ACIL ALLEN CONSULTING

REPORT TO
WATER WEST

NOVEMBER 2016

FUTURE OPPORTUNITIES FOR WATER SERVICES IN PERTH

FUTURE DEVELOPMENT SCENARIOS

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EXECUTIVE SUMMARY

Current water services delivery model

Perth's current potable water and wastewater infrastructure is based on a large network model owned and operated by the State Government owned utility, the Water Corporation. In the Perth region, each year 264GL[1] of potable water is delivered to homes and businesses via the integrated network, and 164GL of wastewater is processed through treatment plants. Almost all treated wastewater is disposed of via the Indian Ocean; yet wastewater is a valuable resource, and Perth lags behind other major cities in wastewater recycling and re-use. Perth's current water services delivery model forces residents to use scarce, expensive to produce potable drinking water for non-potable uses such as toilet flushing and garden irrigation. At the same time their wastewater, a possible source for recycling and supply of non-potable water, is collected and pumped long distances to treatment plants before being discharged to the ocean. Water supply-demand projections indicate a looming shortage unless the State invests significant capital on new desalination plants, whereas the reality is that all Perth communities (existing and future) already have close to half their household water needs immediately available on their doorstop – i.e. wastewater which could be recycled and re-used.

The current delivery model for water services in Perth materially oversizes potable water supply and connection network infrastructure relative to that required to meet only the fit-for purpose use of potable water (drinking, kitchen, showers). Arguably, the necessary size (and cost) of this potable water infrastructure could be approximately 50 percent smaller than the current Business as Usual model, with consumers and the community also better off.

Stakeholders in Perth's water future need to progress the conversation as to how their valuable wastewater resource can be better collected, treated, and recycled for local re-use. From an open conversation the steps needed to transform Perth into a water sensitive city will become clear. Transforming the water service delivery approach for Perth will reduce the future need and use of potable water, reduce pressure on Perth's over allocated groundwater resources, and reduce the necessary size and cost of potable water supply (desalination) and connection infrastructure.

Current participants in the water services market

The Water Corporation is the incumbent and dominant provider of water services in the Perth metropolitan area. Private sector involvement is currently limited but interest and activity is increasing, particularly since the passing of the *Water Services Act 2012.* The *Act* went a long way towards cleaning up process, role and responsibility issues that had previously impeded private sector involvement in the sector. However, planning and approval issues remain a challenge that restricts private sector engagement. Meaningful private sector participation in Perth's future water supply and delivery infrastructure and services not only offers the opportunity for non-government funding of

[1] In this report, the abbreviations GL, ML and kL refer to gigalitres, megalitres and kilolitres.

otherwise expensive infrastructure, but can also promote innovative solutions and ideas to address the very real and growing challenge of future water demands exceeding natural supplies and how we as a community can best bridge this gap.

Current state of water supply infrastructure

The main supply sources for water in Perth are dams (7%), groundwater (46%), and desalination (47%). However, current groundwater extraction levels are above sustainable limits, and future dam inflows are expected to fall. This means that in the future Perth's existing water supply infrastructure will deliver less water than it does today. Published projections suggest existing groundwater, dam, and desalination resources will provide less than 200GL of supply by 2050.

Future water demand

Future water demand can be forecast based on population projections and assumptions about the trajectory for per capita water consumption. A number of population projections have been prepared for Perth, with a key planning scenario suggesting a population for the Perth-Peel area in 2050 of 3.5 million. Current per capita water use in the metropolitan area is 126kL per person, but was significantly higher in the recent past. Based on a range of population projections multiplied by a range of per capita water consumption values it is possible to develop a picture of future water demand in Perth. For the central case of annual per capita water consumption of 125kL per person, and a population of 3.5 million, the expected Perth water demand in 2050 is 438GL.

The water supply gap

The water supply gap in 2050 can be calculated by subtracting the supply that existing infrastructure is expected to deliver in 2050 from the water demand projections. This supply gap is shown in Table ES 1, and for the central case of a population of 3.5 million, and per capita water use of 125kL, the water supply gap in 2050 is 238GL.

TABLE ES 1 THE FUTURE WATER SUPPLY GAP (GL PER ANNUM)

Population	Annual Water use per person		
	120 kL	**125 kL**	**130 kL**
3,100,000 (1.32% CAGR)	172 GL	188 GL	203 GL
3,500,000 (1.67% CAGR)	220 GL	238 GL	255 GL
3,900,000 (1.99% CAGR)	268 GL	288 GL	307 GL

SOURCE: ACIL ALLEN

Delivering water infrastructure: Business as Usual

Under a Business as Usual development scenario, the main new supply sources will be new desalination and centralised water recycling projects; with identified future desalination projects providing between 165GL and 250GL, and centralised water recycling projects providing as much as 54GL.

Both desalination and centralised water recycling projects are associated with high capital costs. Reflecting this, as the share of desalination in Perth's water supply has increased, so too has the debt level at the Water Corporation. For example, between 2006 and 2016 Water Corporation's long term debt has increased almost fourfold, from $1.4 billion to $5.8 billion.

State planning policy provides that 47 percent of new dwellings in Perth should be infill developments, where the Water Corporation is the incumbent service provider. Water Corporation will therefore need to invest heavily in capacity upgrades for infill infrastructure. Meeting this demand will put pressure on the Water Corporation's financial capacity to invest in servicing new frontal growth developments.

The development of water infrastructure under a Business as Usual scenario will therefore require many billions of dollars in addition capital investment between now and 2050. This, in turn, means further increases in the State debt.

Current State debt levels work to restrict capital investment in water infrastructure, and given the priority of new water supply, this has stressed maintenance and upgrade investment in other parts of the water supply network. For example, independent reviews of Water Corporation capital investment spending have found spending levels to be too low. Total State debt levels are therefore already restricting investment in the sector. Given State debt is projected to rise by $10 billion, to $40 billion, between now and 2020, this situation will only worsen.

Delivering water infrastructure: An alternative approach

It is possible to model the savings to government in terms of capital expenditure required by 2050, under different water service delivery scenarios. For example, if the population in the greater Perth area was to increase to 3.5 million by 2050, and if the private sector was to provide local wastewater and recycling services to 25 percent of the new dwellings constructed, the savings to the Western Australian State Government, in terms of lower capital expenditure, would be $1.45 billion. The savings in terms of capital expenditure rise as private sector involvement increases, and by 2050, if 50 percent of new residential developments have wastewater and local water recycling services delivered by the private sector, the savings to the State Government in terms of capital expenditure would be $3.37 billion (see Table ES 2).

TABLE ES 2 POTENTIAL SAVINGS FROM ADOPTION OF LOCAL WASTEWATER RECYCLING SCHEMES RELATIVE TO BUSINESS AS USUAL

Details	Units	New development share		
		10%	25%	50%
Water Supply Infrastructure Capital Saving	$M	278	278	1,018
Net Wastewater Infrastructure Capital Saving	$M	470	1,174	2,349
Total Capital Investment Saving	$M	747	1,452	3,367
Potable Water Saving	GL	127	318	636
Households Served	No.	68,560	171,402	342,803
Population Served	No.	150,833	377,080	754,167
Proportion of the Population Served	%	4.3	10.8	21.5

SOURCE: ACIL ALLEN

Decentralised third pipe systems separate the supply of water for potable use and water for non-potable use. As the production costs for water treated to the appropriate non-potable use standard are lower than the cost of treating water to potable standards, by separating the water supply into potable and non-potable streams, it is possible to lower household water supply costs. For the representative household, these savings are likely to be around $68 per year, or a saving of around 10 percent on the average household annual water supply and service bill.

TABLE ES 3 ANNUAL HOUSEHOLD WATER BILL SAVING

Persons per household	Household non-potable water use per person kL		
	42 kL	46 kL	50 kL
2.2	$57	$62	$68
2.4	$62	$68	$74
2.6	$67	$73	$80

SOURCE: ACIL ALLEN

Allowing decentralised wastewater recycling through third pipe systems also has additional benefits, including:

i) Allows/unlocks development in areas where there is a shortage or unavailability of groundwater, as recycled water can be used to plan and irrigate more liveable green open space and gardens.

ii) Can enable and promote industry and drive job creation in proximity to the decentralised scheme.
iii) Allows for water to be returned to the environment to support groundwater dependent ecosystems in the local area. Estimates of this environmental value suggest that each GL of water returned to the environment is worth around $0.40 million, annually.
iv) Assists with reducing the urban heat island effect.[2]

Local wastewater recycling and third pipe re-use has already been adopted in other parts of Australia, by both state water utilities, for example Sydney Water at the Rouse Hill (NSW) greenfields development, and private sector utilities, for example Flow Systems at the Pitt Town (NSW) greenfield development and at the Central Park Sydney infill development. In Western Australia, the Water Corporation recognises the existence of third pipe (dual reticulation non-drinking water schemes) but is yet to implement a wastewater recycling third pipe re-use scheme.

The introduction of private sector water service providers will also assist with moving charging in the water service sector to a more transparent and cost reflective basis. Better costing and pricing of water supply and services will ultimately lead to more efficient use of an increasingly precious resource.

The introduction of local wastewater recycling and third pipe re-use in Perth can not only save taxpayers money and transform Perth into a water sensitive city, but can also help the State Government meet its stated water recycling policy objective of recycling 30 percent of wastewater by 2030.

This study aims to progress the conversation on transforming Perth into a water sensitive city. The study starts by examining the future water supply options and demands for a growing Perth, and the resulting water supply gap projected out to 2050. The study then considers the costs of expanding Perth's water supply and service infrastructure under a Business as Usual scenario in comparison to an alternative delivery model where a certain proportion of new development is serviced by local wastewater and recycling schemes owned and operated by private sector utilities. Economic savings to the State Government and potable water usage savings are then presented for different development and adoption scenarios.

[2] The urban heat island effect is the warming of urban areas due to the nature of the surfaces and activities that are present in those areas. This effect can be mitigated through changes in the type of building materials used, and through greening the local environment.

1

WATER SUPPLY

1.1 Introduction

Perth's Integrated Water Supply Scheme (IWSS) serves over 800,000 properties, and annually delivers almost 300GL of water via almost 14,000km of mains and reticulation pipes. The way water is supplied to the system has changed dramatically over recent years, and further change is expected.

1.2 Current sources of water

In Perth, scheme water is sourced from dams, groundwater sources, and desalination plants. The relative importance of each water supply source has changed substantially over recent years. For example, over the past six years the proportion of Perth's water sourced from dam infrastructure has fallen from 45 percent to 7 percent. The proportion of Perth's water that is sourced from groundwater resources has remained approximately constant over this period, with growth in desalination supply replacing dam supply. Specifically, between 2010 and 2016 the proportion of Perth's water supplied by desalination has increased from 16 percent to 47 percent (Table 1.1 and Figure 1.1).

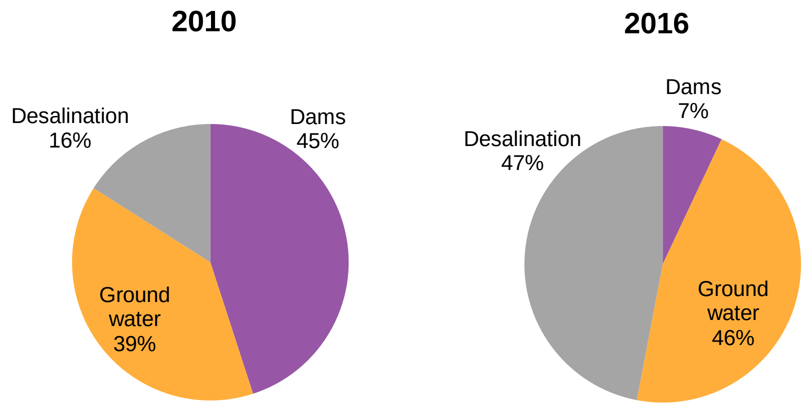
TABLE 1.1 SOURCES OF SCHEME WATER (RELATIVE SHARE)

Source	2010	2011	2012	2013	2014	2015	2016
Total hills (dams) output (%)	45	35	26	17	17	17	7
Total groundwater output (%)	39	49	50	49	44	42	46
Total desalination output (%)	16	16	25	34	39	41	47
Total hills (dams) output (ML)	136,337	115,293	81,386	46,786	49,025	49,519	20,100
Total groundwater extraction(ML)	119,656	163,578	157,789	139,622	124,850	122,127	136,879
Total desalination output (ML)	47,693	52,010	78,847	95,770	113,060	119,457	138,645

SOURCE: WATER CORPORATION ANNUAL REPORTS, VARIOUS YEARS

NOTE: TOTAL WATER SUPPLIED INCLUDES BULK WATER EXPORTED OUT OF THE METROPOLITAN REGION. AS SUCH TOTAL WATER PRODUCTION IS GREATER THAN TOTAL WATER USE IN THE GREATER METROPOLITAN AREA.

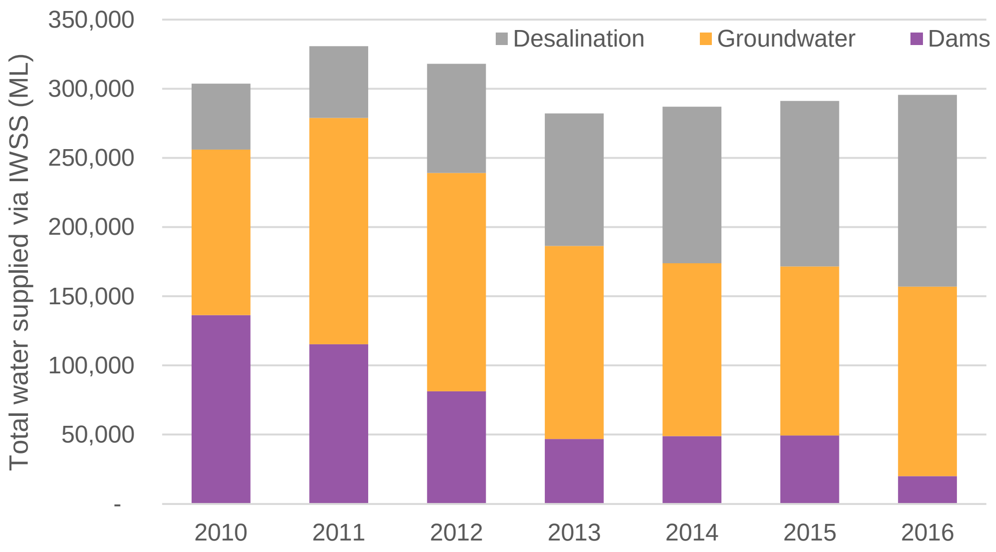
FIGURE 1.1 SCHEME WATER SUPPLY SHARES: 2010 AND 2016



SOURCE: WATER CORPORATION ANNUAL REPORTS, VARIOUS YEARS

In GL terms, water from dams has fallen from 136GL in 2010 to 20GL in 2016, while over this same period desalination output has increased 190 percent from 48GL to 139GL. The level of water supplied from different sources is shown in Figure 1.2.

FIGURE 1.2 INTEGRATED WATER SUPPLY SCHEME WATER: BY SOURCE



SOURCE: WATER CORPORATION ANNUAL REPORTS, VARIOUS YEARS

1.3 Future sources of water

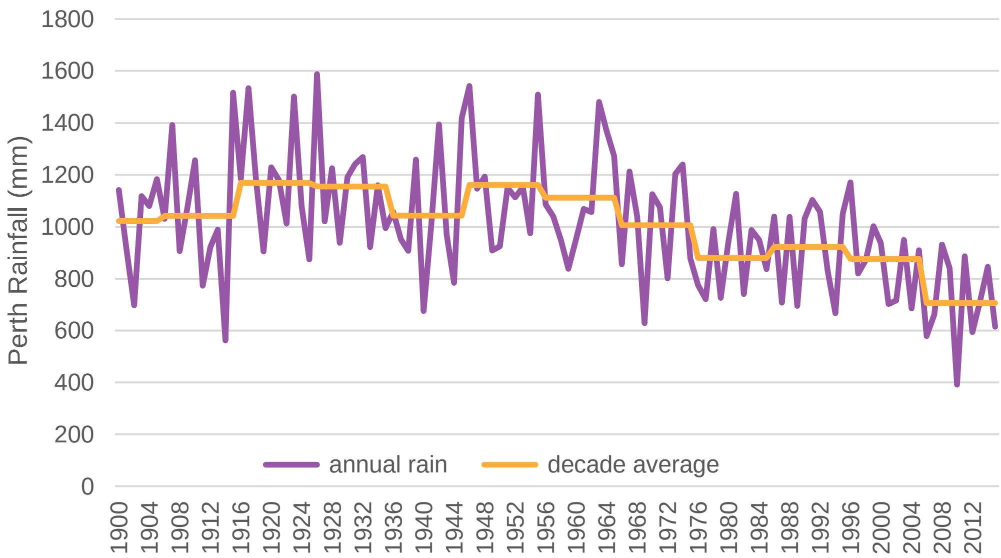
1.3.1 Surface water

The proportion of water sourced from dams has fallen significantly over the past six years. At the same time the total water storage level in Perth's dam infrastructure has fallen from 35 percent to 24 percent; or in GL terms, the fall in storage has been from 216GL in 2010 to 138GL in 2016.[3] That both the amount of water sourced from dams and dam storage levels have fallen is due to lower rainfall in Perth. There is significant variation in rainfall from year-to-year, but as can be seen from the decade-by-decade averages shown in Figure 1.3, average rainfall today is much lower than it was in

[3] Water Corporation Annual Report (various years).

the past. The Mundaring weir dam was originally constructed in 1903, with a major wall height extension completed in 1951. At the Mundaring Weir weather station the average annual rainfall over the past decade has been 705 mm. For the first half of the 20th century, i.e. prior to the wall height extension, average rainfall at the location was 1,097 mm.

