Government of **Western Australia**
Department of **Water**

ROYALTIES
FOR REGIONS

WATER FOR GROWTH

Urban

Western Australia's water supply and demand outlook to 2050

Securing Western Australia's water future

June 2016

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Cover photograph: Bunbury, Collie River and Leschenault Inlet looking west

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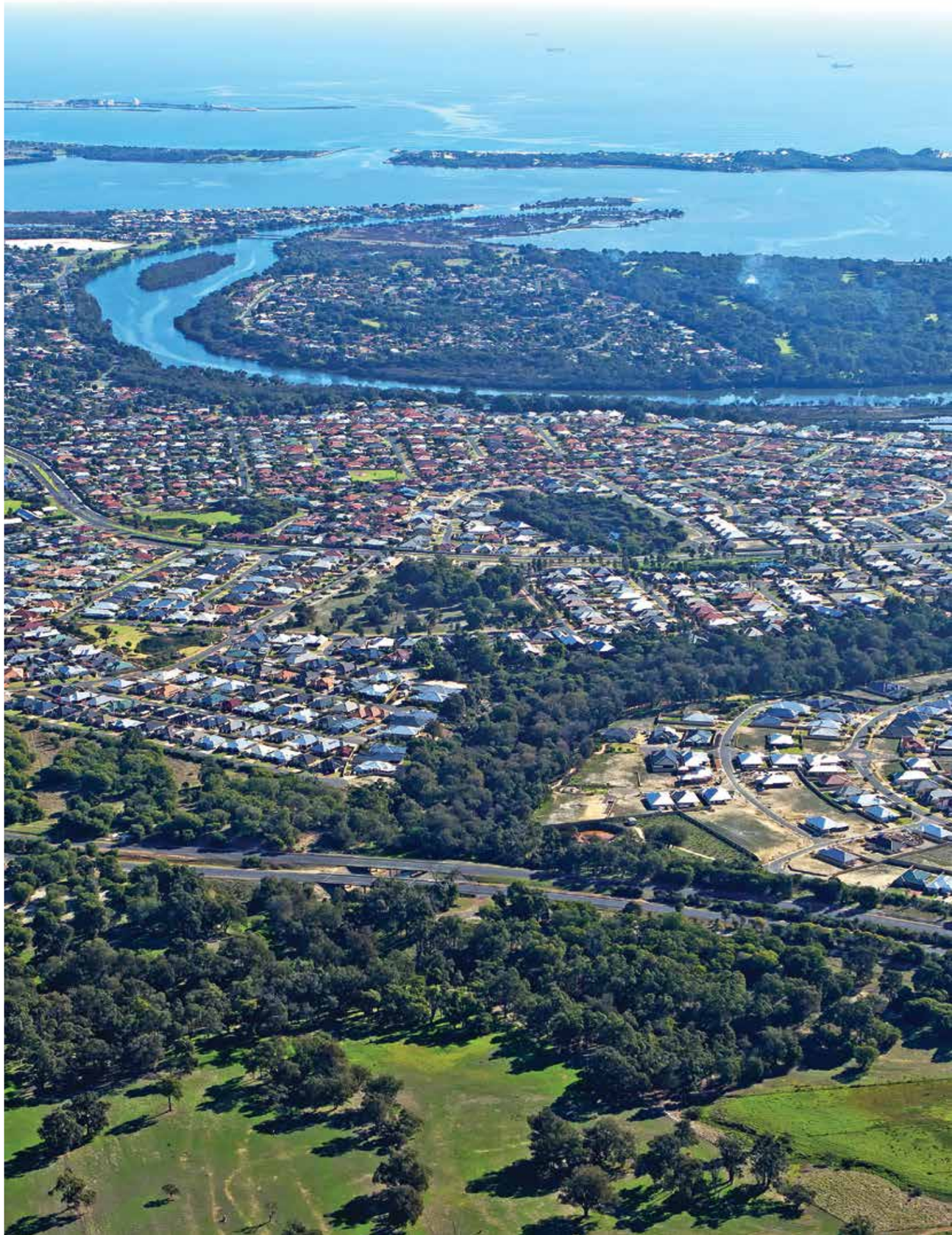


Water for Growth: Urban is part of the Water Supply and Demand Outlook series. Other reports in the series cover the agriculture, heavy industry and mining sectors. The information provided in these reports draws from the Department of Water's Water Supply-Demand Model. The model and report series was funded through the State Government's Royalties for Regions 'Regional water availability, planning and investigation program'. The program aims to support regional development by assessing the water resources and supply options needed for Western Australia's future population and economic growth.

How much water is that?

1 gigalitre (GL)

= one billion litres

Volume of Melbourne Cricket Ground stadium
≈ 1.6 GL

1 megalitre (ML)

= one million litres

Volume of Beattie Park swimming pool
≈ 2.4 ML

1 kilolitre (kL)

= one thousand litres

Volume of four wheelie bins
≈ 1 kL

Contents

A message from the Minister

Hon. Mia Davies MLA, Minister for Water

In meeting the challenges and opportunities for the future of Western Australia's growth and development, the security and availability of water is a key consideration. To support the extensive planning and activity already happening to maintain long-term growth of the State, the Department of Water has created the Water for Growth report series.

The Water for Growth report series builds on Western Australia's history of excellent science and research into water resource use and management. It combines the Department of Water's knowledge of water resources with industry insights and expert advice on projected growth of the population and economy.

This comprehensive water demand and supply forecasting is grounded in other important trends for the State. In the past thirty years, Western Australia's population has increased by more than one million people and our economy has reached new heights on the back of demand for our mineral resources. Rainfall has decreased and the dams that once met most of Perth's water needs are no longer being replenished. Our groundwater resources, which now supply most of our urban water needs, are under pressure due to increasing demand for water and the drying climate in the south west of the State. Against this backdrop, the Department of Water has prepared Water for Growth: Urban.

Water for Growth: Urban is a long-term outlook of water supply and demand for households, parks and gardens and commercial use in urban areas across Western Australia. The report supports collaboration between government, industry and the community to co-design solutions for timely and cost-effective water supplies. Accurate and timely water advice gives the urban development sector confidence to invest in regional development and new projects needed to boost our economy. It also helps connect land planning with local water resources and identify areas for improved water use efficiency.

With increasingly precise science to support effective management we can ensure our use of groundwater resources stays in balance with a drier future. We can also build on the significant water savings made by Western Australians over the past decade with more innovation and smart design of water-sensitive urban areas.

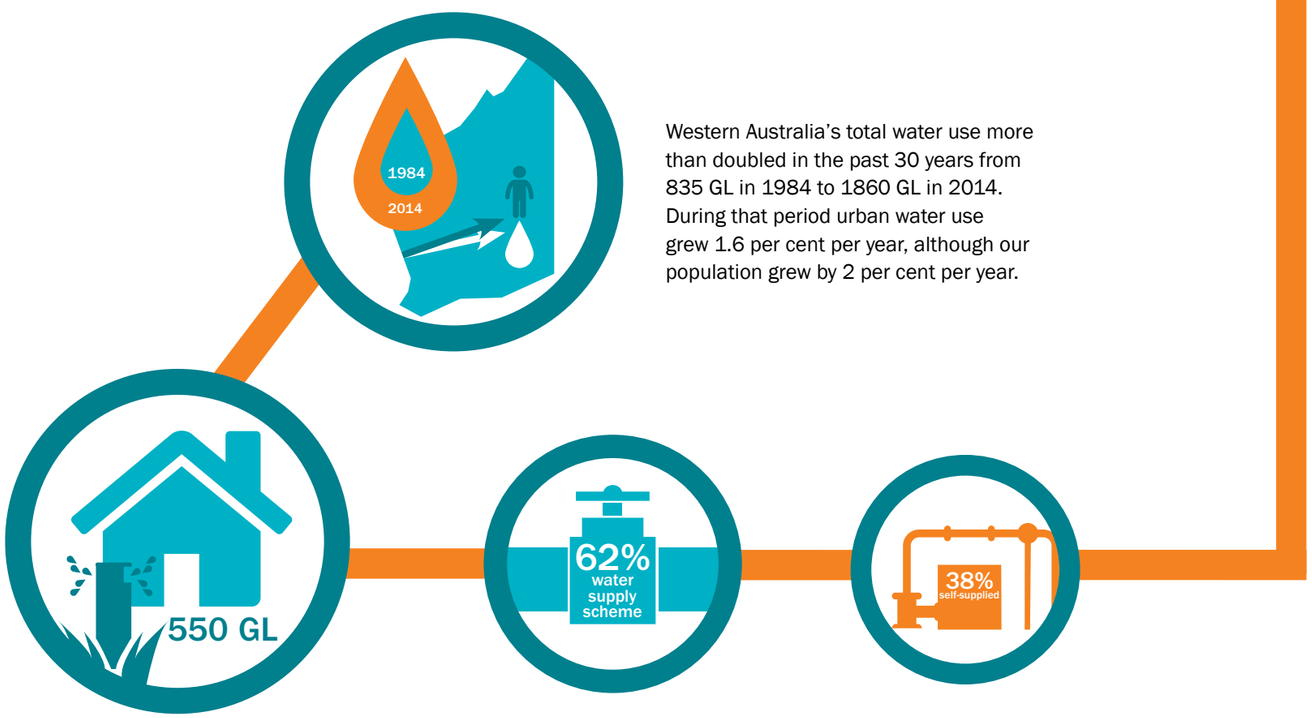
Over the past decade, our largest urban areas have started transitioning to climate-resilient water sources like seawater desalination and treated wastewater, which will become increasingly important into the future. In regional centres, we are expanding the identification and use of 'fit for purpose' non-drinking water sources so drinking water supplies can continue to meet demand as the population grows.

Our State's future growth and prosperity and its water future are closely linked. I invite Western Australia's community, industry and government to continue working together to meet the challenges of supplying water for sustainable and productive use under changing climatic conditions. I hope the water supply-demand outlook series assists and encourages you to be part of this journey, where we all have a key role to play in securing water for the future.

Summary

- *Water for Growth: Urban* examines the water demand and supplies for Western Australia's cities, towns and localities, both now and 35 years into the future.
- The Water Corporation, Aqwest (Bunbury) and Busselton Water operate Western Australia's public water supply schemes that reticulate drinking water for domestic, commercial and industry use.
- Households, local government, schools and businesses also independently source groundwater where available, mainly to irrigate parks and gardens.
- We estimate that at least an additional 250 gigalitres per year of water will be needed for Western Australia's urban areas by the year 2050 to meet the growth in demand from households, parks and gardens and to produce goods and services.
- Western Australia's community, private sector and three tiers of government will each play a critical part in building our state's future water security. Our approach is to optimise the sustainable use of groundwater and surface water, achieve water efficiency targets and develop new water sources that are appropriate for a drying climate.

