldn't have otherwise been irrigated*

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked what percentage of trees were supported by an alternative water source. Conducted February-March 2020.

State Government of Victoria (2018) Tree cover spatial data. Provided by DELWP.

iv. *Retarding basins that have been converted to useable public open space*

Retarding Basin Multi-Use data provided by Melbourne Water (unpublished).

Melbourne Water GIS data (2020) - Spatial layers for retarding basins & wetlands and water quality assets.

v. *Waterways or water bodies where substantial riparian planting and landscape improvement has been undertaken*

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked about waterways or waterbodies where substantial riparian planting and landscape improvement has been undertaken. Conducted February-March 2020.

Melbourne Water enhances waterway riparian areas as part of its waterway improvement works. However, spatial data was not available to disaggregate this estimate to sub-catchments and local government areas. Melbourne Water expects to collate and process spatial data later this year, however it was not available in time for inclusion in this project.

vi. *Waterways or drainage channels that have been naturalised (sealed base converted to a natural landscape)*

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked about waterways or drainage channels that had been naturalised. Conducted February-March 2020.

Melbourne Water (2016) Better waterways and drainage for our community. An investment Plan 2016-2021.

vii. *Drains that have been daylighted (so that water flow is along a surface channel)*

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked about drainage channels that had been daylighted. Conducted February-March 2020.

viii. *Large public areas where paved or impermeable surfaces has been permanently converted to vegetated open space*

Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked about paved areas that have been converted to permeable areas. Conducted February-March 2020.

Key assumptions

i. Refer to Background Appendix A: Water and Pollutant Balance Analysis for WSUD analysis description. Only WSUD assets that are vegetated were included: green roof, streetscape raingardens, passively irrigated trees, swales, wetlands, bioretention basins, ponds. Projections based on historical council WSUD delivery and future delivery rate as determined by council cluster.

ii. No change anticipated under the Future reference state. Assumed that new irrigation of open space using alternative water resources focuses on active open space that would have otherwise been irrigated with potable water.

iii. The area of tree canopy supported through IWM is calculated by multiplying the percentages of street trees supported by an alternative water source (see measure 5.1) by the total street tree cover in each area. Rural areas were removed from this calculation as the provision of green-blue infrastructure to enhance greening and amenity is more pertinent to urbanised environments.

iv. Only retarding basins that were found to provide use as an open space were included. No change anticipated under the Future reference state.

v. Data provided as km length. 20m wide riparian area assumed to calculate area. Future investment in waterway revegetation is expected to remain at current levels under the Melbourne Water waterway enhancement program. Based on the 2016-2021 investment plan, co-investment with landholders, farmers and communities will occur for improvement of 196km of waterways per year. A 20m wide riparian area assumed to calculate area. This has been projected across the study area based on the fraction of the total length of priority waterways for revegetation in each LGA or sub-catchment (as identified in the Healthy Waterways Strategy).

vi. Data provided as km length. 20m wide riparian area assumed to calculate area. No change anticipated under the Future reference state.

vii. No change anticipated under the Future reference state.

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Current state

Across the region, the current state records a proportion of 0.59% which seems small, but actually represents 4,050 hectares of green-blue infrastructure that provides improved amenity and health outcomes to the community as a result of IWM initiatives such as the integration of green stormwater management assets, the conversion of retarding basins to multi-functional open spaces and the enhancement of waterway corridors. Under the current state, the spatial distribution of green-blue infrastructure shows the highest concentrations in the inner metro and suburban council areas. Indeed, suburban councils demonstrate the highest proportion of land use where green-blue infrastructure has been created or enhanced (>1.00%), followed by inner metro councils (~0.5%).

Performance across the Catchment

Total hectares of green-blue infrastructure enhanced by IWM for councils within the Yarra Catchment vary significantly, due to the presence of densely populated urban areas and less densely populated, more highly vegetated landscapes. Lower performing areas are in the inner city, with the smallest areas registered for City of Stonnington. Higher performing areas are located on the Catchment fringe, with the largest number of hectares registered for Yarra Ranges Council. The predominant infrastructure types registered for the Catchment are vegetated stormwater treatment assets, alternative water irrigation assets supporting trees that wouldn't have otherwise been irrigated, retarding basins that have been converted to usable public open space, and landscape improvements to waterways and water bodies.

Future reference state

Similar to the current state, there is a continuing trend of inner metro and suburban council areas exhibiting the highest concentrations of green-blue infrastructure compared to other LGA clusters, particularly through the delivery of vegetated WSUD assets and passively irrigated trees. Compared to the current state, the proportion of land use where green-blue infrastructure is created or enhanced within each council cluster is expected to increase approximately between two- and three-fold on average.

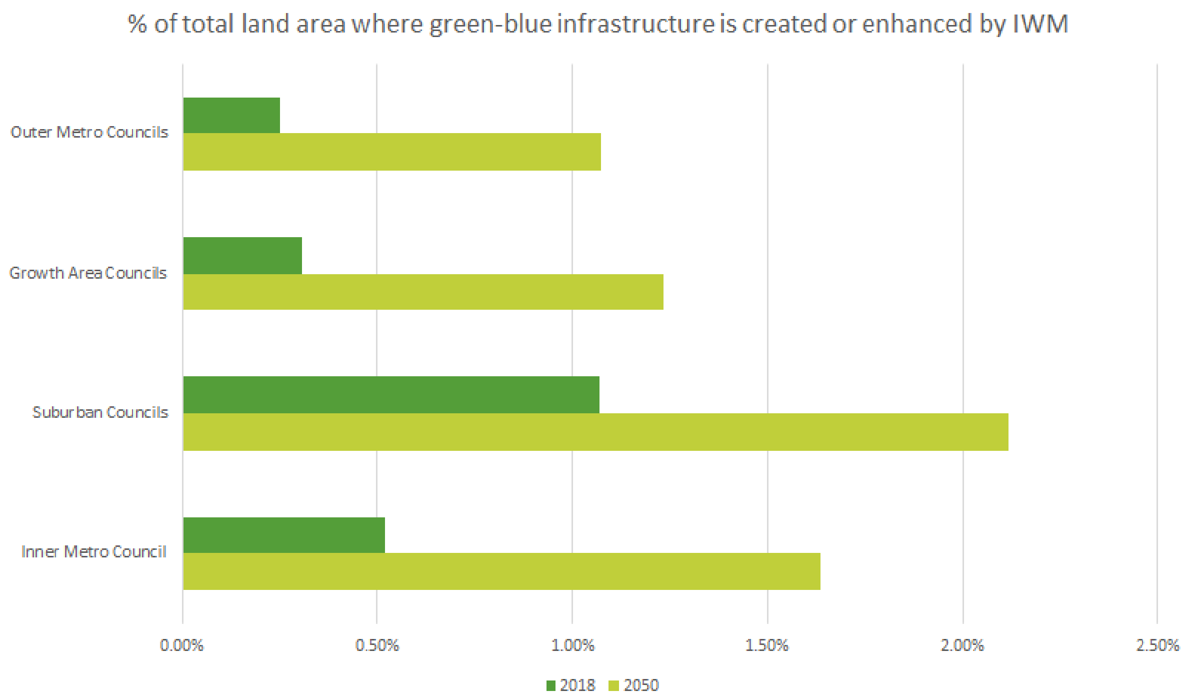

Figure 79: Current and future reference state for measure 6.2. Blue-green infrastructure created or enhanced by integrated water management as a proportion of land area (%), by council cluster.

Performance across the Catchment

Continued investment in vegetated WSUD assets by councils and developers will enhance greening and amenity, particularly in established urban areas. Enhancements of priority waterways across Melbourne will also increase amenity in some areas.

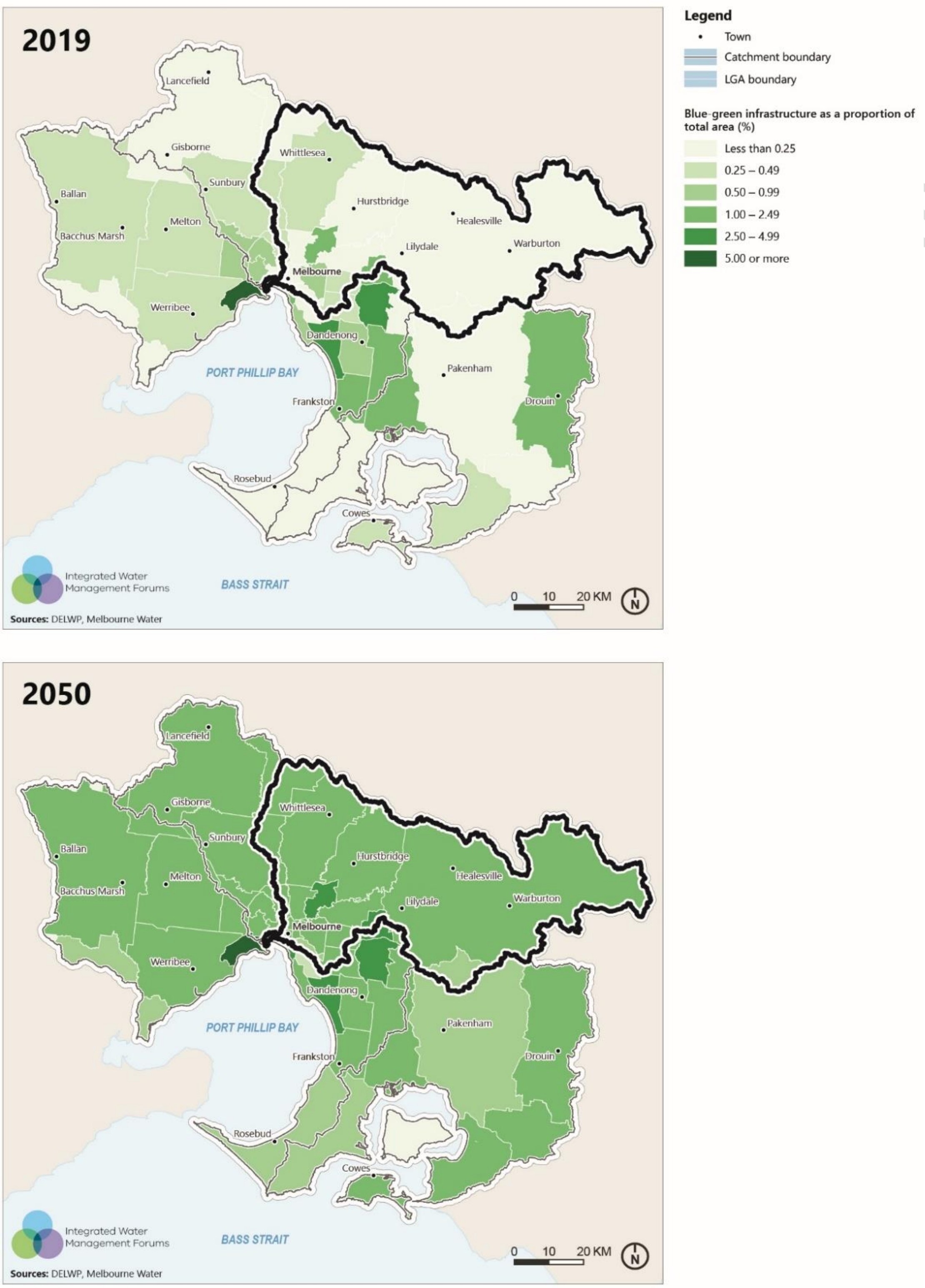

Figure 80: Measure 6.2. Green-blue infrastructure created or enhanced by integrated water management as a proportion of land area (%) (current and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

There are no known targets for the relative amount of blue-green infrastructure in an area. Melbourne Water has committed to 'investing directly in improving 30 hectares of green spaces for shade and cooling across Melbourne by 2021',[108] but there are no existing long-term targets.