FIGURE 1.3 RAINFALL TRENDS IN DAM CATCHMENT AREAS



SOURCE: MUNDARING WEIR WEATHER STATION: BUREAU OF METEOROLOGY STATION NUMBER: 9031

The change in rainfall has had a significant impact on the water flowing into Perth dams, with average inflows since 2011 averaging less than one third the level prior to 1975.[4] It is unlikely that the current low level of rainfall, and hence low dam inflows will be reversed. Rather, there is a strong consensus in climate model projections that there will be a further substantial decline in rainfall in the south west of Western Australia, and the most likely scenario is that dam inflows will continue to fall. The decline in rainfall, in turn, is expected to have a substantial impact on the availability of drinking water from dams:

> *Further, if the rainfall reduces by 40% [from 1990 levels], likely yields would be reduced to only 25 gigalitres a year. At these levels, dams would cease to be a reliable part of Perth's water supply.[5]*

Perth has already seen a 40 percent reduction in annual rainfall in the past 25 years, with records at the Mundaring Weir weather station showing rainfall falling from 1,032 mm in 1990 to only 614 mm in 2015. For the south west of Western Australia, the CSIRO states that there is "very high agreement of a substantial decrease" in annual seasonal (June-November) rainfall over the rest of the century, where very high can be interpreted as implying above 90 percent.[6]

Water Corporation planning documents, a key input for water planning in Perth, also make it clear that planning is taking place under the assumption of further substantial reductions in rainfall going forward, and that surface water will continue to decline in importance as a water supply source.[7]

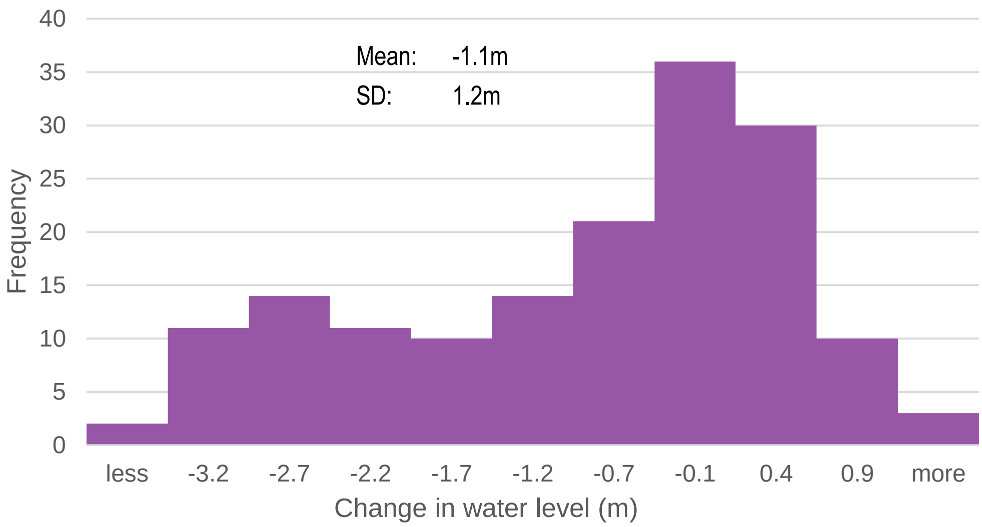
The scientific and planning consensus is therefore to expect further rainfall reductions in the future and so this implies existing dam infrastructure is likely to become an insignificant water supply source in the near-medium future.

[4] Murphy, S (2016) Perth Water Supply – Beyond Compliance, Presentation to UDIA, 28 July 2016.
[5] Murphy, S (2016).
[6] CSIRO (2015) Climate Change in Australia Technical Report, p. 99; 108.
[7] Water Corporation (2009) Water Forever: Towards Climate Resilience.

1.3.2 Groundwater

Going forward, the proportion of water supplied from existing groundwater sources is also expected to decline substantially.[8] This is due to a combination of lower rainfall, and hence less recharge, and current groundwater extraction rates being unsustainable. For example, as illustrated in Figure 1.4, since 2001 the Gnangara mound water level has fallen by over one metre, which is a material depletion of the resource. Current groundwater extraction rates are therefore unsustainable. That extraction limits are unsustainable is recognised in existing planning documents, and water supply in GL from existing groundwater sources in 2050 is expected to be half the level it is today.[9]

FIGURE 1.4 CHANGE IN WATER LEVEL OF GNANGARA MOUND: 2001 -2014



Note: Maximum Water level measurements at 162 matching sample pairs

SOURCE: IFTEKAH AND FOGARTY (2016)

Large scale groundwater resources, such as the Yarragadee aquifer, have been reserved for use in the south west and are not available to augment metropolitan water supply.[10] However, some small new groundwater resources are potentially available, despite overall groundwater extraction levels being unsustainable.

1.3.3 Climate independent water sources

Over coming decades, groundwater and dam supplies are likely to decrease further, and supply will increasingly be met from climate independent sources. Under a Business as Usual development process, it is expected that the main new supply source will be additional desalination capacity, which will be augmented by centralised groundwater replenishment supply.[11] The Economic Regulation Authority has also acknowledged that future water sources will need to be climate independent.[12]

The next major supply augmentation in Perth, due to come on stream in 2016, will be the commissioning of a groundwater replenishment (Aquifer Storage Transfer and Recovery) project. The project is proceeding in two stages, with each stage delivering around 14GL of water.[13]

Although the current water supply augmentation project is a water recycling project, the major additional supply options identified by Water Corporation, under a Business as Usual scenario, are either new desalination plants or expansions at existing desalination plants. Five desalination projects

[8] Water Corporation (2009), p. 7.
[9] Water Corporation (2009), p. 7
[10] Department of Water (2012) South West groundwater Areas Allocation Plan: Evaluation Statement 2009-2012.
[11] Murphy, S (2016) Perth water Supply – Beyond Compliance, Presentation to UDIA, 28 July 2016.
[12] Economic Regulation Authority (2013) Inquiry into the Efficient Costs and Tariffs of the Water Corporation, Aqwest and the Busselton Water Board: Revised Final Report, p. 7.
[13] Our State Budget 2015-16 – Investing in infrastructure to grow the State: Groundwater replenishment surges ahead, Press Release Thursday 21 May 2015.

have been identified as potential development options, and combined these projects represent additional supply capacity of between 250GL and 165GL.[14] In addition to the existing groundwater replenishment project, two additional groundwater projects (Woodman Point and Subiaco treatment plants), with a combined capacity of 26GL, have been identified as potential new supply sources.[15]

1.4 Summary

The current water supply infrastructure delivers around 300GL of water to the greater Perth area, but is under stress. Going forward this supply infrastructure will deliver less water due to a combination of falling inflows into dams and a reduction in future groundwater extraction. Under some realistic climate change scenarios Perth's existing dam infrastructure would actually cease to be a reliable part of the overall water supply infrastructure. Published projections suggest existing groundwater, surface water, and desalination resources will provide less than 200GL of supply by 2050, and only around 160GL by 2060.[16] [17]

Under a Business as Usual development scenario, the main new supply sources will be new desalination and centralised water recycling projects. Identified future sources suggest:

– desalination projects could provide 165GL to 250GL
– water recycling projects could provide 54GL[18], and
– new groundwater sources could provide 14GL.[19]

Whilst the cost of bringing on-line new groundwater sources is relative low, there are substantial costs to the State Government in generating future water supplies from new desalination plants and centralised recycling projects.

[14] Murphy, S (2016) Perth Water Supply – Beyond Compliance, Presentation to UDIA, 28 July 2016.
[15] Murphy, S (2016).
[16] Water Corporation (2009) Water Forever: Towards Climate Resilience, p. 7.
[17] Note that this value includes supply from both desalination plants, and so has added in supply that was not commissioned at the time the forecast was made to reflect the supply expected from the existing asset base. The figure excludes the supply from managed aquifer recharge, as this capacity was not yet online at the time of writing.
[18] Includes the water recycling contribution of 28GL under construction.
[19] Murphy, S (2016) Perth water Supply – Beyond Compliance, Presentation to UDIA, 28 July 2016.

2

FUTURE WATER DEMAND

2.1 Introduction

Total water demand can be calculated as a function of population and per capita water use. As such, future water demand can be forecast based on population projections and assumptions about the trajectory for per capita water use.

2.2 Population projections

A number of agencies prepare population projections for Western Australia. Each population projection scenario involves different assumptions, and over time small differences in assumptions can lead to quite different population estimates. For example, the Western Australian Planning Commission (WAPC) has a series of long term population projections for Western Australia that forecast a population of between 4.3M and 5.2M in 2050;[20] while the ABS population projections suggest a population in Western Australia of between 4.8M and 6.4M in 2050.[21]

As part of a standalone planning scenario -- Perth and Peel @3.5M -- the WAPC has also prepared both population and dwelling construction projections for the greater Perth region to 2050. These projections are detailed in Table 2.1, and as can be seen, they suggest a population in the greater Perth region of around 3.5M by 2050. The implied compound average population growth rate (CAGR) for this scenario is 1.7 percent.

TABLE 2.1 POPULATION AND HOUSING GROWTH IN THE GREATER PERTH METROPOLITAN REGION

Region	Pop 2011	Pop 2050	New dwellings
Central region	782,974	1,195,000	215,000
North-West region	322,486	740,300	172,000
North-East region	209,156	450,500	106,000
Southern and Peel region	523,400	1,200,000	305,000
Total relevant growth corridor	1,838,016	3,585,800	798,000

Note: Some of the values are indicated only approximately in the report

SOURCE: PERTH AND PEEL@ 3.5MILLION

[20] Western Australian Planning Commission, Population Report No. 9, Long Term Population Forecasts for Western Australia, 2031 to 2061.
[21] ABS, Population Projections, Australia. catalogue 3222.0.

The ABS also produces population projections for the greater Perth region, and similar to the State level estimates, the ABS estimates are higher than the WAPC projections and suggest a population of between 3.9M and 5.4M for greater Perth by 2050.[22]

Although there is uncertainty surrounding the future population of Perth, the projections detailed in Table 2.1 are a reasonable basis for framing discussions on what the population of the greater Perth region might be in 2050. Relative to other population projections, the Table 2.1 projections have the added advantage of being matched with residential construction estimates. Specifically, over the period 2011 to 2050, the expected annual average increase in population is 44,815 people, and the expected annual increase in the housing stock is 20,461 dwellings. The implied number of people per new dwelling is 2.2.

A ratio of 2.2 people per dwelling, on average, is lower than what has historically been the case, but the ratio of people to dwellings implied in the Perth and Peel @3.5 projections is consistent with broader trends in terms of smaller average households, and the infill projections contained in planning documents.

A further advantage of the Perth and Peel @3.5 projections is that they also contain information on the expected infill dwelling construction share and the expected new greenfield dwelling construction share. The expected shares for new dwelling construction are 48 percent infill and 52 percent greenfield.

Decentralised water supply and recycling systems are possible in both new infill and greenfield developments, but for greenfield developments such schemes can be completely independent from existing water supply infrastructure, and require no partnership with any Water Corporation infrastructure.

TABLE 2.2 EXPECTED FUTURE PERTH DWELLING CONSTRUCTION TO 2050

Region	Infill	Greenfield	Total
Central region	215,000	-	215,000
North-West region	49,000	123,000	172,000
North-East region	40,000	66,000	106,000
Southern and Peel region	76,000	229,000	305,000
Total relevant growth corridor	380,000	418,000	798,000

SOURCE: PERTH AND PEEL @3.5

2.3 Water use efficiency

Over the past decade per capita water use in Perth has fallen by over 15 percent: from 151 kL per person to 127 kL per person (Figure 2.1).

[22] ABS, Population Projections, Australia. catalogue 3222.0.

FIGURE 2.1 WATER CONSUMPTION PER CAPITA FOR PERTH REGION: 2006-2016

SOURCE: WATER CORPORATION ANNUAL REPORTS, (VARIOUS YEARS)

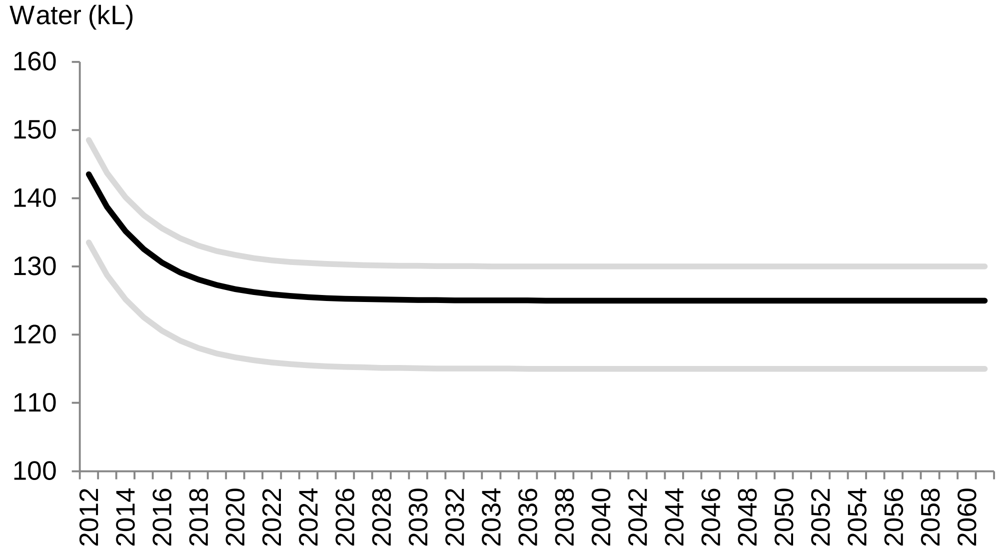
Although there have been substantial water use efficiency gains over recent years, due to changes such as outdoor watering restrictions, there is a limit to these gains, and existing gains may not be sustained. The fact that Perth's per capita water use in 2016 was higher than per capita water use in 2015 is evidence that efficiency gains may have plateaued. Also, although the Water Corporation has a target for water demand of 115kL per person in 2050, they also consider scenarios where per person consumption is181kL in 2050.[23]

Despite the recent uptick in per capita water use, it is possible that, over time, further modest gains in water efficiency could be made; but that at some point these gains will be exhausted. The initiatives that generated substantial gains, such as the outdoor watering restrictions, have already been implemented. Additional gains will therefore be increasingly difficult to achieve. Figure 2.2 illustrates this situation. The figure shows a stylised high, low, and mid case trajectory for water use efficiency, but under all possible trajectories efficiency gains hit a limit at some point. That water use efficiency gains are exhausted at some point in the future is also an assumption embedded in the Water Corporation model used to estimate Long Run Marginal Cost.[24] So, limited potential for future per capita water use reductions is not a controversial assumption.

There is also the philosophical debate as to whether the government should be dictating how people use water, particularly for gardens and verges, where there is a willingness to pay for supply. A general availability of local recycled wastewater for such uses would only highlight this issue further.

[23] Water Corporation (2009) Water Forever: Towards Climate Resilience.
[24] Economic Regulation Authority (2013) Inquiry into the Efficient Costs and Tariffs of the Water Corporation, Aqwest and the Busselton Water Board: Revised Final Report, p. 67.

FIGURE 2.2 WATER USE EFFICIENCY: PER CAPITA STYLISED HIGH, LOW, AND MID WATER USE TRAJECTORIES



SOURCE: ACIL ALLEN

2.4 Future total water demand

If population projections are combined with per capita water use information it is possible to derive estimates of total water demand for Perth. For example, as shown in Table 2.3, if we assume a population of 3.5M in 2050, and average annual per capita water use of 125kL, total Perth water demand is 438GL per annum. Alternatively, using a population of 3.9M, which is the lower bound of the ABS population projection series, and average per capita water use of 125kL, total water demand is 488GL per annum.

TABLE 2.3 POSSIBLE PERTH WATER DEMAND SCENARIOS TO 2050

Population	Annual water use per person kL		
	120 kL	**125 kL**	**130 kL**
3,100,000 (1.32% CAGR)	372 GL	388 GL	403 GL
3,500,000 (1.67% CAGR)	420 GL	438 GL	455 GL
3,900,000 (1.99% CAGR)	468 GL	488 GL	507 GL

SOURCE: ACIL ALLEN

Different assumptions about population growth and per capita water use necessarily imply different estimates of future water demand. The water demand values in Table 2.3 are, however, reasonable values to use for planning purposes, and may be conservative. For example, the implied population growth rate and water use values used to derive these estimates are lower than the values used in the most recent regulatory assessment of water demand for Perth (Table 2.4). Higher population growth would result in an increase in the water supply requirement. For example, a simple projection based on a continuation of the values used in the regulatory assessment implies Perth water demand in 2050 of around 562GL.