Current urban water supplies and demand



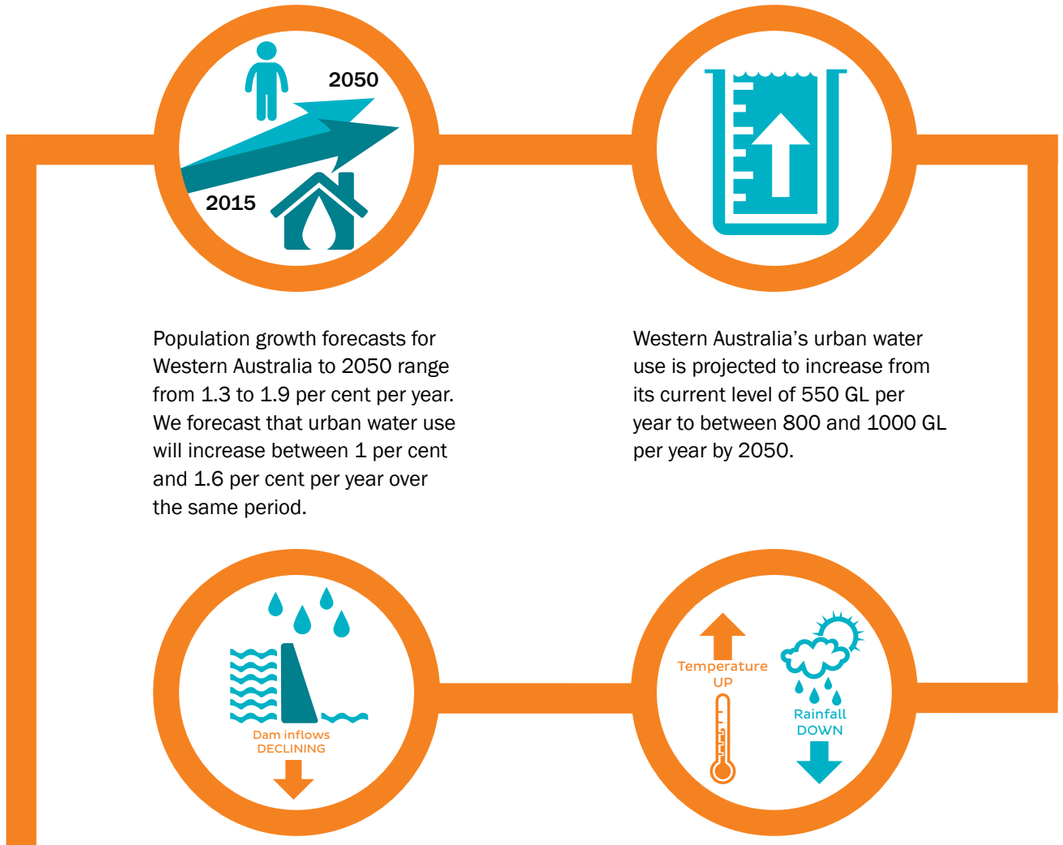
Western Australia's total water use more than doubled in the past 30 years from 835 GL in 1984 to 1860 GL in 2014. During that period urban water use grew 1.6 per cent per year, although our population grew by 2 per cent per year.

Urban water users across Western Australia currently consume 550 GL of water a year, comprising of:
69 per cent for households
17 per cent to irrigate parks and gardens, and 14 per cent for commercial purposes.

62 per cent of urban water is supplied via public water supply schemes operated by the Water Corporation, Aqwest (Bunbury) or Busselton Water.

38 per cent of urban water is self-supplied, mainly from groundwater bores owned by households, local government, schools and businesses.

Future urban water supplies and demand



Population growth forecasts for Western Australia to 2050 range from 1.3 to 1.9 per cent per year. We forecast that urban water use will increase between 1 per cent and 1.6 per cent per year over the same period.

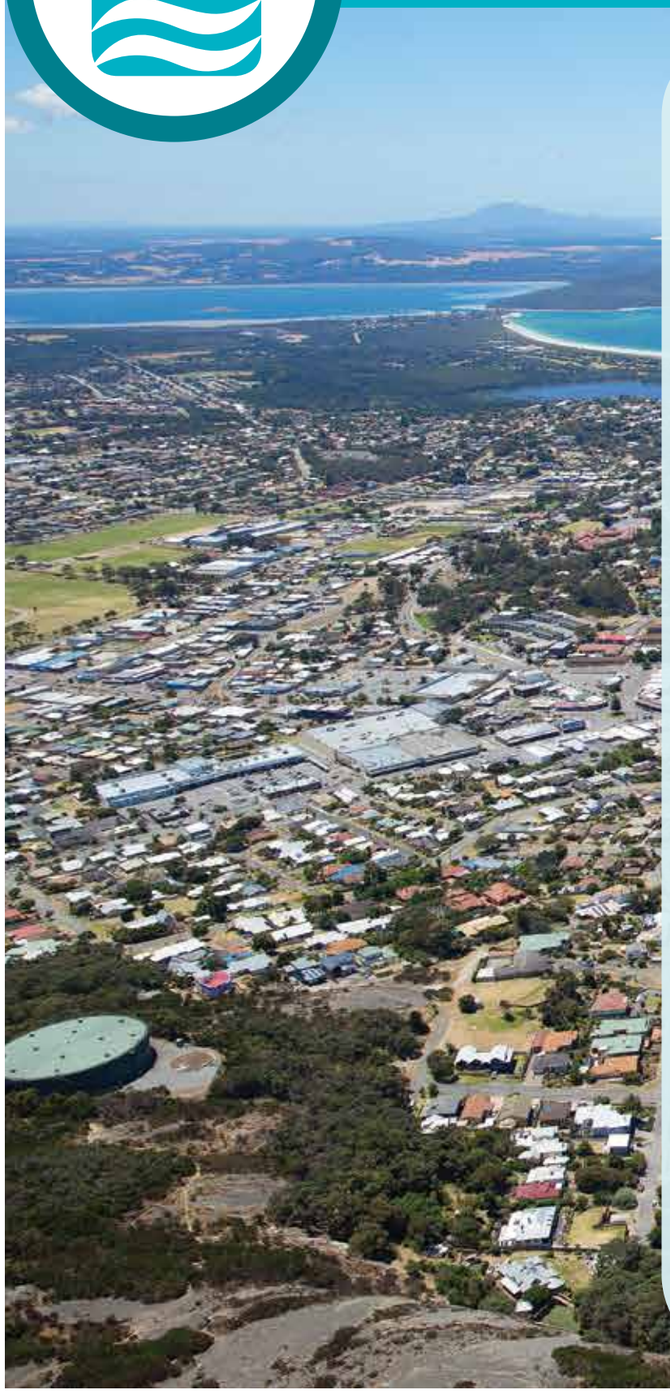
Western Australia's urban water use is projected to increase from its current level of 550 GL per year to between 800 and 1000 GL per year by 2050.

Declining and more variable inflows into dams used to store drinking water in south west Western Australia mean new climate-resilient water sources will be needed to secure public water supply schemes.

The availability of shallow groundwater in urban areas including Perth, Kwinana, Mandurah, Greater Bunbury and Busselton is now limited and recharge to these aquifers will decrease in a drying climate.

The Department of Water uses a water supply–demand model to identify when new water sources will be needed to meet long-term demand across the state. The model projects future water demand and supply by combining data related to current water use, water resources, economic growth and population forecasts.

Building water security



Supplying groundwater and surface water for now and the future

- The Department of Water regulates how much groundwater and surface water can be sustainably taken for use. Our water resource investigations and monitoring provide the scientific rigour needed to make water available now and for the future.
- Independent use of shallow groundwater by households, local governments, schools and businesses reduces demand on scheme water and can be sustained with efficient watering of gardens and carefully planned urban design that helps to recharge aquifers.
- Water service providers and the Department of Water are closely monitoring regional and independent town water supply schemes and planning ahead for when licensed groundwater and surface water can no longer meet demand.
- We are preparing to develop new legislation to reinforce how we manage and share water between users in a drying climate.

Innovation in water use efficiency and water sensitive development

- Western Australia's urban water consumption improved by 15 per cent per person in the last 30 years. The focus is now on innovation in water use to achieve a further 15 per cent per person reduction in household, commercial and local government water use by 2030.
- Planning for new urban areas must now consider the total water cycle and the water resources available locally. The efficient use of local groundwater, stormwater and wastewater can help maintain urban green spaces, reduce urban heat and ease pressure on public water supply schemes.
- All Western Australians can support the growth and liveability of our urban areas by using less water through efficient irrigation practices and smart use of water at home or in the workplace.
- Water service providers will continue to demonstrate efficient use of water from public water supply schemes before developing a major new water source. This includes achieving targets to reduce water demand and water lost from leaks and breaks in the supply system.

Moving to water sources for a drier climate

- The Water Corporation is reducing our reliance on surface water from dams to supply Perth and towns and farms along the Goldfields Pipeline to Kalgoorlie, as well as small towns in the South West, southern Wheatbelt and Great Southern regions.
- Groundwater is also affected by reduced recharge in a drier climate. Groundwater replenishment and recovery with treated wastewater and new areas of groundwater abstraction along the northern metropolitan corridor will meet some additional demand for water in Perth.
- In the longer term seawater desalination is a more cost-effective option than piping groundwater or river water from dams in distant locations like the Kimberley region. This also allows the regional water source to be used for developing the region.
- The Department of Water is supporting developers and local governments to consider managed aquifer recharge using treated wastewater and/or stormwater to meet some of our non-potable (non-drinking) water needs.

Western Australia's urban water supplies and demand

Western Australia's population is concentrated in urban centres along the coast These are generally areas where high-quality groundwater from sedimentary aquifers is available. Local aquifers supply most of the water we use in our homes, public open spaces and for commercial purposes.

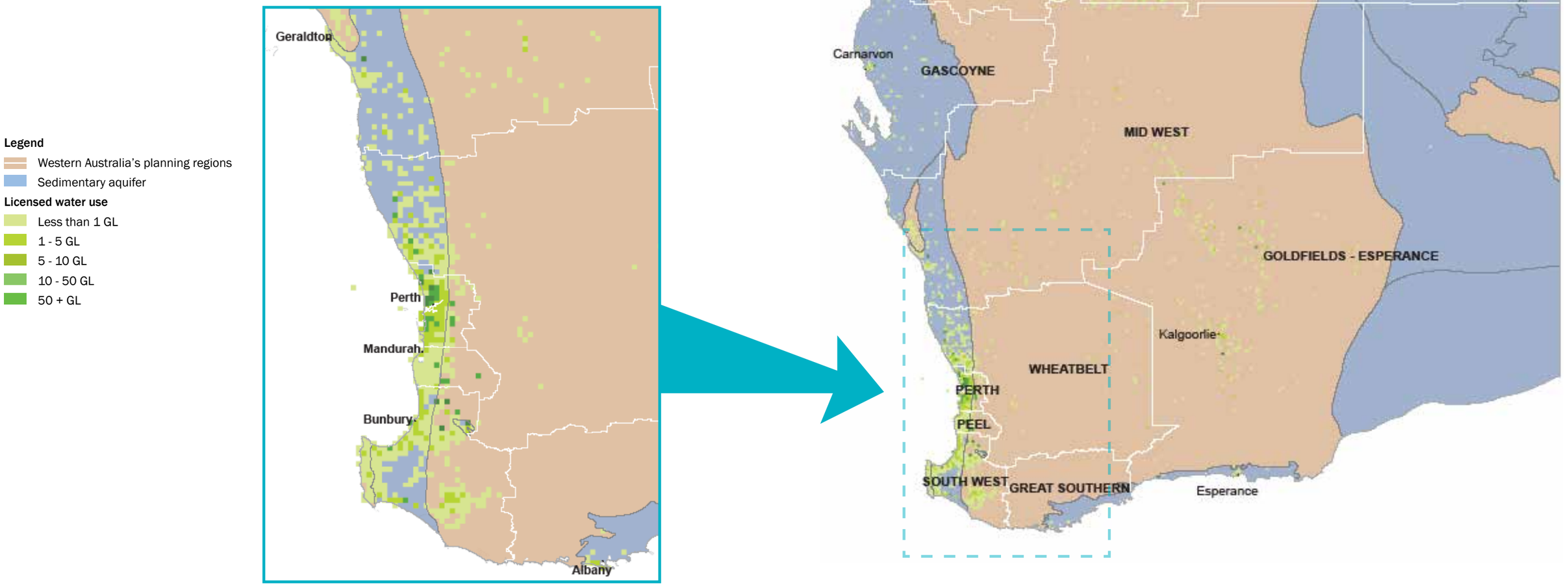


Figure 1 | Licensed water use and the state's major urban centres

Urban water use

Urban water users (other than heavy industry) across Western Australia consume around 550 GL of water per year, accounting for 30 per cent of the state's total water use.

Perth is the largest urban centre in Western Australia, with just over 1.9 million of the state's 2.5 million population. The Perth region has a wide range of commercial, light industry and public enterprises in addition to the residential population, and has the greatest demand for urban water in the state, using 395 GL per year.

