Water's recovery

How purified recycled water could provide supply resilience - a Greater Melbourne case study

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Bringing ideas to life

Introduction

We need to think differently about how to create and manage more high-quality recycled water to achieve resilience, liveability, and productivity outcomes.

Increasingly, communities throughout the world are being encouraged to recognise highly treated wastewater as a valuable resource and consider producing purified recycled water (PRW) for drinking to increase urban water resilience as the population grows and patterns shift under climate change.

So far, the idea of purification of wastewater for drinking has not been as palatable in certain regions or countries while in Singapore, South Africa, Namibia, and the United States, projects are common. Australian States and Territories have 'tested the waters' to different extents. Perth's groundwater aquifer recharge scheme has been pumping treated, recycled water into its underground aquifers for several years and Seqwater is considering switching on the Western Corridor Scheme (a PRW scheme built during the Millennium drought, but never used for its original purpose). The Draft Greater Sydney Water Strategy (2021) also identifies PRW for drinking as an option and Sydney Water is considering building a PRW Demonstration Plant to engage with communities and stakeholders on the benefits of PRW.

Water recycling involves the reclamation of water from wastewater. Australia has a long history of successful and safe purple pipe recycling schemes where wastewater is highly treated and distributed in a dedicated pipe network for non-drinking water uses such as irrigation, toilet flushing and clothes washing machines. There are multiple treatment steps and comprehensive management plans and controls to consistently ensure the safety of the water.

PRW for drinking extends the proven recycled water treatment approach with more stringent treatment steps. This ensures the water that is returned to the drinking water system meets all drinking water requirements and is safe for the public, even the most vulnerable, to drink.

This white paper was developed to reinforce the Water Services Association of Australia's (WSAA) "all options on the table" approach for urban water supply. The paper uses Melbourne as a case study of where PRW could provide financial benefits and water supply resilience.

Melbourne may be known for its often wet and changeable weather – the city has been described as having four seasons in one day. But, the same as its northern capital city neighbours Sydney, Canberra and Brisbane, water security has been a significant area of concern for Melbourne since the severe Millennium drought of the mid-to-late 2000s, which saw water levels drop by 30 per cent in one-and-a-half years.

Although we are using Melbourne as an example, we know from our work with clients across the Asia Pacific that PRW can provide significant benefits and customer outcomes for many communities.

PRW can be a cost competitive, climate resilient, and sustainable option with a relatively low carbon footprint compared to some other water supply options. The evaluation and selection of the best option to provide a community with water security is site specific and dependent on a wide range of technical, financial and social variables This paper intends to initiate an open conversation of PRW as a potential supply option for communities to consider when seeking increased water security.

Water security and its role in society

Water has a significant role to play in shaping cities where people who live, work, study and play, feel happy and healthy, and connected to their communities. This was evident in the 2000s when much of Australia was hit by the Millennium drought with the lowest ever recorded annual inflow to water storage in 2006/07. During this period, communities struggled to have enough water for household needs, without even considering the water required for commercial industries and agriculture. The Millennium drought was the beginning of longer drier periods and a permanent drop in water supply for Melbourne. It catalysed a shift in considering how water resources could be better managed, in particular, the role of recycled water in urban water systems.

Australia will continue to experience harsher droughts into the future due to climate change. The Greater Melbourne Climate Projections conducted in 2019 (Clarke, 2019), projected that by 2050, the median total rainfall in Melbourne is projected to decrease by up to 20 per cent. Meanwhile, the population of Melbourne is expected to increase from 4.6 million to almost 8 million in the next 50 years. This means that the current drinking water supply will struggle to meet demand, and utilising recycled water in its current capacity may not be sufficient or be a cost-effective solution to take pressure off the drinking water supply.

We need to think differently about how to create and manage more high-quality recycled water to achieve resilience, liveability, and productivity outcomes for Melbourne. Diversification of water supply sources is one important consideration. Having all options on the table would include PRW, which could be considered together with more familiar solutions such as desalination, recycled water, groundwater extraction and increasing dam capacity. PRW is a proven safe and sustainable way to supplement drinking water supplies and would give communities the opportunity to reclaim water rather than discarding it, saving hundreds of Olympic size swimming pools of valuable water from going to waste each day.

What is purified recycled water?

