**Confronting the System: An Exploration of the Water Security Crisis in Melbourne**

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**Abstract**

Melbourne, a city of nearly 5 million people, is facing threats to water security. This is due to a multiplicity of factors, such as the impacts of climate change and population growth. Rising temperatures and reduced rainfall are prolonging droughts, and depleting storage water levels. An increasing number of residents, on the other hand, is creating greater demand in spite of decreasing stocks. In response, authorities have adopted a strategy meant to enhance their capacity to provide water, based on the concept of 'security through diversity'. This approach, however, is neither sustainable nor a true embodiment of the principle of diversification. It is predicated on a centralised system of urban water management that is unsuited for present circumstances, and places greater importance on supply side interventions such as desalination than on initiatives meant to address demand. Thus, the strategy needs to be transformed if it is to better embody the principle of diversification and ensure water security. This could be accomplished by including a broader range of relevant stakeholders, such as Indigenous and other civil society groups, to improve the city's current water management strategies and tackle its dependence on a centralised urban water management system.

**Keywords**
Melbourne, Water Security, Climate Change, Population Growth, Security Through Diversity, Urban Water Management

**Introduction**

Melbourne is the capital of the Australian state of Victoria and serves as the home of approximately 75 percent of Victoria's population (World Population Review, 2020). Water security is at the forefront of Melburnians' minds due to a multiplicity of factors, including the impacts of climate change and population growth (Ives et al., 2013; Moran, 2008; Sousa et al., 2016; Werbeloff & Brown, 2011). In the aftermath of the Millennium Drought, which lasted from 1997 to 2009, citizens of Melbourne have become highly aware of the city's declining water storage levels and of their personal water consumption (Low et al., 2015; Rowley, 2016). In the past five years, the city's water storage has decreased by an average of 61 billion litres due to successive droughts, leading the Victoria State Government to adopt a 'security through diversity' approach (Heggie, 2019; Werbeloff and Brown, 2011a). This approach includes initiatives to increase storage levels such as building the Victoria Desalination plant, and to decrease demand through initiatives such as permanent water saving rules restricting outdoor water consumption, and the voluntary 'Target 155' campaign (Victoria State Government, 2020; Victoria State Government, 2015). While the Victoria State Government and the Melbourne Municipal Government have embraced the philosophy of the security through diversity approach, in practice they appear to have placed an over-reliance on the desalination plant to increase storage levels (Werbeloff and Brown, 2011a). Hence, these governments need to consider alternative solutions to improve water security for the long-term, particularly as Melbourne faces the threats of climate change and population growth. Further, although Melbourne's current strategy is considered an improvement on the city's previous methods of conducting

urban water management, the city remains dependent on the very same system that made way for present vulnerabilities to emerge in the first place (Werbeloff & Brown, 2011b); referring to the factors affecting the city's ability to ensure water security (i.e., the impacts of climate change and population growth). Therefore, the city's water security strategy needs to be transformed, if it is to be able to adapt and respond to these urgent challenges.

The urban water management system presently in place in Melbourne is not entirely suited to tackle the impacts of climate change and population growth, as it dates from the colonial era. Thus, it is predicated on historical processes which have altered and significantly degraded the natural environment, water resources included (Brown et al., 2009; Werbeloff & Brown, 2011b). This includes the centralised nature of the strategy, which has meant that certain stakeholders have been excluded from its development and operation, and its reliance on methods transplanted from the United Kingdom (UK), meaning that it has not been tailored exclusively to meet local needs (Brown et al., 2009; Werbeloff & Brown, 2011b). In the face of current challenges, therefore, reliance on such a system is not sustainable (Werbeloff & Brown, 2011a; 2011b). The population is booming, the city is expanding, and climate change is continuing to evolve (Ives et al., 2013; Moran, 2008; Sousa et al., 2016; Werbeloff & Brown, 2011b). It is hence important for Melbourne to alter its approach to water security, according to the changing nature of these challenges.

This could be achieved by implementing a truer embodiment of the principle of diversification, as outlined in the security through diversity model promoted by state and federal governments (Werbeloff & Brown, 2011a; 2011b). Melbourne should include a broader range of relevant stakeholders in the city's urban water management scheme, to not only confront, but also address the latter's centralised nature and deviate from its inherent colonial methods which are unsuited to meet evolving local needs. Such stakeholders should be local and derive from civil society, as many of them have demonstrated a commitment to fighting for the adoption of more sustainable methods of managing water resources in the area. They include Traditional Owner Groups[1] (e.g., the Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation and the Bunurong Land Council Aboriginal Corporation), as seen through their activities centred on the recalling and application of traditional Aboriginal[2] ways of perceiving and engaging with nature within the context of modern-day Melbourne (e.g., the Wurundjeri Cultural Values Project in partnership with Melbourne Water and the Victorian Environmental Water Holder)[3] (Bunurong Land Council Aboriginal Corporation; State Government of Victoria, 2019a; Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation), along with other community and environmental actors (e.g., Friends of the Earth Melbourne and Watershed Victoria), whose activities have included opposing municipal plans for desalination (Friends of the Earth Melbourne; Watershed Victoria, 2008).

Community and environmental actors are important collaborators, as they defend the preservation of natural resources and advocate for what is in the common interest of their communities (see, e.g., Brown et al., 2009 p. 853). Thus, their inclusion in decision-making processes related to water resources could arguably serve to hold Melbourne's current public and private water managers accountable, and lead to the management of water resources in ways that demonstrate consideration for the wellbeing of people and the environment. Furthermore, Aboriginal organisations are highly relevant to this discussion

[1] The term refers to Aboriginal groups formally recognised as Traditional Owners of Country, as outlined by the State Government of Victoria (2019b).

[2] The terms Aboriginal and Indigenous are used interchangeably within this paper.

[3] Although the project may appear to be an example of Aboriginal peoples' inclusion in local water resource management, in reality, the latter continue to lack water management rights as will be later explained.

because, in addition to their activism, they comprise and represent segments of the population publicly recognised as the rightful owners of the land in Melbourne. Considering, therefore, the historical and present-day implications of their dispossession of land and water (see, e.g., Hall, 2018), particularly in light of the cultural significance of these resources to them, involving local Aboriginal groups in the region's urban water management could constitute an important step in the process of 'reconciliation'. More specifically, it would demonstrate willingness on the part of authorities to work toward redefining and improving their relationship with Indigenous people, by partnering with them to establish mechanisms through which together they can affect change more concretely. Nonetheless, as actors such as O'Bryan (2017) contend, partnerships of the like must move beyond the symbolical. These partnerships must enable Indigenous people to partake in meaningful decision-making over the management of water resources. This could lead to a diversion from the current situation, both in terms of the reconfiguration of Melbourne's urban water management system to render it more sustainable, and through the inclusion of Indigenous groups among the more diversified ensemble of stakeholders, as a step towards reconciliation.