Region	Scheme urban water use (GL)	Self-supplied urban water use (GL)	Total urban water use (GL)
Kimberley	11	2	13
Pilbara	16	7	23
Gascoyne	3	1	4
Mid West	14	3	17
Wheatbelt	15	2	17
Perth	230	165	395
Peel	13	11	24
South West	17	18	35
Great Southern	8	1	9
Goldfields–Esperance	13	1	14
Total	340	210	550

Table 1 | Urban water use and supply type in Western Australia for 2014-15

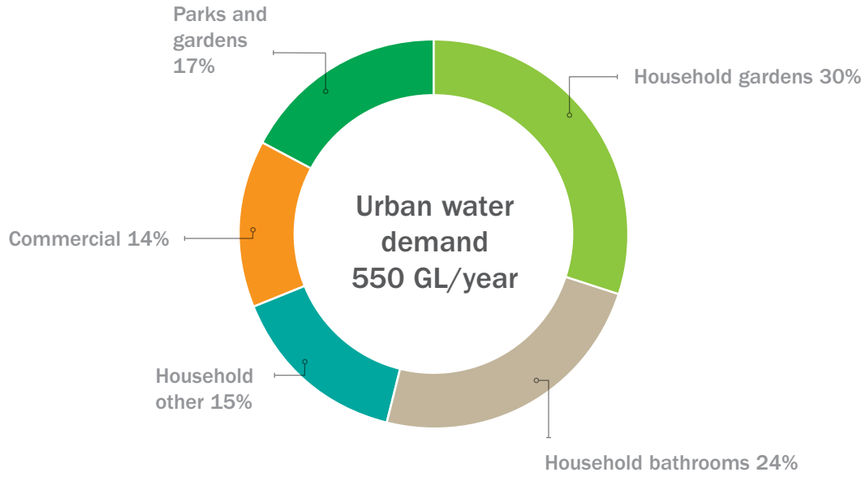


Figure 2 | Proportion of urban water uses in Western Australia

Households account for 69 per cent of Western Australia's urban water use, most of which is used outdoors and in bathrooms. With local government authorities, schools and businesses also using large volumes of water to irrigate parks, gardens and sports grounds, about half of the water used in our urban areas is outdoors.

Commercial water use accounts for 14 per cent of total urban water use and includes some of the largest individual water consumers. Large water users include the food and beverage industry, public institutions, shopping centres, hospitals and hotels.

Urban water sources

Local groundwater is fundamental to our way of life in Western Australia. Our most populated urban areas are spread over the Perth Basin, which is the state's largest renewable, mostly fresh groundwater resource. Groundwater currently provides two-thirds of all water used in urban areas of Western Australia, while water from rivers (surface water) contributes 11 per cent. Until the 1990s surface water stored in dams supplied at least 40 per cent of the water used in the state's urban areas.

Our urban areas are currently transitioning from using low-cost, high-quality groundwater and surface water sources to water sources like seawater desalination and treated wastewater that are climate-resilient.

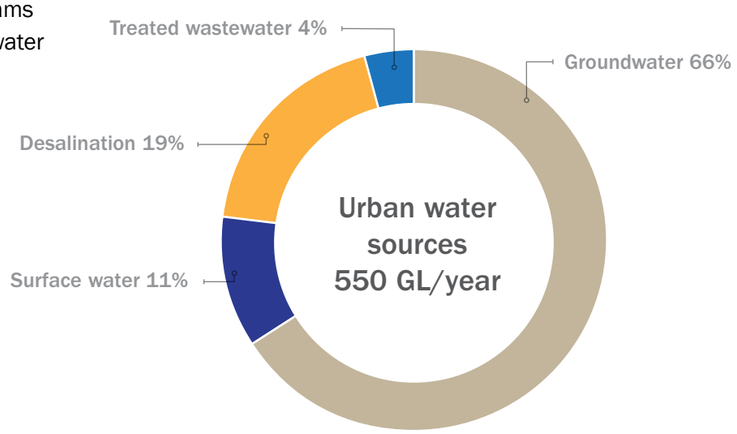


Figure 3 | Sources of urban water supplied in Western Australia

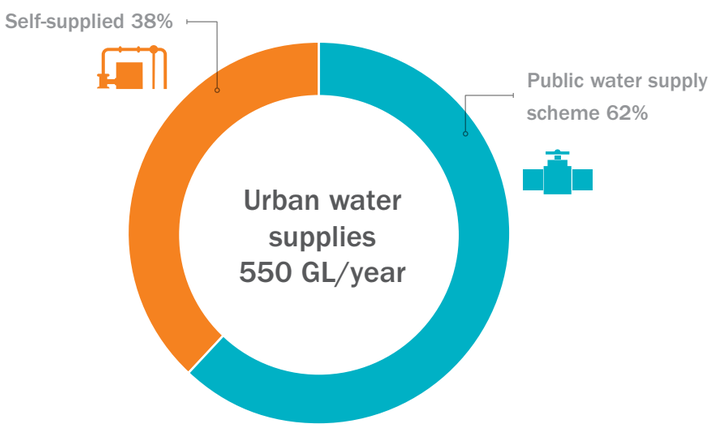


Figure 4 | Urban water supply type in Western Australia

More than 60 per cent of the water for urban areas is supplied through reticulated public water supply schemes. Almost 40 per cent is drawn independently (self-supplied) from groundwater bores by households for residential garden use, local government to irrigate public open space, schools and clubs for sports grounds and businesses for various commercial purposes as well as gardens.

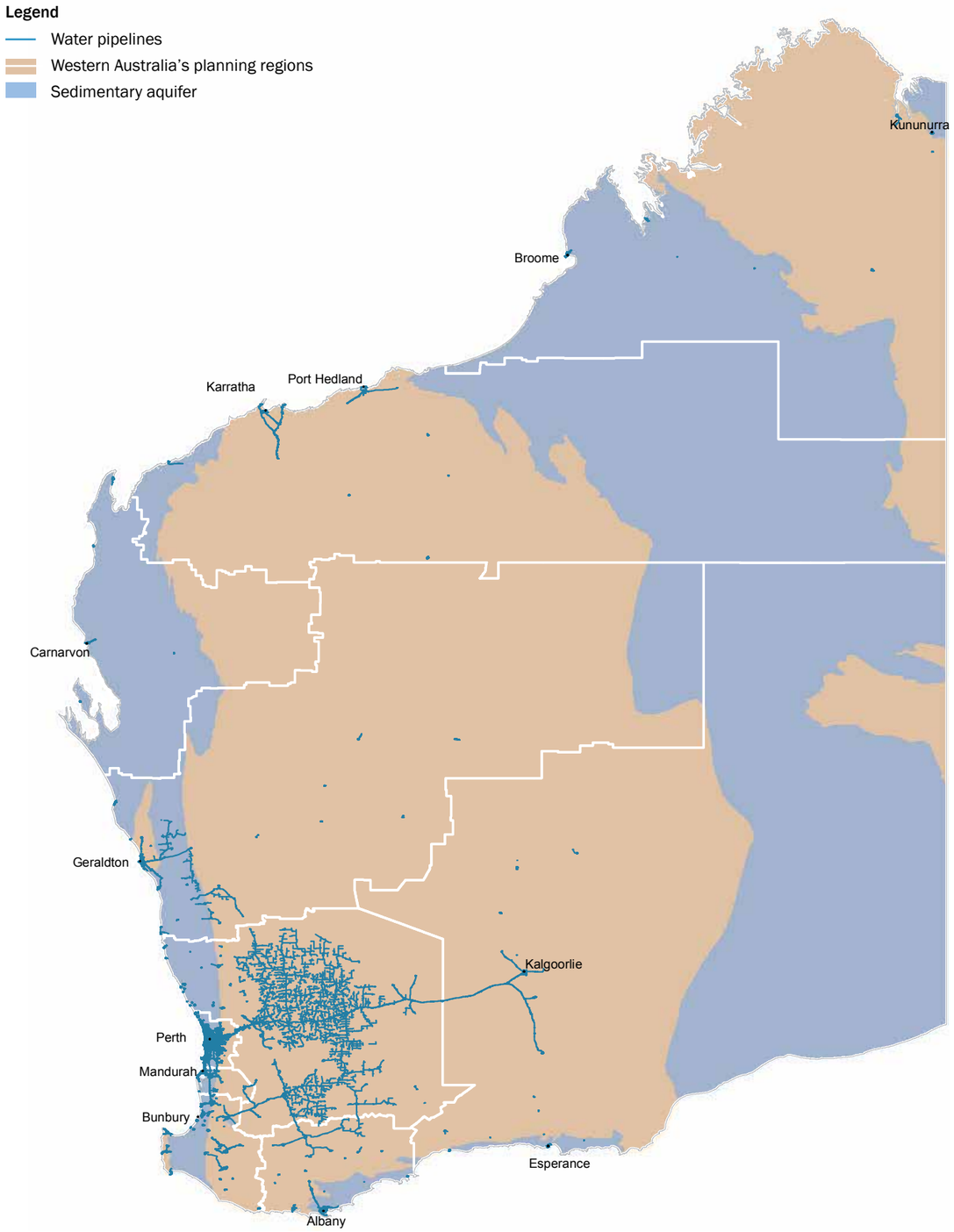


Figure 5 | Western Australia's major drinking water supply schemes and urban centres

Public water supply schemes

Public water schemes supply drinking water to residential and commercial properties and can also supply water for heavy industry and parks and gardens where other sources are unavailable. The Water Corporation is responsible for the supply of scheme water for most of the state, with Aqwest providing water in Bunbury, and Busselton Water supplying the Busselton area.

The Water Corporation operates several large, interconnected water supply schemes in addition to most of Western Australia's individual town water supply schemes.

Since the year 2000, improving water efficiency has had a major influence on demand from Western Australia's public water supply schemes. All regions now have permanent garden sprinkler rosters for scheme water users and a range of additional water efficiency programs have been introduced across the state. These programs have been highly successful and have seen average water use per household decrease consistently over time. However despite this improvement in water efficiency, the state's existing drinking water sources are under increasing pressure from population growth and a drying climate in south west Western Australia.

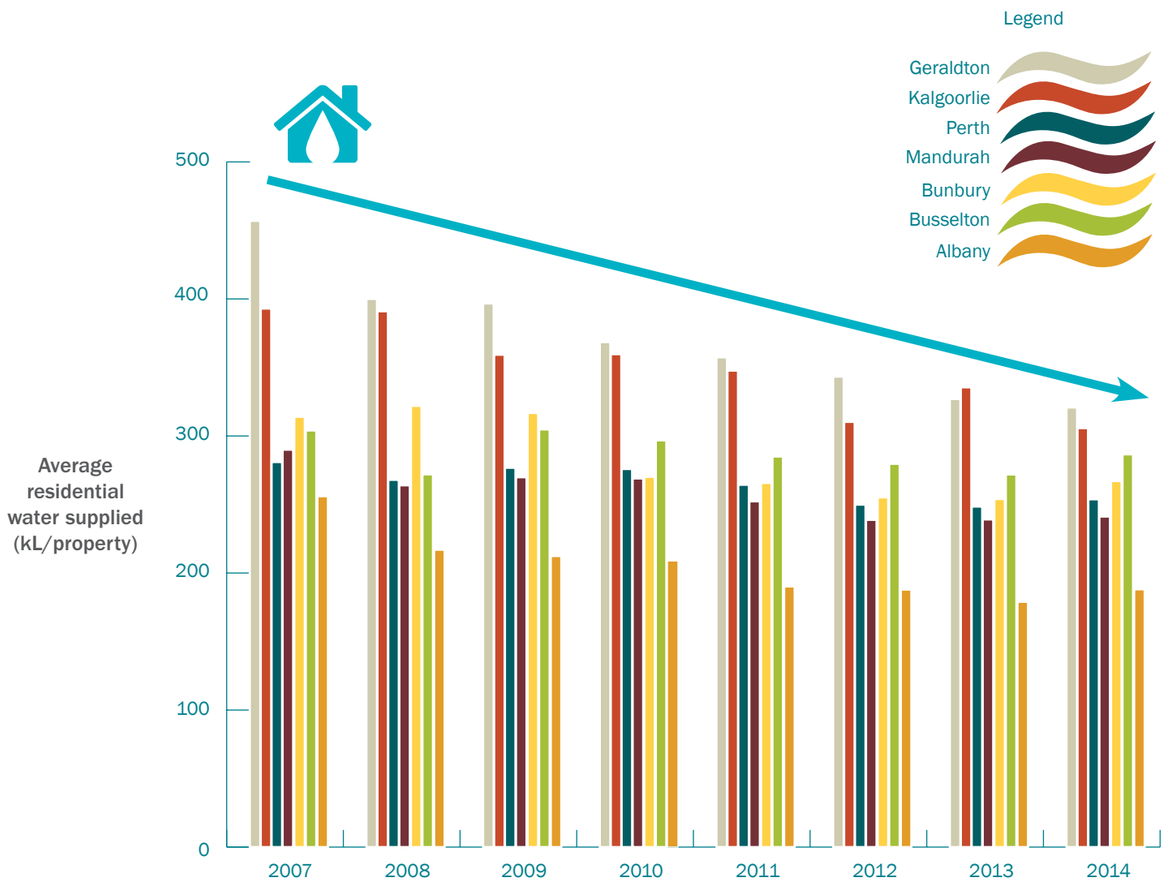


Figure 6 | Average scheme water use per residential property in Western Australia's major urban centres

Western Australia's water services

The Western Australian water services industry serves around 1.7 million customers in over 300 towns and communities throughout the State.

