Transferring Lessons from Australia's Millennium Drought to California:

Accelerating Adaptation to Drought, Flood & Heat

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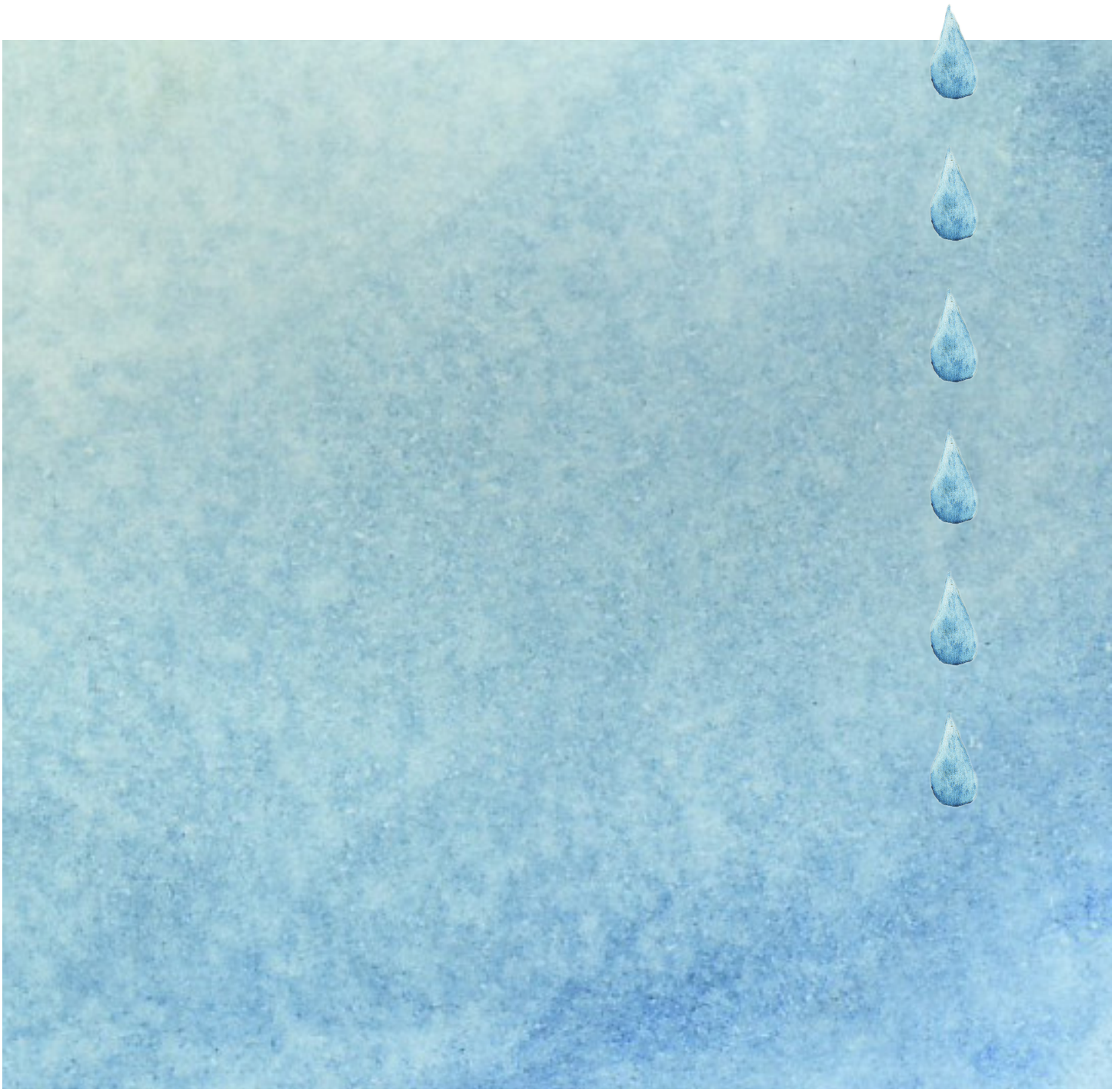

TREEPEOPLE

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TreePeople's mission is to inspire, engage and support people to take personal responsibility for the urban environment, making it safe, healthy, fun and sustainable and to share the process as a model for the world.

Transferring Lessons from Australia's Millennium Drought to California:

Accelerating Adaptation to Drought, Flood & Heat

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Generating Capital for Communities Through Energy

Contents

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Executive Summary

Australia experienced the devastating "Millennium Drought" from 1997 to 2010, a period that brought the longest stretch of rainfall deficit on record. Four years in, their drought was similar to California's current one: overwhelming and destructive to both ecology and the economy. Australia responded in numerous ways. They overhauled their existing water governance framework with long-term structural changes, and implemented a host of water-management solutions, ranging from comprehensive water conservation programs to desalination facilities. Some of these solutions worked and helped Australia make efficient use of their dwindling water supplies. Others proved challenging, with growing costs and lengthy construction times rendering the benefits associated with extra water supplies negligible.

The two regions of the world share many climatic, socioeconomic and demographic characteristics that lend themselves to meaningful exchanges of knowledge and innovations. With the benefit of Australia's documented experiences, California can learn what solutions worked and did not work in Australia, potentially avoiding major pitfalls. While some changes in California are already underway, many opportunities – and challenges – still remain. Our state's policymakers and residents can adopt and adapt the most fitting solutions from Australia's experience. We can use these to appropriately and effectively respond to the extremes of our long-term water and climate crises. In doing so, we will put California on a better path towards water and climate resilience as we navigate the challenges of drought, flood and extreme heat forecast to increase in our future.

Recognizing the tremendous value of learning from Australia's experience, TreePeople has been leading research and facilitating an information exchange focusing on technologies, policies and programmatic efforts between Australia and California since 2012. TreePeople began the work with a study tour and findings report, documenting more than 40 meetings, presentations and tours in Australia's five largest cities.[1] Staff met with local, state and federal government officials, research institutions, utilities, engineering firms and nongovernmental organizations, identifying viable solutions to California's water and climate challenges.

As part of this ongoing initiative, in October 2014, TreePeople and The Energy Coalition co-organized and co-led a delegation of policymakers and elected officials from throughout California (including representatives from the federal, state, regional and local levels) to the Australian cities of Melbourne and Adelaide. These cities implemented innovative water management solutions during the Millennium Drought that helped to drought-proof their respective water supplies and increase water- and climate-resilience in anticipation of a changing climate. The goals of this delegation were to show California water leaders first-hand the drought and climate response initiatives that Adelaide and Melbourne employed during their drought and to focus on transferring and implementing viable approaches – for immediate and longer-term application – to California.

[1] The 2012 study tour report is available at www.treepeople.org/resources/publications.

An analysis of these critical successes and challenges is integral to understanding how California can not only address its current drought, but also lead the state forward on a better, more water- and climate-resilient path. Through these applied lessons, California can lead the nation in transforming how water is managed and demonstrate a viable suite of alternatives to conventional approaches – from optimizing efficiency and fostering sustainable behaviors in California's nearly 40 million residents, to developing alternative water sources, to enhancing and restoring natural processes toward a resilient future.

Several lessons were gleaned from studying the water and climate crisis strategies employed in Adelaide and Melbourne, and numerous policy recommendations were identified that California can use to address its current challenges. As California grapples with its fifth year of drought, progress is underway in some areas – but much more must be done to put the state on a viable path to water and climate resilience.

Lessons Learned:

1. *Drought urgency represents a unique opportunity to reshape water management strategies and requires swift, smart actions.*

If Melbourne had not acted during Australia's 12-year drought to aggressively pursue water conservation, storage reservoirs would have run dry by July 1, 2009. At that time, the City's stream flows plummeted, and for the first time in their history, did not rebound with expected precipitation. This cautionary tale stresses the importance of:

- Implementing drought-response strategies early on during a drought; and
- Not relying on historical records to predict the severity of future periods of water scarcity.

Further, the Millennium Drought showed that water managers and policymakers can successfully harness public and political will to institute drastic changes during times of water scarcity. Melbourne and Adelaide were able to leverage the drought to implement significant supply and demand-side reforms that would have proven difficult during normal precipitation years. Given that California is now experiencing a strong El Niño season after an extended dry period, the state will have to work hard to ensure that the reality of continued drought is not dismissed, and the opportunity to implement these changes is not squandered.

2. *The whole-of-water-cycle[2] approach created a more efficient and effective water management system.*

Melbourne restructured its water management framework multiple times to improve efficiencies in urban water management and increase collaboration among urban planning, public health, industry and natural resource management entities. Community-level engagement was used to identify and prioritize supply and demand-side water management options. Even after the drought ended, the state of Victoria continued to institute new collaborative governance structures involving the public and water management authorities to develop projects that maximized shared benefits.

[2] Whole-of-water-cycle planning is a multi-disciplinary, fully collaborative structure by agreement of agency leaders to provide effective coordination across all agencies that have a role in the water cycle, which includes planning, energy, transportation, and others.

In contrast, it can be difficult to future-proof and ensure the long-term viability of projects and programs unless a holistic approach is taken, in which multiple benefits are incorporated into design and implementation. In an era of increasing scrutiny over public investments, single-benefit infrastructure faces challenges in garnering popular and political support, as such investments are often costly and can be rendered obsolete by changing conditions. Desalinated water, for instance, is energy-intensive and therefore significantly more expensive to produce than traditional sources. In 2010, with the return of heavy rains, dam levels throughout Southeast Australia rose, restoring the water supply that most Australians historically depended on. With the loss of demand for more expensive desalinated water, the desalination plants built for drought-response in Sydney and Melbourne went idle, except as necessary to maintain their condition as operational.

A whole-of-water-cycle approach can help ensure that issues arising out of single-purpose investments are avoided or minimized. However, to facilitate a robust future for this approach, a common framework for quantifying costs and benefits to various agencies and stakeholders still needs to be developed – for both Australia and California.

3. Decentralized water sources can increase and accelerate water system resilience.

Adelaide and Melbourne employed a mix of decentralized strategies including wastewater recycling, managed aquifer recharge, rainwater harvesting and stormwater capture during and after the drought. These short- and longer-term strategies augmented and accelerated the development of water supplies, providing a diverse mix that reduced dependence on any single source. These diversified supplies ensured that public green spaces would be irrigated with non-potable, fit-for-purpose[3] water, helping reduce the cost and strain on potable water supplies during times of water scarcity. In many cases, these decentralized water sources come online faster than larger, centralized projects.

4. Water scarcity issues are fundamentally tied to public health, safety and quality of life.

In the midst of the drought crisis, Australia focused almost exclusively on water supply. Hindsight brought the realization that livability and quality of life issues should not be forgotten in times of drought. As predicted by climatologists, severe heat kicked in, with urban temperatures sometimes rising above 115⁰ F (46⁰ C) and heat waves lasting for several days. At the same time, in order to save water, vegetation in public open spaces was allowed to turn brown and dry, resulting in the loss of cherished recreation, shade and ecosystem services. Trees began to die in large numbers, and negative impacts befell both public health and quality of life as Australians could no longer recreate in parks and fields that turned to dust from heat and lack of water.

Without the ecosystem services provided through the shade and evaporative cooling of leafy tree canopies, the urban heat island[4] intensified, and at times, became lethal. In 2009, Melbourne experienced a 62% in increase heat-related mortality, prompting the city to rethink the way drought restrictions impact public green space.[i] Public health researchers determined the best way to protect lives in times of extreme heat is to ensure everyone lives in a community with dense tree canopy. After the drought ended, Melbourne set a goal to double its tree canopy to 40 percent to reduce peak

[3] Fit-for-purpose water is water that is treated only to the level needed for its intended end use.
[4] The term "urban heat island" describes developed areas that are hotter than nearby less developed areas. Heat islands can affect communities by increasing peak energy demand, air conditioning costs, air pollution, greenhouse gas emissions, and heat-related illness and mortality.

temperatures by approximately 7⁰ F (4⁰ C). This goal is part of the City's climate adaptation plan, which also calls for keeping soil moisture at adequate levels to help cool urban temperatures, and for all new green spaces to be irrigated with non-potable, fit-for-purpose water from recycled water and stormwater harvesting projects.

5. Public behavior programs focused on water conservation were tremendously effective.

The Millennium Drought resulted in residents of Adelaide and Melbourne dramatically changing their behavior around water consumption. This was accomplished most effectively through a mixture of efforts focused on water restrictions, water pricing, public education, target-setting, rebates for water-saving technologies and developing new social norms. Daily per-capita water use was reduced substantially by residents of both Adelaide and Melbourne. In Melbourne, daily per capita demand started at 121 gal (458 L). By the end of the drought, Melbourne averaged 65 gal (246 L) per person per day for all land uses.[ii] For residential properties, Melbourne's per capita use dropped to about 40 gal (150 L) per day during the drought.

In 2003, Adelaideans were using 87 gal (330 L) per person per day. In 2009, toward the end of the drought, water demand averaged 60 gal (227 L) per person per day.[iii] This compares with the current (as of January 2016) average demand of 107 gal (405 L) per person per day for all land uses in the City of Los Angeles, as reported by the Los Angeles Department of Water and Power. This number, lower than previous averages, represents some progress thanks to conservation efforts at many levels due to the drought.

Today, Australia is employing numerous strategies to adapt to the increasingly common weather extremes brought by climate change. The country is using a two-pronged approach to adaptation: government agencies coordinate and collaborate to make policy and program changes, while residents and businesses participate through taking effective action. This strategy successfully led Australians through the most dire periods of drought, and is still helping the country become more climate-resilient while improving its economic strength.

This report will describe these lessons and draw policy recommendations to provide direction for how California and its cities can continue transitioning towards sustainability and water resilience in a future with a changing climate. Melbourne and Adelaide leveraged the drought to make critical changes to their water systems, making them world leaders in innovative water management and climate adaptation. California cities now have the same opportunity. We must act quickly to safeguard our water supply and ensure that policies will be in place to protect us from the vulnerabilities we face due to our state's outdated water management system.

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INTRODUCTION

AUSTRALIA AS A CASE STUDY AND ROAD MAP

Australia is the world's driest inhabited continent, and is heavily urbanized, with approximately 89 percent of the country's 21 million inhabitants living in urban areas. Ensuring that residents of Australian cities have access to water resources is an ongoing challenge, to which the country has dedicated an immense number of resources.

Australia shares several similarities with California that make the country an ideal case study and road map for analyzing drought and climate change response strategies. Both Australia and California: 1) enjoy a high standard of living and support similar lifestyles for their residents; 2) are subject to wet and dry seasons and consistent drought; 3) project increases in population for major metropolitan areas; and 4) have sufficiently similar governance systems to provide applicable models for change. However, while both Australia and Southern California have populations of around 21 million, a notable difference between the two regions is the geographic scale. Australia is 2.97 million sq mi (4.88 million sq km), approximately the size of the entire United States.