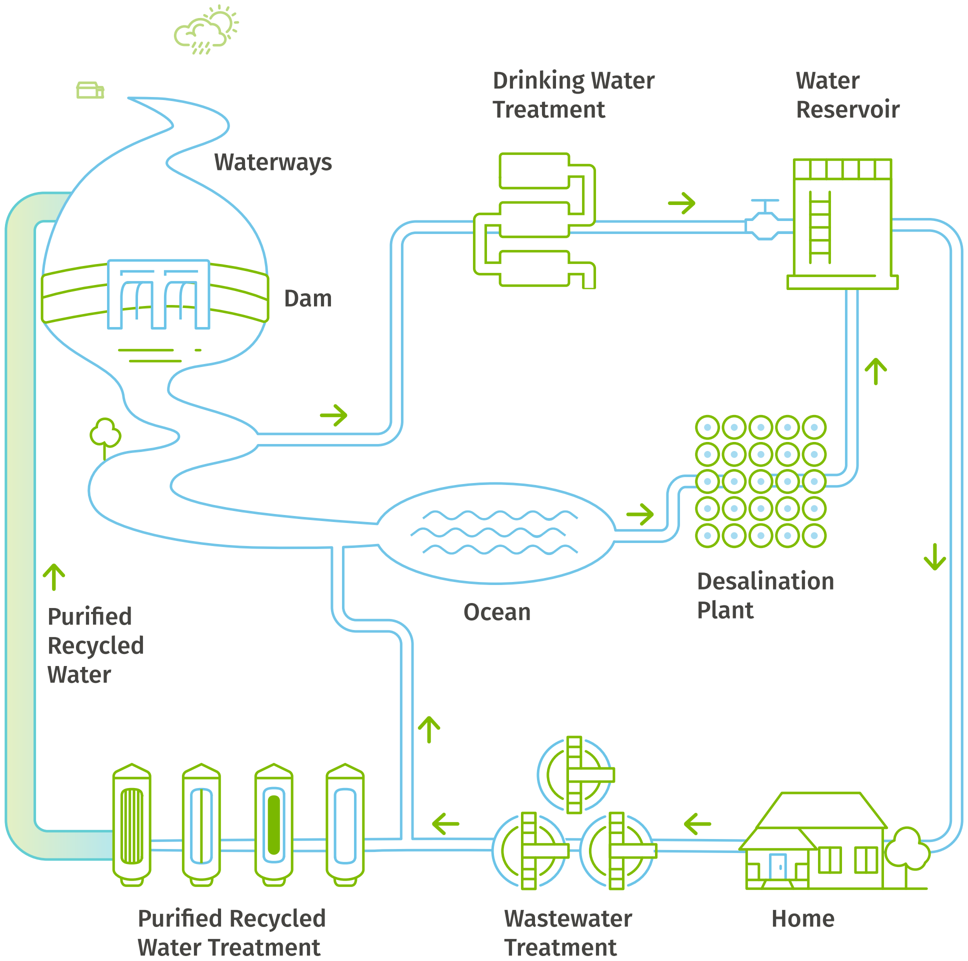
Recycling is a tried and tested process. All water is recycled as part of the natural water cycle. A town downstream of another town already participates in what is known as unplanned water recycling as the downstream community is reusing water from upstream. Modern developments in water treatment technologies are used to accelerate this cycle using multiple stages of treatment, transfer, and storage before supply to the drinking water system. The first step involves collection and treatment at a wastewater treatment plant (WWTP). From there, the treated effluent is transferred to a PRW treatment plant (PRWTP) for further treatment.

The PRWTP comprises multiple treatment process units combined in sequence to purify the treated effluent, creating a high-quality water product. This high-quality water is PRW and is safe for drinking. For more cost-effective and equitable distribution, the PRW is often pumped to the nearest drinking water storage, such as a dam or reservoir, where it is stored, blended with other water sources, and re-enters the existing potable water system.

More than 35 different communities across the world have successfully incorporated PRW into their water supply, with more than 15 different communities currently exploring the possibility of it in the future.

Notable international examples include the NEWater scheme in Singapore and Pure Water scheme in San Diego. In Australia, Perth is a well-known example where PRW is injected into ground water aquifers. Another Australian example is the Western Corridor Recycled Water Scheme; this scheme is not currently active but Seqwater is considering restarting production.

Urban water cycle with purified recycled water for drinking



Case studies

Water Corporation
Perth

Perth is a city with a very dry climate. In 2001, dam levels declined significantly and in 2004, groundwater replenishment was identified as a climate independent water source. This involves producing PRW and using it to recharge groundwater aquifers. In 2017, Water Corporation, which is the principal supplier of water, wastewater and drainage services throughout Western Australia, implemented the first stage of this PRW programme and doubled the capacity in 2021 as water stress continued to increase in the city. Water Corporation has committed to recycling 30 per cent of wastewater by 2030 (Water Corporation, 2009).

Pure Water
San Diego

San Diego began exploring PRW in the 1990s after the price of importing 85 per cent of its water supply tripled. Currently, San Diego, and the State of California, are at the forefront of PRW having developed large bodies of research and frameworks for PRW schemes and systems. The programme is expected to supply more than 40 per cent of the entire city's water supply by 2035 (City of San Diego, 2021). More recently, California has begun a journey to direct potable reuse (DPR), which will see PRW sent directly to the inlet of drinking water treatment plants without any intermediate environmental buffers.

NEWater
Singapore

Singapore is a small island with little land available to collect rainwater to serve its relatively large population. With increasing population and the desire to reduce dependency on imported water from Malaysia after the country's independence, there was a need to explore alternate sources of water. As part of their Four National Taps strategy, Singapore's Public Utilities Board (PUB) launched the NEWater reclaimed water programme in 2003. The process recycles treated wastewater (referred to as "used water") into ultra-clean reclaimed water suitable for drinking. Today, there are five NEWater plants supplying up to 40 per cent of Singapore's current water needs. By 2060, NEWater is expected to meet up to 55 per cent of Singapore's future water demand (PUB, 2017).