TABLE 2.4 RECENT REGULATORY PERIOD DEMAND FORECASTS

Metropolitan customers	2012/13	2013/14	2014/15	2015/16
Water customer growth (%)	2.0%	2.1%	2.2%	2.3%
Wastewater customer growth (%)	2.2%	2.3%	2.3%	2.4%
Water consumption per person per year (kL)	140kL	139kL	138kL	137kL

SOURCE: ERA (2013) INQUIRY INTO THE EFFICIENT COSTS AND TARIFFS OF THE WATER CORPORATION, AQWEST AND THE BUSSELTON WATER BOARD: REVISED FINAL REPORT

Total water demand can be decomposed in several ways, for example potable demand versus non-potable demand; residential demand versus non-residential demand, etc. In Perth, outdoor use of water is significant, with studies suggesting outdoor water use accounts for approximately half of all total water use.[25] [26] Within the category of outdoor use the main use is irrigation.[27] In-house residential demand consists of a combination of potable uses (drinking, cooking, showering) and non-potable uses (toilet flushing, washing machines). The quality requirements for non-potable water are lower than the scheme water quality required for in-house potable use.

Although now somewhat dated, the detail from the Department of Water survey on water use is shown in Table 2.5. These volumes relate only to residential water demand and exclude non-residential water demand for purposes such as irrigating public open space (see Section 2.6 below).

TABLE 2.5 HOUSEHOLD WATER USE SURVEY: 2008/09

Use category	kL per person per year
Indoor	
Shower and bath	27
Toilet	10
Washing machine	8
Taps	6
Evaporative air-conditioner	4
Dishwasher	1
Total indoor use	*56*
Outdoor	
Hand watering	3
Pool and spa	2
Irrigation	41
Total outdoor use	*46*
Private plumbing leaks	4
Total household water use	***106***

SOURCE: WATER CORPORATION (2009A)

Current Business as Usual infrastructure planning is based on supplying 100 percent of total household water demand with potable scheme water, whereas in reality household potable demand is less than half total demand. At the same time, the marginal cost of supplying new potable water is high, driven by the costs of supply from desalination. The possibility of designing and planning a future Perth metropolitan potable scheme water scheme to service and specifically meet only potable water demands -- i.e. not to use potable water for non-potable demand -- presents an opportunity to improve on both the water cycle efficiency and infrastructure costs of Perth's water planning model.

[25] Syme, G. J., Shao, Q., Po, M., & Campbell, E. (2004) Predicting and understanding home garden water use. *Landscape and Urban Planning*, *68*(1), 121-128.
[26] Department of Water (2009) Perth Residential Water Use Study, 2008/2009, Perth, WA, Government of Western Australia.
[27] Department of Water (2009).

2.5 Supply demand gap

The supply demand gap in 2050 can be calculated by subtracting the supply that existing infrastructure is expected to deliver in 2050 from the water demand projections contained in Table 2.3. This supply gap is shown in Table 2.6, and as can be seen from the table, for the central case of a population of 3.5M and annual per capita water use of 125kL, the annual water supply gap in 2050 is around 238GL per annum – or equivalent to 95,200 Olympic size swimming pools per year. Depending on the assumptions made, the future supply gap could be as low as 172GL or as high as 307GL per annum.

TABLE 2.6 PERTH METROPOLITAN WATER SUPPLY GAP PER ANNUM: POSSIBLE SCENARIOS

Population	Annual water use per person		
	120 kL	**125 kL**	**130 kL**
3,100,000 (1.32% CAGR)	172 GL	188 GL	203 GL
3,500,000 (1.67% CAGR)	220 GL	238 GL	255 GL
3,900,000 (1.99% CAGR)	268 GL	288 GL	307 GL

SOURCE: ACIL ALLEN

Under the Business as Usual development scenario, the main new desalination and water recycling projects identified by Water Corporation could deliver 219GL up to 304GL of new supply, and new groundwater sources could deliver an additional 14GL of supply. Identified potential supply development options are therefore consistent with the expected supply gap to 2050 and the costs of these Water Corporation infrastructure options should be considered as the likely required State Government expenditure in a Business as Usual scenario.

2.6 Public open space and additional demand

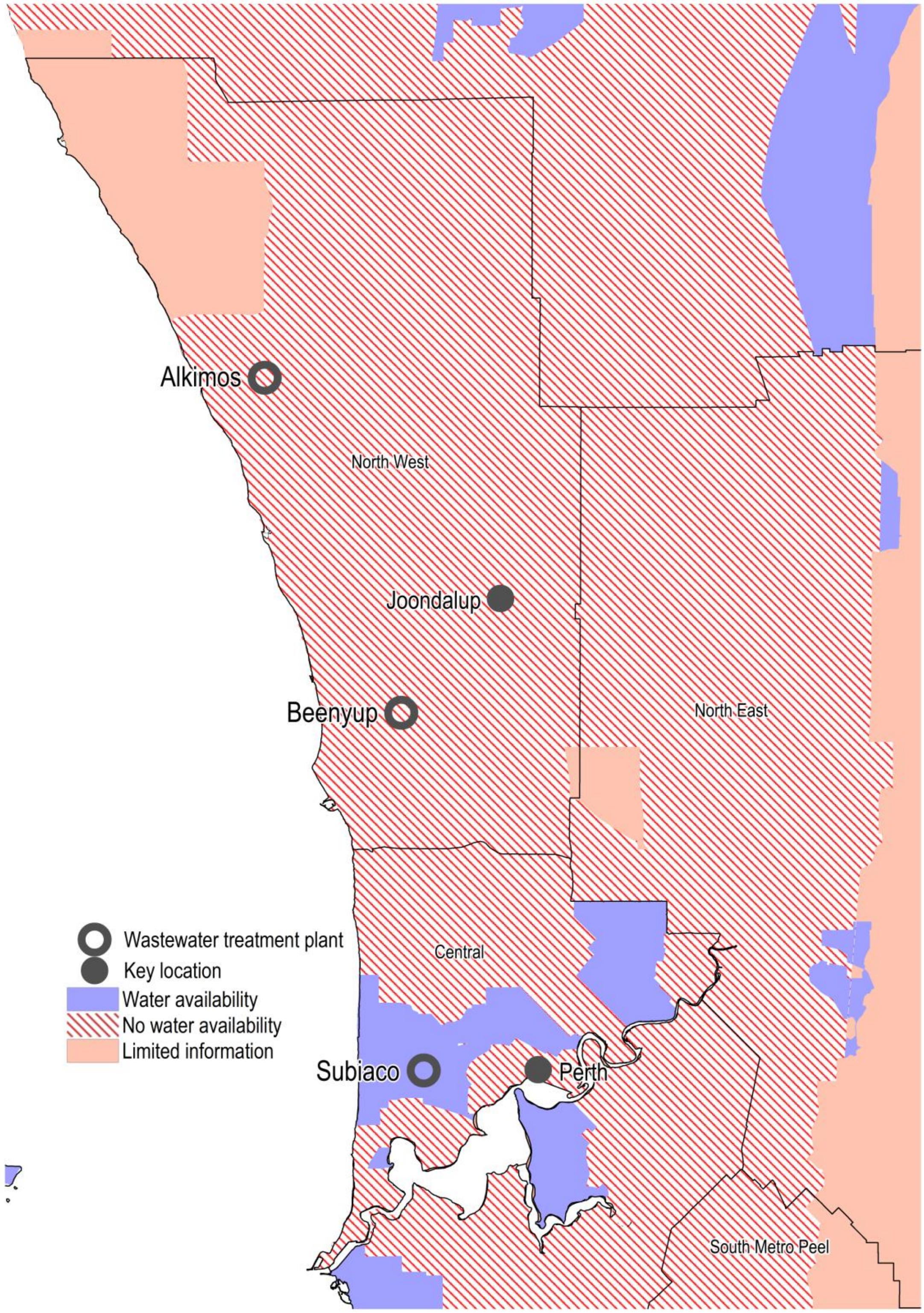
Developers are required to provide 10 percent public open space (POS) as part of any development, which is then vested with the Crown (effectively local councils) via the provisions of Section 152 of the *Planning and Development Act (2005)*. Historically, groundwater has been used to irrigate and maintain active use public open space. However, as shown in Figure 2.3 and Figure 2.4, groundwater resources in many potential greenfield development areas are either fully allocated or over allocated.[28] Where groundwater, or other non-potable sources of water are not available to deliver the public open space requirement, developers may need to access scheme water for POS irrigation. For developers, historically it has been relatively easy to access drinking water to irrigate parks and gardens if Water Corporation Integrated Water Supply Scheme (IWSS) infrastructure is already in the area, albeit there is an argument about whether such high quality water should be generated and supplied for such purposes.

The accepted irrigation rate for active use land is 7,500kL per year,[29] but not all public open space has a water requirement, and various allowances are made when calculating the public open space requirement for any given development. As such, it is worth illustrating the public open space calculations for a stylised development.

Table 2.7 provides details for a stylized 200 ha development, and shows that for a 200 ha development the public open space allocation to high water demand land uses, such as playing fields and recreation areas, might only be around 12 to 13 ha. So, the ten percent public open space requirement does not mean it will be necessary to irrigate ten percent of the development area, but the requirement does means that developers will typically need to find water to irrigate around five to six percent of the development area.

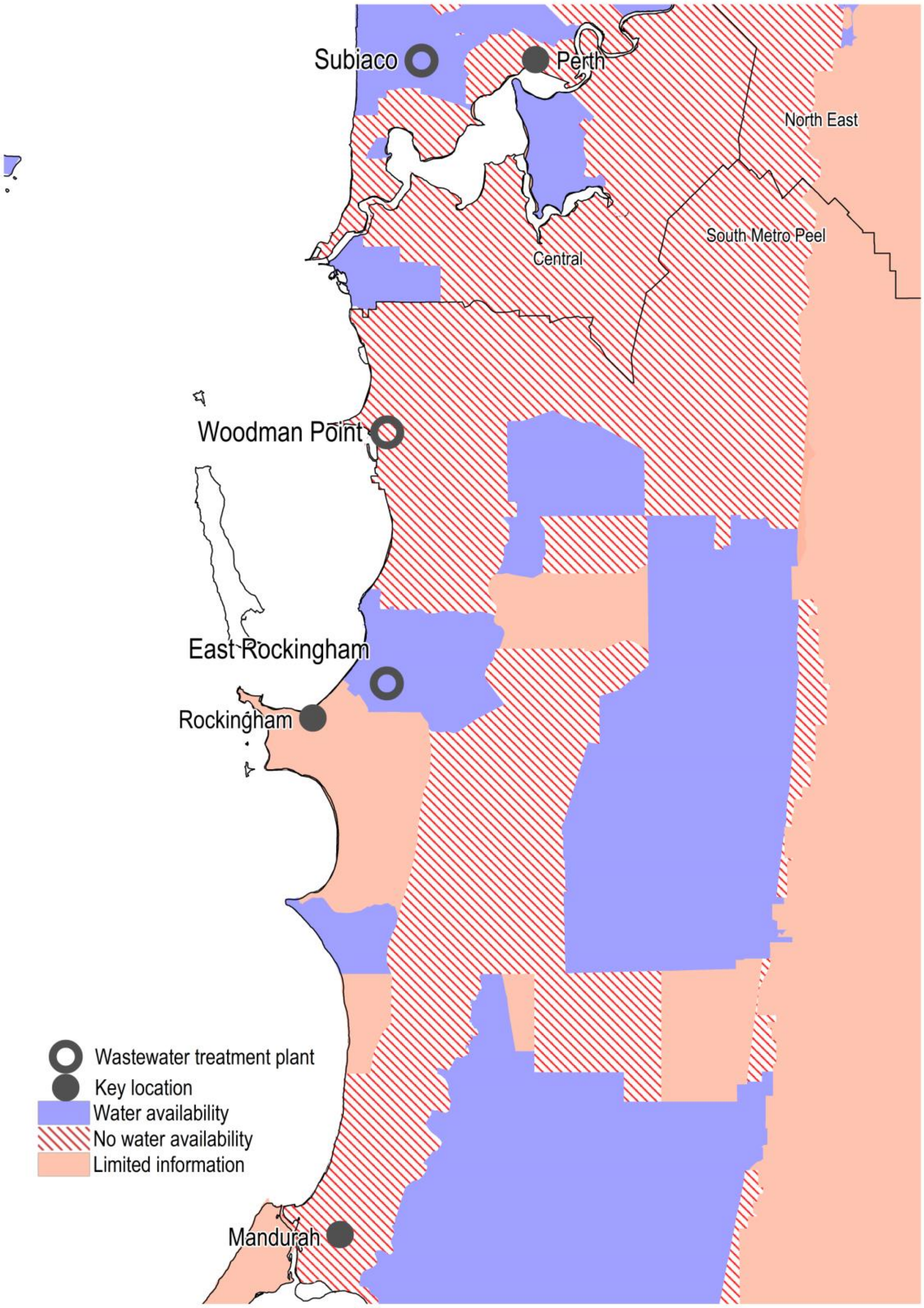
[28] Department of Water (2014). *North West corridor water supply strategy.* Perth, WA, Government of Western Australia.
[29] Department of Water(2014). *North West corridor water supply strategy.* Perth, WA, Government of Western Australia.

FIGURE 2.3 WATER AVAILABILITY AND DEVELOPMENT AREAS: NORTHERN FOCUS



SOURCE: DEPARTMENT OF WATER

FIGURE 2.4 WATER AVAILABILITY AND DEVELOPMENT AREAS: SOUTHERN FOCUS



SOURCE: DEPARTMENT OF WATER

TABLE 2.7 CALCULATING THE PUBLIC OPEN SPACE REQUIREMENT FOR A DEVELOPMENT

Details	Value
Total site (ha)	200
Land allocated to all non-development purposes (ha)	27.8
Gross Subdivisible Area (total site area minus land allocated to other activities)	172.2
Required Public Open Space (10%)	17.2
Claimed restricted use PoS @ max 20% rate as a contribution to PoS requirement	3.4
Total additional PoS requirement: comprised of:	13.8
- Sport	5.7
- Recreation	6.6
- Nature	1.5
Total contribution	17.3

SOURCE: DEPARTMENT OF PLANNING (2015) LIVEABLE NEIGHBOURHOODS

It is also possible to think of the water for public open space in terms of a per capita or per household requirement. For example, if we use the currently accepted water irrigation rate for active public open space of 7,500kL per ha, assume an irrigation rate of half this for other recreation space, and no irrigation requirement for nature space, the annual POS water requirement for the development described in Table 2.7 is 67,500kL. Given a historical development density of ten properties per gross developable area,[30] and assuming a per house population of 2.4, the implied per person POS requirement for the development is around 14kL per person per year.

For groundwater constrained development sites the default option available to developers is to meet the irrigation requirement for public open space with scheme water. This additional water demand has not been considered in planning scenarios, or the calculations presented in Table 2.6, and this demand could be large. For example, if it is assumed that the new suburban greenfield dwellings have 2.4 people per dwelling, and that half these developments are in water constrained areas, the additional annual demand on scheme water to meet public open space requirements would be around 7.0GL to 7.5GL.

The price charged by Water Corporation, to a developer or council, to supply potable water to meet POS demand, may also be below the marginal cost to supply this water. This is particularly the case for greenfield frontal developments. In such a case, any reduction in potable water usage in both homes and for POS can provide a substantial saving or avoided cost to the Water Corporation and the State.

Local wastewater treatment and recycling schemes can provide generous amounts of secure, cost effective fit-for-purpose water to irrigate parks, gardens and verges – allowing developments to look green with the feel and amenity expected by residents. This contrasts with the recent calls by the Water Corporation to restrict developers and impact residents by removing grass from verges in order to save water.[31] [32] In reality, there could be an adequate supply of fit-for-purpose water available to irrigate verges and other POS if local wastewater treatment and recycling schemes are adopted in new urban developments.

2.7 Summary

Perth's population is expected to increase substantially by 2050. Due to climate change, Perth's existing water supply infrastructure will supply less water in 2050 than it does today. There is also a limit to the water efficiency gains that can be achieved going forward. If population projections for Perth are combined with reasonable estimates of future per capita water consumption and projections for the volume of water that will be delivered from existing water infrastructure, it is clear that there is a

[30] WAPC (2015) Perth and Peel@3.5million, Western Australian Planning Commision.
[31] Treadgold T. (2016) "Water pressure highlights competing priorities" Business News: Western Australia, 16 August 2016.
[32] Murphy S. (2016) "Planning, efficient use vital for water" Business News: Western Australia, 29 August 2016.

large water supply gap in the coming decades. Different assumptions suggest different outcomes for this supply gap. If further meaningful water efficiencies can be achieved, and population growth is low, the supply gap by 2050 could be as low as 180GL per annum. A supply gap of this size is equal to more than 60% of current water supply. On the other hand, if population growth is relatively high, and there is some stabilisation or reversal in the recent water efficiency gains, due, for example, to the use of potable water to maintain POS in groundwater constrained development areas, the supply gap by 2050 could be greater than 300GL per annum. A supply gap of this size is greater than the total current water supply for Perth.