A deeper exploration of the water security issue in Melbourne through historical and modern-day facets will provide greater understanding of the aforementioned challenges. In this paper, we argue that Melbourne's approach to water security fails to address the following two important elements: broader stakeholder inclusion in water resource management, and environmental protection. Melbourne's water security measures neglect to meaningfully include important stakeholders such as Indigenous, community and environmental actors in decision-making processes; and lack adequate consideration of the impacts of desalination on marine life and the ocean, and the limits of the environment.

**Historical Overview: Differing Perceptions of Water and Land**

Water security is indeed under threat in Melbourne, due to a number of climate and population-related factors as described. However, these components do not paint a full picture of the issue. Before European settlement in the area, and its gradual development into a metropolis, present-day Melbourne served as a ceremonial meeting ground for Aboriginal clans, who sustained themselves on surrounding ecosystem goods and services (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). Their cultural gatherings were regular, and involved hundreds of people for up to 3 to 4 consecutive weeks (Ives et al., 2013; Oakley & Johnson, 2013). They benefited from clean drinking water provided by the Yarra River, and food from abounding vegetation and wildlife (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). Much of their environment comprised of low-lying wetlands and alluvial plains; the former resulting from beach ridges that inhibited drainage. They included swamps and lagoons, and varied in size depending on seasons and rainfall (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). Water and land, including the swamps, were indivisible from one another, as they were together considered by Aboriginal people to be one and indispensable to their spiritual and physical survival. Accordingly, natural resources were managed in such a way as to enable them to last and continue to be relied upon for tens of thousands of years (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014).

This manner of engaging with nature, however, belonging to the Woi wurrung and Boon wurrung clans of the Eastern Kulin nation, did not correspond to that of the subsequent British colonisers who seized control of their territory (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). On the contrary, the latter perceived nature as needing to be subdued and put to meaningful use by man, based on their understanding of Genesis 1:28 in the Bible (Presland, 2014). Undertaking this task, therefore, required appropriating the new environment that was to become Melbourne, and dramatically altering it in

accordance with their needs. As such, settlement was initiated in 1835 (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014).

This occurred upon European people's encounter with the chosen site's natural wealth. It comprised of arable land on the alluvial plains, and timber that could be sourced from forests, in addition to the available potable water. It was situated along the northern banks of the Yarra River, at the top of Port Philip Bay, and was protected against flooding (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). The latter was due to the area's rocky and elevated nature, which formed the limits beyond which tides could not attain (Presland, 2014). Hence, once agreed upon as the ideal place, development began.

Initial activities involved converting waterways into ports, and building industry zones to export goods such as gold and wool to the metropole (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). These led to population and economic growth during the 1850s, and necessitated town expansion beyond the initial site's confines (see Figure 1 and Figure 2) (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). Surrounding ecosystems, therefore, had to be either cleared to create space or converted according to other needs (Ives et al., 2013). The process began with the tackling of swamps, which covered much of the area and were viewed unfavourably by the Europeans (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014).


*Figure 1: Hobson Bay and River Yarra leading to Melbourne, 1864. Henry L. Cox.*


*Figure 2: Enlargement. Hobson Bay and River Yarra leading to Melbourne, 1864. Henry L. Cox.*

The wetlands had been valued by Indigenous Australians, as they perceived water and land to be undifferentiated from one another. However, for the Europeans it was not so (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). In their culture, swamps were considered futile and detrimental to health. They could not be cultivated or built upon like dry land, nor be put to use in the same manners as rivers, lakes and oceans (Oakley & Johnson, 2013; Presland, 2014).

To convert waterways, the Yarra River was dredged, straightened, broadened and made deeper, to render its port more efficient and delineate its separation from the mires (Oakley & Johnson, 2013). The latter were completely removed by being either drained or filled in, enabling the multiple problems they posed to be addressed (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). As such, a clear demarcation between land and water was created, transforming the river on one hand, and swamps on the other (Oakley & Johnson, 2013; Presland, 2014). Beyond the physical implications that these actions carried, however, was also contained ideological meaning. They not only reinforced the establishment and dominance of British culture in the environment, but further signified local Indigenous people's dispossession of and exclusion from it (Oakley & Johnson, 2013; Presland, 2014). Many among them succumbed to the onslaught of diseases, while others found themselves relegated to precariousness within the town, and then entirely moved to grounds that would later become reserves (Oakley & Johnson, 2013). The new powers thereby consolidated their vision for Melbourne, proceeding with its execution in a manner that could be understood to have constituted a transplantation of Europe to the

colony. Further, encompassed within it was the establishment of a water system modeled after that of the UK.

The need for a water supply system surfaced alongside other developments in the town, as it would enable the processing of industrial goods and improve on waste management, among other things (Oakley & Johnson, 2013). Therefore, plans were launched to extend the centralised system that had been established in other parts of colonial Australia in the early 1800s to Melbourne (Brown et al., 2009). The country's urban water management system occurred in 3 initial states, categorised by Brown et al. (2009) as the 'historical transition'. Other transition states followed suit, however, are not addressed herein.

The first state unfolded in the early 19th century, resting on the knowledge of hydraulic engineers brought in from the metropole. The foreign experts sought to provide clean and safe water to a growing urban population, using an effective centralised scheme. Their focus was particularly on supplying the elite, due to the social movement of cleanliness at the time that was tied to social status. They therefore orchestrated the planning, construction and management of the system; relying on dams, pipes and the extraction of large volumes of water from a source considered benign (Brown et al., 2009). Once operational and secure, prevailing thoughts then shifted. They turned to the idea of 'limitless fresh water' being a public right, that should be provided by governments at an affordable cost, to all people equally —like in the UK (Brown et al., 2009). As such, a centralised system of taxation emerged (i.e., the hydro-social contract) to enable water infrastructure and delivery to be funded and achieve this new vision. It came to be enforced by regional and subsequently metropolitan governments, and symbolised the provision of safe, affordable and 'limitless' water, from a benign environment to booming cities (Brown et al., 2009).

Following the latter, the second state of the process arose, concerning the installment of sewerage. It occurred between the mid to late 1800s, when public health concerns were at the time prevalent in the UK, due the outbreaks of cholera and typhoid across Europe —hence the same period of time within which marshes were being removed in Melbourne (Brown et al., 2009; Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). Researchers in London discovered that pathogen infections from effluents, not bad air, caused people to be ill (Brown et al., 2009; Presland, 2014). In accordance, a combined and networked sewerage system was developed, to dispose of industrial and waste waters in waterways outside of cities. The method was thought to be environmentally sound, and was subsequently adopted in Australia (Brown et al., 2009). Sydney led the way in realising these developments, investing in a combined sewerage and stormwater drainage system in 1850. Other cities followed suit, starting from the late 1800s (Brown et al., 2009).