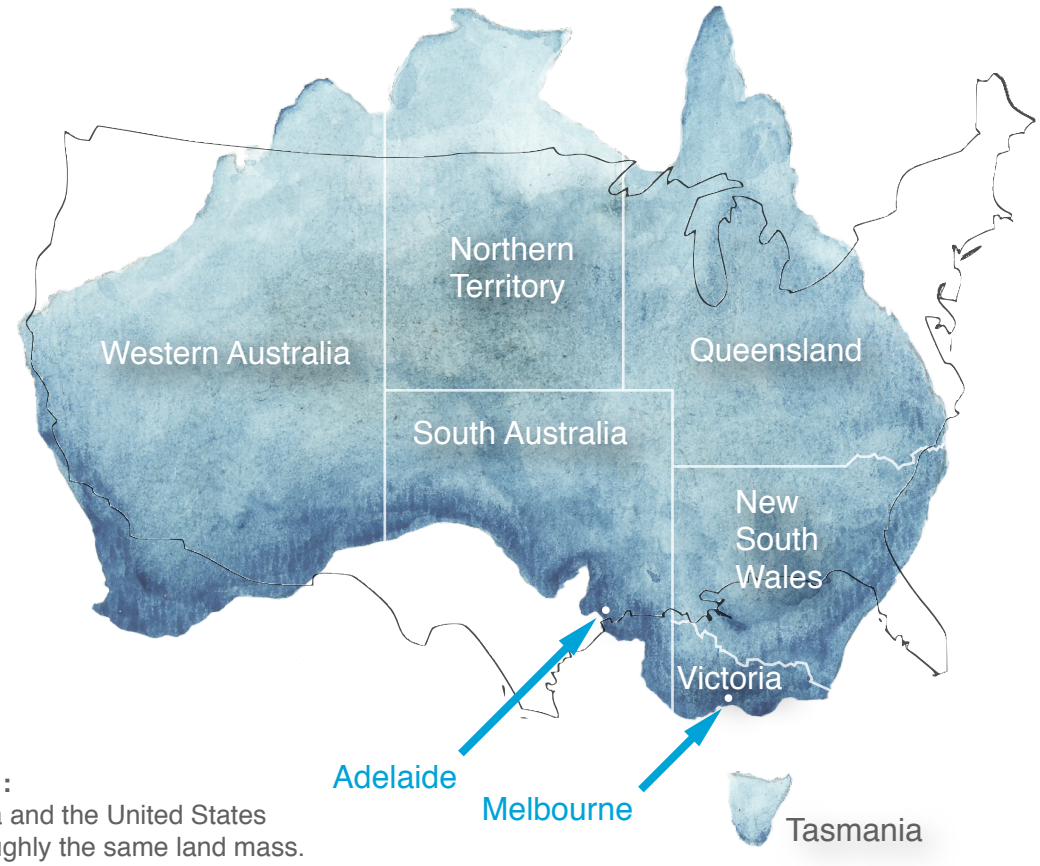

Figure 1:
Australia and the United States have roughly the same land mass. This report focuses on drought-response lessons that emerged in the cities of Adelaide and Melbourne.

The Australian cities of Melbourne and Adelaide offer particularly relevant examples of water- and climate-resilience strategies for California, and particularly for Southern California. The Millennium Drought greatly impacted both cities, and both were forced to reshape their water management strategies in response. Melbourne is located in the state of Victoria, in southeastern Australia, and has a moderate oceanic climate with average annual rainfall totaling approximately 25 in (635 mm) (see Figures 1 and 2). Adelaide is located in the state of South Australia and has a Mediterranean climate similar to that of much of California, with hot, dry summers and cool, wet winters (see Figure 2). Historic average annual rainfall is approximately 17 in (432 mm) in Adelaide. Of all of Australia's capital cities, Adelaide has a climate pattern and average annual precipitation that most closely approximates that of Los Angeles, with Los Angeles receiving an approximate annual rainfall average of 15 in (381 mm) (see Figure 2).

Figure 2: Average Annual Rainfall for Adelaide, Melbourne and Los Angeles.

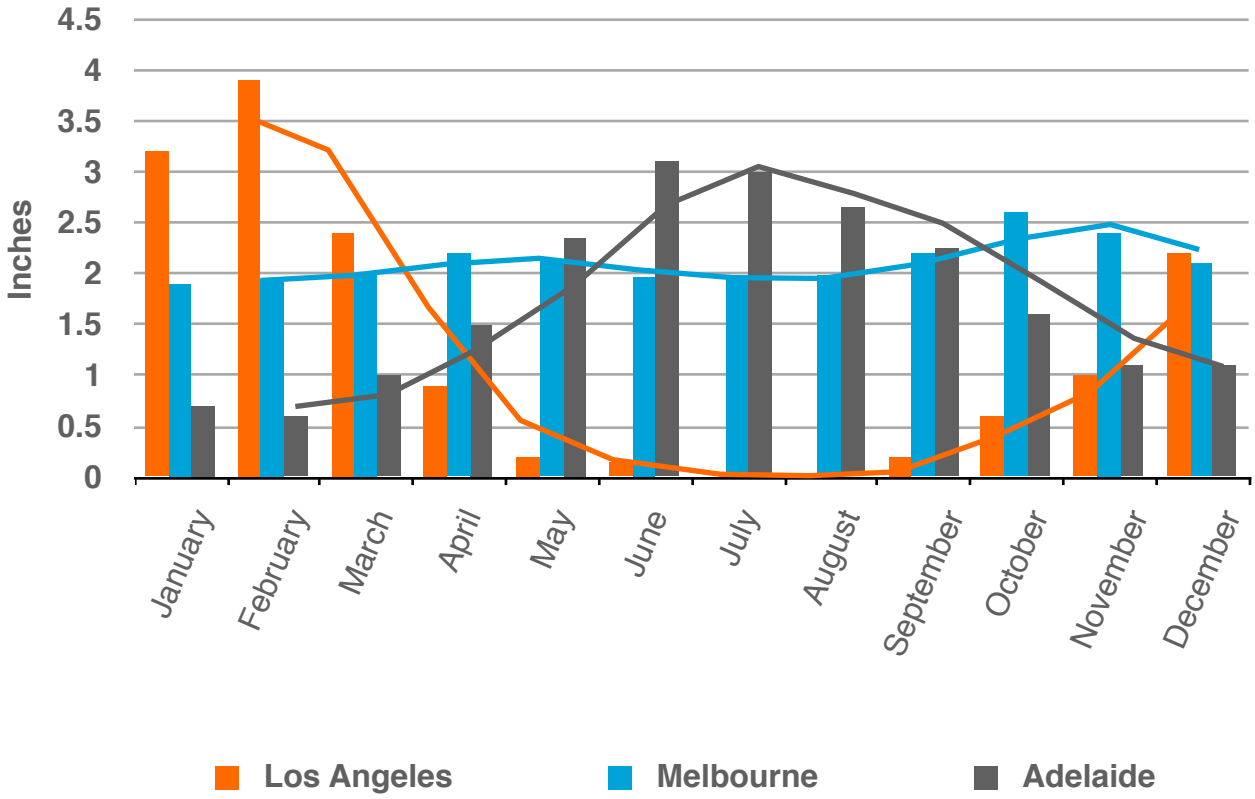

Figure 2 shows average monthly precipitation for the three cities. Australia is in the Southern Hemisphere and thus experiences seasons opposite to Los Angeles. Adelaide and Los Angeles are in Mediterranean climate zones and thus experience the wettest months in winter (June, July and August in Adelaide; December, January and February in Los Angeles). Adapted from data provided by Bureau of Meteorology.[iv]

In responding to the drought, Melbourne constructed both a new desalination facility and interbasin transfer pipeline, subsidized water-efficient appliances and fixtures, set aggressive targets related to the use of non-potable water (primarily for irrigating landscapes) and implemented a suite of demand-side interventions to drive down per-capita water use. Similarly, Adelaide constructed a desalination facility, implemented demand-side interventions and incentivized the use of non-potable water for irrigating landscapes. Additionally, Adelaide focused on employing decentralized managed aquifer recharge[5] projects at scale, allowing excess water to be stored in the winter and then used again in the summer.[6] Both cities implemented these drought-management strategies through collaborative water management frameworks that were restructured multiple times during the drought to increase efficiency.

TreePeople's History with Australia

TreePeople is a Los Angeles-based non-profit organization that was founded in 1973. The organization has a long history of advocating for systemic changes in the water management of California's cities and watersheds, and has over 20 years of experience demonstrating the cost-effectiveness of multi-agency, multi-purpose urban water infrastructure. It specializes in facilitating processes to bring agencies together with communities to plan, fund and implement these projects. TreePeople has organized projects with partners that demonstrate the feasibility of implementing decentralized green infrastructure at the individual parcel, school, park, street, neighborhood and watershed levels.

In 2012, TreePeople embarked upon an information and best practices exchange program between government, research and community organizations in Australia and Southern California that continues to this day. The program is aimed at sharing innovations, best practices and experiences related to community, business and government agency engagement in urban water management. A particular focus is on identifying successes, challenges and lessons learned from Australia's devastating Millennium Drought. The 12-year drought profoundly impacted the way Australia manages its water supply, and offers critical guidance in helping prepare California to develop and implement a sustainable approach to meeting water needs in the face of its looming long-term water crisis.

Research is a major element of this exchange program. TreePeople staff took two research trips to Australia in 2012 and met with water management and planning entities in Australia's five largest cities. Lessons from these trips were compiled in a study tour report, *Lessons from the Land of Oz for the American Southwest: Australia's Response to its Millennium Drought*.[7] The 2012 study tour report highlights data that were collected on innovations and experiences related to urban water conservation, rainwater harvesting and other drought responses.

[5] Managed Aquifer Recharge is the process of adding a water source (such as stormwater or recycled water) to aquifers under controlled conditions for withdrawal at a later date.
[6] Adelaide has extensive aquifers that allow for managed aquifer recharge projects; Melbourne does not.
[7] https://www.treepeople.org/resources/publications.

POLICY DELEGATION TO AUSTRALIA

In October 2014, TreePeople and The Energy Coalition co-organized and co-led a delegation of policymakers and elected officials from throughout California (including representatives from the federal, state, regional and local levels) to visit Australia on a quest for solutions to ensure urban water and climate resilience in the face of drought and climate change (see Appendix C for a list of delegates). From prior research trips, TreePeople had learned that some Australian strategies – such as water restrictions, decentralized stormwater and rainwater capture systems, tiered water pricing and collaborative governance – worked well and helped Australian cities and states maximize their limited water resources during the drought. Other strategies – such as desalination facilities and interbasin transfer pipelines – did not work as well, as lengthy construction periods yielded water supply benefits only *after* the drought had ended, leaving taxpayers to foot the bill. The aim of the delegation was to identify viable approaches for application to California to address the state's immediate drought emergency, as well as help to solve the long-term water crisis.

The range of drought-response strategies offered by Melbourne and Adelaide made these two cities ideal to highlight for California during the policy delegation. At the most general level, Melbourne offered lessons related to: 1) collaborative water governance; 2) scaled stormwater capture and wastewater reuse; 3) behavior change around water conservation; and 4) a cautionary tale around desalination. Adelaide offers lessons related to: a) Managed Aquifer Recharge; and b) scaled rainwater harvesting in a Mediterranean climate.

The Policy Delegation Tour emphasized each city's lessons with the hope that they be modified and applied rapidly as viable drought-response strategies in California.

Policy delegation visiting The Watershed Cafe, part of The Watershed Function Centre, in the outskirts of Adelaide, South Australia.

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Findings And Results

Lessons Learned

1. *Drought urgency represents a unique opportunity to reshape water management strategies and requires swift, smart actions.*

Australia's experience shows that it is impossible to rely on historical records to predict when a drought will end. Prior to the Millennium Drought, the City of Melbourne had been historically able to meet water demand since the mid-1800s with its four reservoirs and source water protection program. However, given climate change and human disturbance in river basins, the Australian government agencies realized that they could no longer count on history to predict the future.

For example, if Melbourne had not acted during the 12-year drought to aggressively pursue water conservation, their storage reservoirs would have run dry by July 1, 2009 (see Figures 3 and 4). This cautionary tale stresses the importance of: a) implementing drought-response strategies early on during a given drought and b) not relying on historical records to predict the severity of future water scarcity events. Deferring hard decisions – like implementing robust behavior change programs and decentralized water infrastructure strategies – leads to more difficult decisions and costly options over time. Because behavior change strategies and decentralized water infrastructure can have long incubation times and require a sustained level of commitment, it is important to act rapidly to implement these programs early on during periods of water scarcity.

Figure 3: Melbourne's Water Supply With and Without Water Conservation Measures.[v]

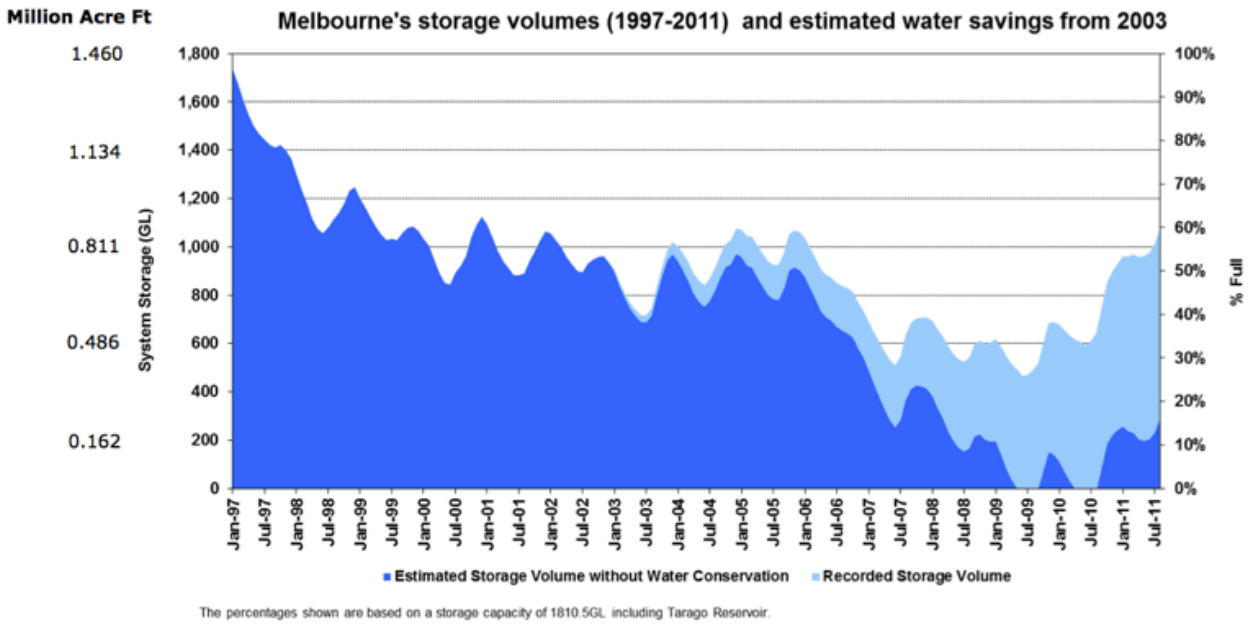
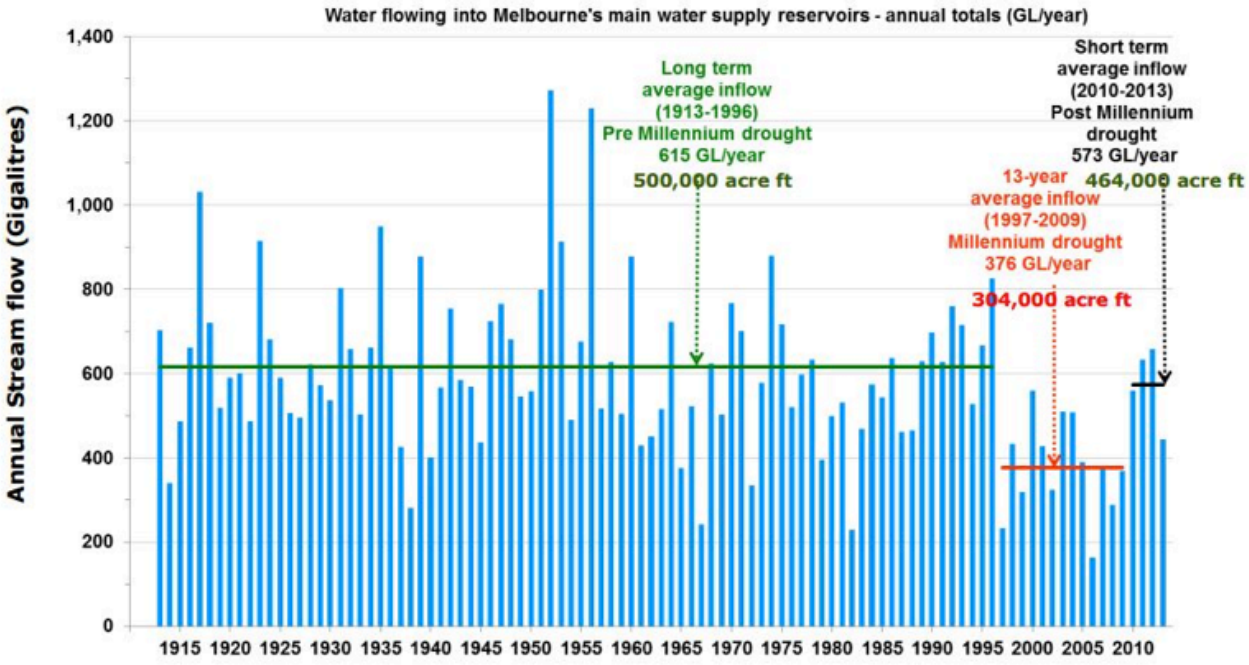