3 WATER INFRASTRUCTURE COSTS AND DELIVERY

3.1 Introduction

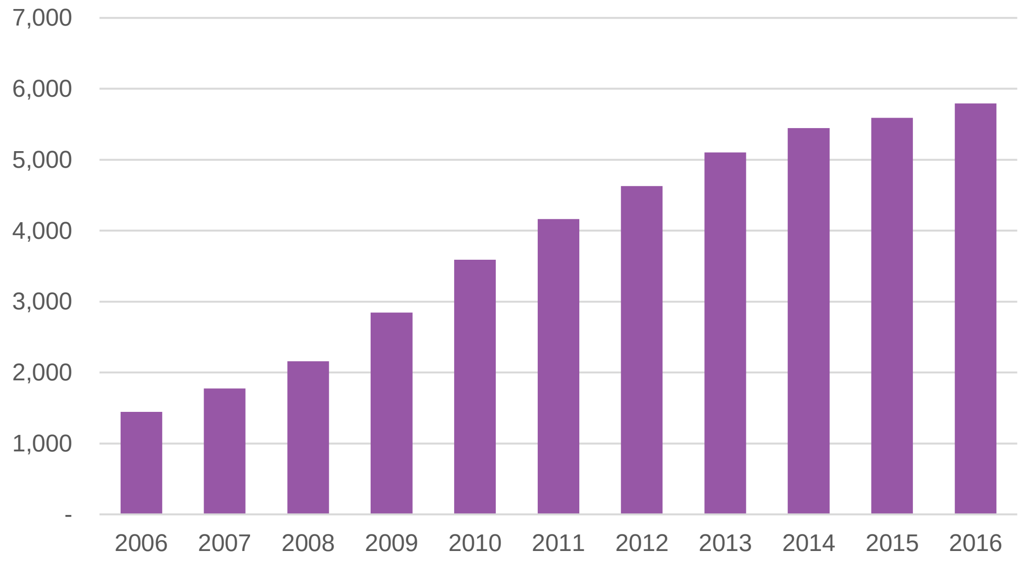
With an understanding of the likely future water demand, it is then possible to consider the best way to deliver Perth's future water supply requirement. This process involves understanding recent water supply investment costs, the cost of future development under a Business as Usual scenario, and the advantages and disadvantages of alternative supply development options.

3.2 Recent trends in water supply investment and costs

Desalination, the main growth source in the water supply portfolio, is associated with both relatively high capital costs, and relatively high operating costs. Reflecting this, both per property water charges to residents and debt levels at Water Corporation have increased substantially in recent years. For example, between 2006 and 2016 Water Corporation's long term debt increased almost fourfold, from $1.4 billion to $5.8 billion (Figure 3.1); operating costs per property have increased by 66 percent, from $479 per property to $796 per property; and total costs per property have increased by 50 percent, from $1,329 per property to $2,004 per property (Figure 3.2). Each new substantial supply augmentation from desalination involves both further substantial capital investment and a further increase in operating costs. For example, the short run marginal cost of supplying water from desalination sources is about five times the cost of water supplied from dams.[33]

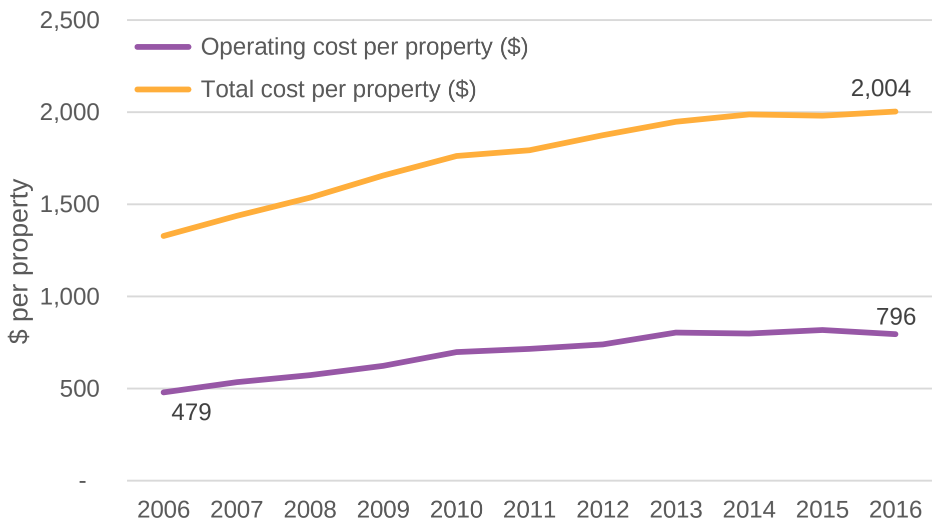
[33] Economic Regulation Authority (2009) Inquiry into the Efficient Costs and Tariffs of the Water Corporation, Aqwest and the Busselton Water Board: Revised Final Report, p. 193.

FIGURE 3.1 LONG-TERM DEBT OF WATER CORPORATION ($M)



SOURCE: WATER CORPORATION ANNUAL REPORTS (VARIOUS YEARS)

FIGURE 3.2 CHANGE IN WATER CORPORATION PER PROPERTY COSTS ($)



SOURCE: WATER CORPORATION ANNUAL REPORTS (VARIOUS YEARS)

Although groundwater replenishment is now also part of the future supply mix, the long run marginal cost of water supplied through groundwater replenishment is approximately the same as that supplied through desalination.[34]

3.3 Future potable water supply costs

There are several approaches that can be used to understand the future cost of water supply infrastructure investment. The approaches considered here are long run marginal cost and the capital cost associated with recent supply augmentation projects.

[34] Water Corporation (2009) Water Forever: Towards Climate Resilience, p. 24.

3.3.1 Long run marginal cost

Long run marginal cost (LRMC) is one way of understanding the likely future costs of water supply.

The long run marginal cost (LRMC) is the cost of providing an additional unit of service over a long-term time horizon where capital or physical infrastructure can be varied to meet changes in the supply and demand balance. A long-term perspective takes into account the cost of long-term investments in assets used to provide water services.[35]

In 2015/16 dollars, the estimates of the long run marginal cost for water supply for Perth range from \$1.49 to \$3.11 per kL, with a central estimate of \$2.06.[36] In broad terms the estimate is sensitive to the:

- rainfall assumption
- population growth and location assumptions
- water use assumptions, and
- energy cost assumptions.

When average rainfall is low, new supply sources are added more quickly. As new supply sources are costly to develop, this increases LRMC. The base case for the above LRMC estimates assume average rainfall over the next 100 years equal to the 2001 to 2010 period. The evidence surrounding changes in rainfall for the southwest of Western Australia has increased in recent years, and the consensus is now that we should expect further reductions in rainfall over the next 100 years. As a result, the above estimates for LRMC are likely to be too low and the actual LRMC higher.

When population growth is faster than expected, new supply sources are added sooner, and this works to increase the LRMC. The base case values cited above assume a population of 3.1M for the Perth Mandurah region in 2060. This is less than the populations projections contained in recent scenario planning documents, such as Perth and Peel @3.5M, so if the recent population projections are realised this will result in an increase in LRMC.

The LRMC base case also assumes that per capita water demand, in the long run, falls to 110kL per year. If per capita water use remains above 110kL per person, then water supply augmentation needs to be brought forward, resulting in an increase in the LRMC. Conversely, if per capita water consumption falls below this level LRMC would fall.

For the Perth and Peel @3.5M planning scenario, and given the latest information available on climate change, it is reasonable to expect that the LRMC of additional water supply for Perth, going forward, will lie in upper half of the current estimated distribution range, which would be \$2.06 to \$3.11 per kL, or higher.

In terms of the impact of new water supply projects on LRMC estimates, it is instructive to note the extent of the escalation in estimates of LRMC as it has become clear that climate independent sources will dominate the future supply mix for Perth. For example, in 2005, inflated to current dollars, the range for the upper and lower bound to LRMC was \$1.02 to \$1.50 per kL.[37] So, in real terms, the LRMC estimate of additional water supply in Perth has doubled over the past decade. It is reasonable to assume that this trend of increasing LRMC will continue as the proportionate supply from dams and groundwater decreases, and the supply from desalination and groundwater recharge increases.

3.3.2 Capital costs

Another way to understand the cost of developing new water supply sources is to look at the capital cost of recent major supply augmentation activities. Stage one of the Southern Seawater Desalination Plant came online in 2011, and cost \$950M to develop.[38] Stage two came online in 2013 and cost \$450M to develop.[39] In 2015 this plant provided 73GL of supply.[40] The name plate capacity of the

[35] Economic Regulation Authority (2013) Inquiry into the Efficient Costs and Tariffs of the Water Corporation, Aqwest and the Busselton Water Board: Revised Final Report, p. 66
[36] Economic Regulation Authority (2013), p. 69
[37] Economic Regulation Authority (2009) Inquiry into the Efficient Costs and Tariffs of the Water Corporation, Aqwest and the Busselton Water Board: Revised Final Report, p. 24.
[38] Hon Bill Marmion, 2 September 2011 Press Release: Southern Seawater Desalination Plant, opened three months early.
[39] Hon Colin Barnett and Hon Bill Marmion, 23 January 2013 Press Release: First seawater through expanded desal plant.
[40] Water Corporation Annual report (2015) Water Corporation Annual Report 2015.

plant is 100GL. If name plate capacity is considered, the capital cost of desalination augmentation was around $14M per GL; while if actual water supplied is used the capital cost of the supply augmentation is around $19M per GL.

For groundwater recharge, as the stage one development at Beenyup involved the construction of a trial plant, along with many years of development studies and work, it is difficult to determine the full cost of the stage one development. The second stage of the development, which will have annual capacity of 14GL, will process as a single development and is expected to cost $232M.[41] As such, for groundwater replenishment, the indicative capital cost is around $16.5M per GL.

The other main cost associated with Business as Usual expansion of Perth's water supply network is the extension of water mains. Over the past five years, on average 17.7 metres of mains have been added for every additional household connected to scheme water.[42] The cost of main pipe varies with diameter. At the upper end of the spectrum would be the Goldfields pipeline, where replacing a six kilometre section of pipe cost $14M.[43] At the other extreme would be a project such as the pipeline between Albany and Mount Barker, where 26km of pipe was replaced for $10M.[44]

In the metropolitan area the 1.3km section of mains along Marmion Avenue to supply the suburbs of Alkimos and Eglinton cost $3.12M,[45] and the 4.0km section of mains in Byford cost $5.3M.[46] So, averaged across these two projects the cost of water supply mains is then $8.42M/5.3km = $1,589 per metre. Since 2010, 83,452 households have been connected to Perth's water supply, and based on Water Corporation annual reports the mains network has increased from 12,997km to 13,850km.[47] This implies that 10.2 metres of main have been added for every connection. Although the values are listed as mains in the annual reports, it is more likely the values reported by Water Corporation reflect a combination of trunk mains, distribution mains, and reticulation pipes. A 2013 audit identified trunk and distribution lines in the metropolitan area as comprising 14.9 per cent of the total network. At the time, the estimated replacement value of trunk and distribution mains in the metropolitan area was $955 per metre, and the estimated replacement value of reticulation pipes was $264 per metre; with the total replacement value of all Water Corporation pipes in the metropolitan area thought to be $11.7 billion.[48]

There are several approaches that can be used to calculate the average cost per connection. If the value of 10.2 metres reflects both the growth in the mains and reticulation network per connection, depending on the assumptions made, the range for pipeline capital expenditure per connection is between $3,890 and $6,233.[49] Some of this cost is recouped through water headworks charges that the Water Corporation charges developers, although standard headworks charges currently collected by the Water Corporation are only $2,150 per connection.

Under a Business as Usual development scenario, not only will there be a significant capital investment requirement to develop future supply sources, there will also be a significant capital investment requirement to connect these new homes to the network. In contrast, decentralised systems can reduce the size of required potable water infrastructure and drive savings in the State investment required to develop future potable water supplies. Decentralised private sector schemes can also reduce the State investment in wastewater transport and treatment infrastructure. Further, if these schemes include potable water, they can reduce the capital costs that the State would otherwise incur to network potable water to these homes.

[41] Young, E.(2016) Treated sewage to entre Perth drinking water by end of year, WAToday.com.au, 15 July 2016.
[42] Water Corporation (various) Water Corporation Annual Reports, various years.
[43] Water Corporation (2014) Water Corporation Annual Report 2014, p. 20.
[44] Water Corporation (2014), p. 20.
[45] Hon Mia Davies, 24 July 2015 Press Release: New water main for Alkimos and Eglinton.
[46] Hon Mia Davies, 27 July 2015 Press Release: New water main to cater for growth in Byford.
[47] Water Corporation (various) Water Corporation Annual Reports, various years.
[48] Office of the Auditor General (2014) Water Corporation: Management of Water Pipes, p. 12.
[49] Using the replacement value data from the Auditor General report, the average cost per metre of each connection can be found by multiplying the implied per metre replacement cost for pipes of different type, by the relative share of the network for each pipe type (mains & trunk 15% and reticulation 85%), and adjusting for inflation in the construction sector. This calculation gives an estimate of $382 per metre for network additions. Alternatively, the calculation can be based on the current reported per metre main pipe charge of $1,589, assuming the ratio of cost between mains and reticulation pipes is as per the Auditor General report ($955 per metre to $264 per metre). This calculation gives an implied average per metre cost of $611. With 10.2 metres of network added per connection the range of values is then $3,890 to $6,233, per connection.

3.3.3 Future energy and other operating costs

Desalination plants and groundwater recharge operations require a significant amount of energy to provide water. As an increasing proportion of Perth's future water supply will come from these sources the overall LRMC of Perth's water supply will be sensitive to changes in the supply and cost of energy. For example, it has been reported that almost half the cost of a desalination plant relates to energy costs.[50] In general, this cost share increases substantially when non-conventional energy generation sources are used.[51] Current practice is for Water Corporation to source renewable energy for projects.[52]

Although the future price path for energy is uncertain, the current revenue generated from energy generation in Western Australia is below the cost of generation and charges to consumers are expected to rise in the near term.[53]

The ongoing operating cost of a desalination plant may be greater in dollars per kilolitre than the operating costs for a decentralised recycled water scheme. As a result, the use of fit-for purpose recycled water instead of desalination generated potable water may not only save on desalination capital costs, but can also drive savings in the form of avoided desalination operating costs.

3.4 Future wastewater costs

Wastewater treatment plants collect, treat and dispose of wastewater from residential, commercial and industrial uses to protect public health and the environment. For wastewater treatment, the main cost categories are: treatment plants, associated infrastructure at treatment plants, pumping stations, and pipe infrastructure.

The majority of wastewater currently collected and treated throughout Western Australia occurs in the Perth metropolitan area at three large wastewater treatment plants: Woodman Point, Beenyup, and Subiaco. These three wastewater treatment plants have a relatively long operating history. The Woodman Point Wastewater Treatment Plant was built in 1910; Subiaco Wastewater Treatment Plant was built in 1927; and Beenyup Wastewater Treatment Plant was built in 1970. Wastewater at these plants is now treated to an advanced secondary level. As can be seen from the detail shown in Figure 3.3 and Figure 3.4, for many residential developments, water is pumped long distances to reach treatment plants, prior to then being pumped long distances for disposal via the ocean.