Once the initial stages complete, the third state of the process began, revolving around drainage. The practice had already been occurring at a micro level, however, came to be incorporated into the centralised system post World War II (Brown et al., 2009). Government public spending at the time had risen substantially, allowing the new discipline of urban hydrology to establish itself firmly in Australia. Professionals in the field consequently innovated techniques to efficiently transport stormwater out of urban centres, into external waterways, through pipes underground (Brown et al., 2009). This transformed the public perception of stormwater, and by extension, dramatically impacted urban development. On one hand, stormwater turned into a nuisance, on the other, waterways came to be viewed as dumping grounds and hence were also undesired (Brown et al., 2009). Meanwhile, rivers in floodplain areas became channelised to make room for continuing expansion, altogether modifying the hydro-social contract further. The latter became such that cost-effective flood protection services were expected to be provided by a centralised authority structure, which was to convey the water to an external

environment and facilitate urbanisation (Brown et al., 2009). Such is how the initial development states of the urban water management system in Australia —and Melbourne— were established.

Following the historical transition, the arrival of environmentalism in the late 1960s and early 1970s brought even greater changes and complexities to the hydro-social contract. A greater number of stakeholders began demanding improvements in the urban water management scheme, to have the extensive pollution it was causing in waterways redressed (Brown et al., 2009). Yet, even in some of the changes that resulted, the system did not wholly adapt to evolving times or needs (Brown et al., 2009; Werbeloff & Brown, 2011b). This is presently evidenced in the fact that Melbourne's urban water management scheme has maintained centralised operating structures and procedures, which have ultimately proved to be ineffective in protecting the city against the mounting threats to water security (Brown et al., 2009; Werbeloff & Brown, 2011b). Hence, the vulnerabilities we currently observe are not simply due to the impacts of climate change and population growth, but result from historical events tied to the past invasion of present-day Melbourne by foreign powers, and their transformation of the natural environment in ways that ultimately proved to be detrimental to residents' ability to possess water security (Brown et al., 2009; Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014; Werbeloff & Brown, 2011b). Not only have the traditional ways of engaging with nature and stewarding its resources, as done by the Woi wurrung and Boon wurrung peoples been done away with, but these have been replaced with practices that have consisted of encroaching on nature, permanently transforming it, and doing so through a consolidated power structure that implements processes predicated on institutions established elsewhere, and therefore unsuited for local circumstances and needs that would emerge (Brown et al., 2009; Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). Seeing as this manner of proceeding —which can also be understood as putting the interests of the powerful above those of others, and of doing so in a way that relies on production and efficiency at the cost of the environment and the common good— has left Melbourne facing threats to water security, it is consequently of importance that the city's urban water management system be transformed if the issue is to be dealt with effectively.

**Water profile**

Melbourne is primarily reliant on "freshwater dominated surface water systems" (Werbeloff & Brown, 2011a, p. 3), thus, the city is especially vulnerable to the increasingly apparent impacts of climate change such as drought and reduced rainfall (Werbeloff & Brown, 2011a). A majority of Melbourne's water comes from "remote, forested mountain streams" (Melbourne Water, 2020a), which are collected in protected catchments (Melbourne Water, 2020a). Melbourne is one of very few cities in the world with catchments that are protected from bushfire pollution and human use and recreation, resulting in high quality drinking water (Melbourne Water, 2020a). The catchments are carefully protected from bushfires, which contaminate the water with ash and sediment, through "strategic planned burns that reduce the risk of intense bushfires", monitoring technology and periodic patrols for rapid fire identification, and frequent grass-cutting in the summer (Melbourne Water, 2020a). Patrol teams keep the catchment areas safe from human contamination through activities such as recreational boating, fishing, and camping, which are treated as serious offences and can result in expensive fines for violators (Melbourne Water, 2020a). Additionally, Parks Victoria leads an annual trapping and baiting program to clear the areas of animals and pests that could potentially contaminate the catchment areas (Melbourne Water, 2020a).

Melbourne's catchments are connected by steams to some of the city's ten major reservoirs (Melbourne Water, 2020b). On-stream reservoirs collect water from the catchments, while off-stream reservoirs collect water from other sources, such as the recently built Victoria Desalination plant (Melbourne Water, 2020b). The city's reservoirs have a combined storage capacity of 1,810 billion litres of water (Melbourne

Water, 2020b). The reservoirs are connected through pipelines so that water can be transferred, as needed, according to rainfall levels and demand variation (Melbourne Water, 2020b). Most of Melbourne's urban water supply derives from the Silvan reservoir, which was built in 1932 (see Figure 3) (Melbourne Water, 2020e).

Notably, only 30 to 50 percent of rainfall in catchment areas reach Melbourne's reservoirs (Melbourne Water, 2020a). A large portion of rainfall in the catchments is either consumed by vegetation, stored in the soil as groundwater, or evaporated into the atmosphere (Melbourne Water, 2020a). In the summer, only about ten percent of rainfall becomes runoff because the soil soaks up most of the rain before it can "flow into streams" (Melbourne Water, 2020a).

*Figure 3: Aerial view of Melbourne's Silvan Reservoir. (Melbourne Water, 2020e)*

Recently, Melbourne has faced an overall decrease in rainfall, which is predicted to continue, although, there will likely be an increase in extreme downpours, which can lead to intense flooding, especially in small catchment areas (see Figure 4) (Victoria State Government, 2015). Additionally, experts predict that Melbourne will face substantial increases in temperatures, and longer warm spells with more days reaching temperatures above 35 degrees Celsius in the future (Victoria State Government, 2015). As Melbourne becomes hotter and drier, there is an increased risk of bushfires, which can further reduce water supplies (Melbourne Water, 2020d). The devastating outcomes of these temperature increases became apparent in January 2020, as deadly wildfires in New South Wales and Victoria, caused by record high temperatures and prolonged drought, destroyed thousands of homes and impacted millions of hectares of land (BBC, 2020). Further, as a result of lower rainfall levels and higher temperatures, the protected catchment areas become drier and provide less water to the reservoirs (Melbourne Water, 2020a). Thus, Melbourne's reliance on rainfall and surface water systems, where a large portion of water is lost to soil and the atmosphere, is unsustainable and unreliable in the face of increased drought and decreased rainfall resulting from the impacts of climate change.