Figure 4: Annual flows into Melbourne's main water supply reservoirs.[vi]



The Millennium Drought also showed that the public and political will is receptive to large changes in water policy during times of water scarcity. As such, policymakers and planners must recognize and leverage the opportunities created by public engagement and concern. Searing images of Melbourne's dried-up storage reservoirs galvanized the public to embrace water conservation measures, and allowed the Victorian Government to implement a number of changes, including:

- Improving water use efficiency through rebates on water saving fixtures and appliances
- Instituting tiered pricing structures to more accurately reflect the value of water
- Effectively restricting water use in accordance with water restriction plans
- Setting aggressive per-capita water consumption targets
- Pursuing the reuse of wastewater and capture of stormwater at scale
- Building a desalination facility and interbasin transfer pipeline.

While Melbourne's desalination facility and interbasin transfer pipeline were largely mothballed due to high energy costs and the drought ending before they became operational, they provided a critical safety net that empowered the government to adopt the progressive Living Melbourne, Living Victoria initiative in 2011. This initiative (which has since been absorbed by the Department of Environment, Land, Water and Planning) is transforming the way urban water is managed in Victoria and provides critical funding for whole-of-water-cycle projects and decentralized infrastructure.

2. *Whole-of-water-cycle planning is effective and facilitates projects and programs with multiple benefits.*[8]

Collaborative Approach to Water Governance

During and after the Millennium Drought, both Adelaide and Melbourne restructured water management frameworks multiple times to better facilitate urban water management and increase collaboration among urban planning, public health, industry and natural resource management. Community-level engagement was used to identify and prioritize supply and demand-side water management options. Involving the public and water management authorities helped develop projects that maximize shared benefits.

Options included reducing household water use, incorporating plans for using low-quality treated rainwater for non-potable needs, and capturing stormwater runoff through biofiltration and recycling wastewater. This process encouraged grassroots collaboration among stakeholders, enhanced social learning among the public regarding the severity of the drought, and helped generate a broad public consensus, which, in turn, empowered city officials to embrace a wide and diverse array of vetted strategies.[vii]

In particular, Melbourne is setting an example of how to drive transformational change across the region's urban water management framework. After the Millennium Drought, the City of Melbourne began closely collaborating with water agencies, stakeholders and the wider community in order to transition to a whole-of-water-cycle approach. This approach strives to holistically manage the entire water system via agreements between agencies with roles in the water cycle. It aims to ensure that actions taken consider the interconnectedness between elements of the urban water cycle – related to water supply, wastewater, rainwater, stormwater, roads, waterways and open space – to achieve shared benefits. Melbourne's governance and decision-making involves many different stakeholders and agencies and operates across a range of geographical scales and timelines. For example, in the whole-of-water-cycle framework established through the Living Melbourne, Living Victoria initiative, a broad group of stakeholders sits on a governing body and interfaces with all partners involved in a given project.

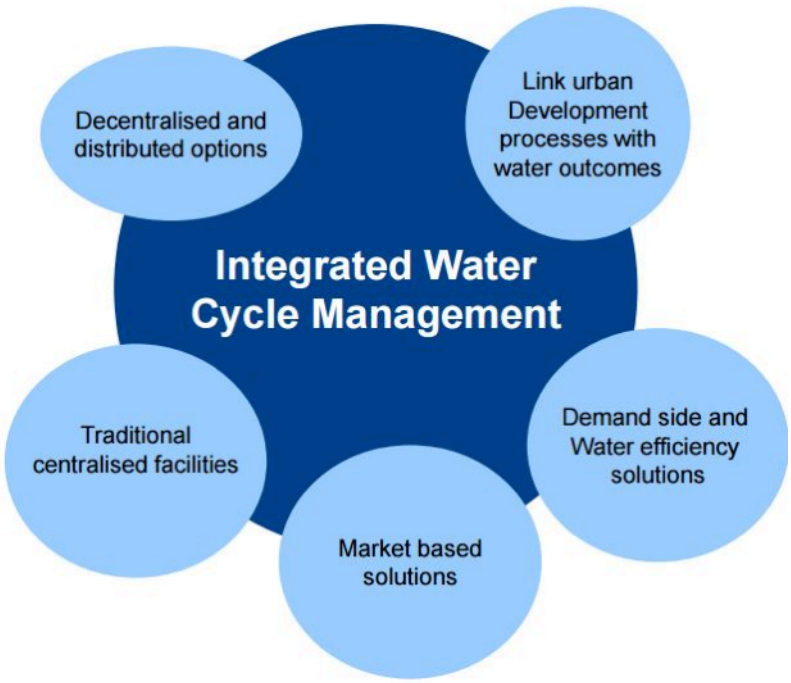


Figure 5: Components of Melbourne's Integrated Water Cycle Management approach.[viii]

[8] Whole-of-water-cycle planning is a multi-disciplinary, fully collaborative structure by agreement of agency leaders to provide effective coordination across all agencies that have a role in the water cycle, which includes planning, energy, transportation, and others.

This group includes: Melbourne Water (state-owned water wholesaler that manages waterways and oversees freshwater and wastewater treatment); the three water retailers operating in the greater Melbourne area (Yarra Valley Water, City West Water and South East Water); a local government representative from each local government jurisdiction; the Metropolitan Planning Authority; and Parks Victoria. This ensures that all stakeholders and appropriate water management authorities work together to develop projects – rather than in isolation – in order to maximize shared benefits.[ix] Their current challenge is how to best embed integrated water planning and governance into normal practice.

Multi-Benefit Projects

Melbourne's approach to collaborative, whole-of-water-cycle management described above facilitates the implementation of projects and programs with multiple benefits. Traditionally, water projects have been designed to address only one component of the water cycle, such as conveyance channels for stormwater runoff. However, by incorporating multiple stakeholders and agencies early on in the design process, water projects can be designed holistically to integrate different components of the water cycle. These multi-benefit projects allow for costs to be shared between agencies, alleviating the burden that traditional 'one-off' projects have on an agency's capital expenditures.

For example, Melbourne's Yarra Park Recycled Water Facility treats sewage produced at the Melbourne Cricket Grounds to recycled-water standards, and then irrigates the surrounding landscape with the locally-recycled water. The project produces approximately 47.6 million gal (180.2 million L) of recycled water annually, and has reduced the Melbourne Cricket Grounds' potable water consumption by 50 percent. Expenses for the project totaled AU$24 million and were shared between the Melbourne Cricket Grounds and the Australian Government.[x]

3. Decentralized water sources can increase water system resilience.

Adelaide and Melbourne employed a mix of decentralized strategies during the drought, including wastewater recycling, managed aquifer recharge, rainwater harvesting and stormwater capture. Critical to the success of these strategies were statewide performance targets (e.g., the Victorian government set a statewide target to reuse 20 percent of all wastewater inflows to its treatment plants by 2010; South Australia set a target of 45 percent by 2013), and tight regulation around water quality and protection of public health.[xi] The governments of South Australia and Victoria now mandate that water be treated only to fit-for-purpose, the standard necessary for its intended end use. Under this approach, rainwater that is plumbed indoors for flushing toilets and other non-potable uses does not have to be treated to drinking water standards, saving potable water and energy. Both governments have developed a comprehensive regulatory framework that covers virtually all use and reuse options with specific guidelines, including general recycled water use, on-site reuse, recycled water dual-pipe (purple pipe) development, direct stormwater use (including rainwater harvesting) and managed aquifer recharge with recycled water and stormwater.[xii]

The following describes the alternative water sources that Melbourne and Adelaide utilized to maximize potable water during the Millennium Drought:

Rainwater Harvesting

Rainwater refers to rainfall that has not come in contact with ground surfaces such as streets and parking lots, and includes rain that is captured from roofs and other above-ground surfaces. *Rainwater harvesting* is the practice of capturing and storing rainwater for later use, most often at the parcel scale. Many households in Australia harvest rainwater from their roofs and store it onsite in tanks.

Stormwater Capture and Use

Stormwater is rainfall that has come in contact with ground surfaces. Stormwater capture and use systems divert stormwater runoff from streets and other surfaces, and store it for later use. Water may be treated prior to its end use.

Managed Aquifer Recharge

Managed Aquifer Recharge (MAR) is the process of infiltrating or injecting water into aquifers under controlled conditions for withdrawal at a later date. It can also be used as a barrier to prevent saltwater or contaminants from entering the aquifer. In Australia, two methods of MAR are used:

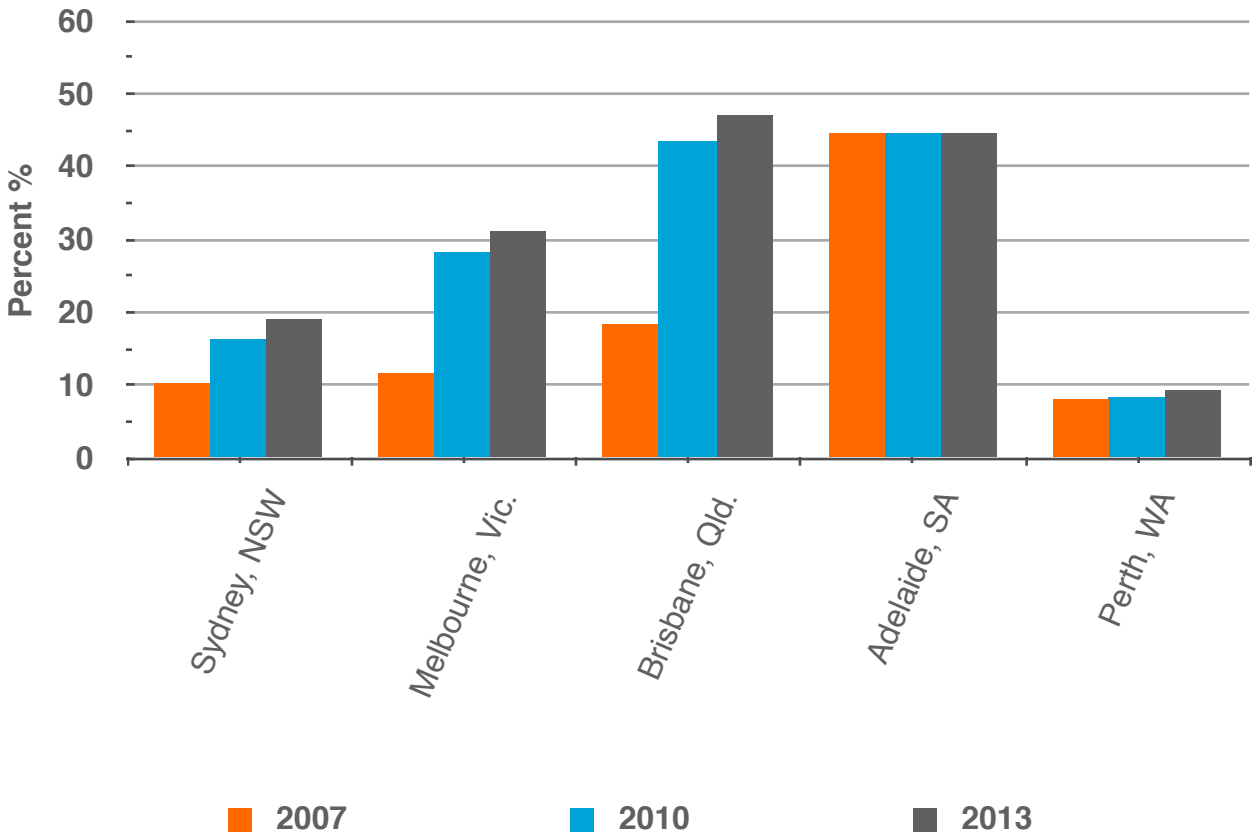
- Aquifer storage and recovery (ASR) is the recharge of an aquifer via a well with subsequent recovery from the same well;

- Aquifer storage transfer and recovery (ASTR) is the recharge of an aquifer via a well for subsequent recovery from another well, to allow a minimum residence time in the aquifer before recovery.

Rainwater Harvesting

Most Australian cities have a culture of rainwater harvesting (RWH), partly because many urban residents are still connected to their outback roots where RWH was, for a very long time (and in many cases still is), the only water supply. The drought reawakened interest in RWH and increased demand for the practice within Adelaide and Melbourne, as well as in other cities, for potable and non-potable uses. Water managers found that the concept of RWH was very popular with ratepayers, in part because severe water restrictions banned the use of potable water for household outdoor landscaping. As a result, the public demanded incentives for RWH tanks and equipment, which effectively gave agencies a mandate to invest in RWH programs. During the course of the drought, many cities throughout Australia saw dramatic increases in the number of households using rainwater tanks (see Figure 6). In Australia as a whole, the number of households with rainwater tanks grew from 24 percent in 2007 to 34 percent in 2013.[xiii] As noted in Figure 6, the growth of residential rainwater tanks increased significantly in a course of six years, fueled in part by government incentives. In Melbourne, households with a cistern increased from 11.6 percent to 31.1 percent. In the city of Brisbane, cistern adoption rose from 18.4 percent to 47 percent.

Figure 6: Households with rainwater tanks installed in Australia's capital cities. Adapted from Australian Bureau of Statistics.[xiv]



Water managers found that the concept of rainwater harvesting (RWH) was very popular with ratepayers, in part because severe water restrictions banned the use of potable water for household outdoor landscaping.

Stormwater Capture and Use

Both Melbourne and Adelaide employed stormwater capture and use strategies to provide alternative water sources for non-potable purposes. This reduced demand for potable water and provided a fit-for-purpose approach to water supply. Water-Sensitive Urban Design projects (referred to as *Low Impact Development*[9] in the United States) were a common response to the drought, and many projects were built to capture stormwater runoff from a given catchment area, store captured water in tanks for a later date and then use the water for irrigation or other non-potable uses.