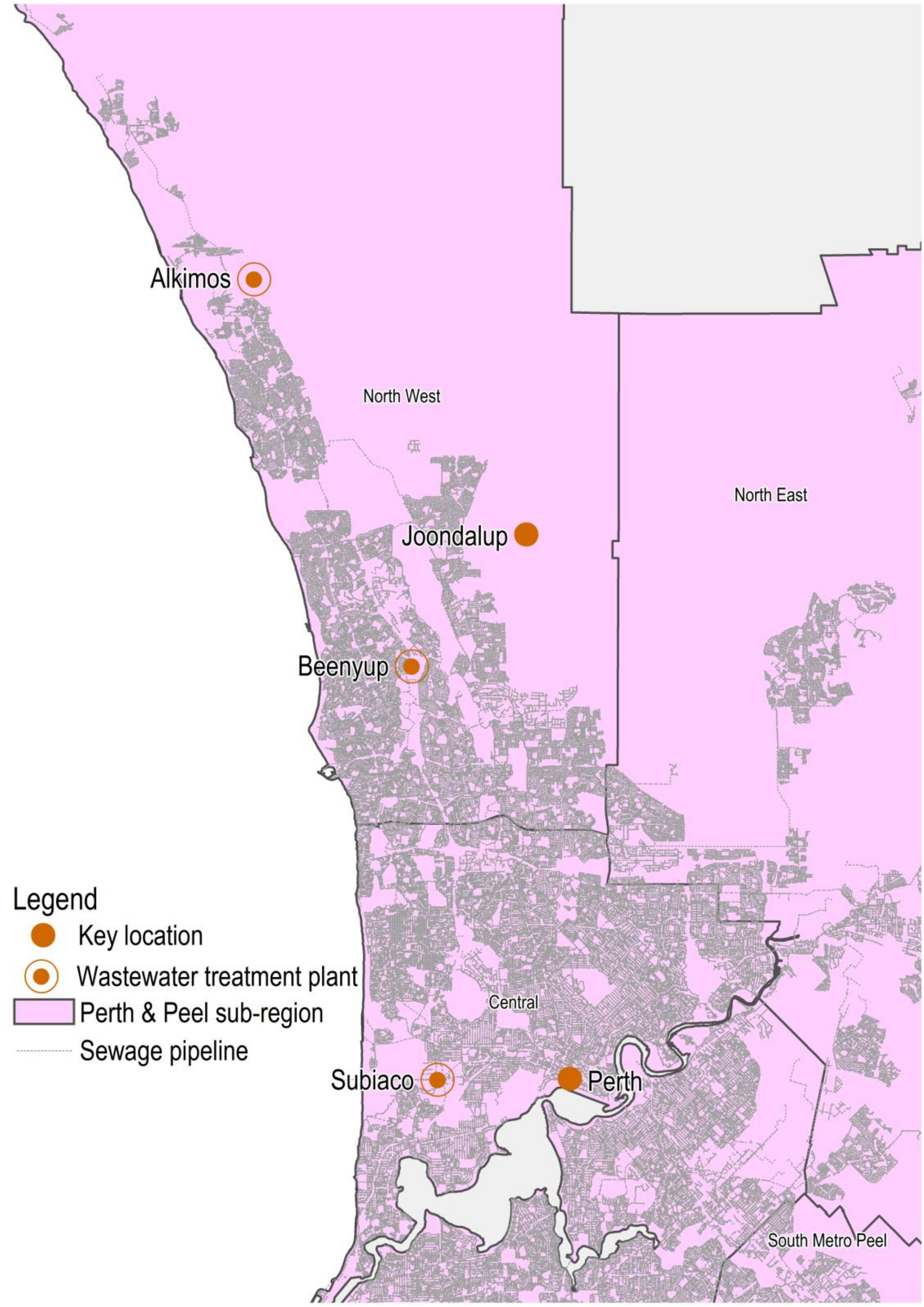
Changes in community standards regarding odour management have meant that significant investments in upgrading plant and equipment have been made at treatment plants in recent years. For example, the first stage of odour management improvement works at Woodman Point cost $137M,[54] and the cost of improvements at all three main treatment plants in recent years was $352M.[55] In 2002 the Woodman Point Treatment Plant received a $150 million capital investment that increased peak capacity by 35,000 kL per day to 160,000 kL per day.[56]

In recent years, the Water Corporation has invested in two new large wastewater treatment plants: Alkimos Wastewater Treatment Plant and East Rockingham Wastewater Treatment Plant. Including the installation of an ocean outfall, and extension of the mains, the Alkimos development, which has a stage one peak capacity of 20,000kL per day, cost $366M.[57] The facility is designed so that it can be expanded in the future to a maximum capacity of 150,000kL per day.

The East Rockingham project, including the extension of mains cost $182M. Similar to the Alkimos plant the peak capacity is 20,000kL per day. Total cost for the wastewater treatment plant component of the project was $96M, with the cost of the pressure main reported as $82M.[58]

[50] Younos, T. (2005) The economics of desalination. *Journal of Contemporary Water Research & Education*, *132*(1), 39-45.
[51] Karagiannis, I. C., & Soldatos, P. G. (2008) Water desalination cost literature: review and assessment. *Desalination*, *223*(1), 448-456.
[52] Hon Bill Marmion, 25 August 2011 Press Release, Renewable energy contracts in place for new desalination plant.
[53] AEMC (2015) Residential Electricity Price Trends, Australian Energy Market Commission.
[54] Woodman Point Wastewater Treatment Plant: available: AustralianTenders.com
[55] Water Corporation (2011) Water Corporation Annual Report 2011, p. 8.
[56] Water Corporation (2009) Woodman Point Wastewater Treatment Plant.
[57] Hon Bill Marmion, 20 April 2011 Press Release, Alkimos Wastewater Treatment Scheme Opened.
[58] Hon Mia Davies 19 February 2016 Press Release: East Rockingham wastewater plant complete.

FIGURE 3.3 DEVELOPMENT AREAS AND THE SEWER NETWORK: NORTHERN AREAS



SOURCE: LANDGATE; WAPC (2015)

FIGURE 3.4 DEVELOPMENT AREAS AND THE SEWER NETWORK: SOUTHERN AREAS

SOURCE: LANDGATE; WAPC (2015)

Comparing nameplate treatment plant capacity for treatment plants in metropolitan Perth indicates that the treatment plant capacity operates at a ratio of 5,000 people per 1,000kL per day treatment plant capacity. The capital cost of capacity at the most recent development was $4.8M per thousand kilolitre per day capacity, but this expenditure excludes related infrastructure spending. As the population of Perth expands this provides a reference measure of the capital investment that will be required for wastewater treatment plants.

There are 627 wastewater pumping stations in metropolitan Perth, and a further 84 pumping stations in the Mandurah-Murray region.[59] Pumping stations vary in size and capital cost, but are a non-trivial part of the total infrastructure spend. For example the Lake Coogee pumping station, built over a decade ago, cost $8M.[60] In the majority of cases pumping station costs are reported as part of an upgrade project, so it is difficult to identify the pure pumping station cost. For example, the Baldivis pump station upgrade was undertaken at the same time as an 11 km pressure main extension, where the combined project cost $19M.[61]

Over the past six years the average ratio of property connections per pumping station has been one pumping station per 1,051 connections; and the average additional pipeline network extension per connection has been 11.8 metres.[62] The cost of mains for wastewater appears to be similar, but slightly higher, than for water supply.[63] For example, if the bounds of $382 per metre and $611 per metre derived using the method described in the above footnote is used, the implied pipe related network costs lie between $4,500 per connection and $7,198 per connection.

Total per capita wastewater capital costs depend on the person per connection assumptions. For treatment plant costs, the cost per person appears to be around $1,000. For additional pipe work the per person cost depends on the assumed number of people per household, but from the available evidence it seems unlikely this cost would be below $2,000 per person, regardless of the assumption made on persons per household. For per person pumping station costs, if we work backwards and assume a cost of $1,000 per person, based on the average number of connections per pumping station, and a range of 2.2 to 2.4 people per connection, this implies average pumping station capital costs of around $2.2 to $2.5 million. Based on the evidence available in the public domain, this seems to imply values that are relatively low. As with water supply costs, a proportion of this expense is recovered through developer charges.

3.5 Relative costs of greenfield, frontal and infill water infrastructure

There is a strong argument that Water Corporation water infrastructure capital costs for a greenfield, frontal development will be higher than the average supply and connection cost to their network, and higher than for an infill development. As a result, the actual savings to the State from adopting decentralised, private sector water services in future greenfield developments could be greater than the average infrastructure and connection values presented in this report.

3.6 Constraints to investment

Since 2013, when the State Government's credit rating was downgraded by the global credit rating agencies Standard and Poor's, and Moody's, it has been increasingly difficult for the Western Australian Government to fully fund the State's capital investment requirements. This financial constraint has implications for the effective delivery of future water supply infrastructure in Western Australia. Specifically, over recent years the capital works budget that the State Government has approved for Water Corporation has been below the amount identified as required by Water Corporation. For example, over the four years to June 2016 the difference between the capital expenditure required by Water Corporation to meet its internal Strategic Investment Business Case budget and the budget approved by the Government was a shortfall of $613 million.[64]

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[59] Water Corporation (2015) Water Corporation Annual Report 2015, p. 31.
[60] Hon Kim Hames, 17 August 2000 Press release: Major contract for new pumping station.
[61] Hon Moa Davies 15 May 2014 Press Release: Wastewater project to cater for growth in south-west corridor.
[62] Water Corporation (various years) Water Corporation Annual Report various years.
[63] Hon Mia Davies 15 May 2014 Press Release: Wastewater project to cater for growth in south-west corridor.
[64] Economic Regulation Authority (2013) Inquiry into the Efficient Costs and Tariffs of the Water Corporation, Aqwest and the Busselton Water Board: Revised Final Report, p. 45.

Long term, a constraint on capital expenditure has negative effects on the supply network, and this has been identified as an issue by the Economic Regulation Authority:

For the past four years, the budget granted by the State Government has been less than the Water Corporation's proposed budget. Competing objectives between the State Government and the Water Corporation work to constrain what the Water Corporation is able to spend and Cardno [the engineering firm employed to undertake the review] has found that this constraint tends to put pressure on expenditure that is required for environmental improvements or asset renewals. … … Cardno also identified the imposition of Government capital constraints as one possible reason for the Water Corporation having relatively low expenditure on asset renewals. Cardno found that the Water Corporation's recent expenditure on asset renewals was unsustainably low, particularly given the age of much of its asset base.[65]

There is little indication that the State Government's debt position will improve substantially over the medium term, with the most recent forecast suggesting total public sector net debt will increase from around $30B in 2016 to over $40B by 2020.[66] This suggests a continuing constraint on State/Water Corporation water supply infrastructure investment under a Business as Usual development and service delivery model.

3.7 The role of the private sector

Infrastructure Australia has argued that where governments serve a dual role as both the monopoly supplier and the regulator of water services, there is a conflict of interest that can result in inefficient service delivery and poor outcomes for end users.[67] The issue of a potential conflict between the role of regulator and service provider is especially relevant in Western Australia, where the government is not bound to follow the recommendations of the Economic Regulation Authority when setting prices.

For a government with a budget deficit, and rising debt levels, as is the case in Western Australia, there is a strong temptation to ignore recommendations that result in lower net revenue from government owned utilities. It is therefore instructive to look at the actual return to the State Government from the ownership of Water Corporation and compare this to the ERA recommended case.

Table 3.1 shows the year-by-year return to the State if the ERA's recommended price structure was adopted by the Water Corporation for the period 2012 – 2016, and contrasts this with the actual payments to government. Under the ERA pricing scenario, the cumulative difference over the five year period is $910M less paid to the Government than the actual payments.

TABLE 3.1 IMPACT OF THE REGULATOR ON THE RETURN TO GOVERNMENT ($M)

Item	2012	2013	2014	2015	2016
Dividend payments ERA	397	357	182	199	207
Tax equivalent payments ERA	223	204	124	126	136
Community service obligation payment ERA	-450	-428	-352	-370	-387
Net payment to government ERA	169	132	-46	-46	-44
Actual net payment to government	216	169	183	163	344
Net difference	47	37	229	209	388

Note: Financial years. Values may not add up exactly due to rounding.

SOURCE: ECONOMIC REGULATION AUTHORITY (2013) WATER CORPORATION ANNUAL REPORTS VARIOUS YEARS

The dramatic revision in July 2016 of the Water Corporation's water headworks charges can also been seen as symptomatic of pricing problems with water charges in Western Australia. In July 2016 per lot water headworks charges were reduced from $4,064 to $2,150,[68] a 47% drop in charges overnight. While the reduction in developer charges is to be welcomed, it suggests that over recent

[65] Economic Regulation Authority (2013), p. 43-4.
[66] Government of Western Australia (2016) 2016-17 Budget: Economic and Fiscal Outlook, Budget Paper No. 3, p. 5.
[67] Infrastructure Australia (2016) Australian Infrastructure Plan: Priorities and reforms for our nation's future, p. 112.
[68] Hon Mia Davies 16 June 2016 Press Release: Water Infrastructure Charges Reduced.

years significant unnecessary extra cost has been imposed on the development industry and ultimately lot purchasers and homebuyers in Western Australia. For example, over the past five years there have been around 83,500 connections to the Perth water supply network. For these properties the difference in the developer revenue collected by Water Corporation at the $4,064 per lot rate compared to the $2,150 per lot rate is around $159.8 million.

In Western Australia it could be concluded that the scenario Infrastructure Australia highlighted of governments extracting monopoly rent revenue from householders and businesses through their state owned water utilities has been implemented and realised. The introduction of private sector water utilities would allow the State to transition to a scenario where there is genuine independent economic regulation that removes the possibility of monopoly pricing in the sector.[69]

The *Water Services Act 2012* went a long way to cleaning up the legacy process issues that previously impeded private sector involvement in the sector; however, planning and approval issues remain a challenges in what is a newly developing market. In practice it continues to be difficult for private sector investment to occur due to misaligned planning and approvals frameworks, and legacy processes.

Allowing, and practically encouraging, a role for the private sector in the water utilities space would provide several material benefits.[70] First, as argued by Infrastructure Australia, it would free up billions of dollars of public funds that could be invested in other priority areas.[71] In Western Australia, one area such funds could be redirected towards is increased maintenance and upgrades of existing water infrastructure, which as discussed in Section 3.6, is currently below the optimal level.

Meaningful private sector participation in Perth's future water supply and delivery infrastructure and services not only offers the opportunity for non-government funding of otherwise expensive infrastructure, but can also promote innovative solutions and ideas to address the very real and growing challenge of future water demands exceeding natural supplies, and how we can best bridge this gap. Competition in service provision, if only at the development stage of residential housing developments, will lead to innovation in approaches to water supply that, over the long term, will result in more cost effective, fit for purpose, and sustainable water service solutions.

3.8 The water services market

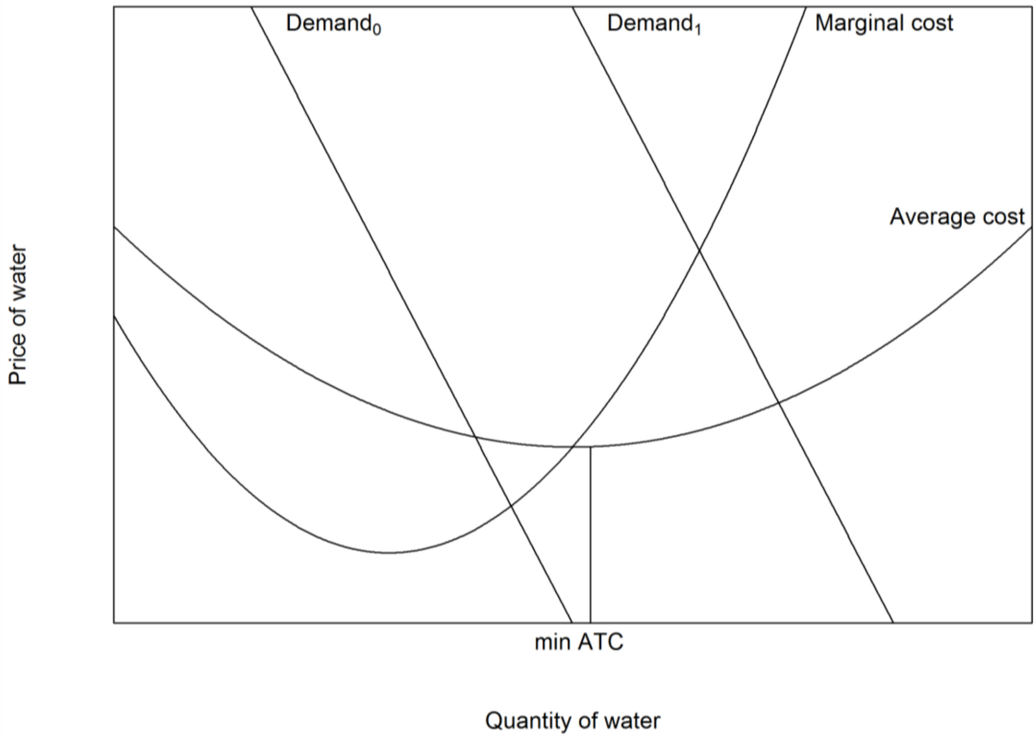
One of the reasons for a lack of private sector involvement in the water service sector is that the market is typically characterised as a natural monopoly. In practice this means that over the effective range of demand, average cost is always falling. In Figure 3.5 the situation is one where demand is always to the left of minimum Average Total Cost. Further customers (an increase in demand) leads to lower average costs, hence water services should be viewed as a natural monopoly. This view of the market structure also leads to water service pricing based on a two part tariff arrangement rather than marginal cost pricing.

[69] The issue of the relative efficiency of public and private sector is discussed in Worthington, A. C. (2014). A review of frontier approaches to efficiency and productivity measurement in urban water utilities. *Urban Water Journal*, *11*(1), 55-73.

[70] Although the *Water Services Act 2012* effectively deregulated the water services industry, in practice planning processes and practices continue to favour the Water Corporation at the expense of the private sector.

[71] Infrastructure Australia (2016) Australian Infrastructure Plan: Priorities and reforms for our nation's future, p. 113.

FIGURE 3.5 WATER AS A NATURAL MONOPOLY



SOURCE: ACIL ALLEN

Today it is not clear that the D_0 demand curve is an accurate reflection of actual market conditions in Australia. For example, it has been argued that due to the addition of relatively expensive desalination and recycled water schemes, the water demand curve now intersects the marginal cost curve at a point where marginal cost is above average cost, ie D_1.[72] If we no longer think of water as a natural monopoly this fundamentally changes the way we should think about the water market.