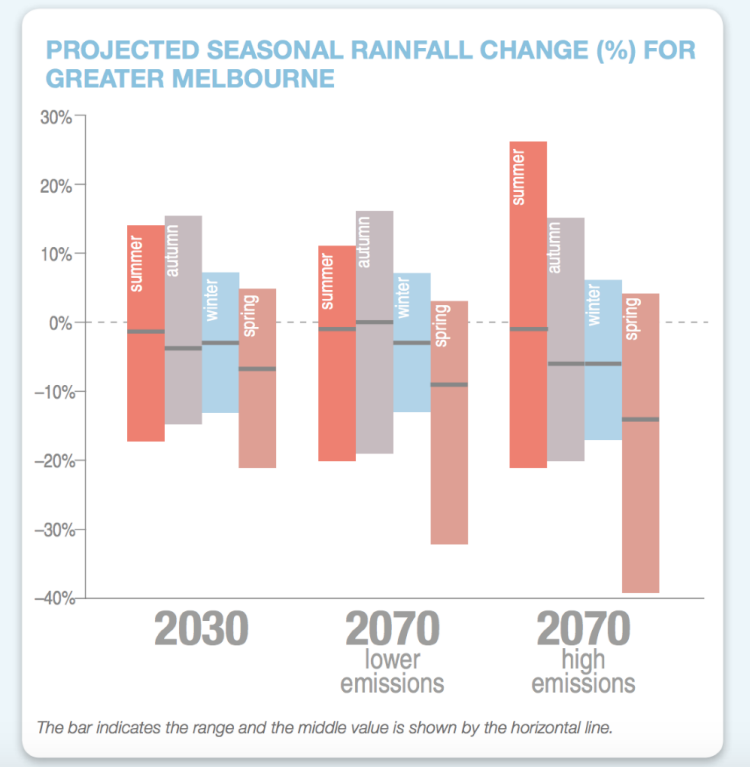


*Figure 4: Projected seasonal rainfall changes for the Greater Melbourne region. (Victoria State Government, 2015).*

Population growth further challenges Melbourne's water security. Melbourne is currently Australia's fastest growing city, with a population of about five million residents (ABS, 2020). The capital city of Victoria continues to grow rapidly, with experts estimating Melbourne's population will reach eight million by 2051 (Barry & Coombes, 2018). In 2018-19, the average person in Melbourne used 162 litres of water per day (Melbourne's Water Outlook, 2019), compared to 161 litres the previous two years (Melbourne's Water Outlook, 2019). This is an increase from the 2010/11 fiscal year, when, for 49 out of 52 weeks people in Melbourne used less than 155 litres of water per day following the introduction of the state-wide 'Target 155 program', which will be discussed later in this paper (Low et al., 2015). In 2018-19, residential consumption accounted for 65 percent of Melbourne's water usage, while 24 percent of the city's water was used for industry and commercial purposes, and 11 percent was lost to leakages, including firefighting and system losses (see Figure 5) (Melbourne's Water Outlook, 2019). That same year, 31 percent of water consumed by residents was used for taking showers (Melbourne's Water Outlook, 2019). Additional research contends that roughly half of per person water consumption in Melbourne is related to outdoor consumption such as car washing, sprinklers, and hosing driveways (Heggie, 2019).

Overall, most people in Australia, including in Melbourne, have access to clean water and sanitation, however, some remote Indigenous communities lack access to these resources (Hall, 2018). Customers of Melbourne's South East water utility company in 2019-20 pay $2.63 per kilolitre for the first 440 kilolitres of water used per day, and $3.35 per kilolitre if they use more than 440 kilolitres in a day (South East Water, 2020b). Therefore, as Melbourne's population continues to grow, so will its water security challenges, particularly in the face of increased demand.

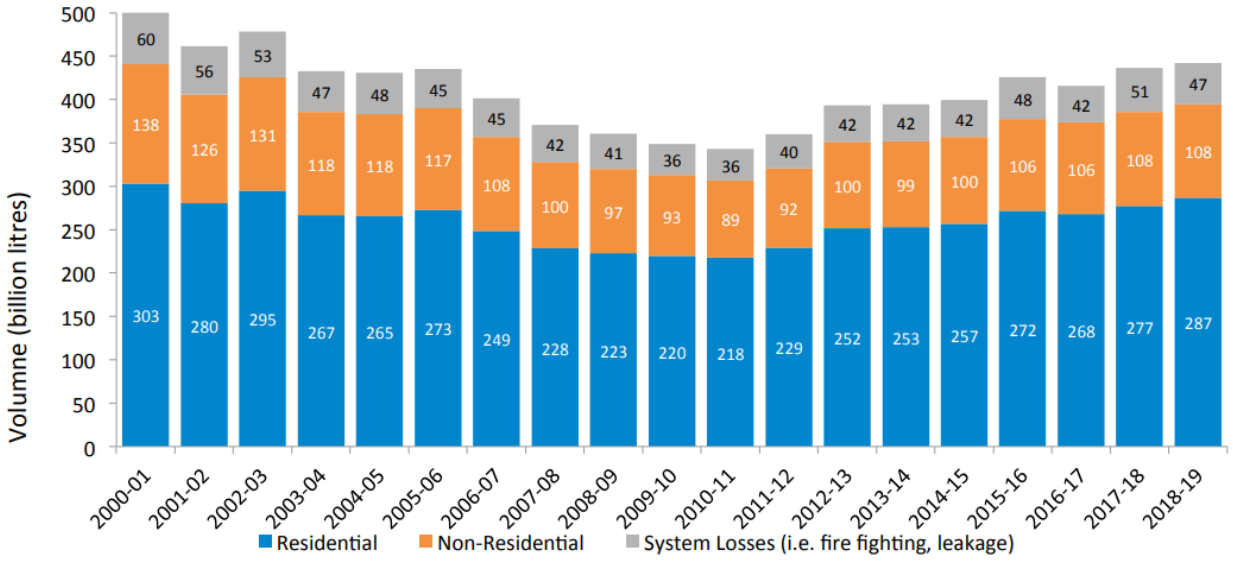


*Figure 5: Melbourne's total water use by sector since 2000. (Melbourne's Water Outlook, 2019)*

**Governance and Management**

Melbourne Water Corporation

Melbourne Water Corporation, which is owned entirely by the Victoria State Government, manages the city's catchments and rivers, as well as the city's water supply and sewage services (IbisWorld). Aside from its role as the wholesaler of Melbourne's drinking water, the not-for-profit corporation's operations include managing Melbourne's ten water storage reservoirs, treating most of Melbourne's sewage, producing and supplying recycled water, protecting local creeks and rivers, flood management, implementing projects to improve livability and reduce environmental impacts, and mitigating climate change (IbisWorld).

City of Melbourne

In response to the Millennium Drought, which lasted from 1997 to 2009, the Melbourne City Government created the 2002 Total Watermark Strategy, which was updated in 2009 and again in 2014 (Low et al., 2015; City of Melbourne, 2014). The latest version, from 2014, includes targets for 2018 and 2030, which consist of increasing the amount of water sourced from "alternative sources" for city council and the municipal government to improve water quality (City of Melbourne, 2014). Notably, Melbourne became carbon neutral certified in 2013 (C40 Cities, 2013). The city aims to be one of the most sustainable cities in the world and works with various stakeholders to attempt to improve the city's integrated water resource management (IWRM) strategies (see Figure 6) (City of Melbourne, 2014; City of Melbourne, 2017).

The city released its Integrated Water Management Plan in 2017, which includes a ten-year stormwater harvesting plan and reviews whether the city has met the 2014 Total Watermark goals (City of Melbourne, 2017). The 2017 report reviews the goals laid out in the 2014 Total Watermark strategy, and claims the city reached most of the 2014 goals, including "modelling effects of green infrastructure on reducing flooding" and improving flood mitigation measures (City of Melbourne, 2017, p.32). However, the 2017 report also acknowledges a failure to sufficiently research areas such as the city's heat island effect and

the "linkages between human health and access to waterways and public open spaces" (City of Melbourne, 2017, p.32).