In Melbourne, for example, the Royal Botanic Gardens Working Wetlands Project is designed to rehabilitate lakes suffering from diminishing water volumes and declining quality. Stormwater runoff is diverted from surrounding streets into the wetlands, treated through vegetated floating islands, circulated through a series of lakes and finally stored in large tanks. Once stored, the treated water is available for irrigation. This approach allows urban runoff to be viewed as a resource, creating a steady demand for non-potable water.

The City of Los Angeles has designed similar projects, including its Proposition O-funded rehabilitation projects at Echo Park Lake and Machado Lake. The Melbourne project differs notably in the inclusion of storage tanks as an additional component that extends the project's function beyond water quality management and into water supply provision. This example may provide a viable model for restoring urban water bodies while addressing runoff, water quality and localizing supply.

Managed Aquifer Recharge

Increasing water demand from development and agriculture in South Australia produced a long-term downward trend in groundwater levels. Managed aquifer recharge is the process of infiltrating or injecting water into aquifers under controlled conditions for withdrawal at a later date. It can also be used as a barrier to prevent saltwater or contaminants from entering the aquifer, as is done in Southern California with recycled water. Adelaide and the nearby city of Salisbury have tested managed aquifer recharge strategies since the early 1990s, and currently use urban stormwater to recharge brackish aquifers to create freshwater reserves that are used for irrigation and non-potable water supplies for industrial and domestic uses.

The Commonwealth Scientific and Industrial Research Organization (CSIRO) is leading several long-term managed aquifer recharge research studies to identify the most effective applications for using this approach to augment and improve local water supplies.[10] Among the managed aquifer recharge methods being tested are: aquifer storage and recovery (ASR) – the recharge of an aquifer via a well with subsequent recovery

[9] Low Impact Development is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible.
[10] CSIRO is the federal government agency for scientific research in Australia.

from the same well, and aquifer storage transfer and recovery (ASTR) – the recharge of an aquifer via a well for subsequent recovery from another well, to allow a minimum residence time in the aquifer before recovery. In particular, a recent CSIRO study[xv] has shown that water moving through an aquifer in ASTR schemes undergoes enhanced microbiological treatment that removes a substantial number of pathogens. This water could then be used for a variety of end uses, such as irrigation, domestic and industrial non-potable reuse, and – with additional treatment – drinking water.

4. Water scarcity issues are fundamentally tied to public health, safety and quality of life.

Climate Change and Extreme Heat

Extreme heat events in January of 2009 – the last year of the Millennium Drought – caused a 62 percent mortality increase in the City of Melbourne.[xvi] Temperatures during this time were 22 to 31° F (12 to 17° C) higher than normal throughout Victoria. Whereas the average January temperature in Melbourne is approximately 70° F (21° C), January, 2009 saw three consecutive days of temperatures exceeding 109° F (43° C).[xvii]

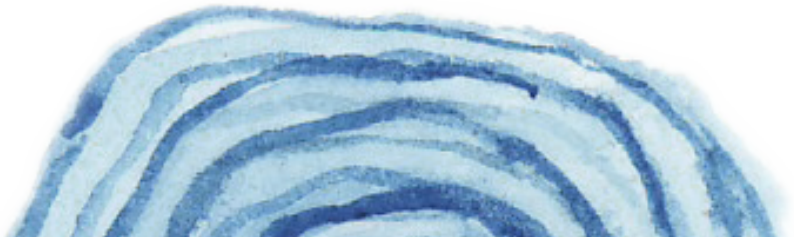
By this point in the drought, water restrictions banning the irrigation of public spaces had substantially reduced vegetation and shade – and the urban heat-island effect exacerbated the heat wave. Climate change is forecasted to increase the frequency, intensity and duration of such extreme heat events in the future.[xviii]

While drought restrictions were imperative on a citywide scale, the city learned a critical lesson: special attention must be paid to keeping public green spaces green, even during severe droughts. Melbourne had to rethink its one-size-fits-all approach to drought-induced restrictions.

Melbourne is addressing this issue by increasing the amount of urban green spaces located throughout the city to provide shade and evaporative cooling. These urban green spaces are watered using non-potable, fit-for-purpose water from stormwater harvesting and recycled water projects.

Water for Livability

The City of Melbourne narrowly focused the first iteration of their whole-of-water-cycle efforts on water security and water conservation. These efforts were effective, but when the city reduced or stopped irrigating sports fields and public green spaces, recreational activities were severely curtailed. The drought-hardened ground caused injuries and many sporting events were cancelled. At the same time, the public psyche was negatively impacted as residents witnessed the city's historic botanical gardens and public green spaces turn brown, and the urban cooling benefits they had enjoyed from healthy vegetation withered.[xix] While drought restrictions were imperative on a citywide scale, the city learned a critical lesson: special attention must be paid to keeping public green spaces green, even during severe droughts. Melbourne had to rethink its one-size-fits-all approach to drought-induced restrictions.



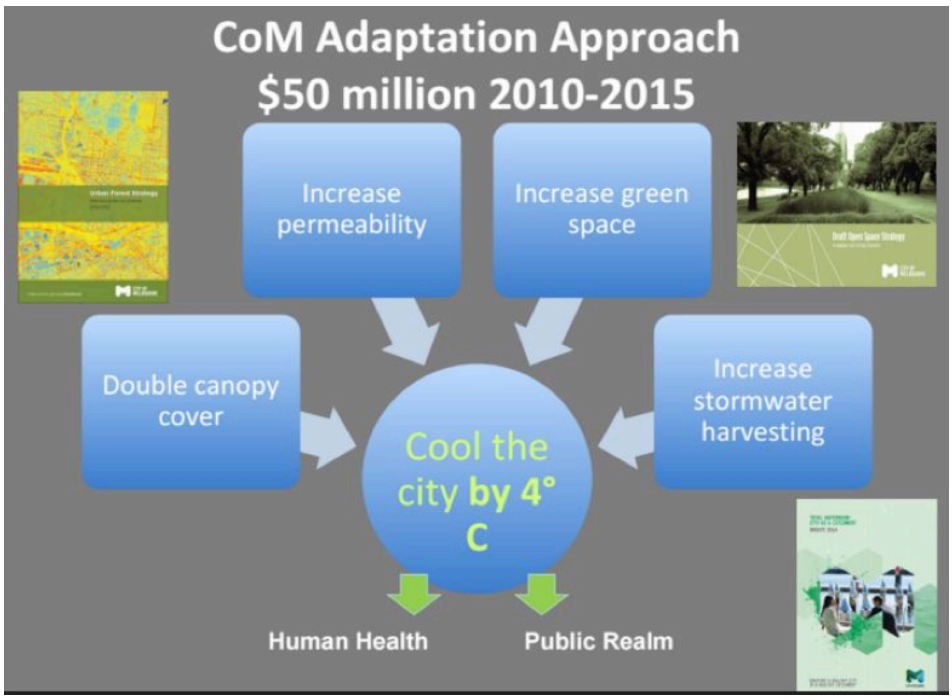


Figure 7: Melbourne's holistic approach to climate adaptation.[xx]

Water for the Environment

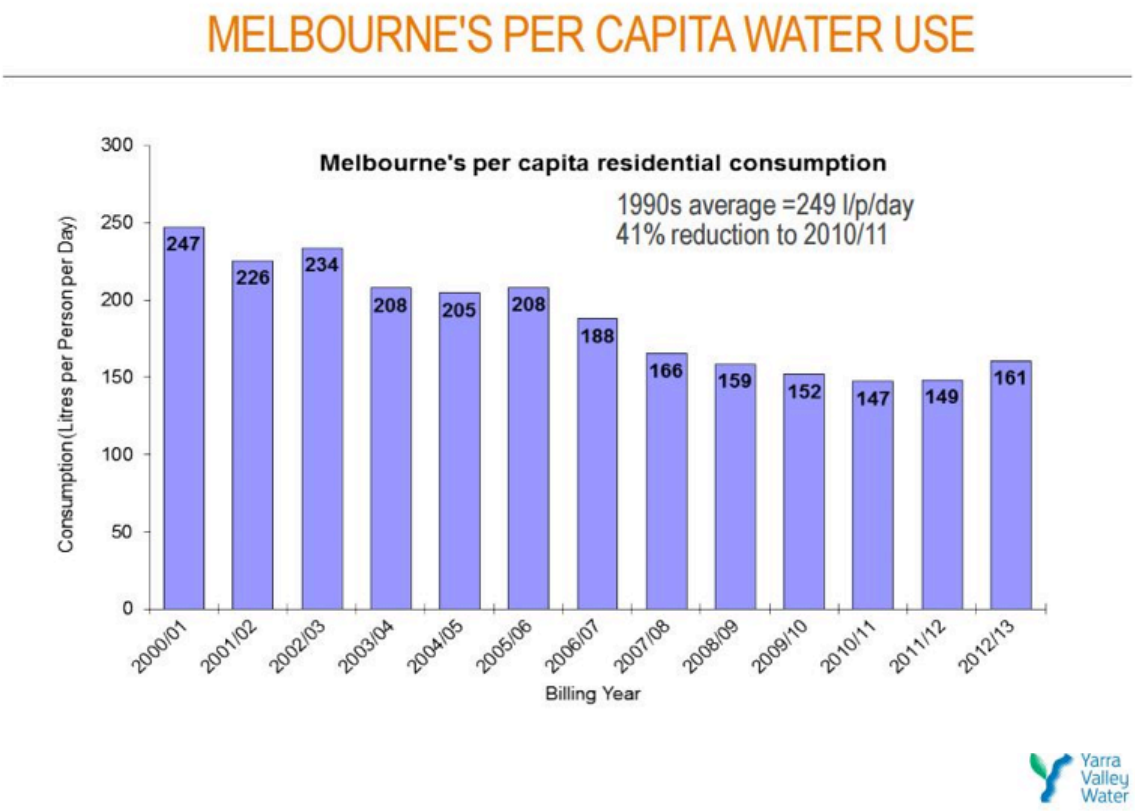
With drought-era water restrictions in place, environmental flow entitlements given to the city's main waterway, the Yarra River, were reallocated to the City of Melbourne. These legally-mandated environmental flow entitlements were suspended from the time of their publication in 2007 until watering restrictions eased in 2010. The Victorian Government justified this decision by estimating that the suspension of environmental entitlements to the Yarra River provided an additional 120,000 acre-feet (148 GL) of water (or five months of urban supply) and avoided the need to introduce more severe water use restrictions.[xxi] However, decreased environmental flows to the Yarra River had devastating impacts and resulted in the acidification of lower lakes, dying floodplain forests, loss of habitat for native species, degradation of water quality and put multiple sensitive species at risk. These impacts are still being felt, and the city has spent millions of dollars trying to restore and rehabilitate the river to pre-drought conditions.

This example illustrates the need for robust environmental flow requirements during periods of water scarcity, and overall proactive water management strategies that prevent future negative consequences. While eliminating environmental flows during the Millennium Drought provided the city with additional water, the negative environmental consequences and mounting costs provide proof that environmental flows need to be prioritized during times of water scarcity.

5. Public behavior change around water conservation is tremendously effective.

The drought fostered a vibrant culture of Australian residents taking responsibility as water managers. This was accomplished most effectively through a mixture of efforts, including water restrictions, water pricing, public education, social comparisons, target setting and rebates for water-saving technologies. Daily per capita water use was reduced substantially by residents of both Adelaide and Melbourne. In Melbourne, daily per capita demand started at 121 gal (458 L); by the end of the drought, Melbourne averaged 65 gal (246 L) per person per day.[xxii] However, for residential properties, Melbourne's per capita use dropped to about 40 gal (150 L) per day (see Figure 8). In 2003, Adelaideans were using 87 gal (330 L) per person per day; toward the end of the drought, in 2009, water demand averaged 60 gal (227 L) per person, per day.[xxiii]

Figure 8: Melbourne's per capita water use between 2000 and 2013.[xxiv]



In particular, the City of Melbourne implemented an aggressive 'Our Water Our Future' water conservation campaign from 2002 to 2010 geared towards changing residents' behavior around water use. This conservation campaign focused on three main areas: water literacy, valuing water and motivating action. The campaign's goals were: reducing individual and corporate water use, changing individual behaviors and creating positive attitudes towards water restrictions. To implement this plan, Melbourne utilized all of the behavior change tools available, including changing social norms, financial incentives, social marketing, regulation, community engagement, increases in water pricing and innovation (see "Right Water" campaign, noted below). The city provided daily water levels for each reservoir on the front page of the newspaper; drought workshops were held frequently to engage the local community; per capita water consumption targets were set (see Yarra Valley Water's "Target 155" campaign, noted below); and water users were compared with their neighbors to inspire reductions in use.

The campaign was enormously effective, and resulted in a 45 percent reduction in water use in 2010 compared to the 1990s.[xxv] Because long-term average stream inflows plummeted by as much as 55 percent during the Millennium Drought, without water conservation Melbourne's reservoirs would have run dry by July 1, 2009 (refer back to Figure 3).[xxvi] Important take home messages from this campaign show that when dealing with complex long term issues like behavior change, political leadership and community engagement are critical to creating an environment receptive to change. Further, additional lessons show that user motivation is inspired by emotion, and that behavior change campaigns need to be implemented early on during a drought due to their long incubation times.

The following describes some of the strategies used by both Melbourne and Adelaide to facilitate behavior change around water conservation.

Coordinated Mass Media and Public Education

The City of Melbourne implemented a large-scale mass media advertising campaign via TV, radio, print, billboards and community events that saturated the market and dramatically increased awareness of the ongoing drought. The campaign's messaging was clear and concise, with motivating messages stating that residents needed to pull together to get through the drought, reminders that water restrictions were in effect, and current information regarding the amount of water available in reservoirs. The campaign was enormously successful, and its efficacy was continually gauged through sampling surveys and phone interviews with customers. The total cost of advertising during the drought was estimated to be AU$8 million, with Melbourne Water contributing approximately AU$6 million, and City West Water and Yarra Valley Water contributing AU$1 million each. Importantly, these agencies pooled their resources to focus on an integrated campaign, instead of individual campaigns for each water agency as is often done in California.

Aggressive Water Consumption Targeting

In Melbourne, "Target 155" (liters) was a voluntary initiative implemented as a result of a task force finding on the importance of setting aggressive targets for residential water consumption. The target urged water consumers to use 155 L (40 gal) or less per day, and was extremely effective in changing consumers' attitudes and behaviors towards water conservation (Figure 9). Target compliance became a badge of honor for the public, and a new social norm around water consumption developed. Weekly reports comparing Melbourne's water use to Target 155 were delivered via the media, and achievement of the goal resulted in intensive coverage in print, television and radio outlets. Today, Melbourne has revised these standards to Target 130 liters in the winter and Target 190 liters in the summer.

Melbourne utilized all of the behavior change tools available, including changing social norms, financial incentives, social marketing, regulation, community engagement, increases in water pricing and innovation.

Figure 9: Target 155 campaign advertisements.[xxvii]

Smart Water Bill

Yarra Valley Water, one of greater Melbourne's water retailers, redesigned its traditional water bill to a new 'Smart Water Bill' – an informative, easy-to-read bill that indicates how a household is faring compared to both normal and water-efficient households. The bill uses both descriptive and injunctive norms to adjust users' perception of 'normal' water use, and then further encourages them to conserve.[11] Research conducted by Yarra Valley Water indicates that the Smart Water Bill was tremendously effective in changing users' behavior towards water, as most water users did not know how much water they were using prior to receiving the bill. In many instances, this simple feedback mechanism was enough to create large changes in consumer behavior. The Smart Water Bill also contains water efficiency tips and rebates, and shows the progress that users are making towards achieving water conservation targets.