3.8.1 Economies of scale evidence

If the private sector is to become involved in the provision of water services, it is important to understand the extent to which economies of scale issues are present. The critical question is whether decentralised, small and medium scale water supply and waste water treatment projects can be delivered in a cost effective manner, relative to provision by a government monopoly supplier.

There is both global and local evidence on this matter. Global comparisons suggest that large publically owned utilities, are, on average, the type of operations that are likely to experience diseconomies of scale and scope.[73] This in turn suggests further expansion of large scale publicly owned utilities may not necessarily be the most cost effective approach to developing the water service sector in Western Australia.

Australian evidence suggests that scale effects are relatively unimportant for water services, and that the efficient operating size can be quite small. For example, a study of NSW local government water service operations found that efficiency under the assumption of constant returns to scale was the same for small operations (200-2,000 assessments) and large operations (over 20,000 assessments).[74] If scale effects were present we would expect efficiency measured under the assumption of constant returns to scale to be different for operations with a small number of

[72] Freebairn, J. (2008) Some emerging issues in urban water supply and pricing. *Economic Papers: A journal of applied economics and policy*, *27*(2), 184-193.
[73] Carvalho, P., Marques, R. C., & Berg, S. (2012) A meta-regression analysis of benchmarking studies on water utilities market structure. *Utilities Policy*, *21*, 40-49.
[74] Woodbury, K., & Dollery, B. (2004) Efficiency measurement in Australian local government: The case of New South Wales municipal water services. *Review of Policy Research*, *21*(5), 615-636.

assessments and operations with a large number of assessments. The same study also found that where economies of scale effects were present, diseconomies of scale effects were 1.5 times more likely to be observed than economies of scale effects. Again this literature suggests that small scale projects can be as least as efficient as large scale water service operations.

A specific issue for some greenfield developments that lie outside the development front is the cost of extending the traditional Business as Usual network to these developments. Given the cost of mains extensions, it is easy to see how local decentralised water service projects could be more cost effective than connecting to a central service. However, it is also true that infill projects can be cost effective locations for local decentralised water supply projects. Recent work on infill and rejuvenation projects is also based on the assumption that water services can be delivered locally, and will include local water recycling projects.[75]

Economies of scale effects do not, therefore, appear to be an issue or an argument against smaller local schemes.

3.8.2 Legislative framework and current practical environment

In Western Australia water services are governed by the provisions in the *Water Services Act 2012*. Charges for water services are governed by Section 123 of the *Act*, and charges are to be set such that an appropriate commercial rate of return is available to service providers. Under the *Act*, the Economic Regulation Authority (ERA) is charged with ensuring only appropriate investment is included in the asset base and that charges reflect only the costs associated with efficient service delivery.

More generally, a review of recent ERA pricing decisions across a range of regulated sectors demonstrates that ERA has rigorous processes; regularly disallows capital expenditure (even if already incurred) and proposed operating expenditure; and ties returns to tight standards such that the allowable rate of return is low, as it should be for regulated assets.[76]

The legislative framework in Western Australia provides no barriers to private sector involvement in the water services sector. However, there continue to be practices and barriers that make it difficult for private sector involvement in the sector.

Water Corporation is still seen by the main planning authorities (including the WAPC) as the only relevant body to consult. Planning process for infrastructure investment in general, not just for water infrastructure, needs to be set such that there is an opportunity at an early stage for private sector engagement and the discussion of alternative servicing models and ideas. Planning processes in general also need to promote transparency and cost reflective pricing.

Similarly, the agency approval framework and process for water licensing in Western Australia is largely based on a legacy and knowledge of only Water Corporation applications.[77] This puts new private sector entrants at a disadvantage from both a process, understanding, and timing perspective.

3.8.3 Consumer impacts

A key element of decentralised systems is the provision of recycled water for non-potable use. Compared to potable water costs, recycled water costs are typically lower. For the Rouse Hill Development in Sydney, the Independent Pricing and Regulatory Tribunal (IPART) has been involved in setting the price of recycled water.[78] IPART, when setting the price of recycled water, considers the costs to be recovered.[79] We can infer from this that the present price of the recycled water is set to recover the costs of the Rouse Hill project, and is a cost reflective price. The 2015/16 usage charges for recycled water for the residents of Rouse Hill are $1.82kL, well below the $2.28kL charge for their

[75] CRC for Water Sensitive Cities (2016) Ideas of Bentley. Cooperative Research Centre for Water Sensitive Cities.

[76] The pricing decision reports are available at the Authority website: www.erawa.com.au.

[77] Agencies involved in water licensing are the: Department of Health, Department of Environment Regulation, Department of Water, and the Economic Regulation Authority (WA).

[78] For mandated schemes where there is insufficient information for IPART to set prices, detailed guidelines have been developed by IPART to assist the water agencies to calculate the prices. Voluntary recycling schemes are not regulated (where the customers have a choice to connect).

[79] Independent Pricing and Regulatory Tribunal (2006) Pricing arrangements for recycled water and sewer mining. Water – Determinations and Report, September 2006.

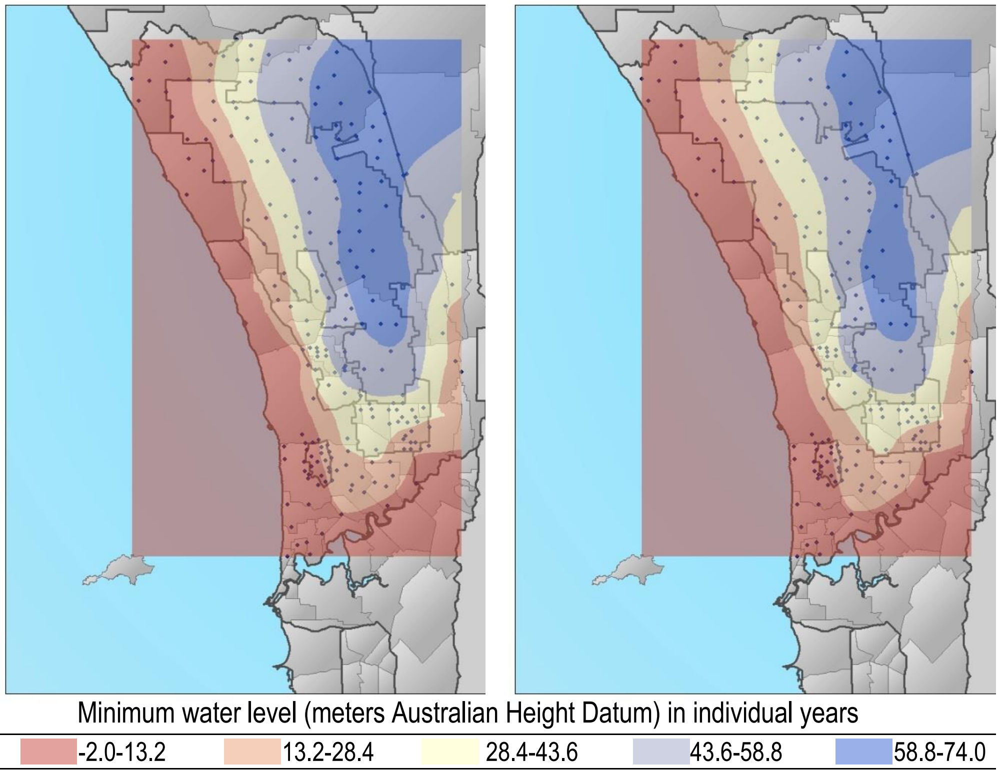
scheme water. So, for residents, the ability to use water that is fit for purpose means a saving on their water bill.

In a Western Australian context, the increasing block pricing structure for potable water means consumers are especially well placed to benefit from any shift in consumption away from potable water to recycled water. Work done by a private utility, Water West, indicates it is generally possible to supply recycled wastewater to new households at a price in the range of $1.25 to $1.50 per kilolitre. The marginal usage of an average household equates to the second tier of the Water Corporation's volumetric charges, which as of September 2016 is $2.114 per kL. So aside from being more suitable or fit-for-purpose, the price of this recycled water would represent a saving to household consumers who would otherwise need to use higher priced drinking water for their toilet flushing and garden irrigation.

3.8.4 Environmental impacts

Local water service projects mean that water can be returned to the environment in locally sensitive areas. Centralised water recycling projects, such as the Ground Water Replenishment Scheme, mean that groundwater sources can be replenished only at the location of major wastewater treatment plants. These sites are not necessarily the sites where groundwater dependent ecosystems are under most stress. Relative to centralised systems, decentralised systems can, therefore, deliver additional environmental benefits.

FIGURE 3.6 CHANGE IN WATER TABLE: 1984 AND 2014 GNANGARA MOUND



SOURCE: IFTEKAH AND FOGARTY (2016)

A number of different approaches can be used to estimate environmental externalities associated with the excess withdrawal of groundwater, but the approach used by the Economic Regulation Authority suggested a value of between $0.24 per kL and $0.33 per kL for excess withdrawal of groundwater, in

2008.[80] Therefore, any future saving in extraction of water from Perth's groundwater resource can be expressed as a monetary saving.

3.9 Summary

There is a common perception that small scale water services projects involve higher costs than large scale integrated projects, but there is little evidence to support this as a general proposition, and projects need to be assessed on a case-by-case basis. Some international evidence suggests that large publically owned water utilities actually suffer from diseconomies of scale. With large publicly owned utilities there may also be a lack of responsiveness to circumstances where more innovative, decentralised solutions are better suited to the circumstances and objectives of a new development.

The ability to have schemes that deliver non-potable and potable water can provide consumers with savings on their water bill.

Local recycling projects also have the ability to deliver local environmental benefits via the return of water to support groundwater dependent ecosystems.

Combined, the evidence on economies of scale effects and the price of recycled water, as set by economic regulation authorities, suggests consumers face no price risk from greater private sector involvement in the water service sector, but rather, face the prospect of lower water service charges, and the possibility of accessing innovative local water supply solutions.

Additionally, the introduction of decentralised systems can deliver local environmental benefits.

A final benefit is that private sector involvement would reduce the pressure on the government balance sheet. Since 2006 long-term debt at Water Corporation has increased by $4.4 billion. The required investment in new supply infrastructure and asset renewal investment means that under a Business as Usual Development scenario debt levels will continue to increase. This is important as the evidence suggests the government balance sheet position has already become a meaningful constraint on water sector investment.

[80] Economic Regulation Authority (2009) Inquiry into the Efficient Costs and Tariffs of the Water Corporation, Aqwest and the Busselton Water Board: Revised Final Report, p. 11.

4 DELIVERY MODELS AND IMPLICATIONS

4.1 Introduction

Based on planning scenarios such as Perth and Peel @ 3.5M, the water supply requirements for Perth and the potential infrastructure investment to 2050 are substantial. Previous chapters have outlined that private sector involvement in the provision of water services in metropolitan Western Australia would provide net benefits. This chapter investigates and quantifies the capital expenditure saving to the State Government that can be driven through private sector involvement relative to continuing with a Business as Usual approach to water services. This analysis considers a number of scenarios and the results offer useful insights for the future planning of Perth's water infrastructure and service delivery options.

Material savings to the State occur when the private sector provides local wastewater and recycling solutions to new developments, saving the need for the State to build new wastewater infrastructure, but also, importantly, saving on the necessary size and cost of the State's potable water supply and delivery infrastructure. This saving is driven by replacing expensive potable water with fit-for-purpose recycled water in new homes.

4.2 Base case scenarios

The base case scenario assumes that the Water Corporation continues to be the monopoly supplier of potable water, but that the private sector becomes involved as a provider of wastewater services and generates and supplies recycled water for non-potable use, including third pipe solutions to homes, as part of this service.

Three base case scenarios are considered:

- 10 percent of new development is served by the private sector
- 25 percent of new development is served by the private sector
- 50 percent of new development is served by the private sector.

4.2.1 Base case modelling assumptions

The core modelling assumptions for the base case scenarios are detailed below. Changes to these assumptions would lead to different estimates of the capital cost saving and the environmental benefit. The impact of different assumptions is explored in subsequent sensitivity analysis.

Population

The population grows to 3.5M by 2050, with the population growth path solved using a growth rate rather than a fixed additive number of people each year. Population growth therefore follows a geometric pattern rather than an additive pattern. For example, the population growth in 2017 is assumed to be around 30,000, and the population growth in 2050 is assumed to be over 50,000. Assuming additive population growth would bring forward the capital cost savings, so the geometric growth rate assumption is thought a conservative assumption for this exercise. It is difficult to unpack the assumptions used in existing planning documents, but geometric growth is intuitively reasonable.

Water use

Total per capita water use is assumed to be 125kL per annum, which is slightly below current water use, as discussed in section 2. This value captures both household use and all other uses. At the household level, the last comprehensive survey found per household water use to be 106kL per person (see Table 2.5). It is however known that there have been water efficiency gains since this survey was undertaken, and so here it is assumed that household water use is 53kL of potable water per person and non-potable use is 46kL per person (total 99kL). Given the focus is on greenfield developments that will have gardens and outdoor space, this is thought a conservative assumption.

Public open space

The public open space water requirement is set at 14kL per person per year, and due to the groundwater constraint for water availability, the base case assumes that 30 percent of new public open space is irrigated with scheme water. This assumption reflects the known significant constraint on access to groundwater in future development areas.

Environmental benefit

The environmental value of water returned to the environment is set at $0.40M per GL. This value reflects the ERA estimate discussed earlier in the report, inflated to current dollar values.

Water supply capital cost

Using information from Chapter 3, the capital cost per GL of desalination water delivered is assumed to be $19.0M. The capital cost associated with centralised water recycling is assumed to be $16.5M per GL. Reflecting the dominant share for desalination supply in the Business as Usual development scenario, the assumed capital cost, per GL of new water supply added, is $18.5M per GL.

Wastewater supply capital cost

The average per person capital cost associated with connecting to the wastewater network is $4,000; comprising $1,000 per person in treatment plant capital costs; $2,000 per person in network and pipe infrastructure; and $1,000 in pumping station construction costs. These values reflect the cost estimates discussed in previous chapters, and while there is considerable uncertainty about these values, based on the discussion presented in previous chapters, these values are thought relatively conservative for frontal greenfield developments.

Developer charges

The per lot developer charge for wastewater is $2,334. This reflects the current actual charge, and represents revenue foregone by the government. To ensure that only net savings to government are calculated it is necessary to deduct this revenue from estimates of the total required capital spend by government.

Additional water use efficiency change

No further improvements.

Capital infrastructure investment decision rule

The identified new supply sources under Business as Usual are either centralised water recycling or desalination projects. Centralised water recycling could be seen as the closest substitute product to local water recycling. However, under Business as Usual, the bulk of the new supply augmentation will be desalination. As such, the model assumes that the first augmentation project avoided is a centralised water recycling project, but that all subsequent avoided supply augmentation is desalination capacity. New centralised water recycling can be added in smaller increments than desalination capacity, and it is assumed that the centralised water recycling project is a 15GL per annum project. For desalination, supply augmentation is assumed to take place in 40GL per annum increments. The decision trigger for when new supply investment is undertaken is the point when demand exceeds supply by 50 percent of the supply augmentation. This decision rule allows for a temporary depletion of groundwater before new supply is added. The supply augmentation decision rule is simple, but reflects the real world situation of modern Business as Usual supply augmentation decisions.

4.2.2 10 percent scenario

If 10 percent of new residential development between now and 2050[81] had local wastewater services provided by the private sector, and these properties were also served by recycled water for non-potable use, given the assumptions made, by 2050 there would be a substantial capital investment savings to government, plus a small environmental benefit.

Water Corporation capital investment in potable water supply infrastructure would be $278M lower than it otherwise would be. However, this saving is not triggered until 2048.

In 2050, the potable water saving, relative to Business as Usual, would be 8GL per annum.

Water Corporation capital investment in wastewater infrastructure would be $640M lower than without private sector involvement.

With private sector involvement, the government will collect less in developer charges. If 10 percent of new residential construction is serviced by non Water Corporation wastewater service providers the government would collect $170M less in wastewater developer charges.

In total, if only 10 percent of Perth’s new residential development adopt private sector local wastewater treatment and recycling water solutions the net capital investment required by government would be $747M less (in 2016 dollars) than it otherwise would be.

The decentralised local service delivery model also means that some water can be returned to the environment to support water dependent ecosystems. These benefits are flow benefits, and in total the cumulative environmental benefit to 2050 would be approximately $7M.