*Figure 6: Stakeholders involved in Melbourne's Integrated Water Management Efforts. (City of Melbourne, 2017).*

Additionally, although the report includes a diagram mentioning the United Nations Sustainable Development Goals, it provides no details regarding the city's efforts to meet these goals, particularly Goal 6, which pertains to water and sanitation and includes a target to reduce water scarcity (City of Melbourne, 2017; United Nations). The 2017 plan contains three new targets, in addition to the existing targets from the 2014 Total Watermark Report, including ensuring a "minimum 20 per cent of each catchment's surface is considered permeable by 2030" (City of Melbourne, 2017, p.13).

Moreover, in 2015, the City of Melbourne engaged the public through roundtables, events, public forums, and online participation to create a document called Future Melbourne 2026 outlining priorities for the city's future (City of Melbourne, 2016). The document includes two sentences describing the goal to "conserve water and improve the health of.... waterways by capturing stormwater" (City of Melbourne, 2016, p. 11). The document also outlines the goal of including Aboriginal experts in future land management planning, however fails to mention Aboriginal people's role in water management, and fails to mention any efforts to include Aboriginal participation during the public engagement phases of the report itself (City of Melbourne, 2016).

State of Victoria

As previously mentioned, the State of Victoria owns and operates the municipal water wholesaler known as Melbourne Water (IbisWorld). The state's Ministry for Water sets water targets and restrictions for the state, including Target 155, which was initially implemented in 2008 and aims to encourage residents to limit water usage to 155 litres per day (Low et al., 2015; Victoria State Government, 2020). The initiative was cancelled in 2011, despite evident success in reducing per person water consumption (Ker, 2011). Recently, the program has been re-instated, and is promoted by both the provincial government and Melbourne's municipal government, however, it is too early to tell if the newly reinstated program will help reduce per person water usage in Melbourne, which has stagnated around 160 litres per person per day for the past few years (see Figure 4) (Victoria State Government, 2020). Further, the state has implemented five permanent water saving rules that regulate outdoor water use by limiting what time of day citizens can water lawns and public gardens, and prohibiting residents from washing driveways (Victoria State Government, 2019).

Security through Diversity Approach

Traditionally, water needs of growing populations in Australian urban centres have been met with large scale infrastructure solutions, delivered through centralised mechanisms in order to cheaply deliver water to a broad number of people (Werberloff & Brown, 2011a). However, there has recently been a push to move away from this linear approach to water delivery, in favour of a security through diversity approach (Werbeloff & Brown, 2011a). All three levels of government —federal, state, and municipal water utilities— have promoted the security through diversity approach to water management, "as a means of maximizing resilience to a range of possible water futures" (Werbeloff & Brown, 2011a, p. 782). This approach aims to reconfigure the traditional linear approach by harnessing numerous demand and supply initiatives, and recycling previously used water, promoting making use of "diverse water sources, demand management and multiple scales of water service delivery" (Werbeloff & Brown, 2011a). The approach includes three pillars: diversifying water sources, implementing various initiatives to reduce consumption and manage demand, and diversifying at both centralised and decentralised scales (Werbeloff & Brown, 2011a). In one study, researchers found that among senior water officials in Melbourne "desalination was widely perceived to be the silver bullet solution to the water scarce conditions faced by [the city]" (Werbeloff & Brown, 2011a, p.784). Interestingly, this perception directly contrasts the philosophy of the security through diversity approach, which advocates for avoiding over-reliance on a singular mode of infrastructure to deliver municipal water (Werbeloff & Brown, 2011a).

The City of Melbourne defines its IWRM approach as "the coordinated management of all components of the water cycle including water consumption, rainwater, stormwater, wastewater and groundwater, to secure a range of benefits for the wider catchment" (City of Melbourne, 2017). While this definition is promising, Melbourne's approach to water security lacks two important elements that could improve the city's water management approach and allow for greater security diversity and inclusion. Firstly, the city's current approach fails to achieve meaningful inclusion of Indigenous Peoples and environmental stakeholders in decision-making processes. Principle Two of the Dublin-Rio Principles states that "water development and management should be based on a participatory approach, involving users, planners, and policy-makers at all levels" (GWP, n.d., p.1). Our vision of this participatory approach involves the direct inclusion of Indigenous peoples at all levels of decision-making in relation to water security.

Secondly, Melbourne's approach to water security neglects some important environmental considerations. While Melbourne's desalination plant was built to include some sustainable measures,

such as the green roof and surrounding green area (Water Technology, 2020), the plant still has the potential to cause environmental damage. Recent studies have found that the brine produced by desalination processes, which is returned to the ocean, has the potential to disrupt marine ecosystems, including the potential to harm marine species due to high concentrations of salination, and could also potentially introduce toxic chemicals into the ocean (Gies, 2019). Many scholars have noted the importance of protecting the environment when building water security capacity. Cook and Bakker (2011) note, "the anthropocentrism...framing of water security risks neglecting the importance of the ecosystem as an integral component of both human and water security" (p. 97). Melbourne's approach does consider the environment in many ways, including the conversion of pavement into green spaces to improve permeability (City of Melbourne, 2017). Unfortunately, the city's over-reliance on costly technology, such as desalination, may lead to a persistent ignorance of the limits of the ecosystem. Further, over-reliance on the desalination plant as "diversity", ignores what Werbeloff and Brown (2011b) refer to as a "more integrated blend of supply and demand initiatives" (p. 2368).

Reducing Consumption through the 'Target 155' Campaign

During the Millennium Drought, policymakers realised the need to reduce residential consumption in Melbourne (Rowley, 2016). In 2008, the state of Victoria implemented various water consumption reduction strategies, including the voluntary 'Target 155' program, encouraging voluntary water consumption reduction through advertisements on television, billboards, radio, and newspapers (Low et al., 2015; Rowley, 2016). In creating the Target 155 program, the Yarra Valley water utility was charged with consulting a team of experts and behavioural psychologists to find ways to make reducing water consumption a social norm (Rowley, 2016). They began with easy targets, such as giving away free water-reducing showerheads and hose nozzles, and eventually moved towards other steps such as training staff at 80 garden centres in Melbourne to encourage customers to plant drought-resistance native plants (Rowley, 2016).

The Target 155 initiative helped the city reduce per person water usage from 247 litres per day in 2000-01, to 147 in 2010-11 (Rowley, 2016). Additionally, a study commissioned by Melbourne's water retailers found "the T155 Campaign netted 53 GL in water savings from December 2008 to August 2010, based on comparing observed water use to a model-predicted water use without this campaign, after correcting for climate variability" (Low et al., 2015). The campaign also successfully strengthened social norms around reducing water consumption (Rowley, 2016). Despite these successes in reducing Melbourne's water consumption, the Victorian government's Water Minister ended the Target 155 campaign in 2011, claiming the program had minimal significant outcomes in reducing water consumption in Melbourne, in contrast to reports that found evidence proving otherwise (Ker, 2011). However, the program has recently been re-instated and is promoted by both the provincial government and Melbourne's municipal government (Victoria State Government, 2020).