Western Australia's three major urban water service providers (Water Corporation, Aqwest and Busselton Water) are government trading enterprises with the Minister for Water as their single shareholder. These water utilities balance commercial objectives with community service obligations and the need to respond to the direction of the State Government, acting on behalf of all Western Australians.

The Water Corporation has had a key role in Perth's transition from a city fully dependent on fresh water in dams and aquifers to a more reliable and diverse water supply augmented by desalinated seawater and treated wastewater. Information on the Water Corporation's future plans to reduce water demand and develop new water sources can be found in a series of reports titled Water Forever (www.watercorporation.com.au)

Community water supplies for parks and gardens

Access to public parks, gardens and sporting ovals is a large part of the Western Australian lifestyle and is important in maintaining an active and healthy community. The total volume of water used for parks, public gardens and sporting fields is increasing with population growth, more intensive recreational activities, and the community's preference for green and more 'liveable' neighbourhoods.

Currently 95 GL per year is used to irrigate parks, gardens and recreation areas, most of which is in the Perth (70 GL), South West (7 GL) and Peel (5 GL) regions.

The majority of parks, ovals and public gardens are the responsibility of local government and are irrigated using self-supplied groundwater. The aquifers accessed by self-supply bores are shallow and rely on rainfall for recharge. The decline in rainfall since the mid-1970s has increased the need for irrigation, while at the same time groundwater recharge has been decreasing.

The growing scarcity of groundwater has led local governments to reduce irrigation rates and to adopt water sensitive urban design principles that distinguish between water used for active and passive public spaces. Local governments are also participating in the WaterWise Councils program, which aims to improve water efficiency and to assist councils with water management. The use of non-potable water sources, such as treated wastewater and stormwater, is increasing for parks, public gardens and sporting fields.

Photo | Minister for Water Hon Mia Davies and City of Wanneroo Mayor Tracey Roberts at the launch of the North West corridor water supply strategy, February 2014

Sharing limited groundwater in Perth's north west corridor

The north west urban growth corridor in Perth is a 9000-hectare area of future urban development that extends along the coast from Quinns Rocks to Yanchep. Groundwater in this region is nearing full allocation and therefore is not available to meet future demand to irrigate public open space in new developments.

The City of Wanneroo and the Department of Water developed the *North West corridor water supply strategy to* guide how the limited shallow groundwater in the area will be shared between the public water supply and the irrigation of parks, gardens and recreational areas. The strategy relies on minimal water use on non-active open space areas such as verges and streetscapes, and optimal water use on active turf areas needed for sport and recreation.

Independent water supplies for the house and garden

In Western Australia, groundwater bores that are owned by households and businesses in urban areas abstract about 110 GL per year for garden use. These domestic garden bores used sparingly in suitable locations are an important source of supply that help to reduce our scheme drinking water use.

An estimated 177 000 domestic garden bores in the Perth and Peel regions take water from shallow aquifers in urban areas and on the metropolitan fringe, accounting for 85 per cent of the state's domestic bore water use. Growth in domestic garden bore water use has recently decreased due to garden sprinkler rostering, decreasing urban property sizes, and increasing difficulty in accessing water resources of a suitable quality in new development areas.

Private garden bore use in the South West region is estimated to be 6 GL per year. The presence of relatively good quality shallow groundwater between Australind and Busselton has seen the installation of about 3 500 domestic garden bores. Unlike domestic bores in Perth, garden bores in the South West are not currently subject to sprinkler rosters.

The winter dominant rainfall in southern Western Australia means rainwater tanks can be empty for long periods in summer when water is most needed for domestic gardens. The cost effectiveness of rainwater tanks is higher when they are connected to the house for non-drinking purposes, such as in laundries and toilets. They are also an important water source for households in semi-urban and rural areas that are not connected to a public water supply scheme.

Reusing greywater from baths, showers, bathroom basins and laundries is also an option for households to meet their non-potable water needs. Depending on the level of treatment greywater can be used for above ground irrigation, toilet flushing and cold water supply to washing machines.

Water information online

The Department of Water collects data on the volume of the state's surface water and groundwater resources to ensure they are properly managed. This data is available from the Water Information Reporting tool on our website (www.water.wa.gov.au) free of charge. The map-based system allows you to select sites of interest and find associated data for groundwater and surface water including groundwater levels, surface water flows and water quality.

In addition, the Perth Groundwater Atlas provides information about shallow groundwater within the Perth metropolitan area. The atlas provides information on the depth of the watertable (at the time of preparation), the aquifer's thickness and an indication of the salinity of the groundwater at the selected site.

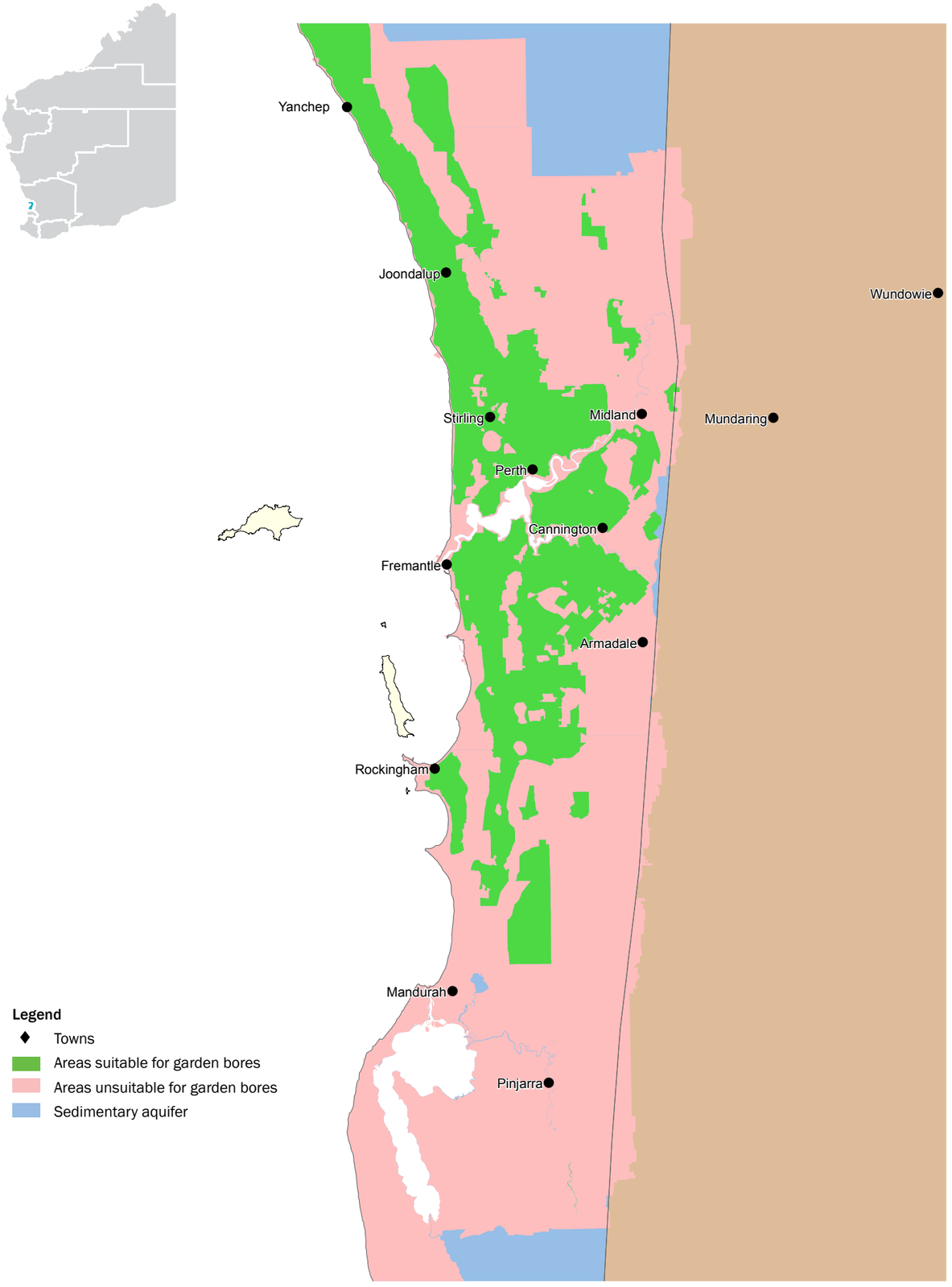
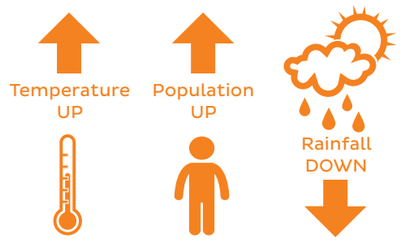


Figure 7 | Suitability of areas for domestic garden bores in Perth

Urban water supply and demand outlook

Western Australia's forecast population growth rate to 2050 ranges from 1.3 to 1.9 per cent a year, reaching between 3.9 and 5.2 million. Our water use forecasts indicate that urban water demand across the state will increase by 1.1 to 1.6 per cent a year over the same period (to between 800 and 1000 GL in 2050).

When planning our future water supplies, we prepare for the highest growth scenario but also set ambitious targets for water users to reduce their water demand. Our target is for total urban water use (scheme and self-supplied) to reduce by 15 per cent per person by 2030 from 2014 levels. This target is based on water saving initiatives by water service providers and self-supplied water users that are underway or planned. We have not attempted to predict further changes in per capita water consumption after 2030, although it is likely that advancements in technology, consumer behaviour and urban form will continue to reduce water demand.