Water Restrictions

Water restrictions in both Melbourne and Adelaide had a tremendous impact on public behavior as parks began to turn brown and public fountains were turned off. Further, deputized "inspectors" and meter readers wearing patrol vests were common and helped the public remember that water restrictions were in place. Water fines for non-compliance were typically AU$100 to $500 and were not issued until the second or third offense.[xxviii] However, as most restrictions were difficult or impossible to enforce, the high compliance with water restrictions was most notably due to the cooperation and goodwill of the public. Australians generally had a "we're all in this together" attitude and were highly supportive of the water restrictions.[xxix]

Water Efficiency Labeling Standards

In 2006, Australia implemented the Water Efficiency Labeling Standards (WELS) program to provide a uniform set of standards promoting water-efficient appliances and fixtures. The WELS program requires faucets, showers, toilets, urinals and flow controllers, clothes washers, and dishwashers to be labeled according to their water efficiency. In addition, the program also provides product testing and the enforcement of required standards. The United States Environmental Protection Agency's WaterSense Program is modeled on WELS; however, WaterSense is a voluntary program and not a required standard for appliances and fixtures.[xxx]

[11] Injunctive norms are perceptions over what behaviors are approved of or disapproved of by others. Descriptive norms are perceptions of how people actually behave.

Water Conservation Rebates and Appliance Retrofits

Beginning in 2003, water conservation rebates were provided by the Victorian Government for a range of water saving products and services such as rainwater tanks, showerheads, greywater systems, dual-flush toilets, dishwashers, washing machines and water conservation audits. These rebates were allocated in four-year cycles based on drought severity and forecasted demand. Rebates generally focused on the large consumers of residential water in the home, targeting single-flush toilets first. Today, dual-flush toilets are mandatory for all households. Victoria offered rebates for rainwater tanks through mid-2015 for up to $1,500 when connected to toilets and laundry.

Water Pricing

Among the many reforms passed during the Millennium Drought, the National Water Initiative created a set of nationwide principles for pricing urban water. These guidelines required utilities to put water rates for all types of customers on a rational footing, removing political pressure to underprice water as a means to win favor with voters.[xxxi] Both Melbourne and Adelaide were forced to raise water rates during the drought, and the rate increases had the dual objectives of signaling the scarcity of water and helping pay for the major investments in water supply infrastructure. In Melbourne, a 5 percent environmental levy was implemented in addition to a modification of the block tariff structure from two to three tiers.[xxxii] In Adelaide, block prices were nearly doubled in comparison with pre-drought levels.[xxxiii]

'Right Water' Campaign

In 2014, Victoria launched the ongoing 'Right Water' campaign geared towards encouraging households to make greater use of alternative water sources. The focus is to educate the public around the notion that there are different types of water for different needs, and that not all end-uses require the most highly-treated forms of water. The initiative incentivizes the installation of rainwater harvesting cisterns and rain gardens by showing the expected water bill decreases that would result from using less potable water. For example, it is estimated that every year Melbourne households have approximately AU$200-400 worth of water fall on their roofs.[xxxiv] During the TreePeople-led policy delegation, this campaign was immensely popular and advertised heavily on billboards, print, trams and during major events, with pop-up tents and staff giving demonstrations on how to install rain tanks and rain gardens (see Figure 10).

Figure 10: An example of a "Right Water" campaign kiosk - educating passersby in a high visibility area in Melbourne.

Policy Recommendations and Accomplishments

The following policy recommendations emerged from research conducted during and as a result of TreePeople's ongoing efforts to bring lessons learned from Australia to California. They include information that was shared by our Australian hosts during the 2014 policy delegation in Adelaide and Melbourne. These policy recommendations provide both short and long-term solutions that can help California address the ongoing drought and long-term water crisis. This section also notes some of the accomplishments achieved in California since the delegation trip.

1. Leverage the drought as an opportunity to implement needed changes despite the 2015/2016 El Niño season.

In Australia, the severity of the drought called for swift and novel responses and investments in water-saving programs and projects. The dismal water supply forecast led to high levels of support for many government agencies to try new approaches. The public responded with a willingness for lifestyle shifts and behavior change. With the return of rain, political priorities temporarily shifted to the economy and many innovative water supply programs were reduced or dismantled. Fortunately, with the benefit of reflection upon the drought experience, many of the programs were subsequently reinstated, and long-term, far-reaching initiatives were established, such as Living Melbourne, Living Victoria, whose functions continue under the State of Victoria Department of Environment, Land, Water and Planning.

Though it is understood that the wet 2015-2016 El Niño season will not end California's current drought, it is imperative for policymakers and water managers to act swiftly to implement decisive changes to water management, so that the political and public will afforded by the drought is not squandered. Education and engagement – both of policymakers and the public – should not waiver from the fact that the current drought is not a temporary situation but is likely signaling a new norm for California.

Though it is understood that the wet 2015-2016 El Niño season will not end California's current drought, it is imperative for policymakers and water managers to act swiftly to implement decisive changes to water management, so that the political and public will afforded by the drought is not squandered.

2. Increase agency collaboration and transition towards collaborative governance through whole-of-water cycle management.

Fragmented California water management systems need to begin transitioning towards a whole-of-water-cycle approach to water management. Collaborative agency efforts should become the norm to create a mechanism for coordinated planning, funding and implementation around a water- and climate-resilient region.

The Los Angeles region offers an example of how this transition might occur. TreePeople's report, *Moving Towards Collaboration: A New Vision for Water Management in the Los Angeles Region* (2015), summarizes findings and recommendations to increase collaboration among the City of Los Angeles Bureau of Sanitation, City of Los Angeles Department of Water and Power and Los Angeles County Department of Public Works.[12] This Multi-Agency Collaborative (MAC) initiative builds a case for a collaborative, systemic approach to address the region's short-term drought emergency and long-term water crisis. Key findings from the report include the following:

- The Los Angeles region stands to benefit from creating a shared vision, defined goals, and coordinated strategy that is managed across agencies through mutually reinforcing activities.
- There is a unique and unprecedented opportunity to make critical and rapid shifts to our local water management systems due to the current financial, regulatory, and political environments. Various factors, including the drought and new water quality regulations, provide an incentive for the region's largest infrastructure agencies to work together to meet their discrete, yet overlapping, goals.
- Annual stormwater costs to City agencies and County are projected to increase to at least $2 billion (AU$2.9 billion) annually – or six times the current costs. With this expected increase, the efficiencies of working together become even more critical, and further the value of a more collaborative management approach for Los Angeles.

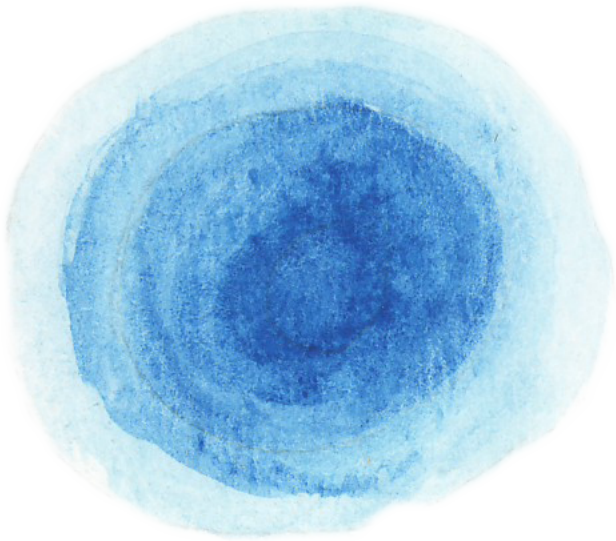
The MAC approach was recognized in a third-party report by management consulting firm Navigant for the City of Los Angeles about the Department of Water and Power. The report acknowledges and validates the MAC approach, recommends collaboration of this type, and takes it a step further by suggesting an "additional in-depth study of the management of the three Los Angeles water agencies as one entity."[xxxv]

This approach emphasizes how agencies can use current water management frameworks to establish shared goals, systems and agreements to increase efficiency and collaboration. Phase Two of the MAC is currently underway, testing collaborative governance among the three water agencies through the installation of several residential pilot retrofits in the City of Los Angeles. The MAC agencies have jointly planned, funded and implemented these retrofits, with real-time remote-monitored technology on cisterns and infiltration best management practices installed where appropriate. A forthcoming report will analyze project metrics along with barriers to address and opportunities for scaling in the future.

Create a cost-benefit / co-investment tool to quantify water supply, water quantity and other benefits to increase collaboration across fields

A robust inter-agency, inter-jurisdictional cost-benefit tool is needed to quantify water supply, quality and other benefits of California's water projects. Without an agreed-upon tool or model, it is difficult to attribute project or program benefits to any particular sector or agency. It is therefore difficult to make the case for co-investments that could make alternative water supply more economically feasible. Current planning occurs using a single-purpose cost-benefit approach – in essence, the costs and benefits to that one agency. This can lead to decisions that rule out certain multi-benefit projects if costs and benefits are not identified for other agencies and potential investors. [xxxvi]

[12] The report is available at www.treepeople.org/resources/publications.



3. Set aggressive targets for decentralized water sources and adopt innovations to reach targets.

Set aggressive targets for stormwater capture and use, rainwater harvesting and wastewater recycling

Water management agencies throughout California should set aggressive volumetric and substitution targets to increase: 1) the volume of stormwater captured and reused throughout the region; 2) the volume of rainwater harvested and reused throughout the region; and 3) the volume of wastewater recycled as a percentage of total wastewater (for example, Melbourne set targets to reuse 20 percent of all wastewater flows to its treatment plants by 2010). By setting aggressive targets, cities and counties in the state can actively form initiatives and policies to achieve the stated goals. This was instrumental in helping Melbourne develop alternative water sources during the Millennium Drought, and one of its key lessons learned.

The City of Los Angeles has already been begun to set targets, with Mayor Garcetti issuing a Mayoral Directive to reduce potable water use by 20 percent by 2017, and also to reduce the Los Angeles Department of Water and Power's purchase of imported water by 50 percent by 2024. Further, progress is beginning to be made with stormwater capture and use. Results of the Los Angeles Department of Water and Power's Stormwater Capture Master Plan indicate that Los Angeles could capture 30 to 45 percent of the city's current water demand with the right infrastructure, programs, and policies in place.[xxxvii] As initiatives like the Stormwater Capture Master Plan are further developed, assigning volumetric and substitution targets can help the city put the right programs and policies in place to achieve its goals.

Invest in and adopt new technologies

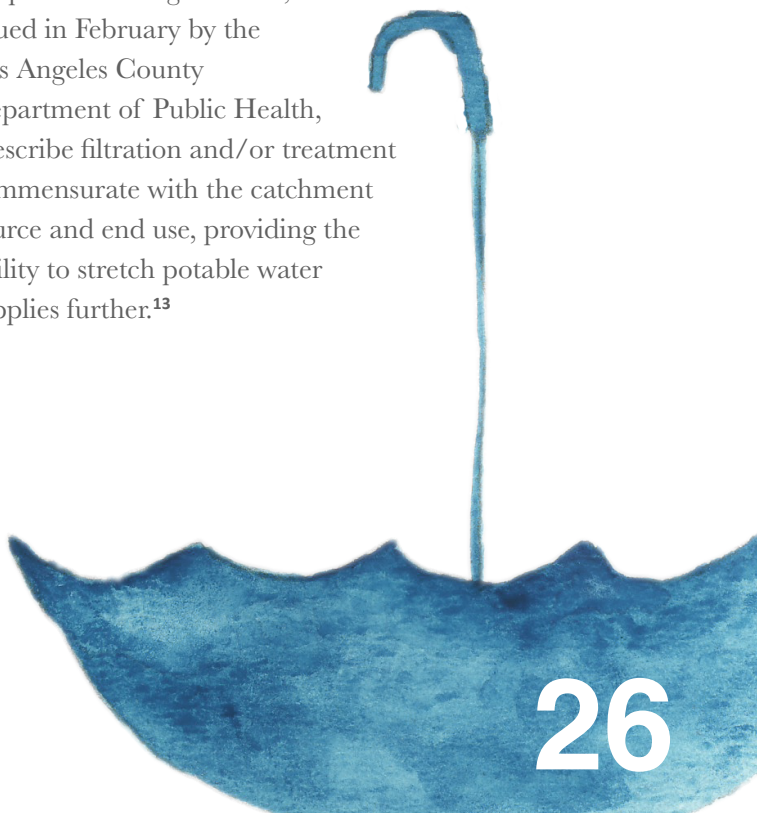
Water managers in California have, in many cases, piloted new technologies in response to drought, such as parkway stormwater capture, distributed rainwater cisterns and managed aquifer recharge. However, these generally remain in the pilot stage. In contrast, Melbourne and Adelaide demonstrate that drought provides the opportunity to move needed technologies from pilots and one-offs, to widespread adoption.

One technology that is relatively unexplored in Southern California is sewer mining, which Australian water managers have found to be a promising approach worthy of investment. In this approach, distributed treatment plants allow for recycled wastewater to be used close to where it is produced, such as at the Melbourne Cricket Ground.

Australia's CSIRO is a good example of how the country values research and investment in alternative water sources and technologies. One benefit of this is that water managers can feel confident in investing in new approaches because they can rely on robust research. California would benefit from similar investment and increased research.