Melbourne's current and future water supply strategy

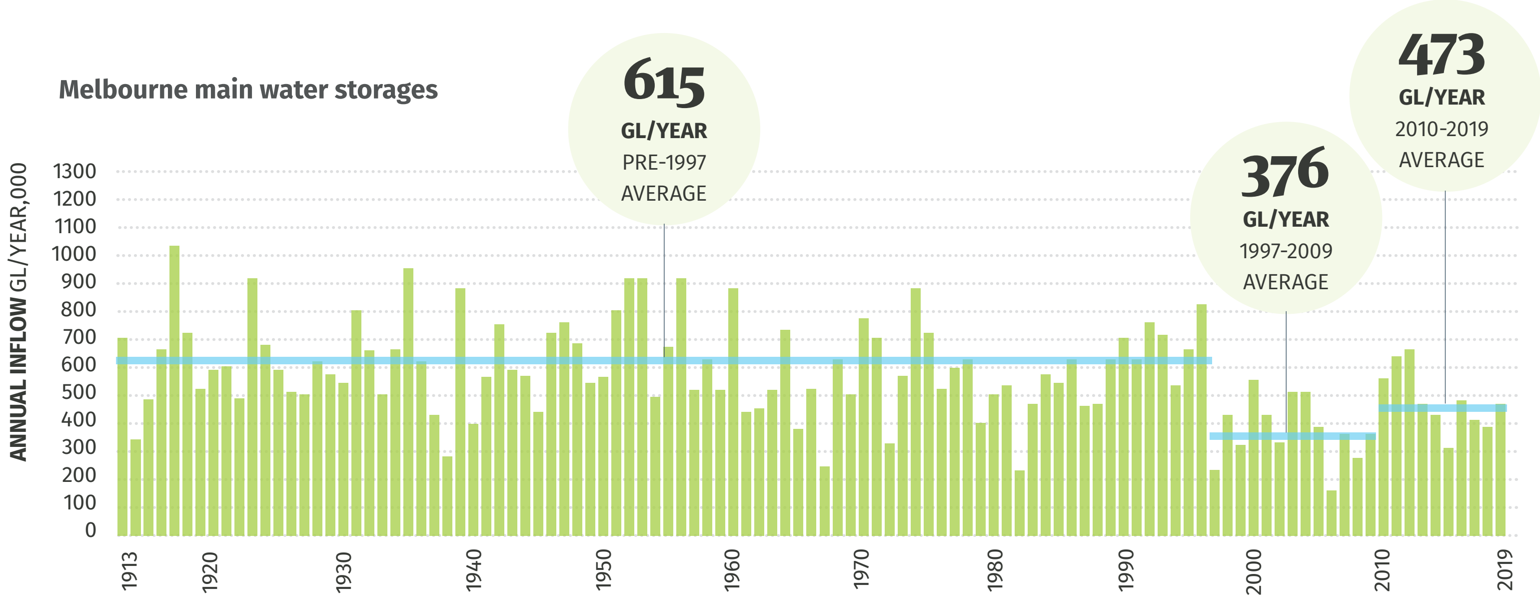
Melbourne's drinking water supply is primarily surface water coming from 10 storage reservoirs across Melbourne and its surrounds, providing an average annual volume of 473 gigalitres (WSAA, 2020). However, over the next 50 years, the population of Melbourne and the surrounding region will continue to grow. The Melbourne Water System Strategy (2017) medium water demand projections have estimated that this water supply volume is enough until 2043; but with higher demand scenarios or climate change impacts, this may only be enough until 2028.

With population growth, increased water usage, and changing and variable climate conditions, there is a strong need for more water supply along with greater water resilience and security. In November 2021, Melbourne Water outlined its future long-term water outlook and Melbourne's water corporations have started working together on the Water for Life Strategy (Melbourne's joint Urban Water Supply and Systems Strategy). The strategy is expected to be finalised in 2022 and will review and build on the 2017 water strategy to ensure that Melbourne water utilities can continue delivering secure water services to Melbourne and connected regions.

This updated water strategy will include Integrated Water Management components to help deliver sustainable and connected water plans and management systems. It will include a greater use of stormwater and recycled water. Stormwater and non-potable recycled water are valuable resources that can potentially be used to reduce demand on the water supply system. However, the use of PRW for augmenting drinking water supplies has not been fully considered as a future supply option in these past strategies. Consequently, we believe that a potentially significant opportunity to diversify water supply sources has not yet been explored with the community.

Melbourne already has rainfall independent supply through the Victorian Desalination Plant (VDP). Phase 1 can currently supply 410 ML/d,

Melbourne main water storages



Source: WSAA All Options on the Table (August 2020) or approximately a third of demand. VDP was designed to increase the production capacity by an additional 140 ML/d. Only the construction of infrastructure at the VDP treatment site is required in Phase 2 to increase the total production capacity to 550 ML/d.

The proposed PRW scheme discussed in this paper could be considered in serval different scenarios:

1. planning for the PRW as an additional drinking water source following VDP Phase 2
2. planning on delivering the proposed PRW scheme first and have VDP Phase 2 ready to be delivered as a contingent drought response because it could be built in a relatively short period of time.