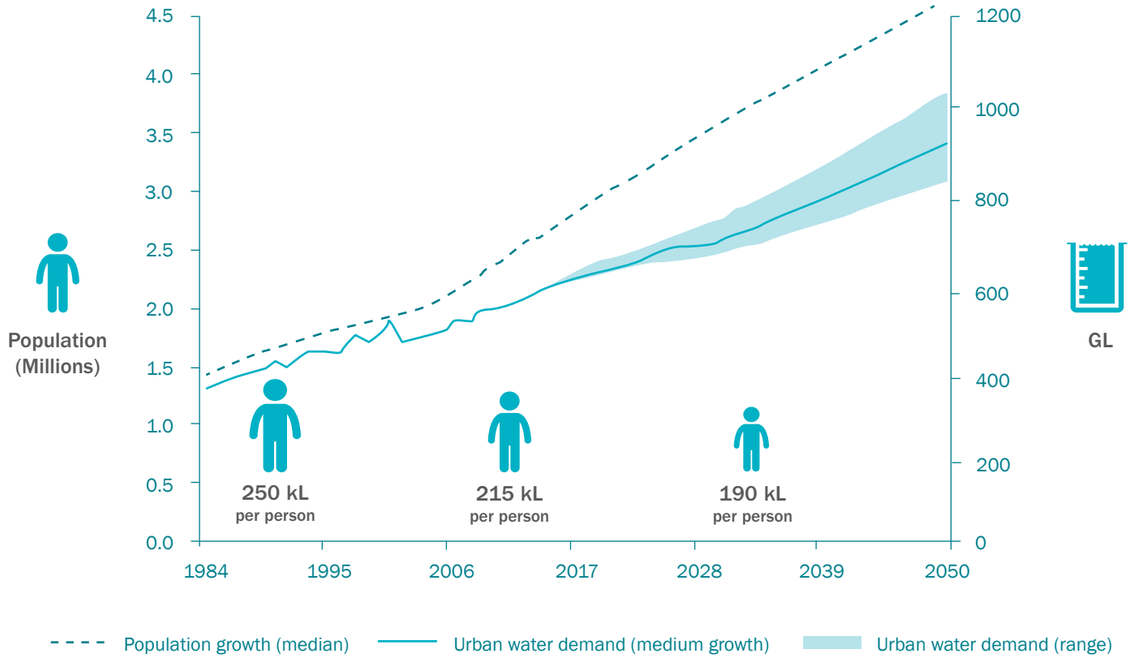


Figure 8 | Historical and projected water demand (scheme and self-supplied) for Western Australia's urban areas

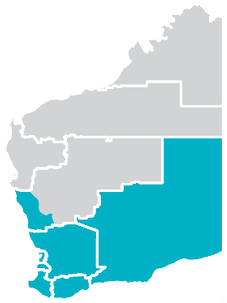
White Gum Valley 'Innovation through demonstration' project

In the City of Fremantle, the White Gum Valley 'Innovation through demonstration' project being developed by LandCorp is setting a new standard in water sensitive urban design and sustainable living for residential estates in Western Australia. The project aims to reduce water use from the public water supply scheme by 70 per cent for each household (based on average Perth consumption for single residential dwellings).

The initiatives planned to achieve the water savings are a community bore irrigation system, integrated stormwater management, dual plumbing to allow the use of rainwater indoors, efficient water fixtures and appliances and low water use landscaping. Each property will have dual water meters (i.e. for both potable and non-potable water sources) and site rainfall will be monitored to match irrigation to the seasonal water needs of the private and public gardens.

The White Gum Valley 'Innovation through demonstration' project shows how the community, private sector and government can work together to provide local-scale solutions to global environmental problems. The performance of the project will be monitored in a four year Waterwise Development Exemplar program that will support further water efficiency initiatives for urban development in Western Australia.

Western Australia - south



Water supplies

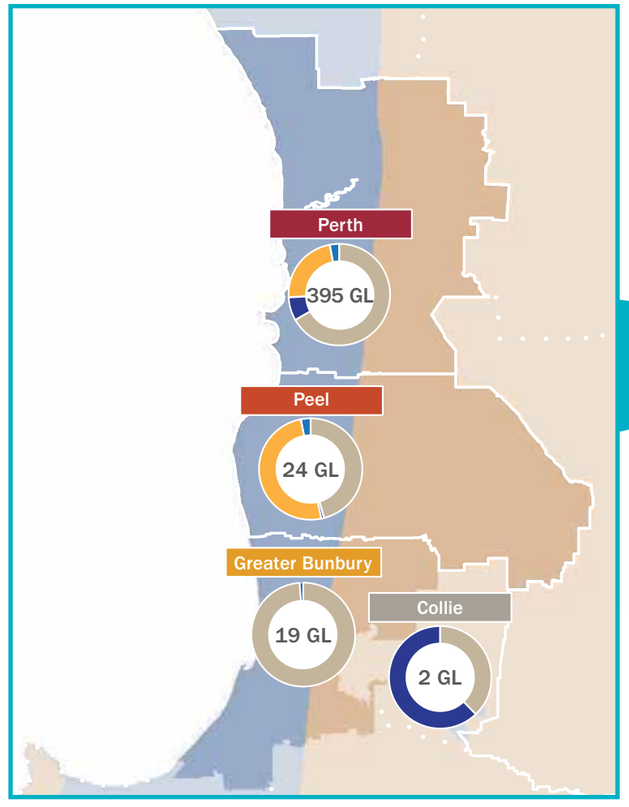
Urban centres located on the coast between Geraldton and Augusta rely heavily on groundwater from the Perth sedimentary basin for drinking water as well as to irrigate parks and gardens.

Shallow groundwater, which is widely used for irrigating parks and gardens, is not available in some new urban areas planned for Perth, Mandurah and Greater Bunbury, so alternative water sources are being identified. Groundwater taken from the deep aquifers is mainly for drinking water supplies and can be sustained, or in some cases increased, by abstracting from the right locations and through groundwater replenishment with treated wastewater.

The Northern Perth Basin, which underlies the western part of the Mid West and Wheatbelt regions, has more groundwater available for future use than the rest of the Perth Basin, which underlies the Perth, Peel and South West regions west of the Darling Scarp.

The Gnangara groundwater system in Perth's north provides almost half of the total water used in the Perth region, including 90 per cent of the groundwater sourced for the Perth Integrated Water Supply Scheme. Increasing abstraction and a decline in rainfall has resulted in falling groundwater levels in parts of the Gnangara groundwater system, so future use needs to be reduced.

In the South West region groundwater from the South West Yarragadee aquifer will be used for the long-term growth of local towns and is no longer being considered as a water source option to meet demand in other regions.



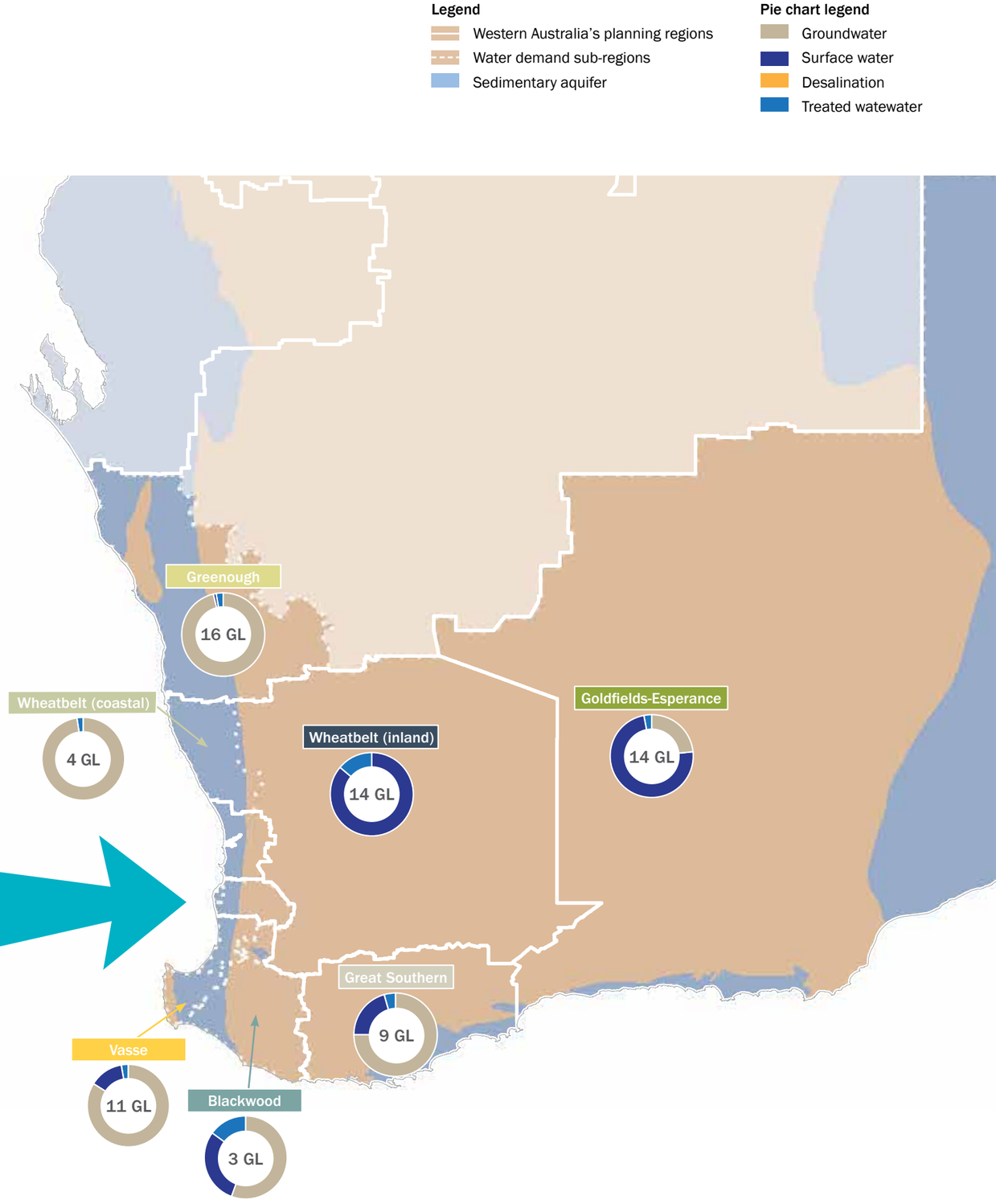


Figure 9 | Water sources and total water use in 2014 for urban areas in southern regions of Western Australia

Dams in the hills east of Perth and Mandurah provide some drinking water for the Perth and Peel regions as well as towns in the Goldfields and Wheatbelt where water is not available locally. Our drying climate means these dams are no longer a major source for Perth's drinking water supplies although they will continue to be used to make the most of the region's future rainfall and for temporary storage of water from other sources. Margaret River is the only urban centre in coastal parts of the South West region that uses surface water, although a reliable source of groundwater was recently added to the town's water supply.

Since 2006, seawater desalination plants have been established in Kwinana and Binningup with a current production capacity of 145 GL per year for use in the Perth Integrated Water Supply Scheme.

In 2014 the Water Corporation began constructing a full-scale groundwater replenishment scheme using treated wastewater from the Beenyup Wastewater Treatment Plant. The treated wastewater is injected into the deep Leederville and Perth Yarragadee aquifers where it is mixed with groundwater. When the groundwater is abstracted in the future it will be treated again before being distributed to customers of the Perth Integrated Water Supply Scheme. The large volume of treated wastewater produced in our urban areas is a valuable resource that will help meet the potable and non-potable water needs of Perth and towns of the southern west coast.

Outside of the Perth Basin, groundwater resources in southern Western Australia are limited to coastal areas of the Great Southern region. The lack of local water sources means southern inland towns rely on fresh water piped from coastal areas via large interconnected water supply schemes including:

- The Integrated Water Supply Scheme, which supplies water via a pipeline from Mundaring Weir east of Perth to the Goldfields and Agricultural Water Supply Scheme primarily for use in Wheatbelt rural towns and Kalgoorlie.
- The Great Southern Towns Water Supply Scheme, which supplies water from the Harris Dam near Collie to towns in the southern parts of the Wheatbelt.
- The Lower Great Southern Towns Water Supply Scheme, which supplies water mainly from the South Coast borefield south-west of Albany to the towns of Albany, Mount Barker and other communities in the lower Great Southern.
- The Warren-Blackwood Regional Water Supply Scheme combines local surface water sources with groundwater piped from the Yarragadee Aquifer near Nannup to supply inland towns of the South West region from Kirup to Manjimup.

Western Australia - south

Future water demand

Future urban water use will be closely related to population growth. The southern regions expect significant population growth and have also experienced some of the most substantial climate change impacts in the world. However the efficient use of local groundwater and surface water resources will allow most towns in the south of the state to continue to sustainably meet their water needs over the next thirty years.

Groundwater available from the Northern Perth Basin is sufficient to meet demand for the Geraldton–Dongara Regional Water Supply Scheme until after 2030. The groundwater available for Jurien Bay is also sufficient to meet long-term future demand, including under high population growth scenarios for the town. The potential for a diverse range of industries to emerge in the Mid West and western Wheatbelt means the population and water demand of towns including Geraldton, Dongara, Jurien Bay and Gingin could grow faster than otherwise expected. Our plans for managing the region's water resources and supplies are therefore adaptable to a range of possible future growth scenarios.