Possible future interventions

Particularly in urbanised areas, having access to nature, or a view of green environments or water from a home or workplace increases human health and well-being. IWM plays a key role in creating green-blue assets (e.g. WSUD), supporting green spaces by enhancing irrigation, and creating and improving water assets like lakes and waterways. City of Melbourne has several strategies in place to protect and increase natural assets in an urban environment,[109] and to also encourage new developments to ensure a significant proportion of developed surfaces (ground and facades) are greened.[110]

For waterway corridors specifically, the Healthy Waterways Strategy does set out targets for establishment of vegetation buffers along waterways on a sub-catchment basis. This will most likely also contribute to social and community values in the areas that have been identified as priorities for stream revegetation.

Desired state target recommendations

It is proposed that this indicator is classified as a 'lagging' indicator, whereby it is monitored or modelled to understand the retrospective impact of IWM interventions on outcomes, but it is not specified as a leading indicator whereby a performance target is set. While amenity and liveability are key benefits of IWM, the level of greening in communities is very site specific, and difficult to set a target against. Advisors felt that this is one to monitor and communicate the change we are making, but other indicators will be the drivers of this change.

Indicator 6.3: Improve communities' connection with and understanding of the water cycle

Measure 6.3: Rating of community literacy regarding the water cycle

Community connection and understanding of the water cycle are important contributors to water sensitive placemaking. This measure considers the level of engagement and the resources provided by the water sector to support community understanding and appreciation of the water cycle. In so doing, this measure seeks to emphasise the role the water sector plays in increasing community understanding of IWM and reflects the participation rates of the community in capacity building and other outreach programs. It encourages a shift in approaches to community engagement that move away from disseminating data and information to collaboratively building knowledge and eventually shared understanding (wisdom or expertise).

Many stakeholders are currently investing in behavioural change and community education programmes, and accordingly it is anticipated that there will be some improvement under the future reference state. However, it is expected that change will be gradual and that it will take time before wide-spread change is apparent.

This is a rated indicator, out of a maximum of 5, as described in the table below. The rating definitions have been adapted from the Water Sensitive Cities Index. It is proposed that the definition of a rating 5 is amended to include:

- Understanding of the water cycle rather than the water sector.
- Remove 'interest in' as this can't be forced.

[108] Melbourne Water. (2016). Better Waterways and Drainage for our Community: An Investment Plan July 2016 – June 2021. Available at: https://www.melbournewater.com.au/about/prices-and-charges/waterways-and-drainage-charge/waterways-and-drainage-investment-plan

[109] City of Melbourne (2017). Nature in the City Strategy. Available at: https://www.melbourne.vic.gov.au/community/greening-the-city/urban-nature/Pages/nature-in-the-city-strategy.aspx

[110] City of Melbourne (2020). Green Factor Tool. Available at: https://www.melbourne.vic.gov.au/community/greening-the-city/green-infrastructure/Pages/green-factor-tool.aspx

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- Remove or lessen focus on schools.
- Education and awareness is delivered in an integrated and collaborative way to make communities aware of the interconnections between parts of the water cycle.

Table 87: Rating of Community literacy (regarding the water cycle)

1	2	3	4	5
Generally little or no understanding of the water cycle and no interest either.	Little interest to acquire knowledge of the water cycle and people understand to a degree what they are paying for.	People have a general understanding of the water cycle and people know what they are paying for. Water cycle and understanding of the water sector are part of school curricula.	People have a good understanding of the water sector and know what they are paying for. People know the current state of affairs in the water sector, both in political terms (who's in charge?) but also in technical (what are the dam levels?) and in environmental (why recycled or harvested water?) terms. Water cycle and understanding of the water sector are part of school curricula and this knowledge is regularly updated. Reasonable participation rates for the outreach programmes the water sector provides.	People have a thorough understanding of all aspects of the water cycle, well beyond what is necessary to understand what they are paying for (political, technical and environmental terms). Moreover, they (e.g. cooperatively) own or help manage (decentralised) water servicing solutions. Stakeholders in the water sector collaborate actively to provide current understanding of the water cycle across all sections of the community. Outreach programmes are developed by, or in close collaboration with, the community and yield high participation rates.

Table 88: Measure overview

Measure 6.3: Rating of community literacy regarding the water cycle parameters												
Indicator type	Leading											
Desired State Target Scale	Region, Catchment											
Measure performance and targets												
Rating	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Westernport**	
Current state	2.6		2.3		2.6		2.6		2.6		2.7	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	2.6	3.1	2.5	3.0	2.5	3.0	2.6	3.1	2.6	3.1	2.7	3.2
Desired state	4.5	5	5	5	4.5	5	4	5	4.5	5	5	5

Table 89: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to rate community literacy regarding the water cycle. Conducted by E2Designlab in February-March 2020. CRC for Water Sensitive Cities, Water Sensitive Cities Indexing, conducted 2017-2020. Water sensitive city indexing was conducted for 10 local councils, providing more advanced understanding across some areas addressed in the Catchment Scale IWM Plan Councils Survey.

Key assumptions
Responses to the Council Survey were rated 1 to 5, with 1 reflecting little or no understanding of the lifecycle and 5 representing a thorough understanding and interest in the water sector. Under the future reference state, the current state rating was increased universally by 0.5 by 2050 under the future reference state, based on anticipated ongoing engagement and education work, except where an LGA already received a rating of 4 or higher. It is assumed no change occurs before 2030. It is assumed that this uplift occurs after 2030 but before 2050, reflecting the time needed to instil changes in policy and practice to cement an uplift in outcomes.

Current state

Current state ratings of indicator 6.3a were collated for different LGA clusters to reflect the performance of all stakeholders involved in water management within suburban councils, inner metro councils, growth area councils and outer metro councils. In general, ratings for LGAs indicated a higher performance in inner metro and growth area council areas, with the lowest performance in outer council areas.[111] Inner metro and suburban councils exhibited the highest average ratings under the current state (2.7), while outer metro councils demonstrated the lowest (1.9).

Performance across the Catchment

For the Yarra Catchment, performance is based on responses to both the Catchment Scale IWM Council Survey and the results of Water Sensitive City Indexing, which has been utilised to provide a more accurate rating for the Cities of Manningham, Monash, Port Phillip, Whitehorse and Whittlesea. Responses across the Catchment fluctuate between 2 and 4, suggesting that the community has a general understanding of the water cycle and water sector. Responses from the Cities of Boroondara, Port Phillip and Yarra indicate that communities in these areas have a greater understanding of the water sector at a political, technical and environmental level and may be actively participating in relevant community outreach programs. The results suggest the Yarra Catchment is above the Greater Metropolitan Melbourne Region average, noting there is no data available for Mitchell Shire Council, a small proportion of the Catchment area.

Future reference state

Future reference state ratings of indicator 6.3a were projected using council clusters to reflect the performance of all stakeholders involved in water management within suburban council areas, inner metro council areas, growth area council areas and outer metro council areas. In general, ratings data indicated a higher performance in inner metro and suburban area council areas, with the lowest performance in outer council areas.[112] Under the future reference state, all areas are expected to improve consistently by 0.5, recognising the ongoing investment by both water corporations, Melbourne Water and councils in improving community awareness and understanding of the water cycle. On average, the highest ratings under the current state (3.8) were seen in the inner metro councils areas while the lowest (2.1) was seen in the outer metro council areas under the future reference state.

Table 90: Current and reference state performance for measure 6.3a by council cluster

	2018	2050
Inner Metro Council	2.7	3.2
Suburban Councils	2.7	3.2
Growth Area Councils	2.5	3.0
Outer Metro Councils	1.9	2.4

Performance across the Catchment

Under the future reference state, community awareness and understanding of water is expected to show a marginal increase.

[111] Based on the council survey and Water Sensitive City index results (where available).

[112] Based on the council survey and Water Sensitive City index results (where available).