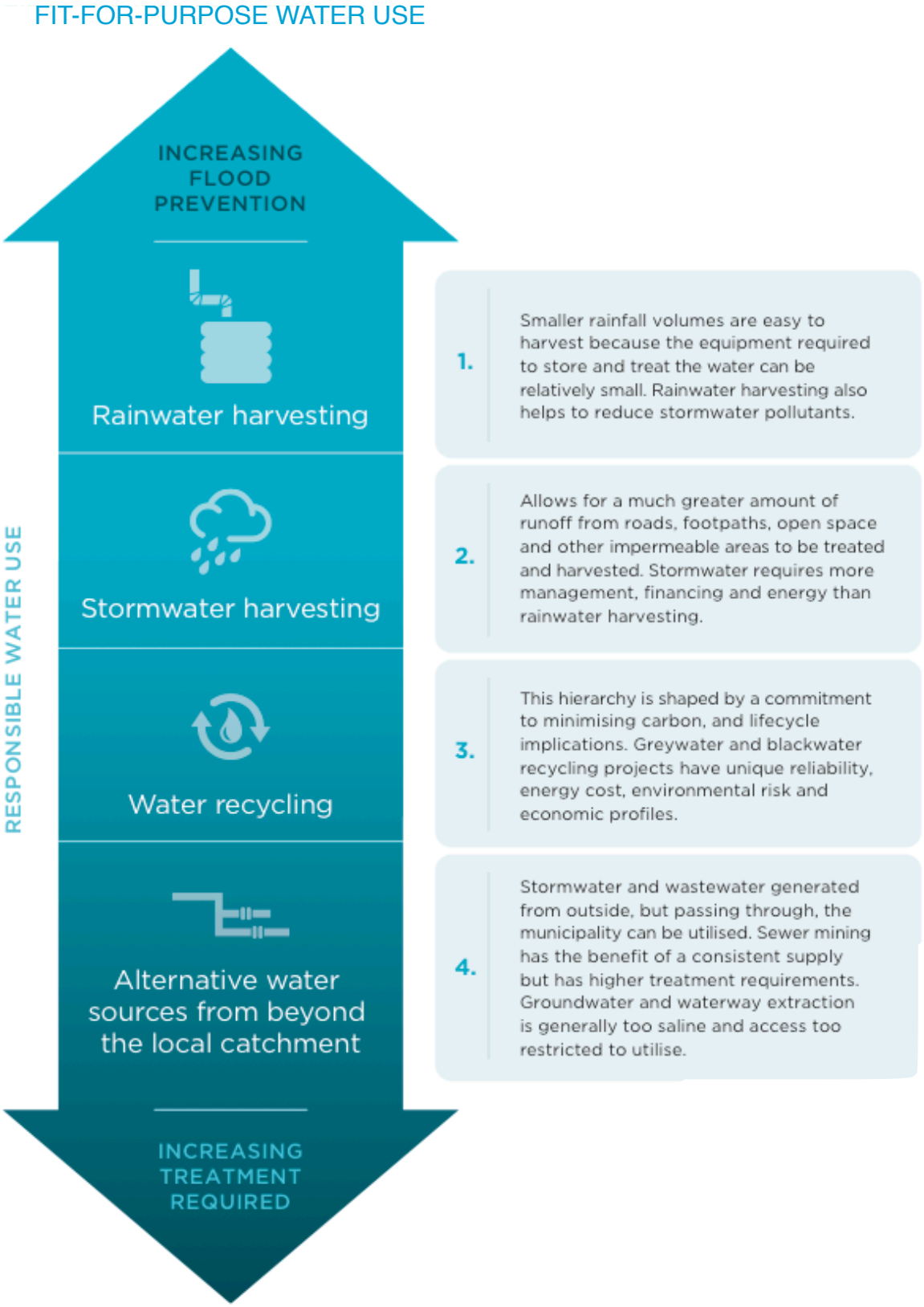
Adopt a fit-for-purpose approach to water supply

The fit-for-purpose approach pairs the appropriate treatment for water with the appropriate end use (a concept which Melbourne's "Right Water" campaign takes to the public). Reducing water treatment saves energy and costs. One example of a fit-for-purpose strategy that has been recently accomplished is the County of Los Angeles' guidelines to allow alternative water sources, including rainwater, stormwater and graywater, to be used indoors and outdoors for non-potable purposes. These guidelines, issued in February by the Los Angeles County Department of Public Health, prescribe filtration and/or treatment commensurate with the catchment source and end use, providing the ability to stretch potable water supplies further.[13]



[13] http://www.publichealth.lacounty.gov/eh/

Figure 11: Melbourne's fit-for-purpose approach to water use and treatment.[xxxviii]



Melbourne's experience shows that recreation and public psyche are dependent on public green spaces, as these areas offer critical respite from both the stresses of urban life and the urban heat-island effect. California must ensure that it maintains its public green spaces, even during times of water scarcity.

4. Protect quality of life during drought and as future climate impacts are felt.

Set aggressive regional cooling and tree canopy targets

Cities and counties throughout California should set regional cooling and tree canopy targets to reduce the impacts of the urban heat-island effect and as a climate adaptation strategy. As urban populations grow and are pushed beyond their adaptive capacity to deal with extreme heat events, higher rates of mortality and morbidity ensue. Measures need to be taken to increase urban green space and vegetation in order to cool the urban landscape. Increasing green space by 10 percent can reduce daytime urban heat temperatures by approximately 1.8° F (1° C), and additional benefits including public recreation spaces and improved air quality can result.[xxxix]

Following deadly heat waves in Melbourne and surrounding areas, the city investigated the correlation between low canopy and higher risk of heat-induced illness and mortality and concluded that the presence of impervious surfaces combined with low vegetation cover puts Melbournians at great risk – and that by 2050 an extreme heat event in Melbourne alone could kill over 1,000 people in a few days if forecasting, preparation and management do not improve.[xl] To take an aggressive stance against this harsh reality, Melbourne used thermal mapping to find areas at greatest risk of extreme heat and developed its Urban Forest Strategy, which calls for doubling the city's tree canopy to 40 percent while increasing soil permeability and moisture. California cities should consider emulating the City of Melbourne's adaptation approach.

City of Los Angeles Councilmember Felipe Fuentes, one of the delegates on the 2014 policy trip to Australia, introduced a motion to the LA City Council to set a cooling target for the City of LA in February, 2015 (see Appendix D). TreePeople and its partner organizations look forward to continuing to work with the Councilmember to make this motion a reality.

The challenge of maintaining a healthy tree canopy during drought is significant. An approach that proved successful in Melbourne was to deploy tanks filled with rainwater or recycled water as irrigation pods to keep the city's historic heritage trees thriving. Following Melbourne's example, in 2014 TreePeople worked with the City of Los Angeles Department of Recreation and Parks to test the use of hollow plastic road barricades retrofitted to act as irrigation pods (see Figure 13). The so-called "irricades" successfully deliver water to areas not served by irrigation lines.[14]

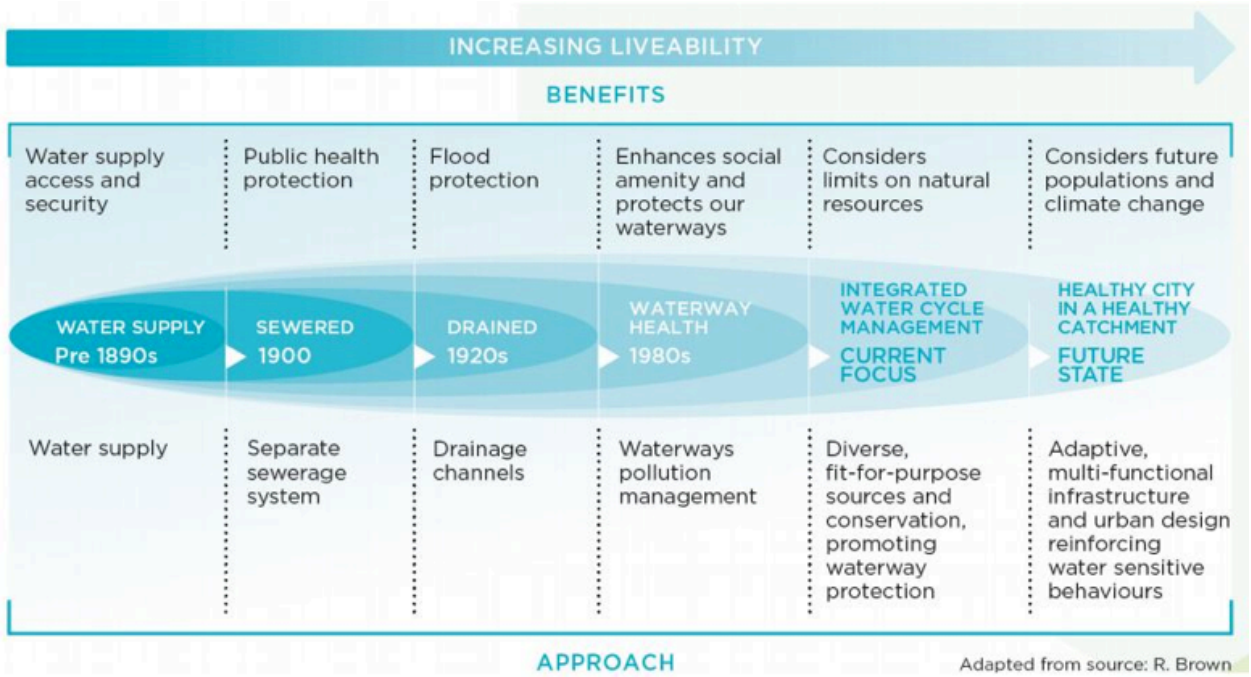
[14] More information about "irricades" is available at www.treepeople.org/resources/irricades.

Create guidance to protect livability and health when in drought

Cities and counties throughout California should implement policies to ensure that public green spaces are irrigated with non-potable water during times of drought. Melbourne's experience shows that recreation and public psyche are dependent on public green spaces, as these areas offer critical respite from both the stresses of urban life and the urban heat-island effect. California must ensure that it maintains its public green spaces, even during times of water scarcity.

Additionally, California governments should develop guidance to protect quality of life and health when in drought and as climate change impacts are felt. This includes creating plans and identifying water sources to keep strategic public open spaces and trees green and healthy to continue to provide needed ecosystem services and public health protection. This may also include recreation fields to ensure communities can continue to enjoy the benefits of outdoor recreation. Various levels of government could implement this guidance through climate adaptation planning or other policy mechanisms.

Figure 12: Framework within which Melbourne is working to re-envision its water management in the city.[xli]



Total Watermark: City as a Catchment Plan

To address unintended issues that emerged due to drought-era water management and restrictions, Melbourne created Total Watermark: City as a Catchment, a AU$50-million 2010-2015 whole-of-water-cycle plan that looks at using water in four specific areas:

- *Change and Adaptation* - A resilient and safe city that is adapted to current and future extreme weather events.
- *Water for Liveability* - A water cycle that supports the health, well-being and enjoyment of everyone who lives, works, visits and plays in Melbourne.
- *Water for the Environment* - Water that is managed for biodiversity, healthy public open spaces and clean waterways.
- *Water Use* - Efficient use of fit-for-purpose water contributes to Melbourne's improved sustainability.[xlii]

One of the drivers behind this planning strategy is to create "a city in the forest, rather than a forest in the city," by focusing on extensive urban forestry efforts. The city plans to increase urban tree plantings in order to double canopy cover, increase green space, increase permeability, increase stormwater harvesting and cool the city by 7.2^0 F (4^0 C). Measurements taken during extreme heat events in Melbourne suggest that a 10 percent increase in vegetation cover could reduce daytime urban heat temperatures by approximately 1.8^0 F (1^0 C).[xliii]

Non-potable water is used to irrigate these new plantings, as water-stressed vegetation has both higher surface temperatures and reduced rates of plant transpiration in comparison with irrigated vegetation.[xliv] Because non-irrigated landscapes greatly intensify urban heat-island impacts, the city sees it as imperative to plant and irrigate landscapes that are capable of absorbing heat. Special emphasis is being placed on retrofitting the city's road networks with green infrastructure and urban trees, as this offers the dual benefits of reducing the amount of heat emitted from asphalt, and also capturing large volumes of stormwater. In an average year, Melbourne's stormwater runoff greatly exceeds demand, and the city is implementing numerous stormwater-harvesting projects to capture this largely untapped water source. In addition to supplementing water supply, stormwater capture and reuse projects also provide numerous ecosystem services, such as restoring predevelopment flow regimes and retaining nutrients and pollutants in a catchment. More than 57 stormwater capture and reuse projects were estimated to be in operation in Melbourne by 2015.[xlv]

5. Create tools to foster sustainable behavior change in the public.

Create an integrated, clear and consistent messaging campaign

California water management agencies should create a clear, unified and consistent water conservation campaign that spans across jurisdictional boundaries. This campaign should be issued through TV, radio, print, billboards, digital media and community events, and be implemented over a sustained time frame. Water districts and wholesalers should contribute a portion of their water conservation budgets toward funding a unified and consistent campaign.

Provide incentives and rebates for water-efficient appliances and fixtures, including rainwater harvesting systems and graywater systems

Water rebates and incentives should be streamlined throughout California to encourage the adoption of water-efficient appliances and fixtures. Although many state water retailers and water districts currently offer rebates for high-efficiency clothes washers, high-efficiency toilets, rotating nozzles, irrigation controllers and rain barrels, more must be done, especially with regard to rebates for graywater systems and larger rainwater cisterns. By offering rebates for rainwater cisterns and graywater systems, non-potable water can be provided for outdoor landscaping irrigation and indoor non-potable uses, and local water supplies can be further developed.

Set aggressive policies, laws and regulations

New policies are needed in California to set the state on a path toward a water- and climate-resilience future, and begin to undo antiquated approaches to water management. There are many areas of lawmaking, from land use planning and transportation to water restrictions and incentives that have a nexus to water- and climate-resilience planning which, under our current siloed governance system, are often overlooked. This underscores the need for whole-of-water-cycle, integrated planning. For example, the City of LA is in the process of developing an ordinance for public rights-of-way to capture stormwater in new construction or reconstruction, which links transportation planning with water planning and urban sustainability (see Appendix E).

While an exploration of other such integrated governance opportunities is beyond the scope of this report, there are a number of fairly straightforward changes that can take place. For example, the drought highlighted the need for a policy to ban the use of potable water for outdoor irrigation in new development. In the City of Los Angeles, landscape irrigation accounts for 54 percent of single family water use.[xlvi] Much of this potable water is used to irrigate thirsty cool-season turf grasses that are often planted exclusively for ornamental value.

Current efforts, both at the state and local levels, are putting us on a path to reduce the use of potable water for outdoor irrigation. Executive Order B-29-15, issued by Governor Edmund Brown in April 2015, calls for a 25 percent reduction statewide in potable urban water usage through February 28, 2016. In February 2016, the State Water Resources Control Board (SWRCB) adopted extended and revised emergency drought regulations which maintains these reductions through October 2016.[xlvii] While many of the reductions directed by Executive Order B-29-15 are achieved through restrictions on usage, the use of potable water not delivered by drip or microspray systems is prohibited for irrigation in newly constructed homes or buildings, as well as for public street medians. Through Mayoral Directive Number 5, Los Angeles Mayor Eric Garcetti has also given directives for reducing per-capita potable water use by 20 percent by 2017.[xlviii]

Set aggressive water use targets

Regions throughout California should implement per-capita water consumption targets. Similar to Yarra Valley Water's Target 155 campaign, these targets should be heavily advertised to increase awareness of both per-capita water use and water conservation. Seasonal targets should be set for winter and summer, and should be based on realistic metrics that are attainable for residents. Water managers should determine whether targets can be mandatory or should be voluntary.

Currently, Governor Brown as well as Mayor Garcetti have called for mandatory percentage reductions. While these are a necessary step, an additional recommendation is to set a numeric reduction target, either per jurisdiction or per-capita. This can help ensure a city or region is clear about, and therefore achieves, its stated target. Additionally, this approach avoids penalizing those who are already doing a good job conserving, and has the benefit of educating people about how much water they are actually using on a daily basis. Traditional water bills do not make this clear.

Increase the cost of non-essential use of water

Water retailers throughout California should continue to pursue increasing block tariffs as a way to curb the consumption of heavy water users while still protecting low-income customers. Increasing block tariffs provide a buffer zone between the low rates required for low-income customers and the high rates required to dissuade heavy water users.[xlix] While many water retailers have implemented increasing block tariffs throughout California, efforts should continue towards implementing tiers that drive down excess water use.

It is worth noting that one aspect of California Proposition 218 – a voter-approved measure that prohibits government agencies from charging more for a service than it costs to provide it – currently stands as a significant obstacle in implementing increasing block tariffs. A recent decision by the California Supreme Court upheld a ruling by the 4th District Court of Appeal which rendered the City of San Juan Capistrano's increasing block tariff structure illegal due to violation of Proposition 218. While tiered rate structures are legal, as a result of the ruling water retailers need to ensure that they have the appropriate cost data in place to justify a decision to change their rate structures.

Deliver social comparison of water consumption

California utilities should work with social science researchers or other experts to deliver social comparisons of household water consumption patterns and identify other effective approaches to foster sustainable water behavior. Normative comparisons, comparing a consumer's usage with the desired norm, have been shown to be tremendously effective in reducing water use when messaging is sustained over time.[l] These normative comparisons can be delivered via a bill or through an independent study.

Figure 13: The City of Melbourne retrofitted hollow plastic road barricades into portable irrigation pods, filling them with rainwater or recycled water and connecting them to drip irrigation lines to save and protect the city's most valued heritage trees. Following Melbourne's example, in 2014 TreePeople worked with the City of Los Angeles Department of Recreation and Parks to test this method locally, deploying 'irricades' in several parks.