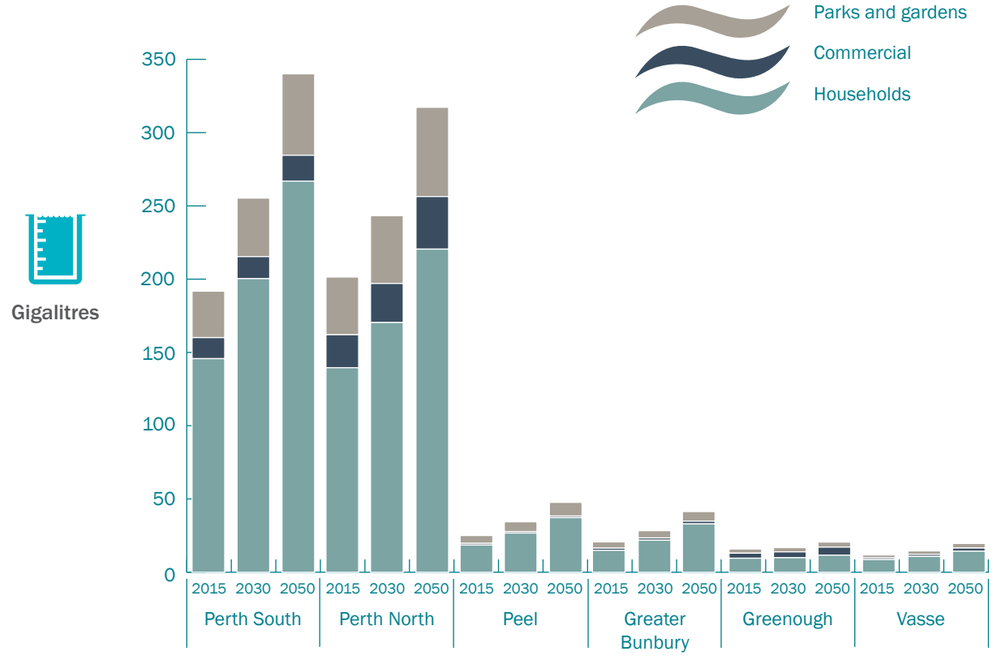


Figure 10 | Water demand forecasts for urban areas in southern west coast regions

The population of the Perth and Peel regions is projected to grow on average by 1.7 per cent per year to 3.5 million people by around 2050. Our medium growth forecast is for urban water use in the Perth and Peel regions to increase by 1.4 per cent per year from 430 GL in 2015 to 690 GL by 2050. Projected growth in urban water demand is lower than population growth as households, councils and businesses are expected to continue improving their water use efficiency over time.

In the South West region, strong growth is forecast for the Greater Bunbury region including the planned urban and industrial expansion in an area east of Eaton in the Shire of Dardanup. The Vasse region, which includes Busselton and Margaret River, also has a fast growing population and a thriving tourism industry that causes a spike in water demand during holiday periods.

The Department of Water and the three water service providers (Aqwest, Busselton Water and the Water Corporation) have determined that groundwater from the South West Yarragadee aquifer can meet future demand for potable water in the region's major urban areas. We found that the public water supply schemes in the region have sufficient water available from current sources to meet demand under a medium-growth scenario until at least 2030 providing residential water efficiency targets of 100 kL per person per year are met.

In the Great Southern region predicted population growth is highest for the coastal and hinterland areas around Albany, Denmark, Walpole and Mount Barker. These towns continue to attract retirees, people seeking a lifestyle change and tourists, who create a high peak in water demand during summer.

The urban footprint of inland towns in southern Western Australia is expected to increase more gradually than in coastal areas. Population growth of inland towns is forecast to remain low and may decline for some towns with an ageing population. Inland towns have a higher proportion of their water used for commercial purposes to support primary industry, so future water demand is also linked to the rise and fall of agriculture and mining activity.

Initiatives such as the State Government's Regional Centres Development Plan (SuperTowns) aims to accelerate economic development and population growth for towns including Collie, Manjimup, Katanning, Northam and Esperance. New or expanded water sources and infrastructure upgrades would be needed for the increased population as well as the industries that are planned to attract people to work and live in these towns.

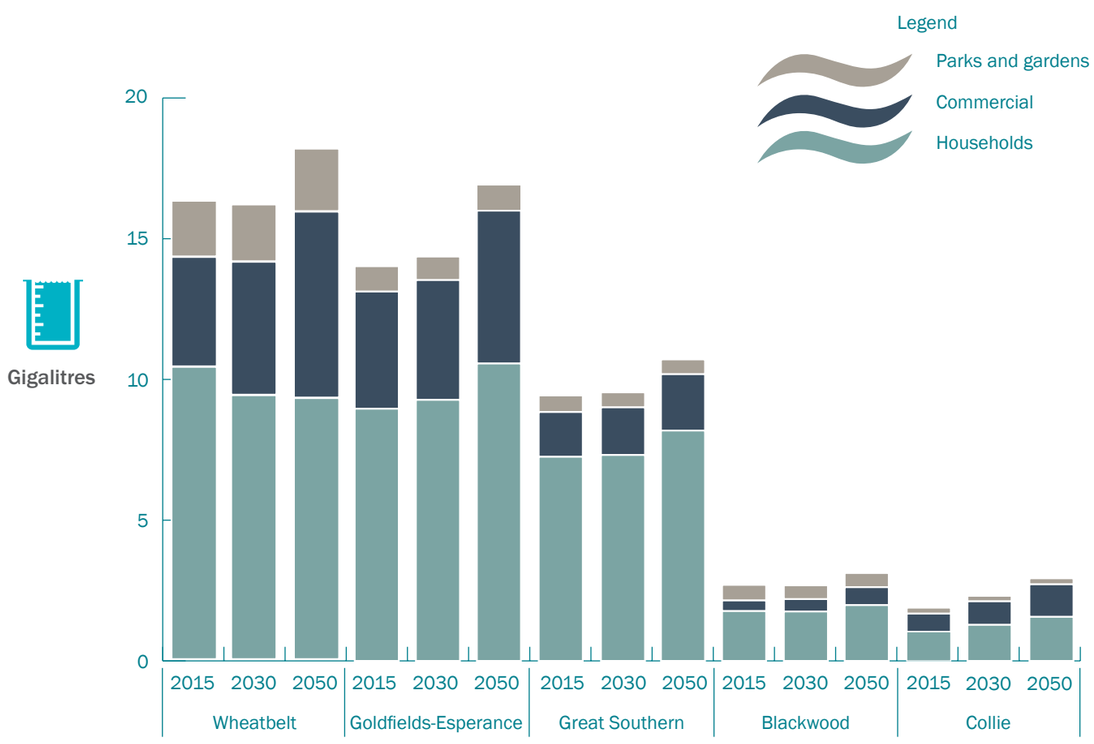
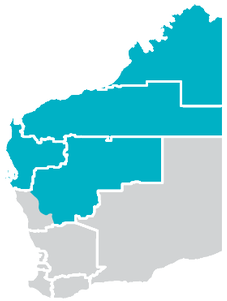


Figure 11 | Water demand forecasts for urban areas in southern coast and southern inland regions

Western Australia - north



Water supplies

Urban water supplies in northern Western Australia vary between the coastal towns and inland areas. Pilbara and Gascoyne coastal towns are mainly supplied from alluvial aquifers via regional water supply schemes operated by the Water Corporation. The East Pilbara Coast and West Pilbara Roebourne sub-regions contain the Port Hedland Regional Water Supply Scheme and West Pilbara Water Supply Scheme respectively.

Water supplies from alluvial aquifers and surface water storages in northern Western Australia depend on irregular river flows caused by cyclones and thunderstorms. To secure water supplies and meet future demand for Pilbara coastal towns and ports new water sources and infrastructure have been developed since 2013. The new Bungaroo borefield, developed through a public-private partnership, has increased supply capacity to the West Pilbara.

Water supplies from the De Grey and Yule River borefields were also upgraded to meet water demand for Port Hedland.

The Canning Basin is the main source of groundwater for towns in the West Kimberley including Broome, Derby and Fitzroy Crossing. Groundwater is still available to support growth although abstraction needs to be carefully managed to prevent saltwater intrusion into the aquifers used to supply coastal towns.

Water supplies for inland towns of the Murchison, Pilbara and East Kimberley regions are generally obtained from old alluvial or fractured rock aquifers. The water supplies in Tom Price, Paraburdoo and Pannawonica are linked to nearby mining activities, with the same source supplying both towns and mines. Water demand is not expected to increase significantly in these areas, but water quality issues and reliability of supply present challenges for some towns.

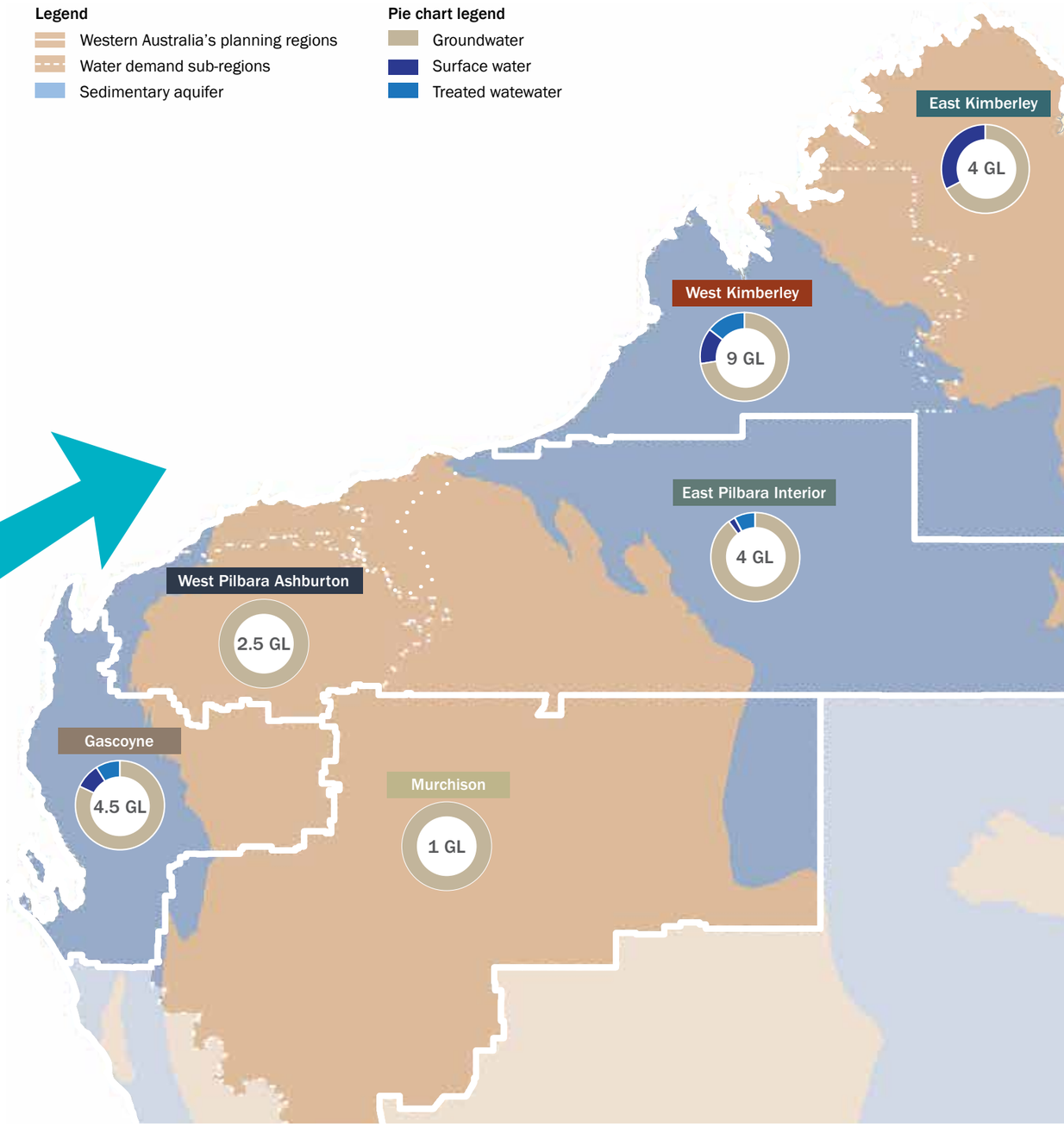


Figure 12 | Water sources and total water use in 2014 for urban areas in northern regions of Western Australia

Western Australia - north

Future water demand

The most significant population and service industry growth in northern Western Australia is expected to occur in the Pilbara and Kimberley coastal towns. Urban water demand in the Pilbara is intrinsically linked to changes in mining resource development projects. While construction activity in the region has slowed, mining and gas production is expected to continue growing over the next decade.