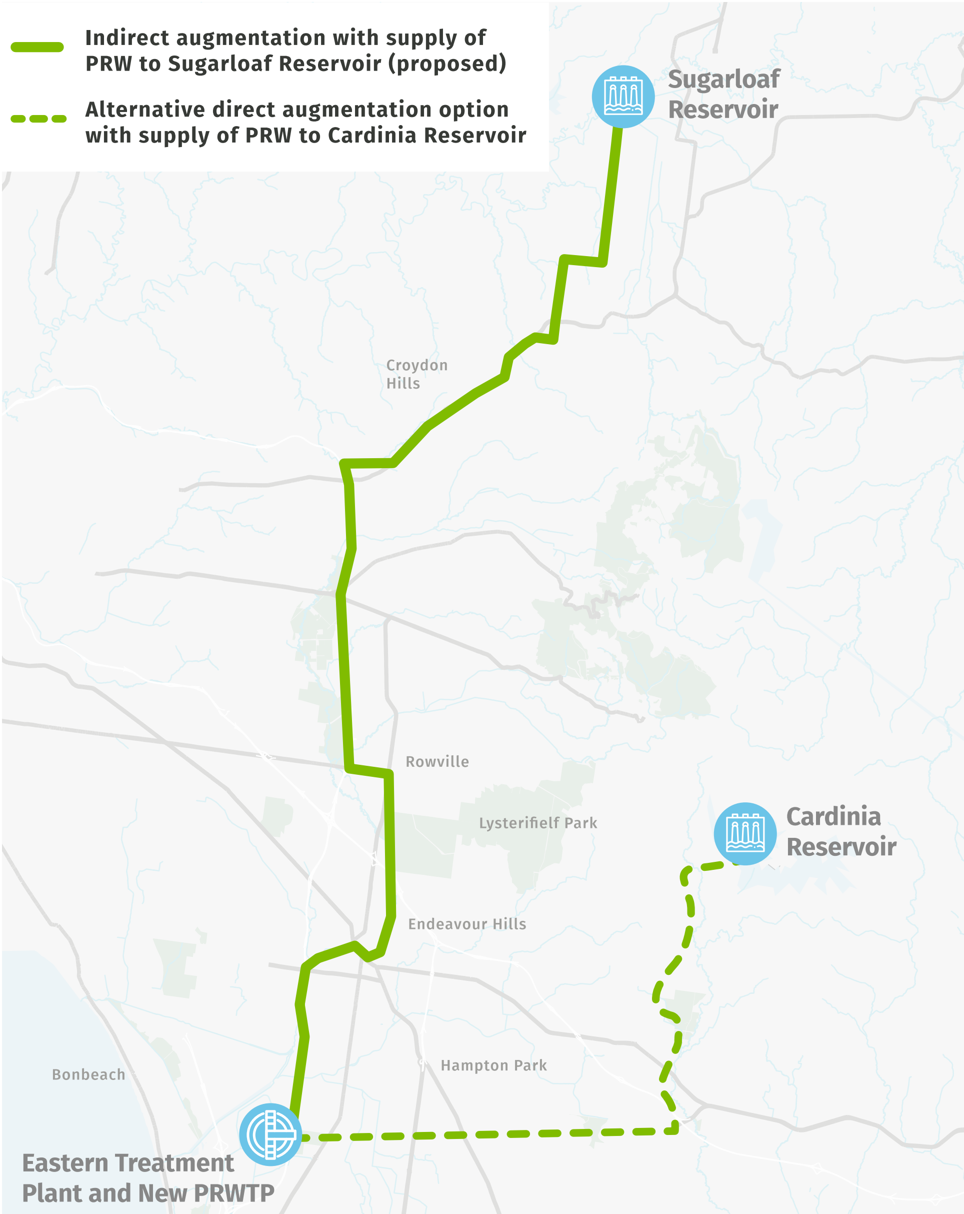
Other scenarios are also possible and will be the subject of financial and risk analyses to determine the best solution to provide water security to Melbourne. A combination of PRW and desalination can provide great resilience and can effectively balance water security risks and customer costs. The optimal solution is site specific and other communities may not have the flexibility of expanding a desalination plant at relatively low incremental cost.

As our climate continues to change and populations are projected to continue to increase, it is essential to adapt our approach to drinking water systems.

An example PRW scheme for Melbourne

The development of a PRW scheme requires, at each step, both complex technical decisions and community engagement activities. We have undertaken at a strategic level, an investigation of how a PRW scheme could be developed for Melbourne. By exploring these technical and social themes, a platform can be created for discussion with the community of the potential benefits that PRW can deliver as a viable option to contribute to long-term water security.

Eastern Treatment Plant and our proposed PRW supply connection



How the scheme could work:

The PRW scheme that we use as our case study begins at Melbourne's Eastern Treatment Plant (ETP). This wastewater treatment plant services a population of approximately 2.5 million people in Melbourne. The daily average tertiary treated effluent from the ETP is 380 megalitres per day (ML/d). This is a substantial volume of good quality effluent, readily suitable for PRW treatment.

Located at the ETP, a new purified recycled water treatment plant (PRWTP) would be constructed. This plant would include best-practice PRW treatment processes, such as ultrafiltration, reverse osmosis, ultraviolet advanced oxidation, and chemical disinfection. Ultrafiltration and reverse osmosis are commonly used for desalination of seawater, however, in our case, they would be optimised specifically for PRW treatment.

In addition to these treatment processes, the PRWTP would leverage the existing ozonation and biological activated filters at the ETP as pre-treatment processes before ultrafiltration. These two processes provide additional barriers for pathogen and chemical removal.