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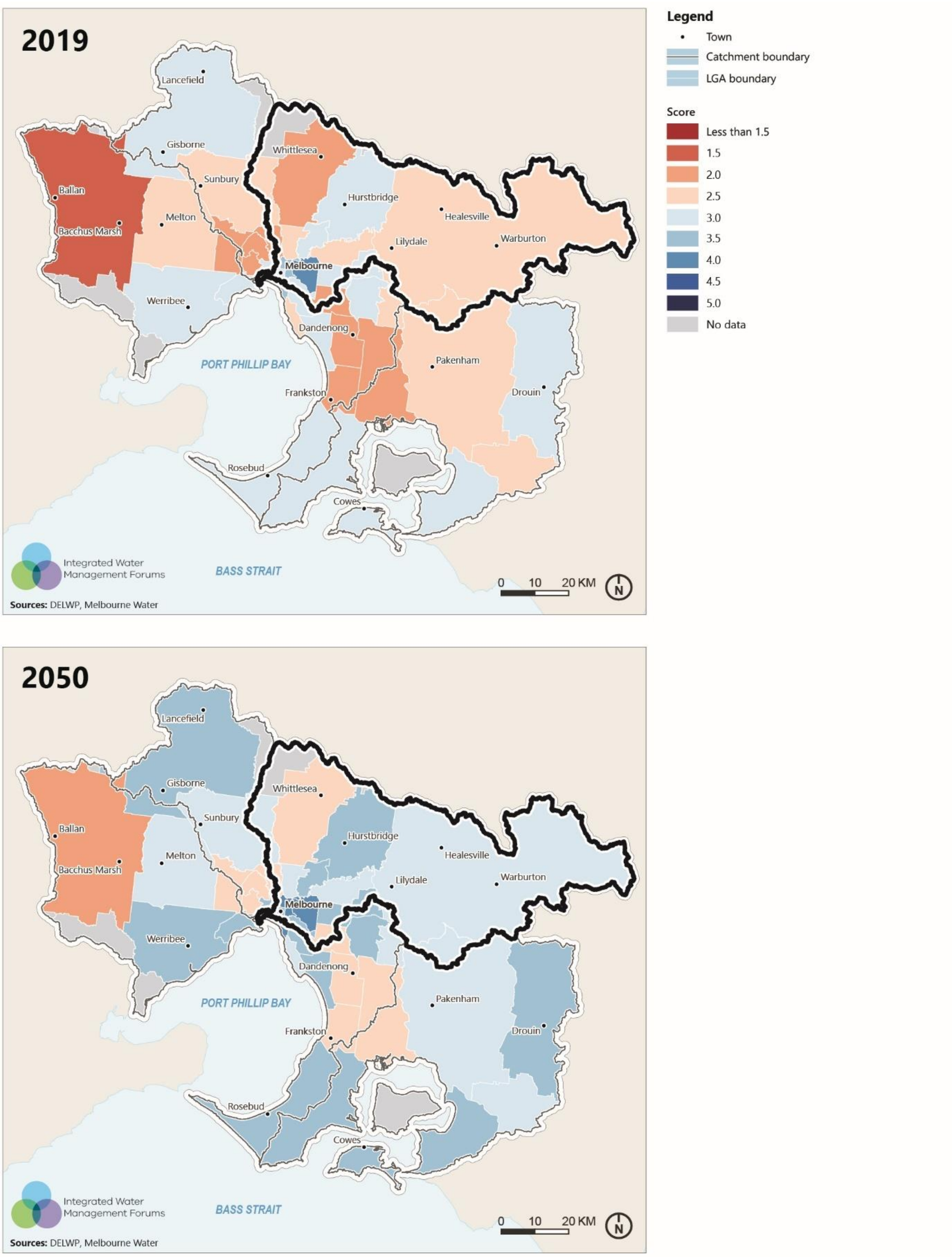

Figure 81: Measure 6.3 Rating of community literacy regarding the water cycle (current and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

While there are no existing targets set out in existing strategies, the metric is constructed around an 'ideal' rating of 5 based on the achievement of this key performance indicator which is key in the creation of a water sensitive city.[113]

Possible future interventions

Water authorities invest in community engagement and knowledge sharing on an ongoing basis. The total current spend by the major Melbourne water retailers on community engagement programs is in the order of $2 Million per annum. This spend is predominantly on water conservation so needs to increase significantly to improve general community knowledge and behaviour change towards a rating 5 outcome. Examples of possible interventions to progress towards rating 5 outcomes are listed below.

Elements of Rating 5	Example of possible interventions to progress towards rating 5 outcomes
People have a thorough understanding of all aspects of the water cycle, well beyond what is necessary to understand what they are paying for (political, technical and environmental terms)	Implement a co-ordinated, long-term water efficiency behaviour change and water literacy program for Victoria. Encourage behaviour change through emerging tools such as water use data platforms, customer dashboards, digital metering and home (sustainability) rating tools. Build on the water industry's strong connection and trusted relationship with community to expand water literacy programs beyond school groups to broader sector groups (i.e. culturally and linguistically diverse communities).
They (e.g. cooperatively) own or help manage (decentralised) water servicing solutions	Clarify where and how community can make choices and contribute to solutions. Disseminate place based/project-based information to empower individuals to make choices that support a water sensitive future. This will ultimately enable the community to become more actively involved in the planning, management and maintenance of blue-green water infrastructure owned and operated at a range of scales. Implement a co-ordinated, long-term behaviour change and water literacy program specific to key elements of IWM (i.e. water efficiency, rainwater use, etc) targeted at a range of community sectors, end-uses and businesses likely to generate the greatest impact. Examine opportunities to encourage behaviour change through tools such as water use data platforms, customer applications or dashboards, digital metering and home (sustainability) rating tools.
Stakeholders in the water sector collaborate actively to provide current understanding of the water cycle across all sections of the community	Introduce requirements for inter-organisational programs to facilitate consistent messaging that reinforces and complements other messages. Expansion of innovative programs, such as, re-imagining your creek, co-design initiatives, etc. Leveraging innovative local projects using champions to empower communities and then scaling up the messaging and outcomes and disseminate to wider audience.
Vision and aspirations of IWM is described using language that will not be lost on the wider community	Explicitly link IWM outcomes to broader community aspirations for greener urban landscapes and improved liveability (outcomes not infrastructure) using easy-to-understand terminology free of technical jargon[114]. Produce visualisations of outcomes that tie several aspects of water management together to engage with the broader community.
Outreach programmes are developed by, or in close collaboration with, the	There is now a clear directive in the *Local Government Act 2020* for deliberative engagement practices (s 55), creating an opportunity to expand programs directed at strategic water planning and implementation.

[113] CRC for Water Sensitive Cities (2018) Water Sensitive City Index. Available at: https://watersensitivecities.org.au/water-sensitive-cities-index-tool/

[114] See CRC for Water Sensitive Cities (2021) Communicating water words and visuals. Available: https://watersensitivecities.org.au/solutions/water-words-and-visuals-2/

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community and yield high participation rates	Deliver community focused educational programs to raise awareness and knowledge of IWM. Focus on the 'why' (create the case for change), the 'what' (shared vision) and the 'how' (practical measures that can be implemented). It will be important to cover all the sectors – homeowners, business, industry, developers, traditional custodians, etc. Use knowledge exchange initiatives between traditional custodians and the water industry. Community champions can play the role of knowledge brokers between water managers and the general population. Empower community members via established groups (i.e. friends of, schools, sporting clubs) by providing easy to access and relevant information for case studies and turnkey solutions on IWM. Employ use of Virtual Reality tours developed for school programs and use these tools more broadly within the community, in locations such as museums, Federation Square etc. Involve the community in IWM projects through inter-disciplinary planning and co-design processes.

Desired state target recommendations

2050 Regional and Catchment Targets

The target for this measure is a rating 5, reflecting the need for communities to be at the core of IWM, and to become partners in its delivery. It is recognised that the other targets in this plan cannot be achieved without high levels of community support and stewardship for IWM solutions.

2030 Regional and Catchment Targets

A 2030 target has been selected for each Catchment that accelerates our path towards a rating 5, recognising the importance of embedding community engagement and understanding early, to support delivery of IWM.

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Indicator 6.4: Increase consideration of the water cycle in town planning

Measure 6.4: Rating of whether water is a key element in city planning and design process

This measure considers the degree to which water system planning is integrated into urban planning and design. This includes whether it is included in local planning policies and statutory planning frameworks, and whether robust decision-making models and approaches are utilised to address uncertainty around future water planning. It anticipates the widespread use of adaptive strategic planning approaches to facilitate the delivery of liveability, sustainability, resilience and productivity goals. This rating does not include planning delivery phases, which are equally critical for translating IWM principles into practice. A focus for future improvement will be working with stakeholders to move place-based planning and infrastructure design to practical and affordable delivery supported by enduring governance arrangements.

This is a rated indicator, out of a maximum of 5, as described in the table below. The rating definitions have been adapted from the Water Sensitive Cities Index. It was proposed that the definition of a 5 rating is amended to include:

- Cross-sectoral collaboration to water system planning is mandated for all IWM stakeholders in regulation/legislation (not just policy) and included in statutory planning frameworks.
- Clear IWM policy and targets at the appropriate Catchment spatial scale are in place to support land use decision-making and IWM planning.
- Enduring governance arrangements are established for both planning and delivery phases.
- Funding and delivery responsibilities are identified and outlined in the planning phase.

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Table 91: Rating of water is a key element in city planning & design

1	2	3	4	5
Water policy and management beyond essential services are rarely considered in matters of urban planning.	General policy on sustainability is in place but there is a lack of focus on integrated water system planning.	Urban water policy acknowledges the role of integrated water management planning, and water system planning coordination between organisations occurs, often led by a single agency or department.	Urban water policy acknowledges the role of integrated water management planning and some collaboration between organisations occurs. Contingency planning is routinely used and incorporates methods such as scenario planning to deal with uncertainty around issues such as population growth and climate change. Monitoring and evaluation of planning is in place.	Water system planning is fully integrated in urban planning and design. Cross-sectoral collaboration to water system planning is mandated in official policy and included in statutory planning frameworks (not just policy) and included in statutory planning frameworks. Contingency planning is routinely used and incorporates methods such as scenario planning, robust decision making and exploratory modelling to deal with uncertainty around issues such as population growth and climate change. Monitoring and evaluation of planning is in place. Urban design guidelines address the critical role of water in achieving liveability, sustainability, resilience and productivity goals. Strategies and plans are explicitly adaptive. Clear IWM policy and targets at the appropriate scales are in place to support land use and IWM planning. Enduring governance arrangements are established for both planning and delivery phases. Funding and delivery responsibilities are identified and outlined in the planning phase.