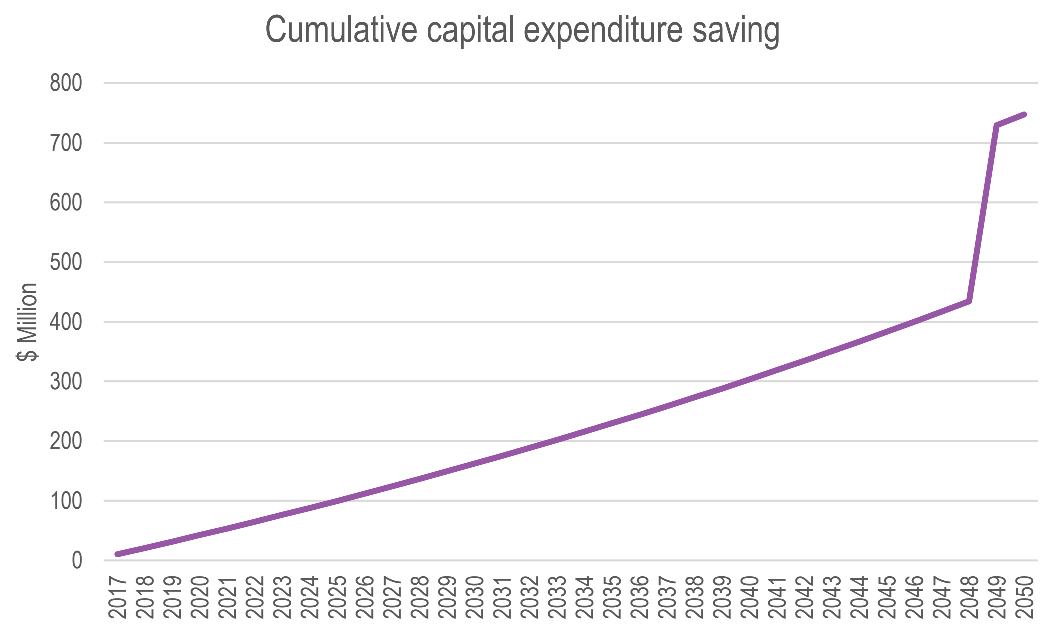
In summary:

— Government Potable Water supply related capital expenditure is lower by: $278M
— Government Wastewater related capital expenditure is lower by: $640M
— Government developer charge revenue is lower by: $170M
— Net reduction (i.e. savings) in government capital expenditure $747M (in 2016 dollars)[82]
— Cumulative net saving in potable water use: 127GL
— Net saving in potable water in the year 2050: 8GL per annum
— Environment benefit: $7M.

Figure 4.1 traces the implied capital investment saving. The step in the capital saving plot in 2048 is due to the counterfactual BaU scenario implying that a supply augmentation will be required in 2048, where this central Government funded supply augmentation would not be required under the local, privately funded water recycling scenario. Figure 4.2 plots both the annual potable water saving (purple line) and the cumulative potable water saving (solid yellow area); and Figure 4.3 plots the annual environmental benefit as a flow (purple line) and the cumulative benefit (solid yellow area).

[81] As the expected population growth is approximately 1.5M this equates to approximately 150,000 residents being served, or approximately four percent of the expected greater metropolitan Perth population.
[82] Note that numbers may not add exactly due to rounding.

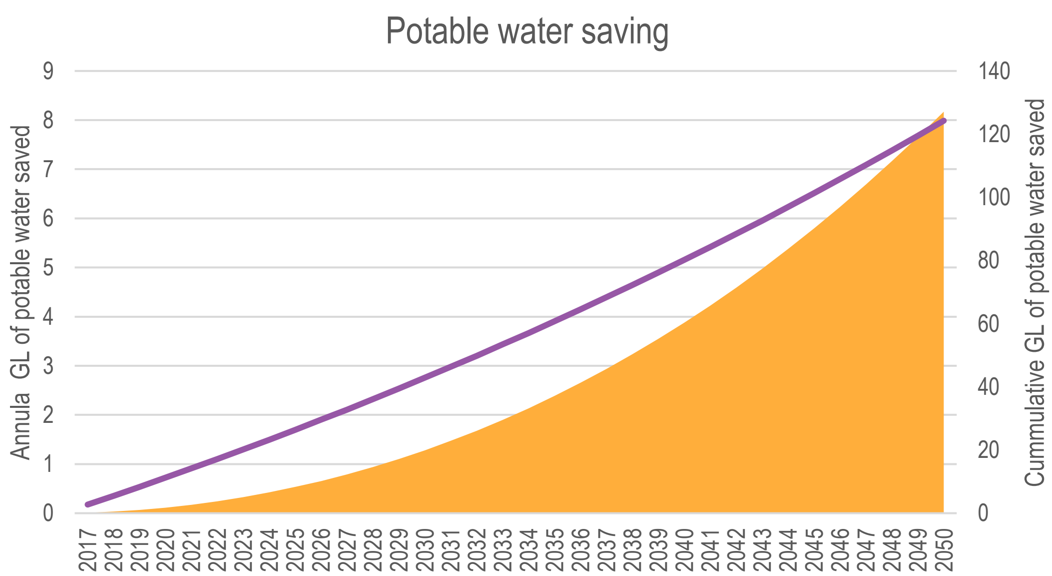
FIGURE 4.1 10 PERCENT SCENARIO: BASE CASE CAPITAL SAVING



SOURCE: ACIL ALLEN

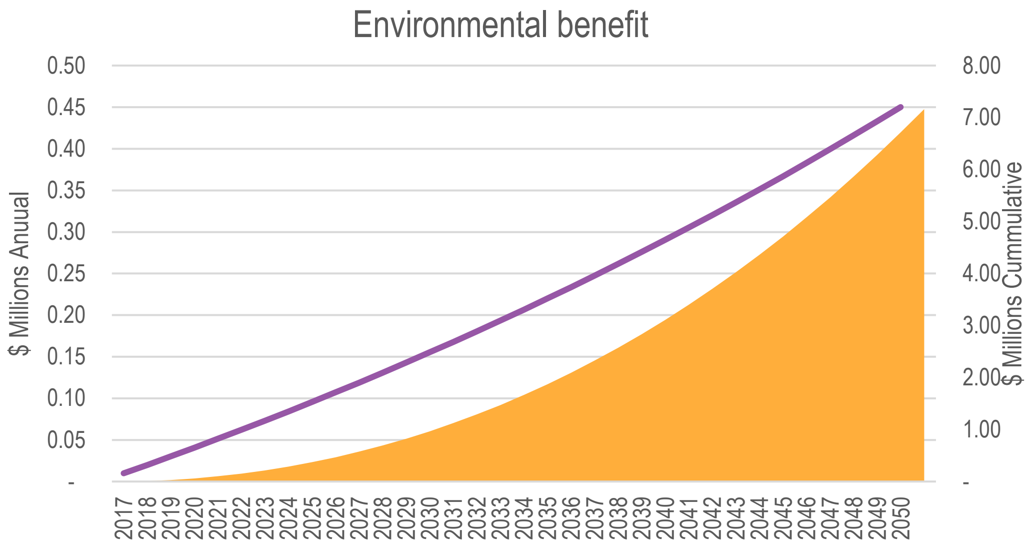
NOTE: ASSUMES FIRST SUPPLY AUGMENTATION TRIGGERED IS A 15 GL AUGMENTATION AND ALL SUBSEQUENT AUGMENTATION IS IN 40GL LOTS

FIGURE 4.2 10 PERCENT SCENARIO: BASE CASE POTABLE WATER SAVING



SOURCE: ACIL ALLEN

FIGURE 4.3 10 PERCENT SCENARIO: BASE CASE ENVIRONMENTAL BENEFIT



SOURCE: ACIL ALLEN

4.2.3 25 percent scenario

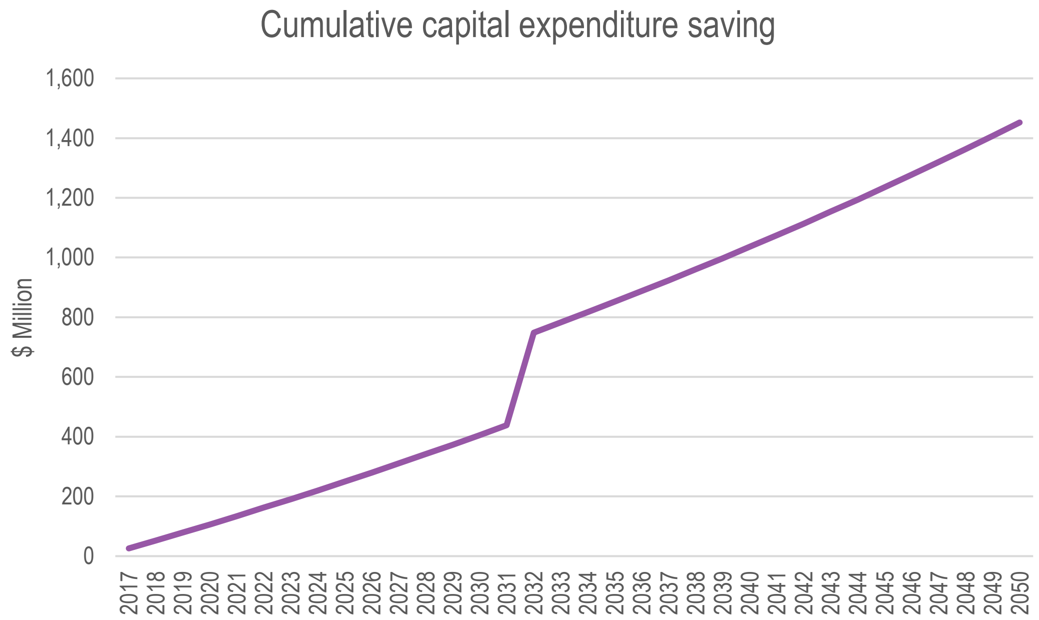
As the proportion of new households connected to a private wastewater service providers increases, so too do the estimated capital savings to the Western Australian State Government. For example, if 25 percent of new residential development between now and 2050[83] had local wastewater services provided by the private sector, and these properties were also serviced by recycled water for non-potable use, the estimated impacts are as follows:

— Government Potable Water supply related capital expenditure is lower by: $278M
— Government Wastewater related capital expenditure is lower by: $1,599M
— Government developer charge revenue is lower by: $424M
— Net reduction (i.e. savings) in government capital expenditure: $1,452M (in 2016 dollars)
— Net saving in potable water: 318 GL
— Net saving in potable water in the year 2050: 20GL per annum
— Environment benefit: $18M.

It can be noted that under this scenario the decision rule for new State Government capital investment in supply results in no additional difference in supply investment relative to the 10 percent scenario. As such, the capital investment saving from supply augmentation (in constant dollars) is the same as for the 10 percent scenario. However, as can be seen from Figure 4.4, the timing of this saving is brought forward from 2048 to 2032. Figure 4.5 and Figure 4.6 provide details on the potable water saving and the environmental benefit, where similar to Figure 4.2 and Figure 4.3, the purple lines trace the flow benefits and the solid yellow areas track the cumulative benefit.

[83] Equivalent to around 375,000 residents.

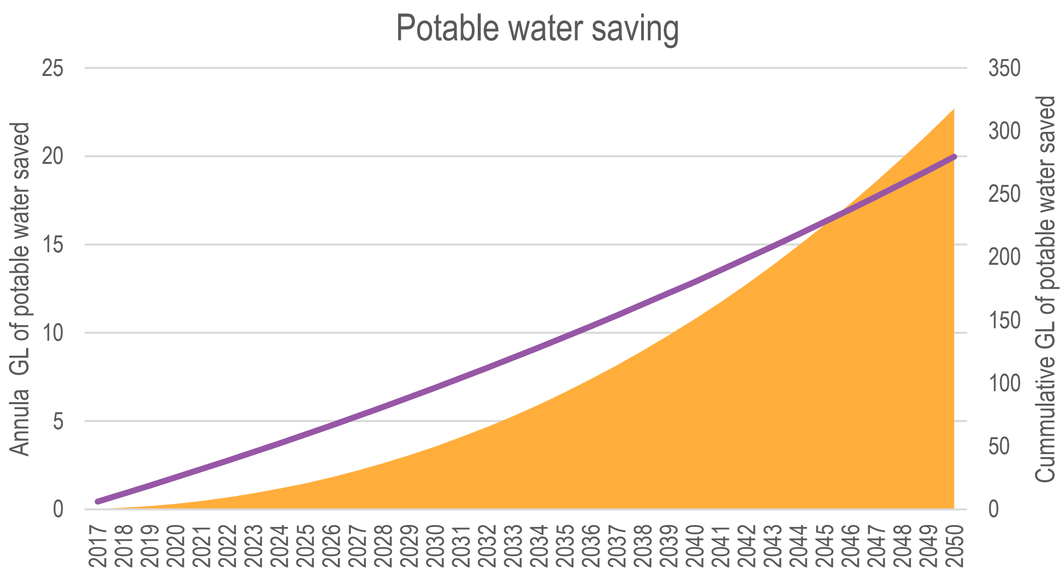
FIGURE 4.4 25 PERCENT SCENARIO: BASE CASE CAPITAL SAVING



SOURCE: ACIL ALLEN

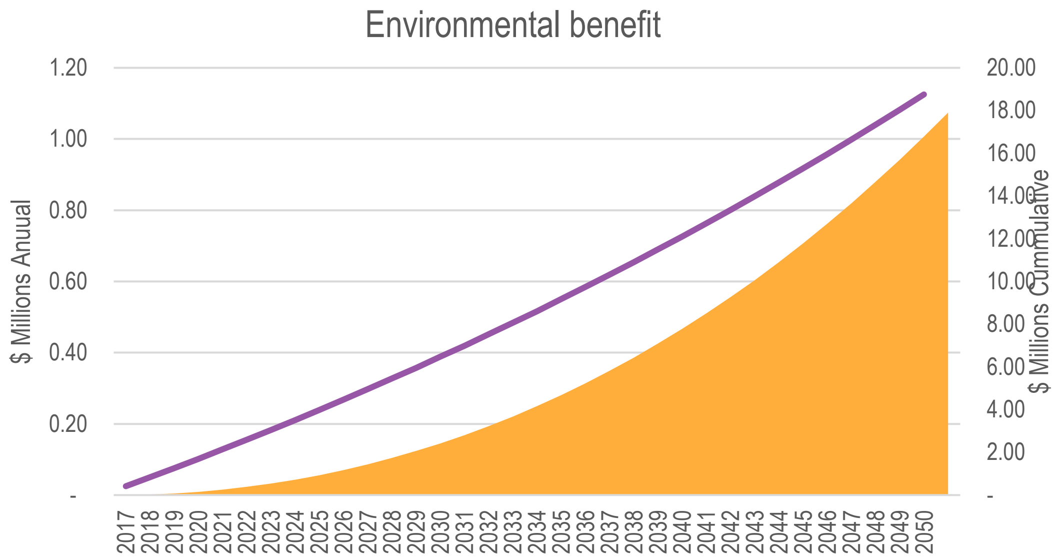
NOTE: ASSUMES FIRST SUPPLY AUGMENTATION TRIGGERED IS A 15 GL AUGMENTATION AND ALL SUBSEQUENT AUGMENTATION IS IN 40GL LOTS

FIGURE 4.5 25 PERCENT SCENARIO: BASE CASE POTABLE WATER SAVING



SOURCE: ACIL ALLEN

FIGURE 4.6 25 PERCENT SCENARIO: BASE CASE ENVIRONMENTAL BENEFIT



SOURCE: ACIL ALLEN

4.2.4 50 percent scenario

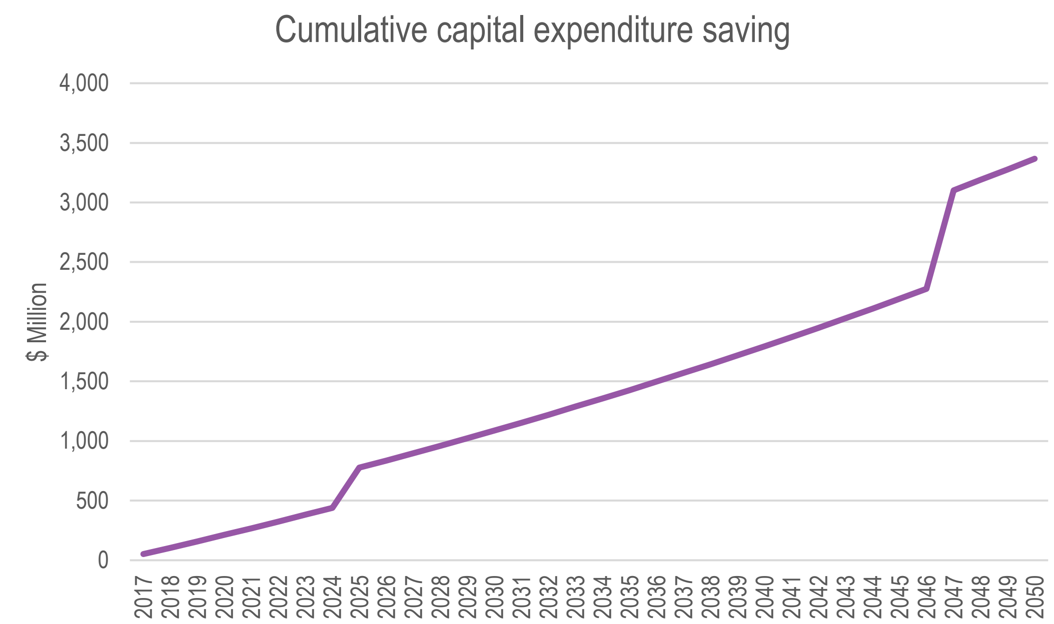
The third base case scenario considered is where 50 percent of new residential development between now and 2050[84] have wastewater services and recycled water for non-potable use provided by the private sector. This results in a net saving to the State Government of $3.4 billion. For this scenario:

- Government Water supply related capital expenditure is lower by: $1,018M
- Government Wastewater related capital expenditure is lower by: $3,198M
- Government developer charge revenue is lower by: $848M
- Net reduction (i.e. savings) in government capital expenditure: $3,367M (in 2016 dollars)
- Net saving in potable water: 636 GL
- Net saving in potable water in the year 2050: 40 GL per annum
- Environment benefit: $36M.