The scheme would transfer PRW to Sugarloaf Reservoir. A new pipeline would be constructed to discharge PRW to the Yarra River, upstream of the Yering Gorge Pump Station from where the PRW would blend with river water and then be pumped into the reservoir. Once the PRW enters Sugarloaf Reservoir, it would be blended with surface water sources and stored for a long period before being extracted and treated through the Winneke Water Treatment Plant (WTP) before supply to the drinking water system.

We have selected supply to Sugarloaf Reservoir as we believe this option with the additional treatment barriers at Winneke WTP would be more readily accepted by the community. This supply configuration can be described as indirect augmentation or indirect potable reuse (IPR) which involves supply of PRW to an environmental buffer before re-treatment at a WTP and distribution as drinking water.

An alternative supply configuration: DPR through Cardinia Reservoir

The new California guidelines for DPR (DDW, 2019) include several configurations to mitigate residual risks when not discharging to an environmental barrier prior to re-treatment. One of those configurations includes the addition of ozonation and biologically active filtration upfront of UF/RO/UVAOP/Cl treatment train that we are proposing in this case study. These new California DPR guidelines open a new discussion pathway for a potentially lower cost water supply.

Direct augmentation, or more commonly referred to as direct potable reuse (DPR) was also assessed as a potential option for supply connection. There are different types of DPR configurations but in principle, DPR involves supply of PRW without an environmental buffer or without further treatment at a WTP. Our case study explores two configurations: a centralised DPR configuration utilising the existing water supply system; and a decentralised, or direct to distribution DPR configuration where PRW is produced at a smaller, local scale and introduced directly into the network at many locations.

From our proposed PRWTP, a convenient centralised DPR entry location is the nearby Cardinia Reservoir. Cardinia Reservoir currently receives the water produced by the Victoria Desalination Plant (VDP), which is then blended with surface water from a protected catchment with all water receiving chlorination prior to entry into the drinking water network. Whist the reservoir can act as an environmental buffer, this configuration is more akin to a DPR configuration because there is limited re-treatment other than chlorination to maintain chlorine residuals in the distribution network.

In supplying to Cardinia Reservoir, the benefits would be lower network capital cost, pumping energy demand and carbon footprint. A less tangible benefit includes less community disturbances during construction. These benefits are all due to the shorter transfer distance. Assuming the same volume of PRW supply, the savings would be approximately 23 per cent, or $190 million in network capital expenditure and $2.3 million in network operational expenditure.

These benefits are not without disadvantages. This configuration would have greater water quality and operational risk due to the more direct nature of the scheme. This then imparts a higher level of water quality and process performance monitoring to ensure that faults in PRW treatment can be detected and addressed quickly. These challenges are techno-centric and surmountable, however, additional cost and effort in planning and operations is required. Additionally, as seen in the latest Californian (USA)

developments, DPR also necessitates more robust PRW treatment and hence a combined train of Ozone-BAC and UF-RO treatment is proposed. Melbourne ETP already has an Ozone-BAC process. We have incorporated this process into our PRWTP design to improve the level of treatment regardless of the supply connection option. Our proposed scheme would satisfy the most stringent requirements as set by the draft Californian DPR guidelines.

An alternate DPR configuration is direct to distribution where PRW is supplied directly to a local drinking water reservoir. This configuration avoids large scale water transfers; however, the production capacity of the PRW scheme would need to be matched with the capacity of the local distribution system. Operating a PRW scheme on-demand or with high turn up and down to match water demands is inefficient from both a cost and operations perspective. It is important to note that with direct to distribution, the system requires real-time water balancing capability to balance water demand with PRW and other water supplies, for example desalinated water or surface water. The absence of a large environmental storage can make this balancing act technically challenging.

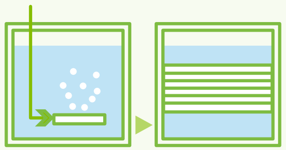
Based on the local drinking water network, direct to distribution was deemed to be uneconomical due to the costs of pipeline infrastructure to re-introduce the large water flow produced by the proposed PRWTP. Decentralised wastewater treatment with PRW production at smaller, locally distributed treatment plants would be better suited to match flow rates for re-introduction into the drinking water network. A decentralised system is worthy of investigation and holds promise as technology changes improve the feasibility of smaller schemes and is worthy of further investigation.

Supply connection options for our proposed PRW scheme

Connection options	Sugarloaf Reservoir	Cardinia Reservoir	Direct to Distribution
Overview	PRW to Yarra River to Sugarloaf Reservoir to Winneke WTP	PRW to Cardinia Reservoir	PRW to local drinking water storage
Scheme classification	Indirect (raw water augmentation)	Direct (treated water augmentation)	Direct (direct to distribution)
Risks and benefits	Low operational complexity Likely easiest to achieve community acceptance	Higher operational complexity Potentially more challenging to achieve community acceptance	Highest operational complexity Most challenging to achieve community acceptance (for initial PRW schemes)
Network CAPEX	$840M	$650M	Not economical at ETP PRWTP scale

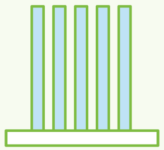
Our proposed PRW treatment:

1



An ozonation and biological activated filter (BAF) processes for disinfection and degradation of dissolved organic matter (already existing at the ETP).