Under a medium-growth scenario, urban water use for Pilbara coastal towns is projected to increase from 25 to around 40 GL per year by 2050. The wide range associated with the long-term urban water demand estimates (between 34 and 46 GL per year by 2050) reflects the uncertainty associated with mining projects and attracting a large, permanent workforce.

Population growth and future urban water demand in the West Kimberley and Gascoyne regions is linked to the growth of irrigated agriculture and tourism. Urban water demand in the West Kimberley (predominantly Broome and Derby) is expected to grow from 9 GL per year to between 15 and 19 GL per year by 2050. Future water demand for urban areas in the Gascoyne region (predominantly Carnarvon and Exmouth) is expected to remain relatively stable at between 4 and 6 GL per year by 2050.

Enough groundwater is available to meet the predicted demand for inland towns of northern Western Australia, including both Kununurra (East Kimberley) and Newman (East Pilbara Interior), which are expected to experience the highest growth. Water demand is not expected to increase significantly for inland towns of the Murchison and Pilbara regions but water quality issues and reliability of supply present challenges for some of these towns.

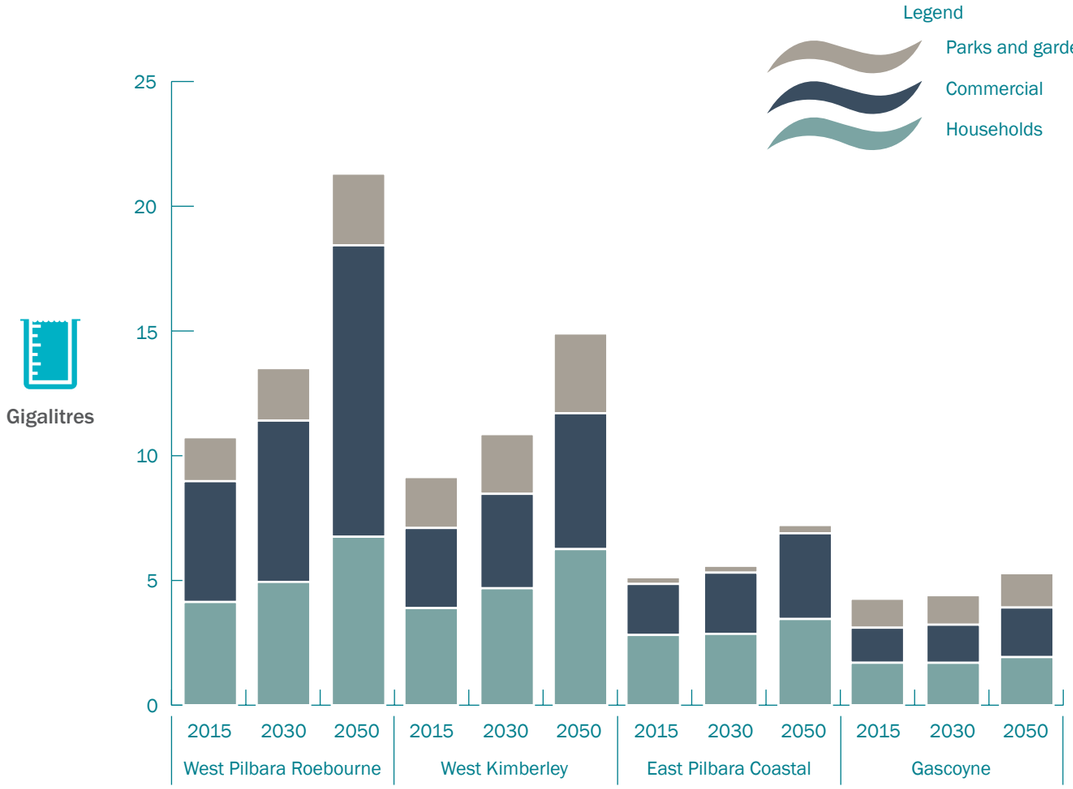


Figure 13 | Water demand forecasts for urban areas in northern west coast regions

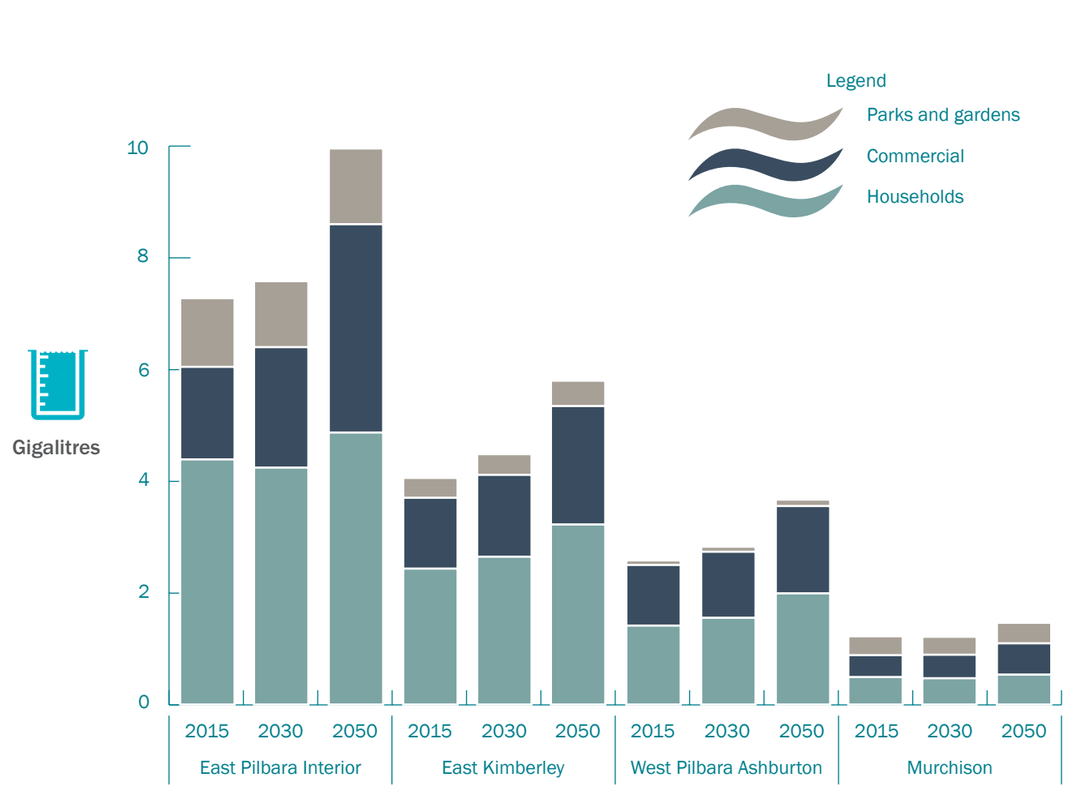


Figure 14 | Water demand forecasts for urban areas in northern inland regions

Building urban water security

The Department of Water manages Western Australia's water resources to support the state's economy, sustain the environment and provide amenity for the community. Water is essential for communities and industry to thrive and prosper, so planning future water supplies and identifying opportunities for growth based on our available water resources is a key role for government. To support the next phase of growth in our urban areas, our focus is on:

1. Supplying groundwater and surface water for now and the future.
2. Innovation in water use efficiency and water sensitive urban design.
3. Moving to water supplies for a drier climate.

Perth's transition to a water sensitive city

A 'water sensitive city' is planned, designed, built and managed to make the most of its limited water resources. In a water sensitive city natural rivers and lakes as well as stormwater management systems are incorporated into multi-use green spaces. Well-designed and managed green spaces make a city more liveable, and also combat rising temperatures, efficiently use available water resources, help manage stormwater, and improve the quality of water discharging to natural water bodies. The challenge is to incorporate these green spaces and other water-sensitive urban design approaches into all new urban developments, as well as retrofitting existing urban areas to create a water sensitive city.

It is important to integrate water planning as early as possible into the land-use planning process. The Department of Water works with state and local government decision-makers, engineers, planners and the development industry to implement Better Urban Water Management. Better Urban Water Management is a framework designed to facilitate better management and use of our urban water resources by ensuring that the total urban water cycle is considered at each stage of land-use planning and development.

We recommend that urban planners consider the water management implications of changing urban density and form. We support the creation of guidelines to embed urban water management into all stages of land development and to evaluate their effectiveness. We facilitate this approach through undertaking urban water research in partnership with the Cooperative Research Centre (CRC) for Water Sensitive Cities and by publishing information on floodplain management as well as Drainage and Water Management Plans. We also assess water management strategies and plans prepared by developers as part of the Better Urban Water Management process, and provide water management and design advice for development proposals.

Managing water demand and supplies in a drying climate

In south-west Western Australia we have historically relied on good winter rains to store water in dams and aquifers for use through our long, dry summers. Since 1990, the average annual rainfall has decreased in Perth by 8.4 per cent, in Donnybrook by 6.3 per cent and in Augusta by 21.6 per cent. Average inflows into Perth's dams have reduced by more than 50 per cent over the same period. We expect this trend to continue.

We have analysed climate projections from many leading global climate models to predict the most probable future rainfall scenarios at 2050 for locations in the south-west of the state. To allow for the range of possible futures we select likely wet, medium and dry scenarios to guide planning. Scenarios provide the rainfall we might see in the future, and inform our modelling and planning. Even under the best-case (wet) scenario, we expect a drier future.

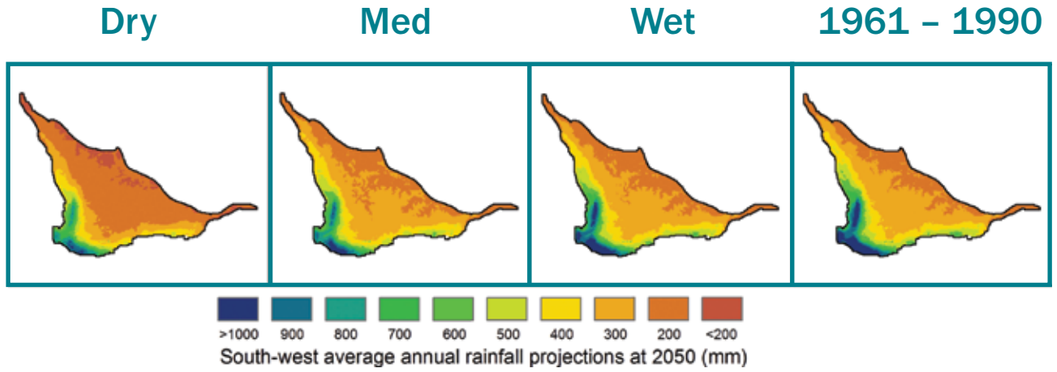


Figure 15 | Average annual rainfall projections for south west Western Australia in 2050 compared to the baseline period (1961-1990)

To plan for Western Australia's future water supplies, we take into account the long-term reliability of potential water sources under future climate scenarios. Currently we are adapting to less winter rain and higher temperatures for longer periods either side of summer. Successive dry years compound the effect of a drying climate on our water supplies, which are highly dependent on groundwater recharge and inflows into surface water storages.