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Table 92: Measure overview

Measure 6.4: Rating of whether water is a key element in city planning and design process parameters												
Indicator type	Leading											
Desired State Target Scale	Region, Catchment											
Measure performance and targets												
Rating	**Region**		**Werribee**		**Maribyrnong**		**Yarra**		**Dandenong**		**Westernport**	
Current state	2.7		2.9		2.6		2.5		2.6		2.9	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	2.7	3.2	2.9	3.2	2.7	3.2	2.7	3.2	2.5	3.0	2.7	3.2
Desired state	4.5	5	5	5	4.5	5	4	5	4.5	5	5	5

Table 93: Data and assumptions

Data source/s
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to rate community literacy regarding the water cycle. Conducted by E2Designlab in February-March 2020. CRC for Water Sensitive Cities, Water Sensitive Cities Indexing, conducted 2017-2020. Water sensitive city indexing was conducted for 10 local councils, providing more advanced understanding across some areas addressed in the Catchment Scale IWM Plan Councils Survey.
Key assumptions
Responses to the Council Survey were rated 1 to 5, with 1 reflecting little or no consideration of water system planning in urban planning and design, and 5 representing full integration of water system planning and cross sectoral collaboration at all levels. For the future reference state, the current state rating was increased universally by 0.5 by 2050 under the future reference state, based on anticipated ongoing improvements in knowledge, skills and resourcing that will support improved planning and design except where an LGA already received a rating of 4 or higher. It is assumed that this uplift occurs after 2030 but before 2050, reflecting the time needed to instil changes in policy and practice to cement an uplift in outcomes.

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Current state

Current state ratings of indicator 6.4a were collated for different LGA clusters to reflect the performance of all stakeholders involved in water management within suburban councils, inner metro councils, growth area councils and outer metro councils. In general, ratings for LGAs indicated a higher performance in inner metro and growth area council areas, with the lowest performance in outer council areas.[115] Indeed, inner metro councils exhibited the highest average ratings under the current state (3.3) while outer metro councils demonstrated the lowest (1.6).

[115] Based on the council survey and Water Sensitive City index results (where available).

Performance across the Catchment

For the Yarra Catchment, performance is based on responses to both the Catchment Scale IWM Council Survey and the results of Water Sensitive City Indexing, which has been utilised to provide a more accurate rating for the Cities of Manningham, Monash, Port Phillip, Whitehorse and Whittlesea. Council ratings against this indicator fluctuate between 2 and 3.5, with some councils applying a more limited general sustainability lens to urban planning and design and others actively incorporating IWM planning into key policy and planning frameworks. Overall results suggest the Yarra Catchment is well placed to collaborate on IWM planning, with efforts required to support some councils in transitioning to more effective IWM planning at a range of levels.

Future reference state

Future reference state ratings of indicator 6.4a were collated for different LGA clusters to reflect the performance of all stakeholders involved in water management within suburban councils, inner metro councils, growth area councils and outer metro councils. In general, ratings for LGAs indicated a higher performance in inner metro and growth area council areas, with the lowest performance in outer council areas.[116] Under the future reference state, all areas are expected to improve consistently by 0.5, recognising the ongoing improvement of the industry and prioritisation by governments to further embed IWM in urban planning and development. On average, inner metro councils exhibited the highest ratings under the future reference state (3.8) while outer metro councils demonstrated the lowest (2.1).

Table 94: Current and reference state performance for measure 6.4a by council cluster

	2018	2050
Inner Metro Council	3.3	3.8
Suburban Councils	2.8	3.3
Growth Area Councils	3.1	3.6
Outer Metro Councils	1.6	2.1

Performance across the Catchment

Under the future reference state, the focus on delivery of good water outcomes through the planning and design process is expected to show a marginal increase.

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[116] Based on the council survey and Water Sensitive City index results (where available).

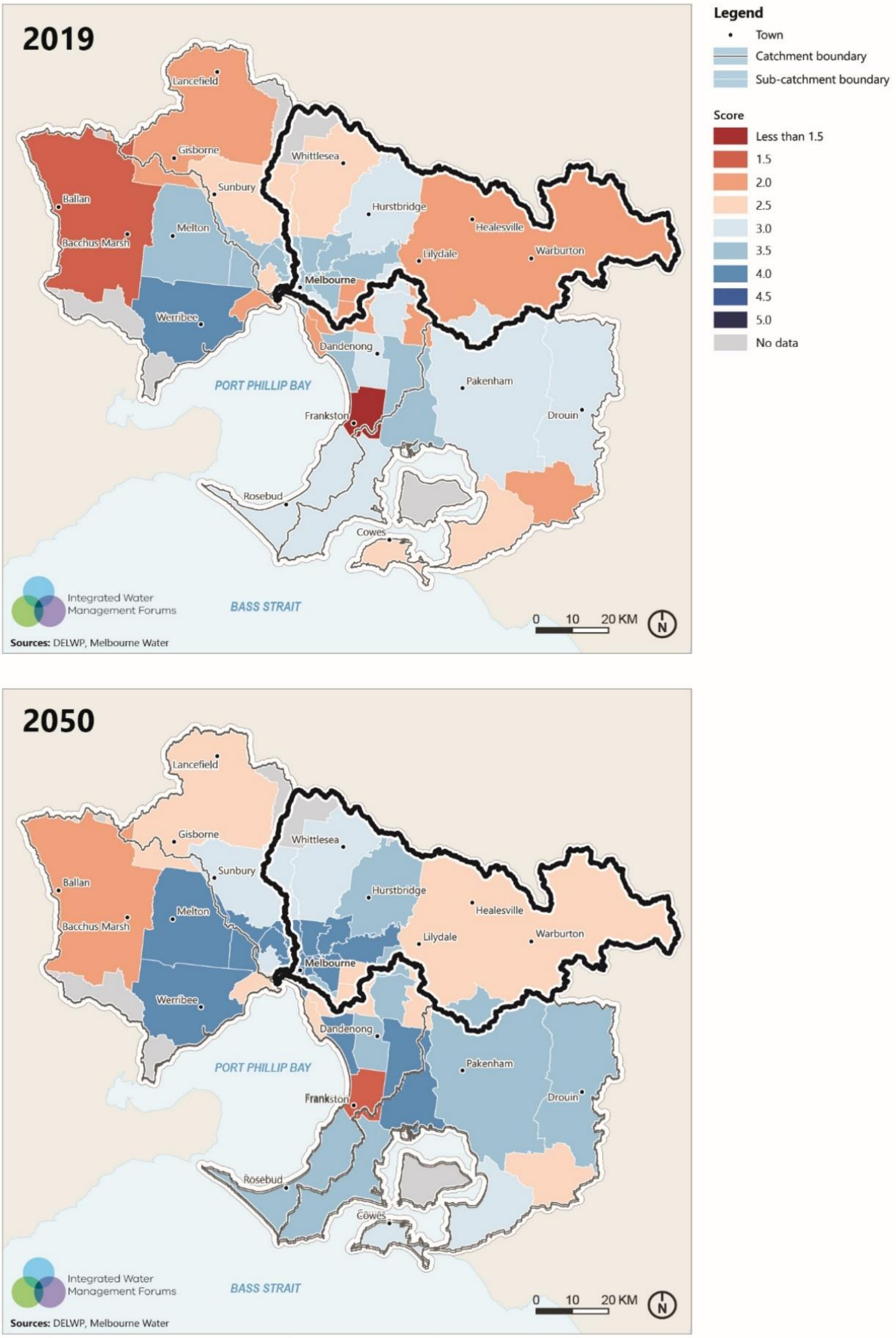

Figure 82: Measure 6.4 Rating of whether water is a key element in city planning and design process (current state and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

While there are no existing targets set out in existing strategies, the metric is constructed around an 'ideal' rating of 5 based on the achievement of this key performance indicator which is key in the creation of a water sensitive city.[117] The creation of a robust planning framework, which recognises and interlinks planning instruments at the following levels has been shown to be essential to the delivery of IWM:[118]

- **Direction-setting level**, in which overarching policies and strategies articulate long-term aspirations for the future and supporting goals and objectives to guide decision-making.
- **Plan-making level**, in which a variety of spatially explicit plans direct long- to medium-term changes in land use, urban form and (water) infrastructure delivery at the Catchment, sub-catchment/corridor and precinct scales.
- **Implementation level**, in which directions, plans and regulatory instruments dictate where, what and how land use and development occur and infrastructure is constructed and connected. Other non-statutory instruments guide some aspects of building and infrastructure design.

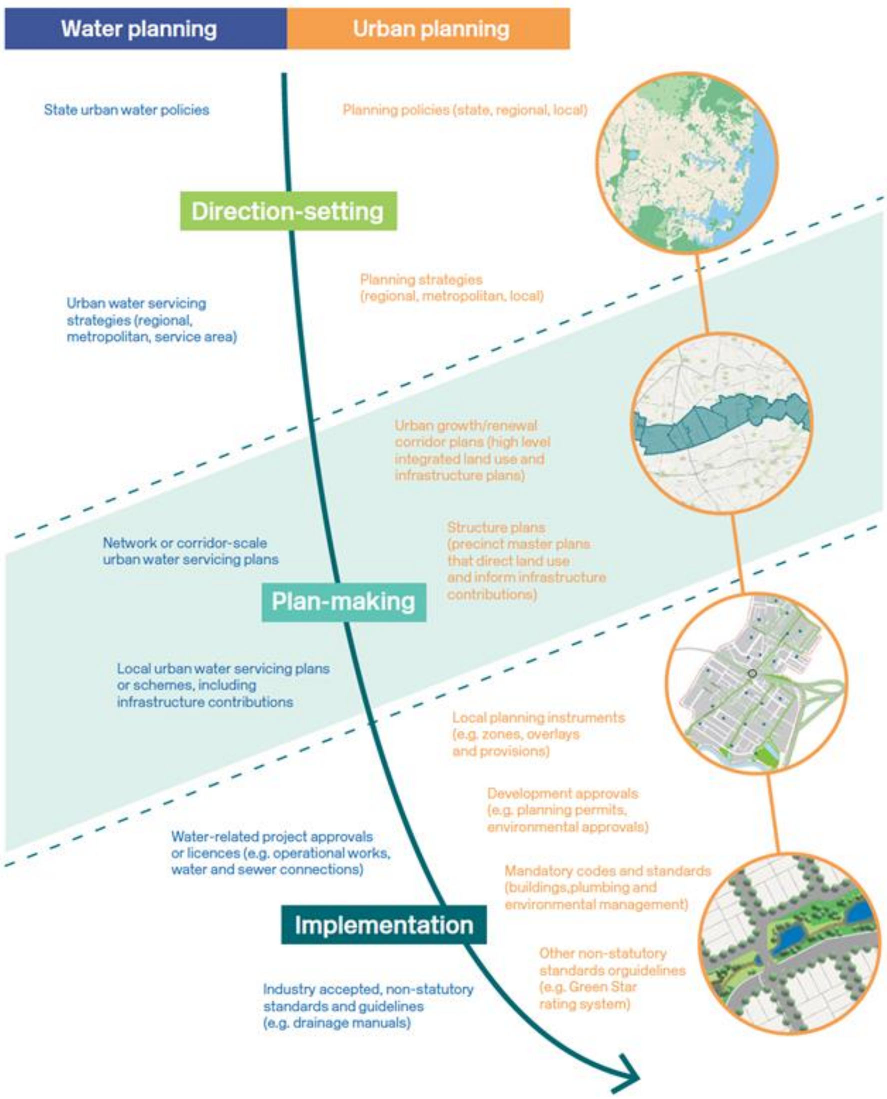

Figure 83: A generalised hierarchy of water and urban planning instruments. Plan making is a bridge between direction setting and implementation.