In terms of supply augmentation savings, the first year of benefit is brought forward to 2025, and by 2047 the savings are sufficient to also replace the need for a desalination plant. Note that due to the large size of desalination capital augmentation investments the vertical scale of Figure 4.7 is different to Figure 4.1 and Figure 4.4. The marginal and cumulative water savings, and the marginal and cumulative environmental benefits (Figure 4.8 and Figure 4.9) increase, relative to the other scenarios, but follow the same pattern as observed for the other scenarios.

[84] Equivalent to around 750,000 residents.

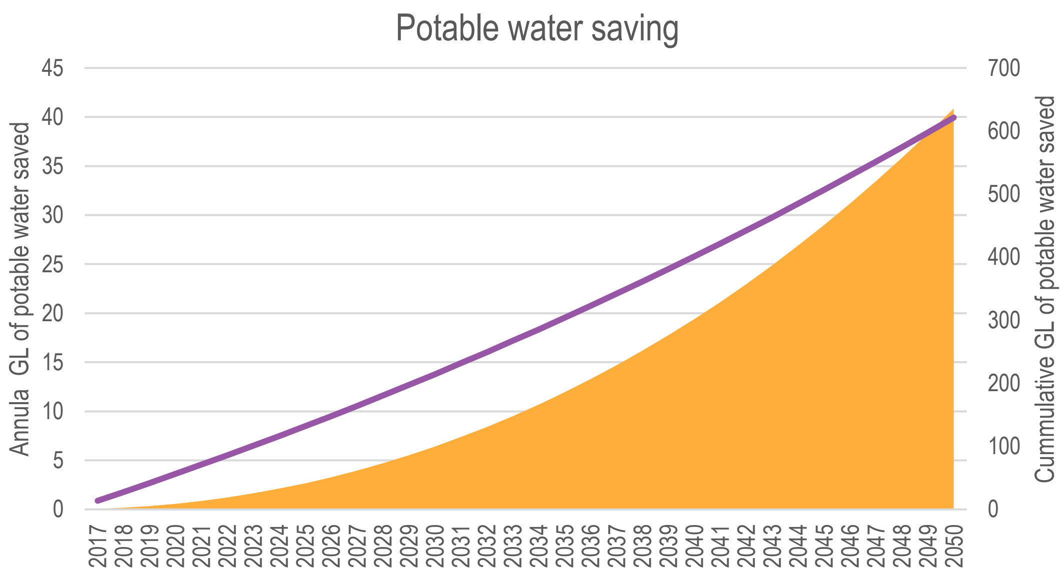
FIGURE 4.7 50 PERCENT SCENARIO: BASE CASE CAPITAL SAVING



SOURCE: ACIL ALLEN

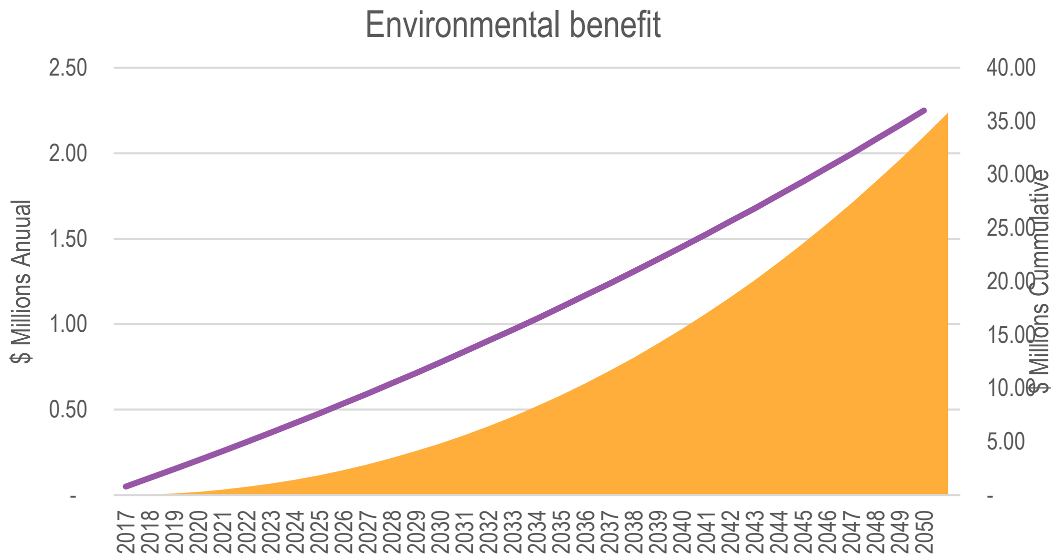
NOTE: ASSUMES FIRST SUPPLY AUGMENTATION TRIGGERED IS A 15 GL AUGMENTATION AND ALL SUBSEQUENT AUGMENTATION IS IN 40GL LOTS

FIGURE 4.8 50 PERCENT SCENARIO: BASE CASE POTABLE WATER SAVING



SOURCE: ACIL ALLEN

FIGURE 4.9 50 PERCENT SCENARIO: BASE CASE ENVIRONMENTAL BENEFIT



SOURCE: ACIL ALLEN

4.2.5 Summary of the base case scenarios

The involvement of the private sector in the provision of water services has the potential to substantially reduce the capital expenditure requirements of the Western Australian State Government between now and 2050. These savings are not through the privatisation of Water Corporation, or through stopping Water Corporation growing, but rather are through the involvement of the private sector in servicing new residential development with decentralised wastewater and recycling delivery schemes. Under all scenarios above, Water Corporation remains the primary supplier of potable water, and the main supplier of wastewater services.

By 2050, if the private sector provides 25 percent of new wastewater services in metropolitan Perth (equivalent to 171 thousand households), the savings to the Western Australian State Government, in terms of lower capital expenditure, would be $1,452M. As detailed in Table 4.1, the savings in terms of capital expenditure rise as private sector involvement increases, and by 2050, if 50 percent of new residential development was serviced by the private sector, the savings to the State Government in terms of capital expenditure would be $3,367M.

TABLE 4.1 SAVINGS SUMMARY ASSUMING CAPITAL INVESTMENT TRIGGER

Details	Units	10%	25%	50%
Water Supply Infrastructure Capital Saving	$M	278	278	1,018
Net Wastewater Infrastructure Capital Saving	$M	470	1,174	2,349
Total Capital Investment Saving	$M	747	1,452	3,367
Potable Water Saving	GL	127	318	636
Households Served	No.	68,560	171,402	342,803
Population Served	No.	150,833	377,080	754,167
Proportion of the Population Served	%	4.3	10.8	21.5

SOURCE: ACIL ALLEN
NUMBERS MAY NOT ADD UP EXACTLY DUE TO ROUNDING

4.2.6 Consumer impacts

The main consumer impact is in terms of a saving due the lower cost of water used for non-potable purposes. The household saving depends on the assumption regarding the number of people in each house, and the level of non-potable water use. The savings, for different average household size, and different non-potable water demand assumptions are shown in Table 4.2, where it is assumed that the non-potable water supply cost is $1.50kL, and that this water displaces water from the second tier of the Water Corporation charging schedule ($2.114kL)

TABLE 4.2 PER HOUSEHOLD WATER BILL SAVINGS

Persons per household	Non-potable household water use per person kL		
	42 kL	**46 kL**	**50 kL**
2.2	$57	$62	$68
2.4	$62	$68	$74
2.6	$67	$73	$80

SOURCE: ACIL ALLEN

4.3 Sensitivity scenarios

The first effect considered is the impact of the investment decision trigger. The decision trigger rule used for capital expenditure means that some capital investment savings occur in large lumps. The lumpiness of this expenditure may distort the capital savings picture. As such, a second set of calculations were prepared that assume a 'smooth' capital savings profile. The smoothed capital investment profile results reflect a case where new supply can be added in one gigalitre increments.

To consider the effect of changing other modelling assumptions, the share of private sector involvement is fixed at 25 percent of new developments, and to abstract from the timing effect of lumpy capital expenditure investment, the sensitivity testing assumes that supply can be added in one gigalitre increments.

The impact of changing specific assumptions is then investigated sequentially. The specific assumptions investigated are: the population growth assumption; per capita water use assumption; the public open space demand for scheme water assumption; and the cost of new infrastructure investment assumption.

In terms of understanding the impact of changing each assumption the metric of focus is the impact on the net capital expenditure saving to government, which with the smoothed capital investment profile is $1,544M by 2050.

4.3.1 Investment trigger impact

Table 4.3 provided details on the savings assuming a smooth profile for capital investment in supply augmentation, compared to the results with an investment decision trigger. As can be seen from the detail in the table, there is no systematic pattern to the results. For the 10 percent and 50 percent scenarios, the savings with a smooth investment profile are lower than with an investment trigger, but for the 25 percent scenario they are higher. This indicates the decision trigger for capital investment has not introduced a systematic bias into the results.

TABLE 4.3 CAPITAL SAVINGS: SMOOTHED INVESTMENT PROFILE V DECISION TRIGGER

Details	Units	10%	25%	50%
Total capital investment saving with investment trigger	$M	747	1,452	3,367
Total capital investment saving without investment trigger	No.	618	1,544	3,088
Difference	$M	129	-92	279
Difference	%	18.9	-6.1	8.6

SOURCE: ACIL ALLEN

NOTE: AS THERE IS NO CLEAR BASE FOR CALCULATING PERCENTAGE CHANGES THE AVERAGE OF THE TWO VALUES HAS BEEN USED AS THE BASE.

4.3.2 Population growth

The base case population scenario is the Perth and Peel @3.5 population scenario, and this projection series has a population in 2050 that is lower than in the ABS population projections. As such, consideration is given to the impact of assuming a population of 3.9M by 2050 rather than a population of 3.5M. If the population in 2050 was 3.9M, then the estimated saving in terms of capital spending on water infrastructure would increase from $1,544M to $1,947M.

In percentage terms, an increase in the population from 3.5M to 3.9M is an increase of 11.4 percent; and an increase in the capital cost saving from $1,544M to $1,947M is an increase of 26.1 percent. This suggests the population growth assumption has a relatively strong impact on the estimated capital cost saving. Recall that the share of new developments serviced by the private sector is held constant, so with higher population growth the absolute number of homes serviced by the private sector increases.

4.3.3 Per capita water use assumption

For the per capita water use assumption, the impact of assuming the steady state water use is 10 percent lower than the base case and 10 percent higher than the base case is investigated. With per capita water use 10 percent higher than the base case the estimated saving in terms of capital expenditure rises to $1,578M. With per capita water use 10 percent lower than the base case the estimated saving in terms of capital expenditure falls to $1,510M.

Overall, this suggests that the results, in terms of capital investment savings, are not very sensitive to modest variations in the per capita water use assumption.

4.3.4 Public open space constraint

As Perth's groundwater resources for the majority of future development areas are either fully allocated, or close to being fully allocated, the base case assumes that 30 percent of the new public open space requirement is met with scheme water. If the public open space requirement can be met completely without recourse to scheme water, then the estimated capital expenditure saving falls to $1,515M. Conversely, if 50 percent of the new public open space water requirement was met with scheme water the saving would increase to $1,564M. Combined, this result suggests that the capital expenditure savings to government are not sensitive to the public open space water requirement assumption.

4.3.5 Cost of works assumption

Changes in the cost of capital works have an approximately proportional impact on estimated capital expenditure savings. A 10 percent decrease in capital construction costs results in the capital expenditure saving falling to $1,347M; and a 10 percent increase in capital construction costs results in the capital expenditure saving increasing to $1,741M.

4.4 Summary

Under reasonable assumptions for the extent of private sector involvement in the provision of wastewater services and recycled water in new developments, there are substantial capital expenditure savings to the State Government. If the private sector was to serve 25 percent of new future residential dwellings expected by 2050, under the base case scenario, the capital expenditure savings to the Government would be just under $1.5 billion. If 50 percent of new residential developments were serviced by the private sector the savings to the Government in terms of capital spending would be over $3.3 billion.

To estimate the capital expenditure savings it is necessary to make a number of assumptions. Systematically changing different assumptions revealed that it is the population assumption that has the biggest impact on capital investment savings.

5

CONCLUSIONS

5.1 Conclusions and summary

This study has reviewed Perth's current water supply infrastructure and estimated the future water supply gap to 2050. For the central case the water supply gap in 2050 was found to be 238GL per annum. The supply gap is due to a combination of demand factors such as population growth, and supply factors such as climate change resulting in less water availability from existing rain fed water infrastructure.

The Business as Usual model for delivering new water supply in Perth is to expand desalination capacity and develop centralised water recycling projects. Due to the high standard of water treatment, both new desalination capacity and centralised water recycling projects involve high capital costs and high operating costs.

The State Government is financially constrained and investment in State water infrastructure is already below what is required. The need to invest in new supply sources means that investment funds for other parts of the water network are less available. Finding sufficient funds for both new potable water supply projects and investment in maintaining the existing infrastructure was identified as a significant challenge.

The potential of local scale fit-for-purpose wastewater treatment and recycled water projects were investigated as a means of reducing the level of investment required by the State Government (or Water Corporation) in new potable water supply and wastewater infrastructure. The analysis found that local wastewater treatment and non-potable water reuse is feasible on both a technically and commercial basis. Lack of scale, technical problems, and health risks are not true or valid arguments against the use of smaller local schemes. Local water recycling can also help the State achieve its recycling policy objectives, and deliver cost savings to residents.

The savings to the State Government could be substantial. For example, if the population in the greater Perth area was to increase to 3.5 million by 2050, and if the private sector was to provide wastewater services to 25% of the new dwellings constructed, the savings to the Western Australian State Government, in terms of lower capital expenditure, would be $1,452 million. For such a scenario, by 2050, the annual recurrent saving in potable water use would be 20GL per annum, and the cumulative potable water saving would be 318GL (equivalent to more than 1-year of current supply needs).

The supply of fit for purpose recycled water to consumers can provide not only amenity benefits, such as water for gardens, but can also drive cost savings to the average household, as recycled water is priced below the cost of drinking water that would otherwise be used for non drinking purposes. For a representative household of 2.4 people, with per person potable water use of 53kL per person and non-potable water use of 46kL per annum, these savings are likely to be around $68 per year. For such a household, the current annual water supply and service charge would be $659; so this represents a saving of just over 10 percent on the average household water service and supply annual water bill.

Local water recycling projects were found to also have other benefits. For example, local projects make it possible to return water to the local environment to support groundwater dependent ecosystems.

The private sector providing wastewater services to 25 percent of new developments is a realistic future. It represents a potential future development scenario where the private sector focuses on providing wastewater services in greenfield developments, which tend to have the most expensive traditional Business as Usual infrastructure connection costs, and where the Water Corporation focuses on infill developments, which are expected to comprise approximately half of all future development in the greater Perth area. Under this scenario, by 2050 the private sector would provide wastewater and recycling services to around ten percent of Perth’s population, with Water Corporation providing wastewater services to the rest of the population. Water Corporation would continue to provide all potable water supplies to both greenfield and infill developments. So, Water Corporation would continue to grow, as would private sector involvement in Perth’s water sector.

Adoption of local wastewater treatment and recycling schemes could be impactful in all of the Perth-Peel growth corridors, including frontal development areas between Alkimos and Two Rocks, and districts such as: Brabham, Bullsbrook, Nambeelup, Ravenswood, and Wungong. Regionally, such schemes could be considered in the strategic planning for future developments such as Wanju near Bunbury.

The *Water Services Act 2012* reforms have helped remove many of the barriers that had previously impeded private sector involvement in the sector. However, planning and approval pathways remain a challenge to private sector engagement. To make private sector involvement a practical reality requires further progress on policy and agency frameworks. A key issue is to involve alterative service providers and delivery solutions at the initial and early stages of land usage and development planning, rather than defaulting to the Water Corporation and the standard Business as Usual approach.

The current delivery model of water services in Perth materially oversizes potable water supply and connection network infrastructure relative to that required to meet only the fit-for purpose use of potable water. At the same time, Perth has a current and future abundance of wastewater that is a valuable yet currently underutilised source for non-potable recycled water. Stakeholders in Perth’s water future need to progress a conversation as to how this valuable wastewater resource can be better collected, treated, and recycled for local re-use. Transforming the water service delivery approach for Perth will reduce the future need and use of potable water, reduce pressure on Perth’s over allocated groundwater resources, and reduce the necessary size and cost to the State of potable water supply (desalination) and connection infrastructure. Further, additional savings to government can be realised if the private sector is engaged to deliver local wastewater and recycling services, particularly to new frontal urban developments.

Exciting opportunities exist to change Perth’s future water services and delivery model and to better capture the value of wastewater via recycling and re-use. To do this, the conversation between stakeholders needs to focus on the positive; on how new things can be done; and how the benefits of these new approaches can be realised.

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