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Conclusion

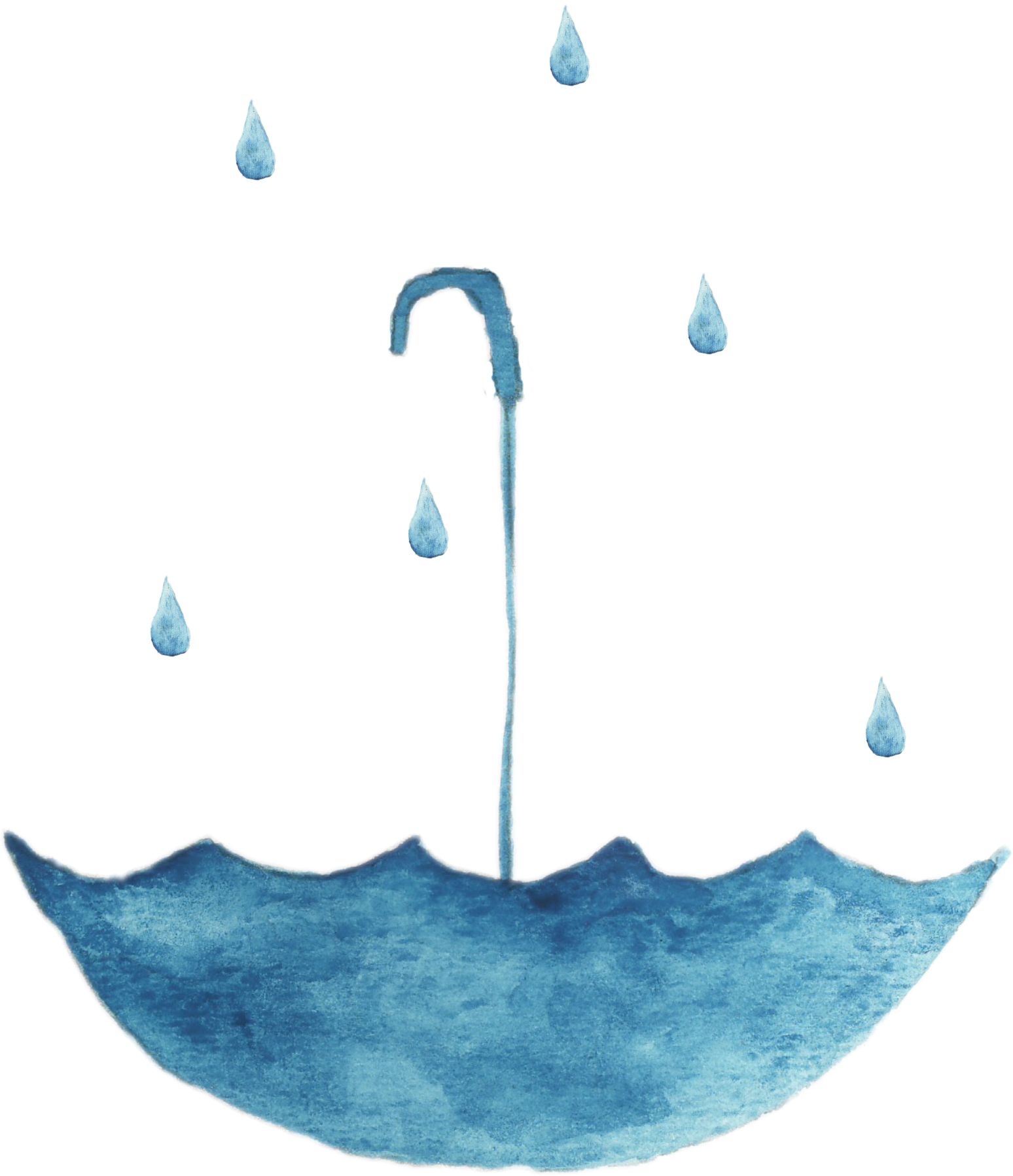
In California, antiquated water policy, fragmented water governance and single-purpose water projects have resulted in much of the state's potable water being squandered – a situation that is starkly apparent during times of water scarcity. As reservoir levels continue to drop and the current drought continues to make history in its severity, the state's residents are beginning to see the flaws of the existing water management system. California now has a rare opportunity to galvanize the public around water scarcity issues and implement transformative water policies that will set the state on a path towards sustainability and climate resilience.

The lessons learned from Melbourne and Adelaide offer key insights into how California cities can best respond to the current drought crisis to maximize potable water supply, mitigate urban heat, protect communities and the environment, and ensure that water is available in the future. These lessons – informing the policy recommendations outlined in this report – can help California continue to be a world leader in environmental innovation.

In the future, a re-imagined California will adapt to drought, flood and heat using the following approaches:

- Agencies that use whole-of-water-cycle management and collaborate to implement projects with multiple benefits
- A diversified water supply that includes decentralized sources, a fit-for-purpose approach, and does not rely too heavily on any one source
- Prioritization of quality of life issues even during times of drought and extreme heat
- Thriving, ample urban forests that mitigate heat and provide stormwater capture
- An engaged public practicing sustainable behaviors.

These components are the foundation of a resilient California that will be able to manage the water scarcity and climate issues of today and the future. California policymakers should leverage the drought and El Niño as an opportunity to implement these needed changes in the rare window of opportunity they are currently afforded.



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APPENDICES

Appendix A:
Overview of Australian Governance, Melbourne's Water Management and Adelaide's Water Management

Differences Between Australian and United States Governance Structures

Institutional differences between the Australian and American political systems stem from distinctions between the U.S. federal republican system and Australia's parliamentary system. In the U.S., a popular vote elects the President and congressional representatives, where the President is the head of state and appoints the administrators of federal agencies, subject to the approval of Congress. In Australia, ministers – or any politicians who hold significant public office – are elected to Parliament by popular vote, and the majority party elects a Prime Minister from its ranks. The Prime Minister directly appoints ministers from the party to head federal agencies.

State level governance generally mirrors federal governance in both countries. However, states have considerably more power in Australia than in the United States. Australian states have primary responsibility for environment and natural resource management, whereas in the U.S. this responsibility is held under the federal government and often delegated to the states by federal agencies. As a result of this, U.S. federal agencies are more commonly involved at the state and regional level in both direct and oversight roles.[li]

Local government structure in Australia and the U.S. also differs. In Australia, more powers – such as education, police and fire protection – are controlled at the state level. Local governments often oversee services related to building regulations and development, public health, local roads and footpaths, parks and playing fields, libraries, local environmental issues, waste disposal, drainage, and many other community needs. Further, many Australian states have reduced the number of local governments as well as the number of local water/wastewater agencies through amalgamation, an action that is rare in America.[lii]

Melbourne Water Management Overview

In Melbourne, Melbourne Water is the Victorian government-owned wholesaler of water supply, sewage treatment and recycled water services. Melbourne Water sources its potable water primarily from protected catchments that deliver water by gravity into ten harvesting reservoirs. From these reservoirs, water is then distributed through a network of aqueducts and pipelines to local service reservoirs. Melbourne Water also sources water for non-potable uses through stormwater harvesting, rainwater harvesting and recycled water from the Eastern and Western Treatment Plants. Three Victorian government-owned water corporations – Yarra Valley Water, City West Water, and South East Water – purchase and sell drinking water from Melbourne Water and provide sewage services for their respective jurisdictions. Since the mid-1800s, Melbourne's protected catchments have provided the city with safe, low-energy and reliable high-quality drinking water. However, the single potable water supply source has left the city vulnerable to water shortages during periods of drought.

During the Millennium Drought, Melbourne's four major harvesting reservoirs dropped by as much as 64 percent in comparison with their long-term average (a decline of around 73,000 acre-feet per year) (see Figure 4). To address this, the Victorian government offered water-efficiency rebates, provided education and technical assistance, developed statewide uniform guidelines for local water corporations to enhance water saving rules and water restrictions and facilitated water trading. The City of Melbourne imposed severe water restrictions, and from January 2007 to August 2010 Stage 3 (out of 4) efforts were in place, completely disallowing activities such as using potable water for lawn watering.[liii] These efforts resulted in per capita municipal water demand dropping by 46 percent over a 12-year period in Melbourne, from 121 gallons to 65 gallons per person per day.[liv] As a comparison, current per-capita water use in the City of Los Angeles is about 131 gallons per person, per day.

The Victorian government also built:

- a seawater desalination plant (Wonthaggi Desalination Plant) capable of supplying 121,600 acre-feet (AF) (150 GL) / year (Y) of water at a cost of AU$6 billion[lv] 2013);

- an interbasin transfer pipeline (the North-South Pipeline) capable of supplying 60,800 AF (75 GL) / Y of water at a cost of AU$700 million.[lvi]

Combined, the two new sources can deliver approximately 40 percent of the city's present-day municipal water demand.[lvii] However, since both projects' respective completion date, neither has supplied the city with water. This is due to: a) both projects being commissioned during the Millennium Drought and completed after the drought was over; b) public concern over the carbon footprint and the high economic cost of producing water from the desalination plant; and c) the politically unpopular idea of transferring water from already water-stressed rural regions via the North-South Pipeline.[lviii]

Following the drought, although water restrictions in Melbourne were lifted, permanent water use rules were kept in place. These rules included requirements regarding handheld hose use, garden and lawn watering, fountains and water features, and cleaning of hard surfaces. Also, Drought Response Plans for Melbourne's three water retailers were revised in 2011 to incorporate the Water Outlook Approach, an adaptive management strategy based on experiences of the Millennium Drought. The plan requires the three water retailers and Melbourne Water to jointly publish a *Water Outlook* for Melbourne by the first of December annually. The *Water Outlook* is a summary of Melbourne's water supply and demand, and includes short- and medium-term strategies to manage water security. These strategies include: efficiency programs, planning, education, benchmarking, water loss control, rainwater harvesting, recycled water, stormwater harvesting, and water restrictions.[lix]

The Victorian government also appointed the Ministerial Advisory Council to provide independent advice on urban water management. In 2011, it responded with the *Living Melbourne, Living Victoria Implementation Plan*, a plan recommending key priorities to improve Melbourne's water management to bring about benefits including healthier urban waterways, greener open spaces, reduced urban heat-island effect, future water security, and decreased reliance on rural water. The plan called for three strategies:

1) Overhauling the existing water planning framework to better respond to broader community and environmental needs and more effectively integrate with urban planning;

2) Transforming the way water resources and the water system are managed; and

3) Establishing the Office of Living Victoria (OLV) to drive reforms by coordinating urban and water planning.[15]

[15] The Living Melbourne, Living Victoria Initiative has since been absorbed by the Department of Environment, Land, Water and Planning.

Adelaide Water Management Overview

In Adelaide, SA Water is the South Australian government-owned water corporation that provides water and wastewater services to the city. SA Water draws its water from numerous sources, including: 1) the Murray River; 2) stormwater for non-potable use; 3) Managed Aquifer Recharge projects for non-potable use; 4) recycled water for non-potable use; 5) protected catchments in the Adelaide Hills; and 6) the Adelaide Desalination Plant. Most of the city's water supply is from the nearby catchments in the Adelaide Hills; however, during dry years 90 percent of water needs are met with water that is pumped from the River Murray.

During the Millennium Drought, the severe impacts on the Murray-Darling Basin rendered the city unable to use much of the Murray River water to meet its supply needs. As a result, compulsory water restrictions were introduced in 2003, and in 2005 the South Australian government developed the *Water Proofing Adelaide* plan. The goal of the plan was to develop a longer-term planning approach to secure Adelaide's water resources until 2025. The plan determined that by 2025, Adelaide's water supply would have an annual shortfall of 32,430 AF (40 GL) during drought years, and new supply and demand interventions needed to be implemented. On the supply side, the plan established that rainwater harvesting tanks and loss reduction strategies were economically feasible and suitable for implementation. On the demand side, the plan established a goal to reduce annual demand by 28,375 AF (35 GL) by. The strategies aimed at achieving these supply and demand interventions were to: 1) implement permanent water conservation measures; 2) introduce a nationally recognized water efficiency labeling scheme (WELS); 3) educate the public through various programs; 4) require all new dwellings to have rainwater tanks plumbed into the house; and 5) implement leak detection programs to minimize water losses in the reticulated system. However, initial demand strategies were largely ineffective, as the only compulsory restriction was the prohibition of outdoor watering in the middle of the day; the rest relied on voluntary responses from customers.[lx]

As the drought continued to worsen and flows in the Murray River dropped to historically low levels, the government responded by introducing temporary water restrictions and permanent water conservation measures that were outlined as part of the *Water Proofing Adelaide* strategy. These actions had a tremendous impact on people's behavior and had a visible public impact, as many public fountains were turned off and public parks turned brown. Further, as an effort to implement some of the voluntary strategies outlined in *Water Proofing Adelaide*, the government offered rebates on water-saving devices, such as water-saving showerheads and front-loading washing machines.[lxi]

Water restrictions had a tremendous impact on people's lives, prompting numerous community discussions on how the government should address Adelaide's water supply shortfalls. Desalination and stormwater capture and reuse (including rainwater harvesting) were determined to be suitable alternative water supply sources, and the government responded by commissioning a 81,070 AF (100 GL) / Y desalination plant for potable needs and a study looking into urban stormwater harvesting for nonpotable uses (though in reality, many residents used rainwater harvesting tanks during the drought as a potable water source). The government also produced a new water security plan, *Water for Good*, that was implemented in 2009 to replace *Water Proofing Adelaide* with a planning horizon to 2050. This more aggressive plan recognized the inadequacies of Adelaide's current water supply and advocated a mixture of new supply types, most notably the 81,070 AF (100 GL) / Y desalination plant and supplemental stormwater and recycled water projects. These projects were funded with increases to the water pricing structure,

with annual water prices doubling for Adelaide residents. The plan also included demand management incentives, such as rebates for water-saving appliances, and outdoor water conservation measures, such as rebates for garden mulch. These demand management and water restrictions resulted in a reduction of Adelaide's per capita water consumption from 87 gal (329 L) per person per day in 2003 to 60 gal (227 L) per person per day in 2009.[lxii] Further, incentives for rainwater harvesting tanks resulted in ~50 percent of Adelaide residents owning rainwater harvesting systems by the end of the drought.

Following the drought, *Water for Good* continued to guide Adelaide's water management. The plan is a 'living document' that is reviewed on an annual basis; therefore changes can be made each year to strengthen the plan's stated objectives of: 1) reforming urban water legislation to support the efficient and effective delivery of water and wastewater services; 2) pursuing water pricing that reflects the true value of water; and 3) developing a holistic urban water strategy linking all existing strategies together to achieve the high level objectives in *Water for Good*.[lxiii] A stormwater strategy was developed that aimed to move away from *ad hoc* projects and transition towards an integrated stormwater planning framework linking urban planning, public health, and natural resource management. To that end, the Department of Water was formed in 2010 to take control of water management and provide a focal point for the integration of water management activities. In 2012, the department was amalgamated into the Department of Environment, Water and Natural Resources to better facilitate the integration efforts.[lxiv]

Appendix B:
Policy Delegation Goals and Learning Objectives

TreePeople and The Energy Coalition hosted a 7-day policy delegation (October 21-27, 2014) to the Australian cities of Melbourne and Adelaide for a select group of California state, regional and local elected officials and policymakers to see and learn about Australia's multiple innovative drought- and climate-response initiatives. The goal of this trip was to understand that Australia offers immediately-implementable solutions for California's drought that also address significant water supply, climate and infrastructure needs. Objectives of the tour were to:

a) Identify the costs and benefits, as well as successes and lessons learned, from Australia's multi-agency governance structures and policies.

b) Identify what governance, technical and programmatic solutions are transferable to Los Angeles and other cities.

c) Understand Australia's drought-response timing and opportunities to accelerate programs and policies for Los Angeles and California.

d) Build a greater *esprit de corps* resulting in a viable team-based collaboration upon returning to California to help implement appropriate Australia-inspired solutions in Los Angeles and California.