[117] CRC for Water Sensitive Cities (2018). Water Sensitive City Index. Available at: https://watersensitivecities.org.au/water-sensitive-cities-index-tool/

[118] Tawfik, S. and Chesterfield, C. (2020). Facilitating water sensitive urban development through planning integration — A discussion paper. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities. Available at: https://watersensitivecities.org.au/content/facilitating-water-sensitive-urban-development-through-planning-integration/

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Possible future interventions

Adopting the three key levels of governance activity, examples of possible interventions to progress towards rating 5 outcomes are listed below.

	Elements of Rating 5 (WSC Index)	Example of possible interventions to progress towards rating 5 outcomes
Direction setting	Water system planning is fully integrated in urban planning and design	Planning system has place holders for incorporation of water planning at different phases and scales of urban planning (e.g. water recycling plant included in Fisherman's Bend Framework). Water sector undertakes integrated planning for water systems services (including stormwater and flooding) to align with and support the different phases and scales of urban planning activities. Assign existing organisations new mandates or responsibilities to enable the necessary resourcing that is supported by formal accountability.
	Clear IWM policy and targets at the appropriate Catchment scales are in place to support land use and IWM planning	CSIWM Plan outcomes and targets are reflected in planning policy and water policy for Greater Metropolitan Melbourne (and eventually across Victoria) to facilitate the incorporation of more ambitious IWM solutions. Ensure planning scheme translates locally relevant preferred treatment outcomes or targets to be applied across different development scales (including greening and urban heat island mitigation requirements).
	Cross-sectoral collaboration to water system planning is mandated in official policy and included in statutory planning frameworks	Ensure water sector is included in explicit policy requirements and planning frameworks. Create statutory requirements to jointly develop overarching strategies or consistency across multiple strategies and scales. i.e. IWM Plan prepared to establish future water servicing directions and innovative water solutions, providing complementary liveability, amenity and ecological benefits. Create human resource policies and procedures that support inter-organisational co-operation.
Plan making	Strategies and plans are explicitly adaptive	The Victorian Planning Authority has recently revised the Guidelines for Precinct Structure Planning (PSP) in Melbourne's Greenfields, proposing a new process (PSP 2.0) that provides for higher standards of design and development, the application of targets and standards, and the creation of pathways for innovation. IWM adaptive pathways is a concept to ensure strategies and plans are robust and provide alternatives that can respond to innovation, changes in policy or unforeseen barriers to implementation. Investigate a 'no regrets' approach for making key decisions now that preserve the opportunity to explore other options in the future (i.e. Sunbury).
	Contingency planning is routinely used and incorporates methods such as scenario planning, robust decision making and exploratory modelling to deal with uncertainty around issues such as population growth and climate change	Sustainable Water Strategy (SWS) is an example of scenario-based planning and needs to be closely linked/integrated to inform urban planning decisions. IWM plans and strategies for precincts, and growth areas need to precede planning requirements being formalised (challenging to change once planning requirements are released).
	Enduring governance arrangements are established for both planning and delivery phases. Funding and delivery responsibilities are identified and outlined in the planning phase	Create formal structures that integrate urban planning processes and delivery of IWM/WSUD outcomes. Consider the need for amendments to existing planning schemes to clarify their intent and address identified policy implementation challenges. For example, these could be through the introduction of an overlay or as an amendment to complementary local planning policies. Consider early in the process funding and delivery models that are applicable given the scale and complexity of development, e.g.

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		Infrastructure funding mechanisms that can be applied within the PSP including Development Contributions Plan (DCP), Development Services Schemes (DSS), Infrastructure Contributions Plans (ICP) and multi-stakeholder agreements.
Implementation	Urban design guidelines address the critical role of water in achieving liveability, sustainability, resilience and productivity goals	Continue to pilot multi-layered flagship projects at a range of scales and complexity, led by inter-organisational working groups (e.g. Fisherman's Bend). Evaluate technical requirements against existing guidelines and develop guidance documents for location specific requirements or more detailed technical information guidance to comply with specific sector requirements (i.e. Conditions of Connection). Create protocols for joint processing of sector approvals, licences, permits etc (with clearly articulated roles and accountability).
	Monitoring and evaluation of planning is in place	Establish joint accountability, monitoring and reporting protocols. Articulate data capture and tracking requirements to ensure reporting against indicators contributing to CSIWM Plan benefits, outcomes and targets. Capture and share project-based learnings (i.e. Fisherman's Bend, Upper Merri Creek, Sunshine NEIC, etc.). There is an opportunity to integrate case studies into Victorian Government online navigator tool for stormwater planning (DELWP & Clearwater) Undertake regular reviews to ensure that the planning process is effectively incorporating the objectives and requirements of the IWM Plan.

Desired state target recommendations

2050 Regional and Catchment Targets

The target for this measure is 5, reflecting the need for planning systems and mechanisms to enable delivery of IWM. It is recognised that the other targets in this Plan cannot be achieved without a planning framework that will drive and support IWM solutions.

2030 Regional and Catchment Targets

A 2030 target has been selected for each Catchment that accelerates our path towards a rating 5, recognising the importance of putting the planning and policy mechanisms in place early, to support delivery of IWM.

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Strategic Outcome 7 – Jobs, economic benefits and innovation

This outcome explores how IWM can enhance business and local economies by supporting food production, tourism and commercial activities. It is difficult to directly attribute increases in business revenue to IWM, but measures have been selected for this outcome which recognise the essential role of water to support agriculture, productive landscapes and the business viability of some industries.

The case for change

Economic support and stimulation

Water is vital for our economy. Many productive businesses and industries, including manufacturing, agriculture, food processing, energy, and mining, rely on safe, secure and affordable water supplies.[119] IWM can support and stimulate local economies by providing resources to businesses and industry which leverage a circular economy and add resilience in times of drought. "One man's waste is another man's treasure" is a sentiment that can be true for complementary water resources. For example, wastewater is an excellent resource for many types of agriculture, where both a reliable source of water and rich nutrients are needed to increase yield. Equally, alternative sources of water can be suitable for certain industrial and commercial water users, and for those who use large amounts of water, as they depend on a sustainable water supply in determining their business viability and selection of location.

Supporting our local food bowl

Agriculture and horticulture in the Greater Metropolitan Melbourne Region are crucial to the economic success and the future resilience of the region. A landmark study into the productive peri-urban areas or the 'food bowl' of Melbourne highlighted that: [120]

- Melbourne's food bowl includes multiple relatively small areas of food production scattered around the city fringe, but Melbourne's food bowl currently produces enough food to meet around 41% of the food needs of Greater Melbourne's population.
- Melbourne's population is predicted to grow to at least 7 million by 2050, and Melbourne will require 60% more food to meet the population's needs.
- By 2050, around 16% of the farmland in Melbourne's food bowl could be lost if long-term urban density trends continue, including up to 77% of farmland in the inner food bowl. As a result, the city's food bowl will only be able to produce enough food to meet 18% of the city's food needs in 2050.

Agriculture and viticulture are significant drivers of economic prosperity for the Yarra Catchment. The Yarra Valley's locally and internationally recognised fine food and wineries attract more than 4.5 million tourists each year.

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[119] State Government of Victoria (2018). Water for Victoria. Available at: https://www.water.vic.gov.au/water-for-victoria
[120] Sheridan, J., Larsen, K. and Carey, R. (2015) Melbourne's food bowl: Now and at seven million. Victorian Eco-Innovation Lab, The University of Melbourne. Available at: https://fvas.unimelb.edu.au/__data/assets/pdf_file/0008/2355155/Melbournes-Foodbowl-Now-and-at-seven-million.pdf

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Synergistic co-location and industrial ecology

More could be done to co-locate alternative water resources and complementary agriculture and industries, but even with current land use locations, there are still opportunities to better utilise water resources locally, including in future growth areas where stormwater and wastewater generation are set to increase.