To plan we set limits on how much groundwater and surface water can be reliably taken both now and in the future, while still protecting the environment and existing water users. We work with all water users and land planners to ensure water use is as efficient and productive as possible. Where future demand is greater than existing supply we identify potential new water source options that could reliably supply our water regardless of climate change effects.

Supplying groundwater and surface water for now and the future

The Department of Water regulates the annual abstraction of surface water and groundwater in Western Australia to maintain renewable water resources for future use. Our groundwater investigations and monitoring support precise and effective management so that the cheapest and most accessible water resources remain viable for the long term. By making best use of these local water resources we help to defer the need for investment in more expensive water supply options.

Use science and modelling to set sustainable water allocation limits

Urban water use needs to be in balance with the future climate for south west Western Australia to maintain ecosystems that depend on water and to secure water for existing users. Through new science and powerful numerical modelling we will continue to optimise the management and sharing of water. To recalculate the groundwater available from the Gnangara groundwater system over the next 15 years and beyond, the Department of Water is looking ahead to estimate recharge with a future dry climate scenario and planned urbanisation for Perth.

Distribute unallocated groundwater and surface water in a way that is fair, equitable and transparent to current and future water users

Where possible, the Department of Water reserves specific water resources for public drinking supplies so future generations can benefit from the state's natural water resources. There is currently about 160 GL of mostly groundwater reserved for public drinking water supplies throughout Western Australia. We protect these water resources from potential contamination and work closely with water service providers to plan when and how to best develop them for the future.

Where groundwater and surface water is fully allocated, support a market approach so water moves to the highest value uses

We are preparing to develop new water legislation for Western Australia that will consolidate six existing Acts that regulate the take and use of water, protect waterways, manage drainage and protect public drinking water sources and supply. Amongst the proposed legislative changes is a more flexible and simplified system to trade and transfer licensed water entitlements in fully allocated water resources to the most productive and highest-value uses.

Innovation in water use efficiency and water sensitive development

Since 1984 water use in Western Australia's urban areas has reduced by around 15 per cent per person. Most of this improvement occurred after the year 2000 with the introduction of a two day per week sprinkler roster, winter sprinkler ban and education programs and incentives aimed at improving water efficiency.

If urban water use decrease by another 15 per cent per person over the next 15 years we would save around 100 GL of water per year by 2030. Achieving this target would delay or avoid the need for major new water sources to be developed and free up funding for other essential infrastructure and services needed in Western Australia. Being more water efficient also helps us to protect our water dependent environments, adapt to a drying climate and save on the energy used in supplying urban water.

Plan urban areas to get the most benefit with the least amount of water at all stages of the urban water cycle

The urban form being planned to support our growing population directly affects future water consumption and groundwater recharge. Urban planning that supports the management and use of local groundwater, stormwater and wastewater can enhance the urban environment and reduce demand on public water supply schemes. Local and state government, industry bodies, urban developers and research organisations, including the Cooperative Research Centre (CRC) for Water Sensitive Cities, are collaborating so water sensitive urban design is a feature of our liveable cities and towns in the future.

Manage demand for water from public water supply schemes through education, incentives and innovation

Water service providers can use a range of measures to improve water efficiency, including education programs, pricing, billing, infrastructure solutions such as pressure management, and new household technologies. In the bathroom simple measures such as water efficient showerheads, toilets, appliances and taps can provide significant water savings. New homes can be designed for water efficiency with features like plumbed in rainwater tanks and wastewater reuse systems. Smart meter technology, which the Water Corporation has established in the Goldfields and Pilbara regions, is an innovation that can save water by detecting leaks and understanding water usage patterns to target demand management initiatives.

Manage demand for groundwater by local governments, schools, businesses and households through education, incentives and innovation

Local governments, schools and businesses can be part of the solution by using drought tolerant turf, improving turf maintenance practices, optimising the design and use of irrigation systems and monitoring water use. Hydrozoning and innovative landscape design can also lead to significant water savings. Less water can be used on household gardens, whether irrigated by a groundwater bore or water from the public water supply scheme, by choosing native and drought tolerant plants, mulching, and using water efficient and well maintained irrigation systems.

Moving to water supplies for a drier climate

Our changing climate is a critical factor influencing the development and use of our water resources. This is evident in the reduced flows into our water supply reservoirs and the declines in groundwater levels across the Perth area. To meet increasing demand for water there is an ongoing shift to climate resilient water supply options like seawater desalination and recycled wastewater.

Develop potable water sources that are climate independent to supplement or replace water from dams and shallow groundwater

The short to medium-term focus for increasing the drinking water supply for the Perth and Peel regions is on groundwater replenishment to support continued usage of the Gnangara groundwater system. The first stage of the Water Corporation's groundwater replenishment scheme will recharge groundwater with 14 GL per year of treated wastewater from the Beenyup wastewater treatment plant. A second stage of the scheme would see this volume increase to 28 GL per year.

In the long term, as the Perth and Peel populations grow, additional water sources will be needed to secure the regions' drinking water supply. The options include further groundwater replenishment with treated wastewater, expansion of seawater desalination, more optimal abstraction of groundwater from deeper aquifers, or transferring water to Perth from other regions. Local groundwater resources along the northern coast of the metropolitan area will also be drawn on as the urban area expands.

The decreasing reliability of surface water and future population growth mean new water sources are now being planned for urban areas in the southern coast and southern inland regions, including Denmark, Walpole and towns supplied by the Great Southern and Lower Great Southern regional water supply schemes. Options to secure water supplies to meet the longer-term demand for Denmark include integrating the town into the Lower Great Southern Towns Water Supply Scheme, providing greater flexibility and certainty of water supply. To improve water security for the Great Southern Towns Regional Water Supply Scheme, the Water Corporation will pipe water from Stirling Dam to augment the current source at Harris Dam.

The Water Corporation and Department of Water are investigating an expansion of the existing South Coast borefield to secure water supplies for Albany and other towns connected to the Lower Great Southern Towns Water Supply Scheme. In combination with water efficiency savings, the prospective additional groundwater could secure the water supply for towns serviced by the scheme until after 2030. Seawater desalination is currently the most likely option to increase supply beyond this timeframe.

Supply options to meet future growth of urban areas in the Pilbara region include piping water from distant aquifers (for West Pilbara and Port Hedland schemes) and desalination of seawater or brackish groundwater (Onslow). Through the Royalties for Regions program the Department of Water is conducting a regional-scale groundwater investigation of the West Canning Basin. This aims to assess how much fresh water could be supplied on a long-term basis to provide public water supplies for Port Hedland and for other uses.

Moving to water supplies for a drier climate

Configure water supply infrastructure to supply water sustainably from where it is available to where it is needed

By necessity, Western Australia already has a well-connected network of scheme supplies. As the state continues to grow, water supply schemes will become more connected to enable bulk water transfers and improve reliability of supply. While connecting water supplies between adjacent towns is feasible, piping fresh groundwater or surface water from distant regions is less cost-effective than developing new seawater desalination or groundwater replenishment water sources locally.

The location of borefields and dams affects the water available for use. Groundwater bores in urban areas can be designed and located to optimise abstraction and to minimise the impact on other users and the environment. In some coastal areas abstraction is constrained by the risks of seawater intrusion and saline up-coning from the more saline aquifers below the fresh water.

Establish new non-potable water sources to replenish or replace shallow groundwater

The Department of Water is developing long-term strategies to meet non-potable urban water needs in Geraldton, the Perth-Peel region, Greater Bunbury and Busselton. The strategies focus on ensuring water is available to maintain public open space and recreational areas for new urban developments. One option being assessed is managed aquifer recharge using treated wastewater or stormwater.

Managed aquifer recharge is the process of infiltrating water into an aquifer where it is stored until needed and abstracted through existing or specially located groundwater bores. In the example illustrated below treated wastewater recharges the superficial aquifer, which is where most of the groundwater is taken for non-potable water use in Western Australia's urban areas. Conversely, the Water Corporation's Groundwater Replenishment Scheme being built at Beenyup, north of Perth, treats wastewater to strict drinking water standards before injecting it into the deeper, confined aquifers for later reuse.

Stormwater can also be stored in suitable aquifers so a portion of the water can be used later in times of peak demand. Applying water sensitive urban design in urban planning can identify the best areas to infiltrate locally generated stormwater such as through infiltration basins and swales for storage and abstraction.

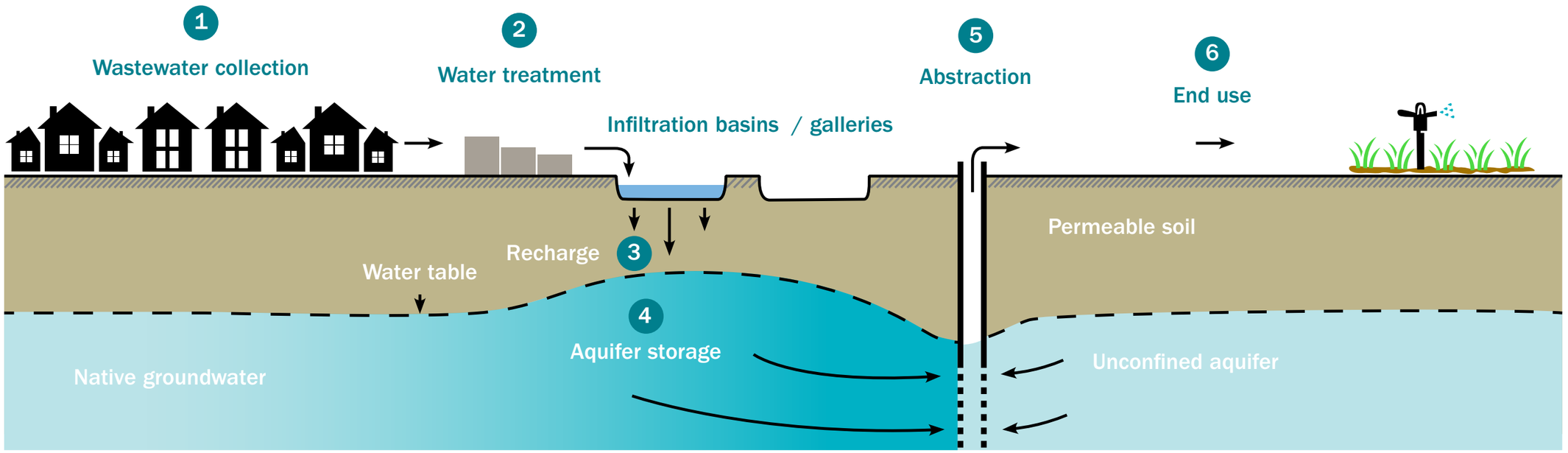


Figure 16 | Managed aquifer recharge using treated wastewater for non-potable water uses

Shortened forms

Abstraction: Taking water from any water source either temporarily or permanently.

Alluvial aquifer: A shallow aquifer comprising unconsolidated sediments deposited by streams and rivers.

Aquifer: A geological formation or group of formations able to receive, store and transmit significant quantities of water.

Confined aquifer: An aquifer lying between confining layers of low permeability (such as clay, coal or rock) so the water in the aquifer cannot easily flow vertically.

Fractured rock aquifer: An aquifer where groundwater is stored in fractures, joints, bedding planes and cavities in otherwise solid rock mass.

Gigalitre (GL): One billion litres (1 000 000 000 litres (L))

Groundwater: Water that occupies the pores and crevices of rock or soil beneath the land surface.

Groundwater replenishment: The process of recharging groundwater with treated wastewater for storage and future use or management of groundwater levels.

Potable water: Fresh and marginal water generally considered suitable for human consumption.

Recharge: Water that infiltrates into the soil to replenish an aquifer.

Sedimentary basin: A low area in which permeable sediments laid down at various times in the past have accumulated.

Surface water: Water flowing over the landscape or held in estuaries, rivers and wetlands.

Unconfined aquifer: The aquifer nearest the surface, having no overlying confining layer. The upper surface of the groundwater within the aquifer is called the watertable. The aquifer contains water with no upper non porous material to limit its volume or to exert pressure.

Wastewater: Water that has been used for some purpose and would normally be treated and discarded.

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