The Australian policy delegation focused on the following key learning areas:

Collaborative Governance

- To better understand the Australian water management integration models and their potential applicability to Los Angeles and California.

Fostering Public Stewardship

- To better appreciate methods, incentives, disincentives and public education campaigns used to create significant shifts in public behavior change around water and energy stewardship.

Deploying Technologies to Scale

- To better understand viable, attainable technologies currently not practiced in Los Angeles that can increase locally-sourced water supplies and regional water supply reliability, including managed aquifer recharge and distributed rainwater harvesting.

Water-Energy Nexus

- To better understand the relationship between the water cycle and energy cycle in Australia and California and various policy mechanisms for addressing the water-energy nexus.

Appendix C:
List of Delegates on the 2014 Lessons from the Millennium Drought Policy Delegation

JARED BLUMENFELD
ADMINISTRATOR, REGION 9
US EPA

LESLIE FRIEDMAN JOHNSON
PRINCIPAL
LFJ STRATEGIES

ANDREW FAHLUND
DEPUTY DIRECTOR
CALIFORNIA WATER FOUNDATION

FELIPE FUENTES
COUNCILMEMBER
LA CITY COUNCIL

GREG GOOD
DIRECTOR OF INFRASTRUCTURE
CITY OF LOS ANGELES

GARY HILDEBRAND
DEPUTY DIRECTOR
LA COUNTY DEPARTMENT OF PUBLIC WORKS

FELICIA MARCUS
CHAIR
CA STATE WATER RESOURCES CONTROL BOARD

TRACI MINAMIDE
CHIEF OPERATING OFFICER
LA BUREAU OF SANITATION

NANCY SUTLEY
CHIEF SUSTAINABILITY OFFICER
LA DEPT. OF WATER AND POWER

FRANCESCA VIETOR
COMMISSIONER
SAN FRANCISCO PUBLIC UTILITIES COMMISSION

MEAGHAN LAVERTY
PROGRAM MANAGER
THE ENERGY COALITION

CRAIG PERKINS
PRESIDENT AND EXECUTIVE DIRECTOR
THE ENERGY COALITION

ANDY LIPKIS
FOUNDER AND PRESIDENT
TREEPEOPLE

DEBORAH WEINSTEIN BLOOME
DIRECTOR OF POLICY
TREEPEOPLE

SETH KINER
BOARD MEMBER
TREEPEOPLE

GRETCHEN KNUDSEN
POLICY FELLOW
TREEPEOPLE

DAVID JAECKEL
RESEARCHER
YALE UNIVERSITY

Appendix D:
Cooling and Urban Heat Impacts Motion

R2

MOTION

ENERGY & ENVIRONMENT

City temperatures are expected to increase about 4 degrees Fahrenheit by mid-century due to climate change, according to research conducted by the Professor Alex Hall of the University of California Los Angeles. As a result, there will be more days of excessive heat each year. In the community of Sylmar, for example, there are currently 54 days a year that exceed 95 degrees Fahrenheit. Dr. Hall's research shows that by the year 2041, that number will increase to 96 days a year.

The expected increase in temperature is a concern, not just for the environment, but also for public health. Vulnerable populations suffer from heat-related deaths and illnesses each year. In Los Angeles County, 115 people were hospitalized due to heat in just a five-month period in 2012, according to the California Department of Public Health. Hotter temperatures can also increase the likelihood of brush fires, putting lives and property at risk.

The challenges presented by climate change are not unique to Los Angeles. Other regions are already working to address the negative consequences of a warmer world.

The Australian city of Melbourne has a goal to reduce the city's average temperature 7 degrees Fahrenheit by 2030. In response to a twelve-year drought, officials there increased the urban tree canopy to lower the city's surface temperature, created an open space strategy, and built centralized and distributed stormwater capture projects to water landscapes and trees using captured rain and to keep soil moisture high in urban areas. Such policies promoted livability and improved physical and psychological health in the face of drought and extreme heat.

As Los Angeles looks to become a more resilient city, it must mitigate the expected increase in temperature and take steps, like Melbourne, to reduce it. This calls for a coordinated strategy that can most effectively deploy resources in areas of the City where it is most needed.

A targeted campaign to cool the urban core would not only help to address the negative impacts of climate change, but also save lives and improve the quality of life.

I THEREFORE MOVE that Council instruct/request the Chief Legislative Analyst, in conjunction with the Department of Public Works, Department of Water and Power, Department of City Planning, and Department of Recreation and Parks to report in 45 days on the formation of a *Committee on Cooling and Urban Heat Impacts* comprised of relevant City departments, and experts in the field, to undertake the following objectives:

- Establish a cooling target for the City of Los Angeles;
- Identify regions within Los Angeles most vulnerable to excessive heat based on current and expected temperatures as well as deleterious air mass types; and current and historical data on heat-related deaths and illness;
- Recommend strategies for achieving the cooling target in Los Angeles; with a priority on strategies that will benefit communities that are identified as the most vulnerable to excessive heat;
- Develop guidance to protect livability and health, especially in drought situations, and identify public open spaces and corridors needed for cooling, including how to maintain such areas in drought situations.

PRESENTED BY: _____
FELIPE FUENTES
Councilmember, 7th District

SECONDED BY: _____

FEB 18 2015

ORIGINAL

Appendix E:
Stormwater Management Guidelines for Public Street Construction and Reconstruction

14-0748

MOTION

ENERGY & ENVIRONMENT
JUN 6 2014

Streets convey not only automobiles and pedestrians but also water. When it rains, water flows from the street into catch basins and storm drains that then divert the runoff into our local tributaries, rivers and ocean. In the process, street pollution contaminates waterways, and stormwater that could be captured and reused is discharged into the ocean.

This system presents a number of challenges for the City of Los Angeles (City). First, it does not sufficiently address runoff pollution, which the City is mandated to mitigate. The City currently must satisfy 22 Total Maximum Daily Load (TMDL) regulations as part of its Municipal Separate Storm Sewer System (MS4) Permit. Failure to comply with the permit could result in extensive financial penalties.

Second, the current system fails to capitalize on stormwater capture and groundwater infiltration opportunities. Local efforts to bolster our local water supply, particularly in this time of drought, are necessary in order to meet the Mayor's goal of reducing City water imports by half.

Finally, it does not adequately protect against flooding. There are more than 400 known locations that have drainage problems causing localized flooding in our neighborhoods and exposing our residents, motorists, and bicyclists to potential safety hazards. In addition, poor drainage and chronic flooding can damage and undermine street pavement.

Incorporating Best Management Practices and green street infrastructure such as bioswales, curb cuts, and tree wells can mitigate a number of these concerns by infiltrating water where appropriate and removing contaminants from polluted water before discharge.

To achieve this, the Bureau of Street Services, Bureau of Sanitation, Bureau of Engineering, and the Department of Water and Power would need to collaborate and develop green infrastructure projects that provide multi-benefit solutions.

An estimated 2,400 centerline miles are currently failing or near failing. A new approach to capital expenditures should be pursued to maximize the public investment in infrastructure as opposed to today's patch-work approach.

City policy should prioritize multi-benefit solutions that improve transportation and safety, minimize flooding, reduce watershed pollution, and increase stormwater capture and local water supply. A multi-benefit approach also necessitates a review of current departmental performance metrics to better measure the efficiency and effectiveness of such projects.

I THEREFORE MOVE that Council instruct/request the Bureau of Street Services and the Bureau of Sanitation, in conjunction with the Bureau of Engineering, Department of Water and Power, Chief Legislative Analyst and the City Administrative Officer, to work with the City Attorney to develop a draft ordinance that requires all public street construction and reconstruction projects, irrespective of funding source, to incorporate *Stormwater Management Guidelines for Public Street Construction and Reconstruction* (as attached) consisting of the following components:

- Drainage capacity/flood mitigation;
- Stormwater infiltration feasibility;
- Water quality improvement and regulatory standards.

I FURTHER MOVE that the Bureau of Street Services and Bureau of Sanitation report to the Council in 45 days on the status of the working group and draft ordinance development.

PRESENTED BY: _____
FELIPE FUENTES
Councilmember, 7th District

SECONDED BY: _____

JUN 6 2014

ORIGINAL

City of Los Angeles
Stormwater Management Guidelines for Public Street Construction and Reconstruction

All public street construction and reconstruction projects in the City of Los Angeles will utilize Best Management Practices and accepted green street infrastructure standard plans to assess drainage, stormwater infiltration, and water quality needs. Street resurfacing projects will be coordinated among city departments to ensure efficiencies in implementation and will utilize Best Management Practices when appropriate.

I. Prioritization of Streets

The system for prioritizing street construction and reconstruction will give a weighted score to street segments based on criteria that include the following:

- Flooding/drainage deficiencies
- Stormwater infiltration and/or capture feasibility for water supply augmentation
- Water quality deficiencies required to be remediated under the City's Municipal Separate Storm Sewer System permit or to meet other regulations or community needs.

II. Green Street Infrastructure Implementation

The Bureau of Sanitation will review all street construction, reconstruction, and resurfacing projects and work with the Bureau of Street Services, Bureau of Engineering, and the Department of Water and Power to incorporate green street infrastructure as appropriate.

For a construction or reconstruction project on a street segment with low to moderate flooding, staff will analyze the stormwater infiltration feasibility of the location based on its soil permeability, groundwater levels, slope, and contamination. Staff will determine if stormwater should be captured onsite or treated and discharged and identify appropriate green infrastructure elements from the Best Management Practices Tool Box. Treat and discharge practices (Tool Box 2) will only be utilized if infiltration and/or capture are demonstrated as infeasible. All projects will be required to follow infiltration standards as determined by the Bureau of Sanitation, with the performance goal of infiltrating or capturing for use, at a minimum, the 85th percentile storm. Infiltration standards will aim to maximize infiltration and ensure protection of groundwater quality.

Best Management Practices Tool Box*	
Volume Capture (Tool Box 1)	**Treat and Discharge (Tool Box 2)**
– Curb/parkway retrofits	– Bioswales
– Infiltration trenches	– Curb/parkway retrofits
– Infiltration galleries	– Bioretention with underdrains
– Dry wells	– Treatment train of BMPs with biofiltration prioritized
– Bioinfiltration/bioretention without underdrains	– Trees
– Cisterns	
– Other Storage BMPs	
– Trees	

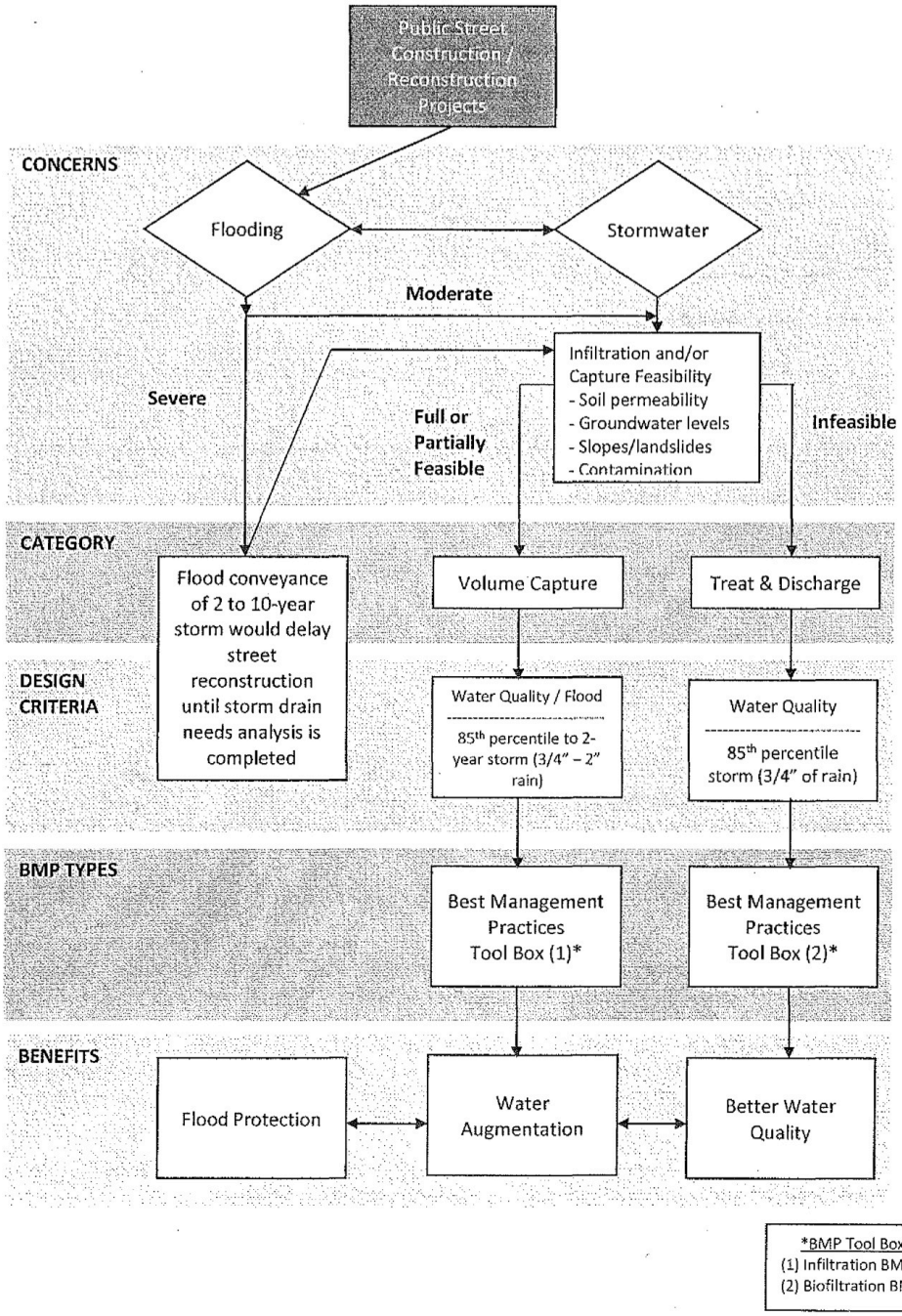
*The Tool Box is not an exhaustive list and will be updated by Bureau of Sanitation as new standard plans are developed.

For a street segment with severe flooding, staff will first conduct a storm drain analysis prior to construction or reconstruction, and then proceed with the above stormwater infiltration feasibility analysis. The analysis shall include the ability for upstream capture to reduce flooding impacts. When construction or reconstruction begins, the performance goal of infiltrating or capturing for use will be, at a minimum, the 85th percentile storm standard.

For street resurfacing projects, departments will coordinate on opportunities to implement parkway Best Management Practices such as bioswales, curb/parkway retrofits, and trees that could be implemented either in conjunction with street resurfacing or on an independent parallel process through contracting or local grants.

This policy will produce multi-benefit projects that protect against floods, replenish local water supplies through groundwater infiltration and capture for use, mitigate water pollutants, and provide community enhancements.

Green Street Infrastructure Implementation



*BMP Tool Box
(1) Infiltration BMP
(2) Biofiltration BMP

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