Today, the city of Melbourne encourages residents to "take the Target 155 pledge" to reduce water consumption to 155 litres per person per day, thereby reducing the city's overall water consumption. Melbourne's South East Water company claims that "right now, all it takes to help reach Target 155 is to each save less than a bucket of water a day" (South East Water, 2020a). Suggestions provided by the city's website to reduce water consumption include taking showers that are one minute shorter than usual, getting leaks fixed, and scraping plates before placing them in the dishwasher, as opposed to rinsing them (Victoria State Government, 2019). The program also encourages water users to read their water utility bill, which informs customers whether they are meeting Target 155 or not and compares their water consumption to that of their neighbours (Victoria State Government, 2020; Rowley, 2016).

Management Profile

Melbourne Water, the water wholesaler owned by the State of Victoria, provides water to the city through the following three retail distributors: City West Water, Yarra Valley Water, and South East Water (Melbourne's Water Outlook, 2019). Each retailer provides water to citizens in different areas of the city (Melbourne's Water Outlook, 2019). Melbourne Water also supplies water to the rural areas outside of Melbourne, and to water suppliers in Melbourne's outer regions: Barwon Water, Gippsland Water, South Gippsland Water, Western Water and Westernport Water (Melbourne's Water Outlook, 2019).

The ownership and management of Melbourne's water catchments locations can be broken into the following four categories: 90,800 hectares are located in national parks, protected by Melbourne Water and Victoria Parks (both are state-owned entities); 56,300 are located in state forests, managed by Victoria State's Department of Environment, Land, Water, and Planning; 7,500 hectares are owned and managed by Melbourne Water Corporation; and 2,100 hectares are on private land (Melbourne Water, 2020a).

During the Millennium Drought, the state government decided to build a new desalination plant in order to create a buffer for water storage levels and reduce reliance on Melbourne's reservoirs (Melbourne Water, 2020c). The plant removes "dissolved salts from seawater" using reverse osmosis technologies (Melbourne Water, 2020c). The water from the plant is distributed through an 84-kilometre-long pipeline (Melbourne Water, 2020c). Notably, the plant runs on 100 percent renewable energy and has a biodegradable roof topped with native plant species (Water Technology, 2020). Victoria's desalination plant is responsible for keeping Melbourne's water storage levels about eight percent higher than they would be otherwise (Melbourne Water, 2020c; Melbourne's Water Outlook, 2019).

However, there is some controversy around the privatization of Victoria's desalination plant. The plant's contract was written as a public-private partnership between the state's Department of Environment, Land, Water, and Planning and the operator of the plant, a consortium called Aquasure (Water Technology, 2020). The consortium comprises three companies: a German mining company called Theiss; an Australian financial services and investment company called Macquarie Capital; and a French water treatment company called Degrémont (Water Technology, 2020). The plant cost $4.5B to build and costs over half a million dollars per year to maintain and operate (Rowley, 2016; Poposki, 2018).

**Discussion**

The threats to water security in Melbourne emanate from both present-day and historical factors. These factors include the dispossession of the environment from the Aboriginal people who initially presided and maintained the land through a distinct cultural lens; followed by the destruction, conversion and minimisation of water in its natural forms and ecosystems overall to make way for population and urban expansion; and the execution of these processes based on frameworks developed in and for external places (Brown et al., 2009; Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). Centuries later, authorities have not diverted from or rectified many of these practices in the strategy they have adopted to tackle mounting water security concerns. Instead, government approaches have constituted the perpetuation of the status quo. While Melbourne's strategy has included some demand side interventions, such as permanent water saving rules and campaigns such as Target 155, one study found that the city's senior water managers viewed these measures as secondary to supply side interventions, such as the Victoria desalination plant, which increase access to supply without requiring a departure from the urban water management system currently in place (Werbeloff & Brown, 2011a; 2011b). This approach fails to adequately consider potential negative consequences to the environment from

reliance on desalination, such as pollution of the ocean, and degradation of marine life habitats, and significant energy consumption (Gies, 2019).

The study mentioned above found some water managers in Melbourne appear to view the desalination plant as the "silver bullet" solution to water security, in direct contradiction with the concept of security through diversity, which promotes moving away from the traditional approach of relying on singular infrastructure solutions to ensure water security (Werbeloff & Brown, 2011a). The Victoria Government's website claims that "with rainfall and streamflow trends suggesting less water will be available from surface water sources in the future, we will increasingly use desalinated water to maintain water supply resilience" (Victoria State Government, 2019). While the desalination plant does keep water storage levels eight percent higher than they would otherwise be, and provided 125 billion litres of water to Melbourne in 2019-20, relying on desalination alone is not a sufficient solution to Melbourne's water security issues (Melbourne's Water Outlook, 2019; Victoria State Government, 2019). Further, although initiatives such as the Target 155 program and permanent water saving rules have significantly reduced water consumption in Melbourne (Low et al., 2015), it is possible that residents are only willing (or able) to reduce their water consumption to a certain point before having to change their lifestyles significantly. Thus, although residential water usage is responsible for over half of Melbourne's water consumption, relying on voluntary residential demand-side reductions in consumption is potentially not a strong enough solution to Melbourne's water concerns, particularly as the population continues to grow. Severe water restrictions and monitoring would inevitably have to be implemented eventually.

Notably, the state owns Melbourne's water wholesaler, and seems to control a great deal of the efforts to reduce water in Melbourne rather than the city itself. This approach is effective because it ensures regulations apply to a broader range of people whose water resources are connected. However, given that 75 percent of the state's citizens reside in Greater Melbourne, it seems like the city should play a stronger role in water resources management (World Population Review, 2020). While the city is making progress on improving flood mitigation measures, it fails to outline explicit targets to achieve Sustainable Development Goal 6 (City of Melbourne, 2017). Further, both the city and the state place an over-reliance on supply measures, such as the desalination plant, considering demand initiatives to be secondary (Werbeloff & Brown, 2011a). Additionally, while the city's 2016 Future Melbourne 2026 report does give consideration to including Aboriginal peoples in land management, it fails to include any mention of Aboriginal authority over water management and failed to seek Indigenous inclusion during its public engagement phase. Further, questions arise around desalination, and whose interests the Wonthaggi plant serves, given that it is partly owned by three foreign multi-national companies (Water Technology, 2020). It is worth considering whether these companies have the best interests of the public, the environment, and Indigenous groups in mind. Without a direct line of communication to the citizen of Melbourne, it seems likely these companies are largely not engaged with the concerns of the public around water security. Thus, the city should consider creating a direct channel for which Indigenous and environmental stakeholders, as well as the public, can communicate concerns directly to not only the municipal and state governments regarding water management measures as a whole, but also to the companies that own and operate the Wonthaggi desalination plant. This approach would ensure greater accountability and would amplify local voices, allowing them to be heard by those in control of the plant. Therefore, to reflect more accurately the principle of diversification, the city should address the centralised nature of the urban water management system on which it depends to tackle the threats posed to water security, by including a broader range of stakeholders in the process, particularly, Indigenous people, and creating means for direct communications between them and

decision-makers, such as the consortium of foreign companies that own a major share of the Wonthaggi desalination plant.