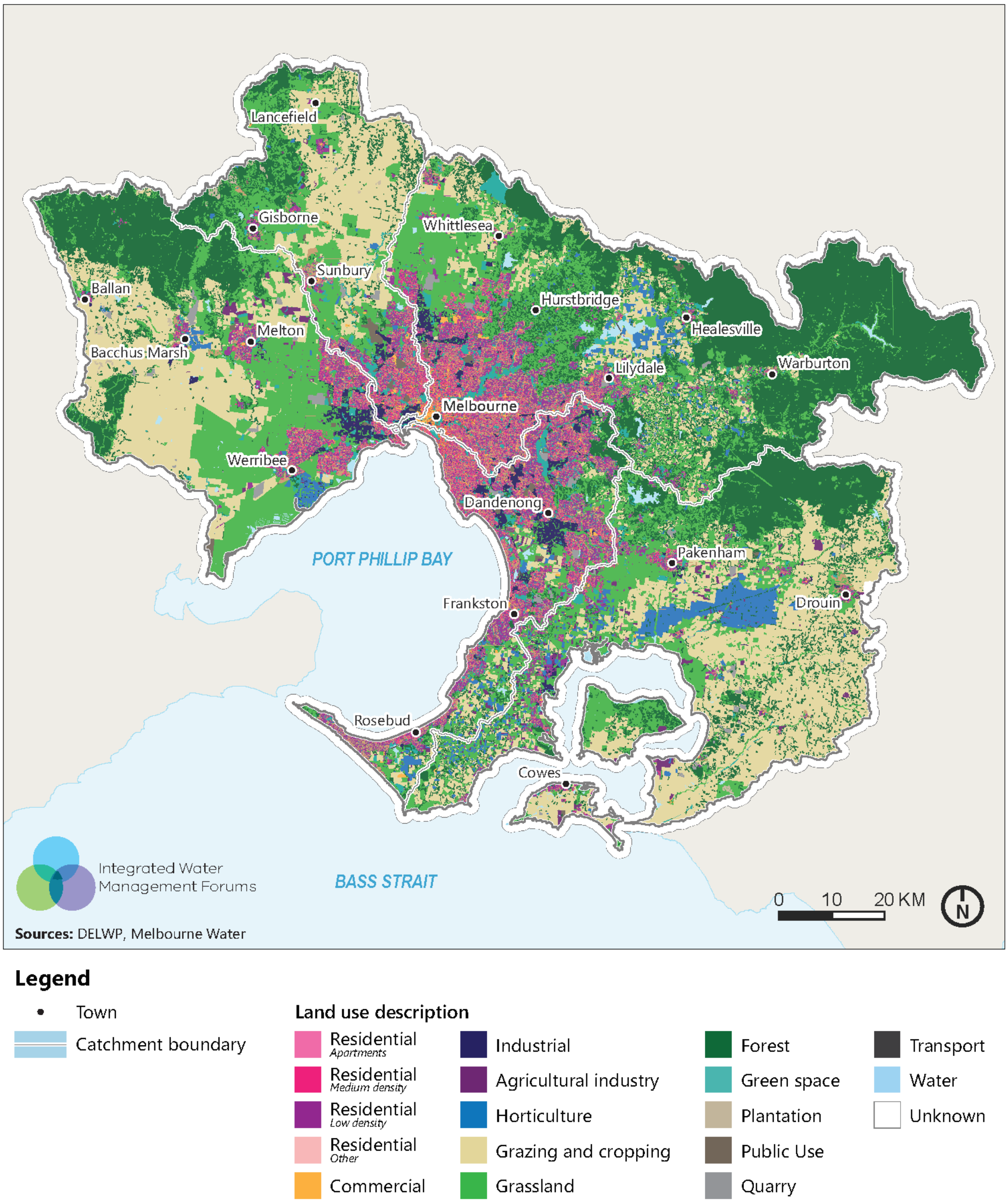

Figure 84: Land use across the region.

As the Greater Metropolitan Melbourne Region grows and changes, commercial and industrial uses of water will also change. Water corporations expect that on a per hectare basis, non-residential water use will increase over time, however the proportion of land in urban areas dedicated to non-residential use is generally declining. The growth areas on the fringe of Melbourne will include commercial and industrial areas and are also generally close to peri-urban agricultural areas, creating opportunities for shared water resources. In these urban-rural fringes in particular, IWM could drive unique opportunities that would support local economies and businesses, and provide broader benefits to the local population.

Under the future reference state, support of businesses, industry and agriculture with alternative water resources is largely unchanged, except for support of new commercial and industrial areas in mandated recycled water areas, and expansion of recycled water supplies to agricultural and industrial customers in Cardinia, Baw Baw and Moorabool under planned major projects.

The Yarra Catchment includes a major growth corridor in northeast Melbourne comprising several areas designated for significant population and economic growth. Three National Employment and Innovation Clusters (NEIC are located within the Yarra Forum Area. The Parkville NEIC currently employs more than 40,000 people through a range of education, research, health, professional and technical industries. The La Trobe Employment Cluster is anticipated to grow from 35,000 people and 25,700 jobs currently to 100,000 people and 80,000 jobs in the future. Jobs and economic growth will also continue at the Monash NEIC, which has Melbourne's largest concentration of jobs outside the central business district (CBD). The Monash NEIC currently supports 75,000 jobs and contributes $9.4 billion to the Victorian economy. The level and pace of growth in these areas will place greater pressure on the Yarra Catchment's water systems and the security of supply to homes and businesses.

The second largest State Significant Industrial Precinct (SSIP) is found in the Yarra Catchment at the Northern SSIP. This major industrial area is dominated by manufacturing, wholesaling and population services, and will continue to attract new investment and jobs to the Yarra Catchment in the coming years.

The Yarra Catchment also contains state and nationally significant infrastructure and commercial industries, including Melbourne's CBD, the economic and employment heart of Victoria. Major roads and public transport networks span the Catchment and keep Victoria on the move. The majority of Victoria's internationally renowned universities, sporting centres, cultural facilities and museums are located here, drawing millions of visitors each year. The international and domestic freight and shipping at the Port of Melbourne and the Yarra Valley agricultural area are other notable contributors to the region's economy.

Measuring the change we are making

The following indicators and measures have been selected for this strategic outcome:

Table 95: Indicators and Measures for Strategic Outcome 7

Indicators	Measures
7.1: Increase the use of alternative water sources for products and services	a. ML/year of alternative water supplied to agricultural production b. ML/year of alternative water supplied to businesses and industry (>10 ML/year)

Indicator 7.1: Increase the use of alternative water sources for products and services

Measure 7.1a: ML/year of alternative water supplied to agricultural production

This measure captures the role of water in supporting agriculture and food production, where water availability is often crucial, and could be enhanced through the provision of alternative water sources. This measure could be expressed as a percentage of agricultural demand, which is largely made up of river water and groundwater.

Table 96: Measure overview

Measure 7.1a: ML/year of alternative water supplied to agricultural production parameters	
Indicator type	Leading
Desired State Target Scale	Region, Catchment

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Measure performance and targets												
GL/yr	Region		Werribee		Maribyrnong		Yarra		Dandenong		Westernport	
Current state	34		26		0.1		0.04		6		0.9	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	45	61	33	45	0.1	0.1	0.04	0.04	6	6	6	10
Desired state	63	112	41	60	2	7	2	7	9	11	9	27

Table 97: Data and assumptions

Data source/s
Recycled water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Westernport Water, Central Highlands Water. State Government of Victoria (2020) health.vic website: Class A Water Recycling Schemes. Accessed March 2020. Available: https://www2.health.vic.gov.au/public-health/water/alternative-water-supplies/class-a-recycled-reclaimed-water Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide a summary of recycled water schemes, rainwater use, and stormwater use. Conducted February-March 2020. Committed Major Projects. Details supplied by Water corporations for alternative supplies delivered by 2030 and 2050. Data received from Western Water, Melbourne Water, City West Water, Yarra Valley Water and South East Water. Please refer to summary of projects in Appendix B: Collaborative Plan Development Process
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis.

Current state

In general, river water and groundwater comprise the predominant water supply for agriculture in the Greater Metropolitan Melbourne Region, though there is also substantial use of recycled water. The data available for surface water use does not include the use of farm dams to capture or intercept runoff within a site, which is likely to also make up a significant water source. Under the current state, recycled water is the only type of alternative water supply used to support agricultural production.

Performance across the Region

Current recycled water use for agriculture is highest in the Werribee Catchment followed by Dandenong and Western Port, and lowest in the Yarra and Maribyrnong Catchments.

Performance across the Catchment

There is limited use of recycled water for agriculture in the Yarra Catchment with the only users located in the Craigieburn area.

Future reference state

Under the future reference state, recycled water is the only type of alternative water supply projected to support agricultural production. The graph below summarises the data on river, groundwater and recycled water use in each major Catchment currently and in the future (2050) reference state.

While groundwater use is expected to remain the same under the future reference state, surface water availability is expected to decline due to climate change impacts. Further, recycled water supplies are expected to extend to new agricultural users due to the impact of several planned major projects, particularly in the Werribee and Westernport Catchments.

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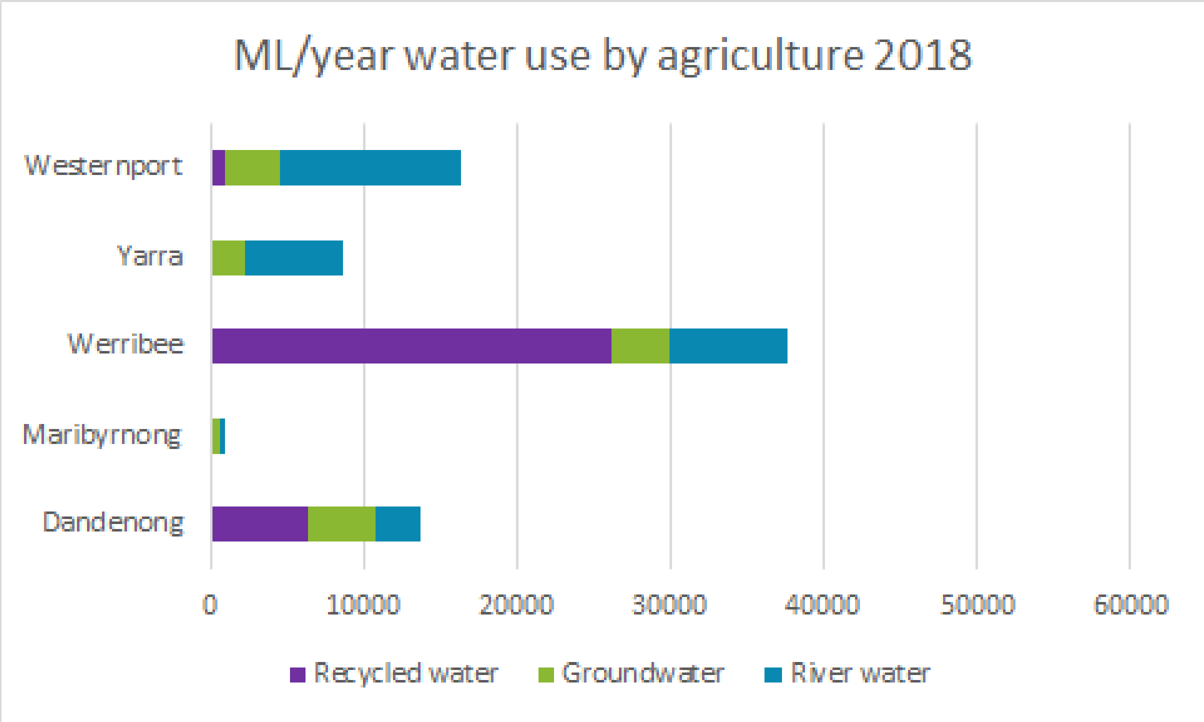