2



Ultrafiltration (UF) membranes to remove solid particles and pathogens in the tertiary effluent, down to 0.1 micron in size (i.e. 0.0001 mm).

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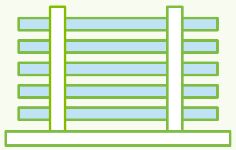

Reverse osmosis (RO) process to remove dissolved chemicals and ions, and almost all pathogens.

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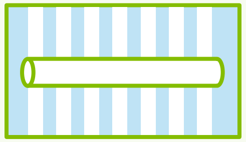
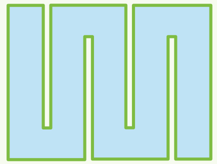


Ultraviolet advanced oxidation process (UVAOP) to destroy any pathogens, trace organic compounds, and contaminants of concern not removed by the RO process.

5



Chlorination for final disinfection and protection of the product water during transfer to supply storages.

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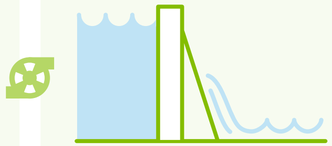


A PRW pumping station to transfer the PRW to Sugarloaf Reservoir.

Importantly, community acceptance is required for any scheme and this should precede any cost benefit or technical solution. However, evidence from other communities that have successfully gone through the journey of accepting PRW as a sustainable source of water are often ready to discuss DPR. These communities are more willing to engage in the discussion on DPR once they understand all the treatment steps, quality control measures and regulatory oversight that are in place for a PRW system. The question often asked by the community after going on this journey is “Why don’t we put the water directly back into the drinking water network?”. Yes, why don’t we?

With any PRW, Indirect Potable Reuse or DPR scheme, it is important that the benefits and risk mitigation strategies are clearly understood to allow better engagement with stakeholders and communities. A more in-depth risk analysis is required to confirm the feasibility of a centralised DPR solution through Cardinia Reservoir. If it is feasible and acceptable to the community, this would be the lowest cost option with the lowest carbon footprint compared to either desalination or indirect PRW.

How safe is PRW to drink?

The PRW scheme would incorporate multiple treatment barriers, monitoring and management systems to ensure that the PRW produced from the scheme is compliant with the Australian Drinking Water Guidelines (ADWG) and the Australian Guidelines for Water Recycling (AGWR) Phase 2 Augmentation of Drinking Water Supplies. Furthermore, the PRW scheme would be benchmarked against international standards and water reclamation frameworks, such as those implemented in the USA and Singapore, to provide cross-checking and further surety in drinking water safety.

The proposed PRW treatment process has the ability to remove chemical contaminants and pathogens down to a level that makes the water suitable for drinking. In water treatment, the log-removal value (LRV) concept is used as a measure of the effectiveness of the water treatment process to remove pathogens such as bacteria, viruses, and protozoa. For example, an LRV of 1 equates to 90.0 per cent removal of a pathogen, an LRV of 2 equates to 99.0 per cent, an LRV of 3 equates to 99.9 per cent, and an LRV of 4 equates to 99.99 per cent. The proposed PRW treatment process is current best practice and can produce PRW that exceeds the AGWR Phase 2 LRV guidelines for pathogens, as well as other global benchmarks. The ozone BAC, RO and UVAOP processes also provide a robust barrier for removal of chemical contaminants and chemicals of emerging concerns.

In addition to the stringent LRV requirements, the PRW scheme would include extensive water quality monitoring and sampling and risk management frameworks to ensure that the PRW scheme is compliant at all times. If there is any indication of out-of-specification water, then the PRWTP is placed into bypass mode and the PRW is returned back to the wastewater treatment plant for local environmental discharge, as per business-as-usual wastewater treatment plant operations.

Pathogen removal capability of our proposed PRW scheme

Treatment Process		Bacteria LRV	Viruses LRV	Protozoa LRV
Existing ETP wastewater treatment process	Secondary treatment	1	0.5	0.5
	Tertiary Treatment (Ozone/BAF)	0	0	0
Purified recycled water treatment plant	UF	2	2	4
	RO	2	2	2
	UVAOP	4	4	4
	Chlorination	4	4	0
TOTAL LRV		13.0	12.5	10.5
Australian guidelines (AGWR, Phase 2)		8.1	9.5	8
Global benchmarks*		8.5	12.0	10

*The most stringent global benchmarks are presented: World Health Organisation (2017) guidelines for Bacteria LRV and California (USA) guidelines for Virus and Protozoa LRV.

What are the benefits of this PRW scheme?

The proposed PRWTP would have a water recovery ratio of up to 80 per cent. This means that with a daily average feed of 380 ML/d, approximately 300 ML/d of PRW can be produced, which in turn equates to 112 GL of water supply per annum, or 27 per cent of Melbourne's current annual drinking water usage.

The PRW provides a significant opportunity for long-term water supply resilience. It is proposed that the scheme would operate continuously. Keeping the storages at higher levels provides greater water supply resilience during drought conditions. In recent years, climate extremes such as bushfires and flooding events have also shown to have direct impact to water quality in dams and reservoirs. Blending PRW with surface water sources would improve the resilience of water supplies because the water quality of PRW is unaffected by these climate extremes.