This inclusion is extremely important, as Indigenous people constituted the first people to preside over the area, and held a particular cultural lens through which they perceived water and land which allowed them to rely upon these resources for tens of thousands of years (Ives et al., 2013; Oakley & Johnson, 2013; Presland, 2014). This Indigenous cultural lens persists in Melbourne today among Traditional Owner Groups, for example, who preserve it through activities and initiatives centred on promoting Indigenous cultural heritage within the modern-day context. Such groups could be very helpful in transforming Melbourne's approach to urban water management, by providing valuable insight to decision-making processes. Additionally, and more importantly, doing so would arguably be an important step toward reconciliation, especially considering the reality of certain Aboriginal people in remote localities today, who lack access to water (Hall, 2018). Granting these groups management rights over water resources could help make way for this unequal distribution of water resources to be addressed more concretely and urgently.

In addition, the inclusion of other community and environmental stakeholders in the urban water management system could also help the city better embody diversification in its strategy, and thus allow the city to better mitigate the urgent threats to water security that its facing. The contribution of such actors is highly important, as they advocate for doing things differently, according to what is in the best interest of their communities and nature (see, e.g., Brown et al., 2009 p. 853). Their inclusion in decision-making processes relating to water resources, therefore, could arguably help hold Melbourne's current water managers accountable and lead to the management of water resources in ways that demonstrate consideration for the wellbeing of all people and the environment.

**Conclusion and Recommendations**

To manage growing water security pressures, all three levels of government have promoted a security through diversity approach in Melbourne (Werbeloff & Brown, 2011a). However, the city's approach reveals significant limitations when juxtaposed with the idea of attaining security (Werbeloff & Brown, 2011). This is due to the methods inherent to the approach, constituting a perpetuation of the status quo, and as such, of insecurity. These methods include the enactment of guidelines and restrictions to reduce residential and industrial consumption; the sensitisation of residents to foster compliance; and the implementation of sea water desalination to broaden sourcing (Melbourne Water, 2020; Sousa et al., 2016; Werbeloff & Brown, 2011). Contrary to the principles of the security through diversity approach, researchers have found that senior water management officials have placed high importance on supply interventions, such as the Victoria desalination plant, which increases Melbourne's annual water supply by only eight percent (Werbloff & Brown, 2011a; Rowley, 2016). Desalination is considered of central importance by city water managers, as it vastly expands stock availability without requiring a shift away from the system already in place. That is, a shift away from the vested interests the said system incorporates (Werbeloff & Brown, 2011).

However, questions regarding the potential adverse effects of desalination aside, Melbourne's strategy is not a sustainable approach to urban water management due to existing limitations within the system it relies on. These comprise the following: the centralised nature of the system, which means it is untailored to local needs; its datedness, which means it precedes the emergence of present social and environmental challenges; its restricted adaptive capacity, which enabled the emergence of the present water related vulnerabilities; and its lack of inclusivity, which left arguably important stakeholders, such as Indigenous,

community and environmental actors unable to contribute to management processes (Presland, 2014; Sousa et al., 2016; Werbeloff & Brown, 2011). If Melbourne is to be able to respond more effectively to the rapidly increasing pressures of a drying climate and an expanding population, the city's urban water management scheme will need to be reconfigured. Authorities will need to take proactive steps toward creating more inclusive decision-making mechanisms, where voices from organised civil society bodies can be heard and have direct influence in the stewardship of local water resources. Specifically, this process can be launched through seeking the targeted participation of Aboriginal, community, and environmental actors through creating spaces that facilitate and encourage discussion and collaboration such as town halls, public events, and online forums regarding the development of strategies for water security. The city should also consider creating communication channels between water resource stakeholders, including Aboriginal communities, and the consortium of foreign companies that own a large portion of the Wonthaggi desalination plant. Ultimately, creating spaces and means for meaningful inclusion of community, environmental and Indigenous groups in decision-making processes, such as granting Indigenous groups water management rights, would enable Melbourne to achieve more sustainable solutions to addressing water security, while also addressing the shortcomings of its current urban water management system.

**References**

Australian Bureau of Statistics (ABS). (2020, March 25). *Regional Population Growth, Australia, 2018-19.* https://www.abs.gov.au/ausstats/abs@.nsf/mf/3218.0

Barry, M. E., & Coombes, P. J. (2018). Planning resilient water resources and communities: The need for a bottom-up systems approach. *Australasian Journal of Water Resources, 22*(2), 113-136. doi:10.1080/13241583.2018.1497125

Brown, R. R., Keath, N., & Wong, T. H. F. (2009). Urban water management in cities: Historical, current and future regimes. *Water Science and Technology: A Journal of the International Association on Water Pollution Research, 59*(5), 847-855. doi:10.2166/wst.2009.029

Bunurong Land Council Aboriginal Corporation. (n.d.). Retrieved from https://www.bunuronglc.org/

C40 Cities. (2013, April 2). *Melbourne Certified as Carbon Neutral City*. https://www.c40.org/blog_posts/melbourne-certified-as-carbon-neutral-city

City of Melbourne. (2014). *Total Watermark – City as a Catchment.* https://www.melbourne.vic.gov.au/SiteCollectionDocuments/total-watermark-update-2014.pdf

City of Melbourne. (2016). *Future Melbourne 2026.* https://www.melbourne.vic.gov.au/SiteCollectionDocuments/future-melbourne-2026-plan.pdf

City of Melbourne. (2017). *Municipal Integrated Water Management Plan*. https://www.melbourne.vic.gov.au/SiteCollectionDocuments/municipal-integrated-water-management-plan-2017.pdf

Cook, C. & Bakker, K. (2011). Water security: Debating an emerging paradigm. *Global Environmental Change 22*: 1. https://doi.org/10.1016/j.gloenvcha.2011.10.011

Cox, Henry L. (Henry Laird) & Bourchier, Thomas & McHugh, P. H & Great Britain. Hydrographic Department (1866). Victoria-Australia, Port Phillip. Hobson Bay and River Yarra leading to Melbourne ([1866 ed.]). Published by the Admiralty, London.