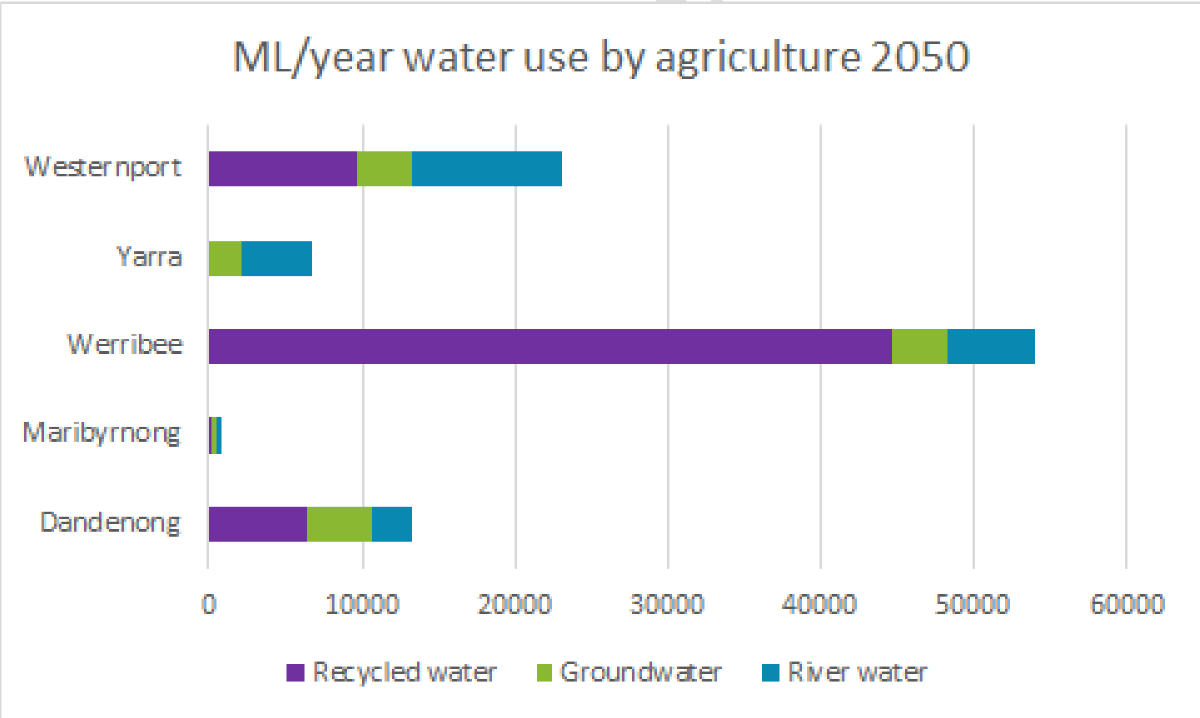

Figure 85: Current and future breakdown of water use for agricultural production in each Catchment. Note that 19,714ML of recycled water use in the Werribee Catchment is for 'on-site agriculture' within the Western Treatment Plant.

Performance across the Region

Under the future reference state, use of recycled water for agriculture is expected to increase in Werribee (~two-fold and Westernport Catchments (~six-fold) but remains low in the Yarra and Maribyrnong Catchments.

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Performance across the Catchment

No change is expected under the future reference state for support of agriculture with alternative water supplies in this Catchment.

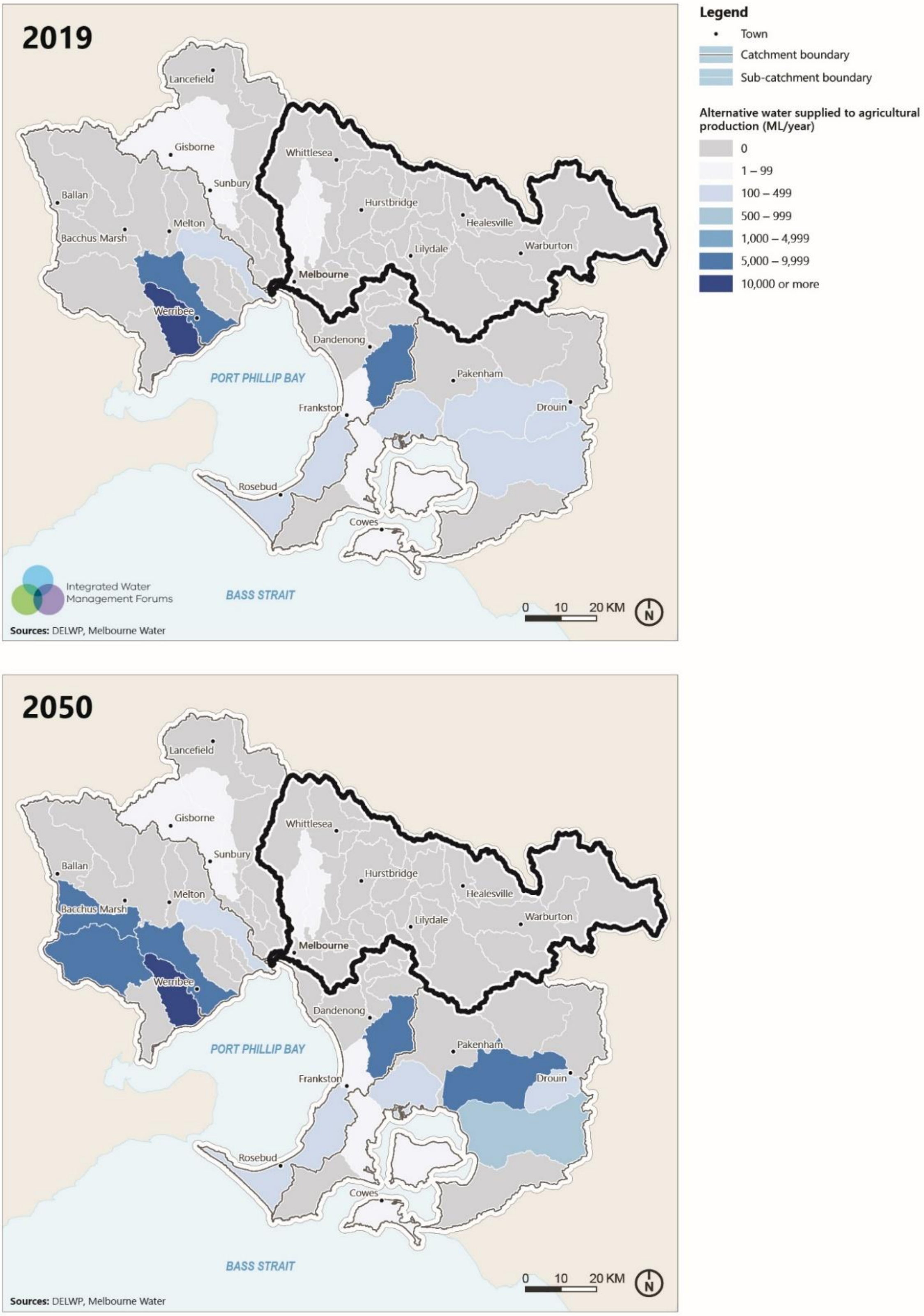

Figure 86: Measure 7.1a ML/year of alternative water supplied to agricultural production (current state and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

No existing targets have been identified for this measure in current strategies. As discussed in the opening section of this chapter, the protection and enhancement of local agricultural and horticultural production is essential to the region to support the Melbourne food bowl.

The background studies demonstrate that compared with other regions, Melbourne's agricultural land is projected to be less severely affected by climate change than other regions in Victoria;[121] making the protection of its green wedge and peri-urban areas ever more important as reliance on its productivity is likely to increase as suitability for agriculture declines in other parts of the state. Accordingly, the region's relative resilience to climate change is enhanced by its proximity to large volumes of recycled water and urban stormwater.

Possible future interventions

There is work in development to plan for the future of agricultural land for the Greater Metropolitan Melbourne Region.[122] This takes into account the various factors that will influence the future potential of land for agricultural production.

Desired state target recommendations

2050 Region and Catchment Targets

This target will ensure we can continue to support Melbourne's population with local food supply (continuing the existing proportion of 41%), by supporting and enhancing the Melbourne region's food bowl through the supply of alternative water resources. River, Catchment runoff and groundwater supplies—the primary sources of water for agricultural production—are likely to decrease in the future due to the impacts of climate change. The provision of alternative water supplies, including recycled water and urban stormwater, to support agricultural production will make use of local resources and build resilience into the sector.

2030 Catchment Target

The regional target is based on foreseeable opportunities identified across the Catchments, particularly in the Werribee and Dandenong/Western Port Catchments, where major recycled water supplies can be harnessed to support agricultural areas.

There are opportunities to expand agricultural demands for alternative water in the Yarra Valley and Whittlesea areas in particular.

Measure 7.1b ML/year of alternative water supplied to businesses and industry (>10 ML/year)

The measure reflects the provision of alternative water sources to major water users where water is essential to the viability of their production process or business.

Table 98: Measure overview

Measure 7.1b ML/year of alternative water supplied to businesses and industry parameters	
Indicator type	Lagging
Desired State Target Scale	N/A

[121] DELWP (2020). Consultation Paper – Planning for Melbourne's Green Wedges and Agricultural Land. Available at: https://engage.vic.gov.au/gwal; Johnson M, Sposito V & Faggian R (2018), Land suitability assessment in Melbourne's green wedge and peri-urban areas, Centre for Regional and Rural Futures, Deakin University, Geelong. Available at: https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/6815/5236/5852/Deakin_land_suitability_assessment.pdf

[122] DELWP (in development) Planning for Melbourne's Green Wedges and Agricultural Land.