In other cases, a PRW scheme can help improve the water quality of waterways. By redirecting the treated effluent of a WWTP to a PRW scheme, the volume of treated effluent discharged to local waterways is reduced. This would improve the health of waterways and generate better environmental outcomes. There may also be long-term capital cost savings in redirecting the treated effluent, reducing investments in the WWTP to meet more stringent effluent nutrient load limits.

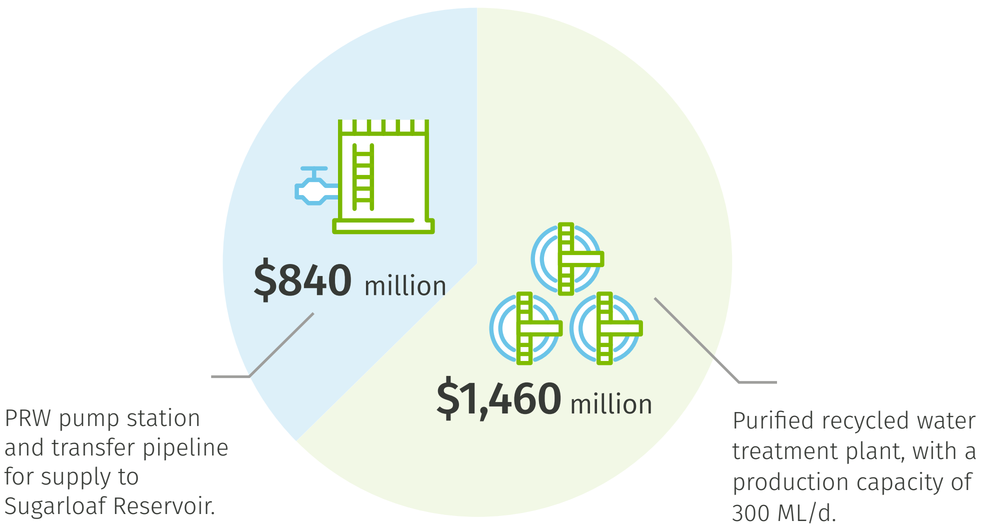
Another environmental benefit includes lower energy requirements for the PRW treatment process compared to desalination. This reduced energy consumption is mostly due to the lower pressure required to pump the water through the reverse osmosis process in PRW. Because of the lower energy, PRW requires less renewable energy and/or carbon offsets to get the treatment process to carbon neutral or net zero, depending on the objective. Depending on geography, the PRW plant may be closer to the community and require less pumping energy to feed back into the drinking water system, but this is site dependent. In some communities, transfer of desalinated water into the system may require lower energy. A holistic review of energy is required to evaluate the lowest energy requirements of any scheme.

Cost of our PRW scheme

The PRW scheme proposed by Aurecon's water engineers would require a total capital cost of AUD$2.3 billion, which is split approximately 2/3 for treatment assets, and 1/3 for transfer assets. As a unit capital cost, this equates to AUD$7.4 million per ML of PRW production capacity. In comparison, according to the Victorian Government Department of Environment, Land, Water and Planning (2015), the Victorian Desalination Plant (VDP) cost AUD$3.5 billion in 2012 for 410 ML/d production capacity, equating to AUD$10.9 million per ML of production capacity, converted to 2021 costs[1].

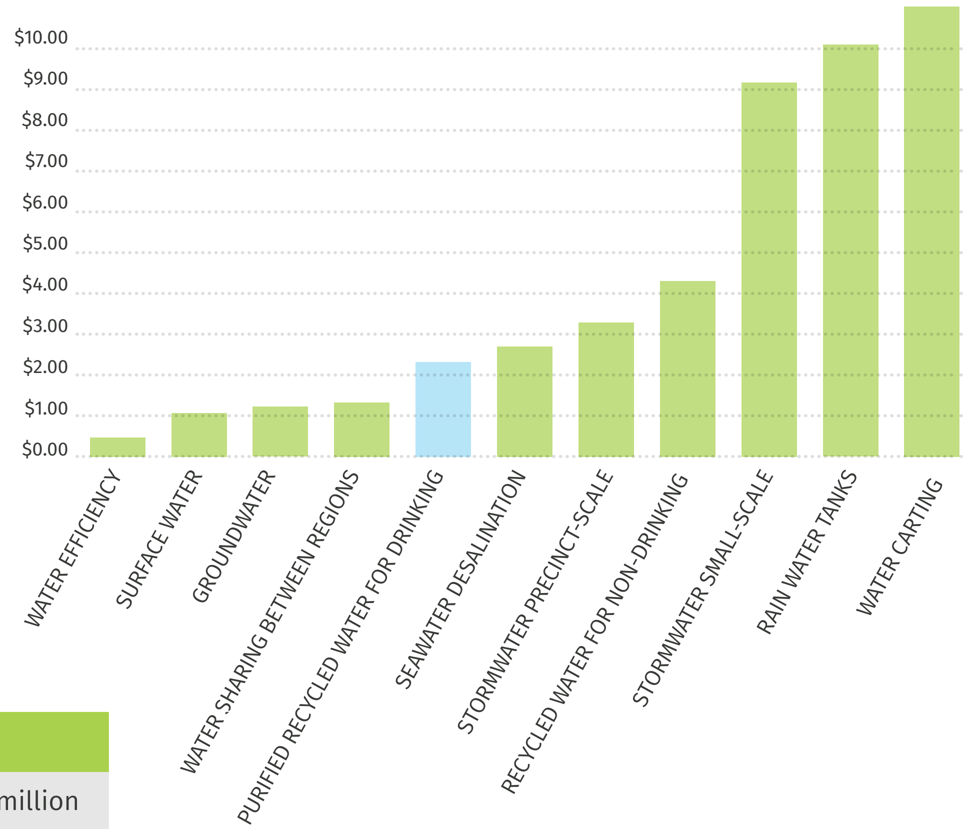
[1] *Assuming an average 3% CPI per annum*