Friends of the Earth Melbourne. (n.d.). Retrieved from https://www.melbournefoe.org.au

Gies, E. (2019, February 7). Slaking the World's Thirst with Seawater Dumps Toxic Brine in Oceans. *Scientific American*. https://www.scientificamerican.com/article/slaking-the-worlds-thirst-with-seawater-dumps-toxic-brine-in-oceans/

Global Water Partnership (GWP). (n.d.). *Dublin-Rio Principles*. https://www.gwp.org/contentassets/05190d0c938f47d1b254d6606ec6bb04/dublin-rio-principles.pdf

Hall, N. (2018). Australian Indigenous remote communities and water, sanitation and hygiene. *Water Source*. https://watersource.awa.asn.au/publications/technical-papers/australian-indigenous-remote-communities-and-water-sanitation-and-hygiene/

Heggie, J. (2019). Failing Rains and Thirsty Cities: Australia's Growing Water Problem. *National Geographic.* https://www.nationalgeographic.com/environment/2019/08/partner-content-australia-water-problem/

Ibis*World*. (n.d). Melbourne Water Corporation - Premium Company Report Australia. https://www.ibisworld.com.au/australian-company-research-reports/electricity-gas-water-waste-services/melbourne-water-corporation-company.html

Ives, C. D., Beilin, R., Gordon, A., Kendal, D., Hahs, A. K., & Mcdonnell, M. J. (2013). Local assessment of melbourne: The biodiversity and social-ecological dynamics of melbourne, australia. In T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, . . . M. Schewenius (Eds.), *Urbanization, biodiversity and ecosystem services: Challenges 385 and opportunities: A global assessment*. Springer Netherlands. doi:10.1007/978-94-007-7088-1_20 Retrieved from https://www.openaire.eu/search?q=&Search=

Ker, P. (2011, March 3). Dumped Target 155 water scheme 'was working'. *The Sydney Morning Herald.* https://www.smh.com.au/environment/sustainability/dumped-target-155-water-scheme-was-working-20110302-1bewe.html

Low, K., Grant, S., Hamilton, A., Gan, K., Saphores, J., Arora, M., & Feldman, D. (2015). Fighting drought with innovation: Melbourne's response to the Millennium Drought in Southeast Australia. *WIREs Water*. doi: 10.1002/wat2.1087

Melbourne's Water Outlook 2020. (2019, November 29). https://media-2.yvw.com.au/inline-files/ANNUAL%20WATER%20OUTLOOK%202020_long%20version_Final.pdf

Melbourne Water. (2020a, March 31). *Water catchments*.

https://www.melbournewater.com.au/community-and-education/about-our-water/why-melbournes-water-tastes-great-tap/water-catchments

Melbourne Water. (2020b, March 31). *Water storage reservoirs.* https://www.melbournewater.com.au/community-and-education/about-our-water/why-melbournes-water-tastes-great-tap/water-storage

Melbourne Water. (2020c, April 16). *Desalination*. https://www.melbournewater.com.au/water/securing-our-water-supply/how-water-sector-taking-action/desalination

Melbourne Water. (2020d, February 15). *Our Water Supply Challenges.* https://www.melbournewater.com.au/water/securing-our-water-supply/our-water-supply-challenges

Melbourne Water. (2020e, March 28). *Silvan Reservoir.* https://www.melbournewater.com.au/community-and-education/about-our-water/why-melbournes-water-tastes-great-tap/water-storage/silvan

Moran, A. (2008). *Water supply options for Melbourne: An examination of costs and availabilities of new water supply sources for Melbourne and other urban areas in Victoria.* Melbourne: Retrieved from https://www.parliament.vic.gov.au/images/stories/committees/enrc/future_water_supply/Submissions_57_110/098_Institute_of_Public_Affairs.pdf

O'Bryan, K. (2017). More aqua nullius? The Traditional Owner Settlement Act 2010 and the neglect of indigenous rights to manage inland water resources. (Australia, Victoria). *Melbourne University Law Review*, *40*(2), 547-593. https://heinonline.org/HOL/Page?lname=&public=false&collection=journals&handle=hein.journals/mulr40&men_hide=false&men_tab=toc&kind=&page=547

Oakley, S., & Johnson, L. (2013). Place-taking and place-making in waterfront renewal, Australia. *Urban Studies, 50*(2), 341-355. doi:10.1177/0042098012452328

Poposki, C. (2020, May 20). Melbourne desalination plant costs tax-payers an eye-watering $649 million in annual operating charges. *Daily Mail Australia*. https://www.dailymail.co.uk/news/article-5749621/Melbourne-desalination-plant-costs-tax-payers-eye-watering-649-million-year-operate.html

Presland, G. (2014). A boggy question: Differing views of wetlands in 19th century Melbourne. Paper presented at the doi:10.25916/5C26C90A6AA85 Retrieved from https://search.datacite.org/works/10.25916/5C26C90A6AA85

Rowley, S. (2016, November 1). Australia's Lesson for a Thirsty California. *The New York Times.* https://www.nytimes.com/2016/11/01/opinion/australias-lesson-for-a-thirsty-california.html

Sousa Júnior, W., Baldwin, C., Camkin, J., Fidelman, P., Silva, O., Neto, S., & Smith, T. (2016). Water: Drought, crisis and governance in Australia and Brazil. *Water, 8*(11), 493. doi:10.3390/w8110493

South East Water. (2020a). *Target 155 to make every drop count*. https://southeastwater.com.au/CurrentProjects/Programs/Pages/Target155.aspx

South East Water. (2020b). *Prices and charges.* https://southeastwater.com.au/Residential/Pages/WaterPricesCharges.aspx

State Government of Victoria. (2019a). The aboriginal water program. Retrieved from https://www.water.vic.gov.au/aboriginal-values/the-aboriginal-water-program

State Government of Victoria. (2019b). Formal recognition processes in Victoria. Retrieved from https://www.aboriginalvictoria.vic.gov.au/traditional-owner-formal-recognition-victoria/formal-recognition-processes-victoria

United Nations. (n.d.) *Sustainable Development Goals – Goal 6: Ensure access to water and sanitation for all.*
https://www.un.org/sustainabledevelopment/water-and-sanitation/

Victoria State Government. (2015). *Climate-ready Victoria - Greater Melbourne.* https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0019/60742/Greater-Melbourne.pdf

Victoria State Government. (2019). *Permanent water saving rules*. https://www.water.vic.gov.au/liveable/using-water-wisely/advice-and-rules/permanent-water-saving-rules

Victoria State Government. (2020, January 16). *Target 155*. https://www.water.vic.gov.au/liveable/using-water-wisely/target-155-target-your-water-use

Water Technology. (2020). Wonthaggi Desalination Plant. https://www.water-technology.net/projects/wonthaggidesalinatio/

Werbeloff, L., & Brown, R. (2011a). Security through diversity: Moving from rhetoric to practice. *Water Science and Technology,* 64(4), 781-788. doi:10.2166/wst.2011.495

Werbeloff, L., & Brown, R. (2011b). Working towards sustainable urban water management: The vulnerability blind spot. *Water Science and Technology, 64*(12), 2362-2369. doi:10.2166/wst.2011.774

World Population Review. (2020). *Victoria Population 2020*. https://worldpopulationreview.com/territories/victoria-population/

Watershed Victoria. (2008). Watershed victoria. Retrieved from http://www.watershedvictoria.org.au/content/

Wurundjeri Woi Wurrung Cultural Heritage Aboriginal Corporation. (n.d.). Retrieved from https://www.wurundjeri.com.au/