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Measure performance and targets												
ML/yr	Region		Werribee		Maribyrnong		Yarra		Dandenong		Westernport	
Current state	3393		2698		63		67		392		172	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Reference state	3543	3643	2698	2698	63	63	67	67	392	392	322	422

Table 99: Data and assumptions

Data source/s
Recycled water use data (2018/2019 Financial Year). Provided by the following water corporations: Western Water, City West Water, South East Water, Yarra Valley Water, Gippsland Water, South Gippsland Water, Westernport Water, Central Highlands Water. A threshold of 10ML/year was set to define major users, but this scale of user level data has not been supplied for most areas. Further requests have been made from water authorities so this measure can be refined.
State Government of Victoria (2020) health.vic website: Class A Water Recycling Schemes. Accessed March 2020. Available: https://www2.health.vic.gov.au/public-health/water/alternative-water-supplies/class-a-recycled-reclaimed-water
Catchment Scale Integrated Water Management Plans Council Survey (2020). Respondents were asked to provide a summary of recycled water schemes, rainwater use, and stormwater use. Conducted February-March 2020.
Major commercial and industrial users of recycled water. Data received from Western Water, City West Water, Yarra Valley Water and South East Water. Specific project data not reported due to commercial confidentiality in some cases.
Committed Major Projects. Details supplied by Water corporations for alternative supplies delivered by 2030 and 2050. Data received from Western Water, Melbourne Water, City West Water, Yarra Valley Water and South East Water.
Key assumptions
Refer to Background Appendix A: Water and Pollutant Balance Analysis.
Data was segmented to include only commercial and industrial users (excluding open space irrigation users) with an annual alternative water use over 10ML/year. As no records exist of major commercial or industrial users of harvested stormwater or rainwater, this data set only includes recycled water users.
Based on recycled water use projections and retailer advice, new commercial and industrial areas in growth areas are not expected to be classified as major users.

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Current state

Alternative water supply for major business and industry users is currently focussed on a limited number of customers, predominantly industrial users near existing treatment plants. Under the current state, recycled water use by major commercial or industrial users is highest in the Werribee Catchment with significant supplies in the Dandenong and Western Port Catchments.

Performance across the Catchment

Support of businesses and industry with recycled water is focussed around the Craigieburn area in the Yarra Catchment.

Future reference state performance

One new industrial user was added to the indicator under the reference state under a planned scheme.

Performance across the Catchment

No new alternative water supplies to major commercial or industrial users are expected under the future reference state.

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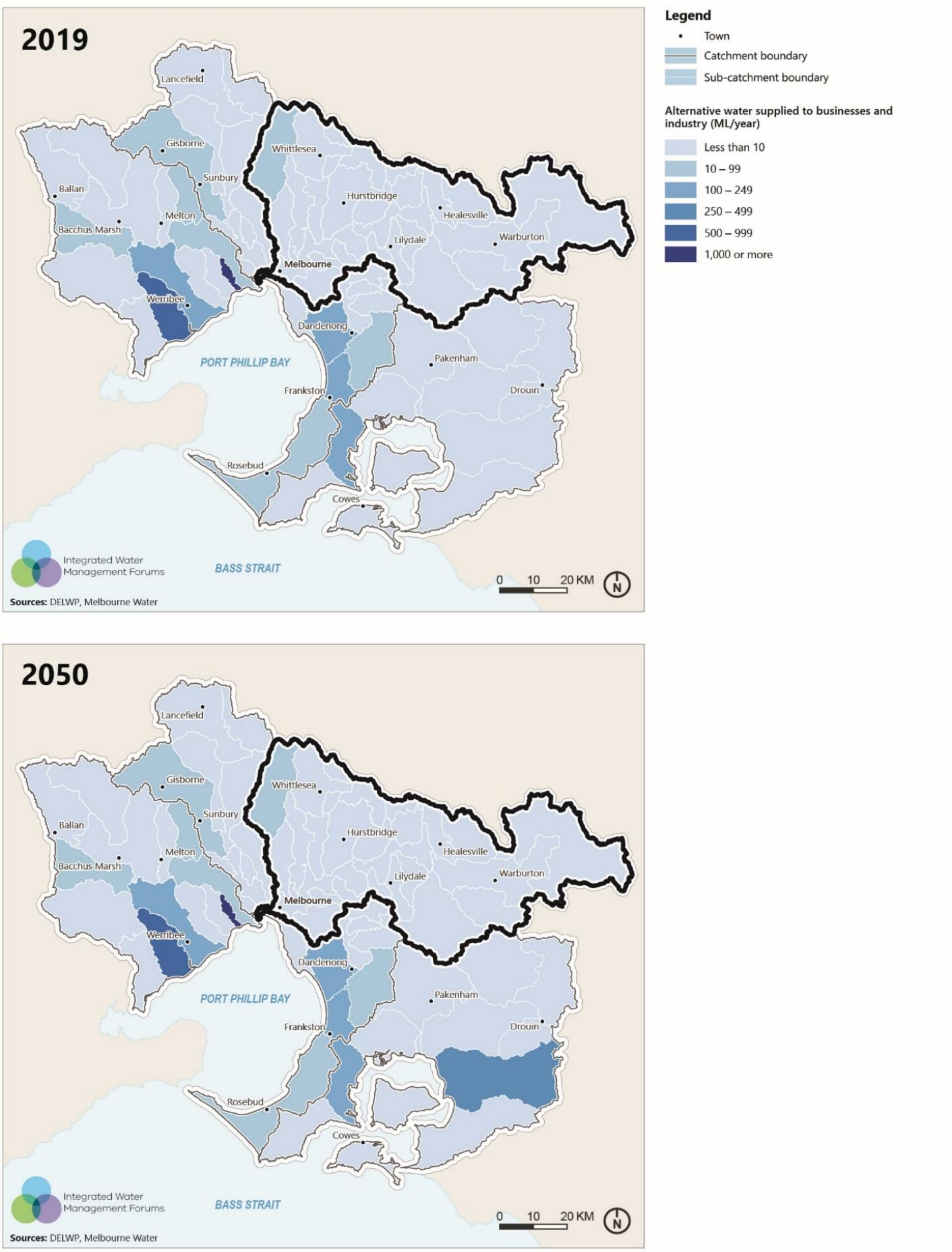

Figure 87: Measure 7.1b ML/year of alternative water supplied to businesses and industry (current and 2050 future reference state)

Future desired state

Existing targets and referenceable evidence

The intent of this indicator is to diversify water supply to major water users to support broader economic production in the region through water management. There are no known existing targets that aim to increase provision of alternative water supplies to support businesses and industry that are major water users.

Possible future interventions

Analysis of the spatial intensity of potable water use by commercial and industrial land uses using the data from Measure 1.1b (see Figure below) shows potential 'hot-spots' that may be worth further investigation to determine whether there is a non-potable demand that could be matched with an alternative supply nearby. Current analysis suggests that there will not be a significant increase in recycled water use by major commercial or industrial users under the future reference state across the Greater Metropolitan Melbourne Region.

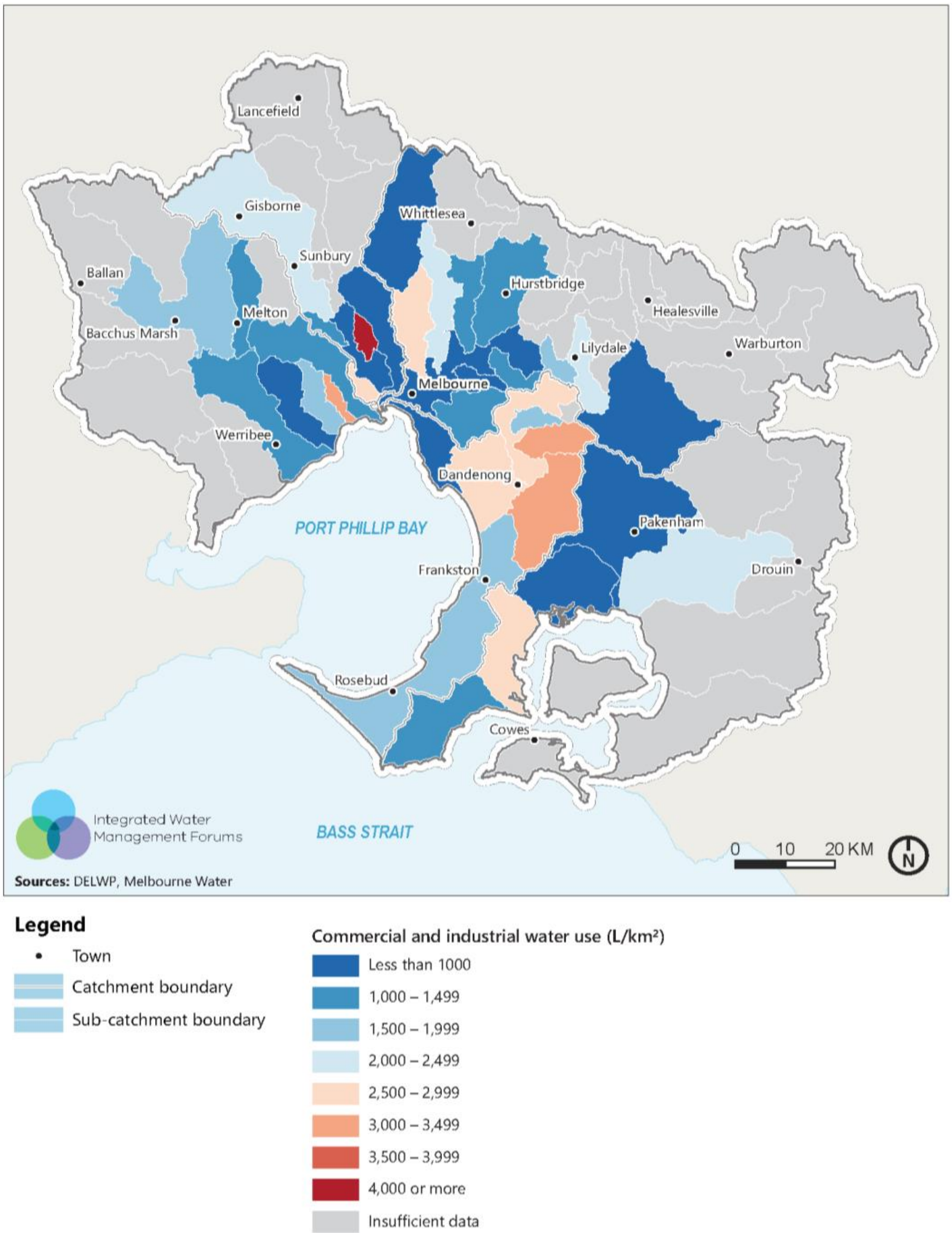

Figure 88: Non-residential potable water use per ha of commercial or industrial land (provides insight into locations with high intensity of use).

Desired state target recommendations

This measure has been nominated as a lagging measure, due to the uncertainty regarding future locations and water demands of major industrial and commercial users. The measure will be monitored to inform action planning.