Capital cost estimate of our proposed PRW scheme



While it can be cheaper to build than a new desalination scheme, the capital cost should not be the only criteria. A PRW scheme is also attractive in terms of energy and lifecycle costs, particularly when compared to desalination. The proposed PRW scheme would require a unit energy demand of 2.3 kW/h per m³ of PRW produced and transferred to Sugarloaf Reservoir. Comparatively, assessments conducted by WSAA (2020) show that a desalination plant requires between 3.3 to 8.5 kWh/m³ for production and supply, significantly higher than our PRW scheme. Lastly, when including operational costs such as chemical consumption and maintenance, the PRW scheme will have a levelised cost of AUD$2.2/m³ of PRW produced and supplied over a 30-year life cycle. This levelised cost excludes any economic benefits such as deferred or avoided costs and externalities. When compared to desalination, the proposed PRW scheme remains attractive as the levelised cost for desalination averages AUD$2.74/m³ (WSAA, 2020). The expansion of the VDP to increase the capacity by 140 ML/d is expected to have the lowest unit capital cost. More analysis is required to evaluate the whole of life costs and whether it is better suited for a drought response compared to base production. The cost analysis shows that PRW is an attractive option both in capital and lifecycle costs and should be considered further as a viable water supply option.

Costs of water supply options included in WSAA study
levelised $/kl 2019-20



Source: WSAA All Options on the Table (August 2020)

Capital cost estimate of our proposed PRW scheme

Metric	Melbourne PRW	Typical Desalination	VDP Expansion
Unit capital cost	AUD$7.4 million per ML production	AUD$9-$11 million per ML production	Estimated <AUD$5 million per ML production
Unit power demand	**2.3 kW/h per m³**	**3.3 to 8.5 kW/h per m³**	**Similar to Original**
Levelised cost	AUD$2.2/m³	AUD$2.74/m³	Similar

A shift in community sentiment

Toowoomba and San Diego are often cited as examples of how public perception and political sentiment can influence acceptance of PRW. Toowoomba in Queensland attempted to develop a PRW scheme without an effective community engagement strategy resulting in strong community backlash. Like Toowoomba, San Diego in the USA experienced similar backlash and journalists coined the phrase "toilet to tap" and the synonymous gag reflex or "yuck factor". However, San Diego persevered and turned the situation around "through long and careful education and public communications" (WSAA, 2019). The city now has plans to supply up to 40 per cent of its water supply with PRW by 2035.

Seqwater in Queensland has been engaging with the community for several years to help understand acceptance of PRW. Seqwater has recently presented results showing that the community's acceptance of PRW is increasing over time (Sims-Chilton et al, 2021). This has primarily been the result of a focused education program to improve water literacy on the urban water cycle and the role that PRW can play to provide water security.

There are now many more successful examples than there are failures of successfully improving community understanding and gaining acceptance of PRW schemes. The best local example of a successful community engagement program is in Perth for the Groundwater Replenishment Scheme. The approach to gain acceptance is well understood and, with a well-defined plan, has a very good chance of success. The barriers to investigating more widespread implementation of PRW to improve water resilience in our communities are not technical but are more social and political. The water sector should start having the conversation with communities about PRW to have a chance of success.

Conclusion

This paper has outlined the economic, social and environmental benefits that PRW could bring to a community looking to improve its water security and resilience. When considering water security and, in particular, PRW, each city will have its own journey while learning from others how to better cater for specific needs and circumstances.

As our climate continues to change and populations are projected to continue to increase, it is essential to adapt our approach to drinking water systems. There needs to be a shift from focusing on the source of our drinking water to the quality of the drinking water that we produce. The journey towards water resilience is not a race, but the time to start considering all the options, including PRW, and initiating inclusive discussions with our communities is now.

We believe that PRW is a cost competitive, climate resilient, and sustainable option with a relatively low carbon footprint compared to some other water supply options. To demonstrate this, we have used Melbourne as an example for technical and cost analysis of a large scale PRW scheme. This analysis showed that a PRW scheme located at the ETP, and supplying to Surgarloaf Reservoir could provide up to 112 gigaliters of climate resilient water supply per annum at a competitive cost to desalination.

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Darren Romain leads Aurecon's Community of Interest focused on exploring water supply challenges and solutions in our urban environment. He has more than 25 years of experience in water treatment in Canada, Singapore and Australia covering the full asset lifecycle from strategy, planning, design, construction, through to commissioning and optimisation. Darren is passionate about creating conversations around alternative water supplies for our communities to ensure a sustainable future in a changing climate and increasing water demand.

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