The cost effectiveness of residential rainwater tanks in Perth

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Marsden Jacob
Associates

Marsden Jacob Associates
Financial & Economic Consultants

ABN 66 663 324 657
ACN 072 233 204

Internet: http://www.marsdenjacob.com.au
E-mail: economists@marsdenjacob.com.au

Perth office:
Level 6, 731 Hay St, Perth (Gledden Building)
Western Australia, 6000 AUSTRALIA
Telephone: +61 (0) 8 9324 1785
Facsimile: +61 (0) 8 9324 1751

Melbourne office:
Postal address: Level 3, 683 Burke Road, Camberwell
Victoria 3124 AUSTRALIA
Telephone: +61 (0) 3 9882 1600
Facsimile: +61 (0) 3 9882 1300

Brisbane office:
Level 5, 100 Eagle St, Brisbane
Queensland, 4000 AUSTRALIA
Telephone: +61 (0) 7 3229 7701
Facsimile: +61 (0) 7 3229 7944

Contact: Phil Pickering phil.pickering@marsdenjacob.com.au
+61 (0) 8 9324 1785
+61 434 884 220

Marsden Jacob
Associates

TABLE OF CONTENTS

Page

1. Introduction

1.1 Background

The household collection and storage of rainwater in a tank has a long history in rural Australia and remains a key source of domestic water in areas that are not serviced with a reticulated water supply.

In recent years there has also been an increased interest in the use of rainwater tanks in urban settings. The sharp rise in rainwater tank installations occurring across the country has been due to a number of factors, including:

- the impact of the recent drought and gardening watering restrictions;
- an growing awareness of the environmental issues associated with developing new water supplies;
- the availability of rebates to offset the cost of installing a rainwater tank (see Table 1);
- regulatory requirements for new homes in some States (see Table 1).

Across Australia there are over 1.5 million households that use a rainwater tank as a source of water, representing 19% of all households.[1]

In Perth, rainwater tank usage lags the rest of the country at only 7.2% of households. This result is in part explained by the different weather patterns experienced in each city. In the eastern and northern states of Australia, where rainfall is more consistent across the year, higher volumes of rainwater can be captured by tanks for use during the summer months. By contrast, Perth is characterised by a Mediterranean climate, with high rainfall in the winter and very little rainfall during summer months, when water demand for garden use is at its peak.

In addition, unlike most other Australian capital cities, many Perth residents have access to a garden bore. Garden bores are not suitable in all areas of Perth, such as areas of high salinity or near important wetlands, however approximately 26% of Perth households currently use a garden bore compared with only 5.9% Australia-wide.[2]

In further support of water conservation initiatives, the Federal Minister for Climate Change and Water, Senator Penny Wong has recently announced the introduction of a federal rebate scheme – the National Rainwater and Greywater Initiative – that will be introduced in addition to existing State rebate schemes (see Table 1 for details).

[1] ABS - Environmental Issues: People's Views and Practices 4602.0 (2007)

[2] ABS - Domestic Use Of Water and Energy 4652.5 (2006)

Table 1: Summary of requirements for rainwater tanks and rebates

State	Requirements on new dwellings	Rebates available
West Australia	No requirements relating to rainwater tanks.	$50 for the installation of a tank $600 for a tank that is plumbed internally Currently extended to 30 June 2009.
South Australia	New dwellings (and large extensions) are required to have an additional water supply plumbed into the house to supplement the mains water. In many areas a rainwater tank is the only option.	$200 - $1000 to retrofit a plumbed rainwater tank into an existing home for internal use
New South Wales	BASIX (the Building Sustainability Index) requires all new homes (and large alterations) to use up to 40% less potable water and produce up to 40% fewer greenhouse gas emissions than the average home. The exact requirements depend on the local environment (soil, rainfall etc.) A rainwater tank is the preferred option to meet the water elements of this requirement.	A rebate of up to $1,500 is available for tanks not installed under the BASIX requirements. The rebate program expires on 30 June 2009. Some local councils also offer a rebate.
Victoria	New homes are required to either install a rainwater tank for toilet flushing or a solar hot water system. Rainwater tank must be reticulated to toilets and a minimum size of 2kl.	A rebate of between $150 - $1,000 is available.
Queensland	All new homes are required to meet a mandatory water saving targets. A 5,000 litre rainwater tank is the preferred option to meet this target.	The Home and Garden Waterwise Rebate Schemes closed on Wednesday 31 December 2008. Previously up to $1500 was available for internally plumbed tanks.
National	No requirements relating to rainwater tanks.	A $400 -$500 rebate is available for tanks installed into existing dwellings and are connected for internal use.

Source: MJA review of state and federal rainwater tank rebates and regulations

1.2 Water supply planning in Western Australia

Western Australia is widely regarded as an industry leader in water supply planning due to its early recognition of, and reaction to, the recent reduction in rainfall that has swept across the southern and eastern regions of Australia. Over the past decade, Perth's Integrated Water Supply Scheme (IWSS) has been augmented with a range of water supply initiatives including a 45 gigalitre per year desalination plant, increased water recycling, water trading with irrigators and trials of new methods such as groundwater replenishment and catchment management.

These augmentations have been complemented by a strong commitment by the Western Australian government to water use efficiency, including the Waterwise campaign, aimed at encouraging efficient use of water through education and a targeted rebate scheme. Until the Waterwise scheme expires, rebates are available on a range of items including rainwater tanks, garden irrigation systems, greywater re-use systems, washing machines and garden bores.

The Water Corporation is also undertaking a substantial planning initiative known as *Water Forever*, a 50 year plan to deliver sustainable water and wastewater services to Perth and surrounding areas. *Water* Forever has involved extensive community consultation and research on a broad range of potential water supply and demand management options, including rainwater tanks and other household scale water supply alternatives.

1.3 Overview of this study

The Water Corporation and Department of Water have jointly commissioned Marsden Jacob Associates (MJA) to undertake a comprehensive analysis of the yield and cost effectiveness of residential rainwater tanks in Perth. The purpose of this study is to provide information on rainwater tanks for a range of uses and users, including both water industry professionals and the wider community.

Importantly, rainwater tanks also provide a range of non-financial benefits and potentially serve a number of objectives. For instance, individuals might install a rainwater tank to improve the value of their property, to access water during water restrictions or to help avoid the environmental impact of constructing new water sources.

However, this study focuses solely on the cost effectiveness of residential rainwater tanks compared with other sources of water. Other reasons for installing a rainwater tank will vary from household to household, but are likely to be key considerations in an individual's decision to install a rainwater tank.

This study therefore represents only one important element of the decision to install a rainwater tank. The study does not seek to assess the intangible benefits of rainwater tanks, but we note that the extensive uptake of tanks across Australia, even in locations where installation is clearly uneconomic, demonstrates that the intangible benefits may be substantial.

In the next section we consider the impact of various factors on rainwater tank yields and costs. We will then outline our modelling approach and the results under various scenarios. This allows us to compare the unit cost of water from rainwater tanks with the cost of alternative, large scale sources. Finally, we will consider the impact residential rainwater tanks would have on the future demand for reticulated water supplies in Perth.

2. Factors affecting yields and costs

The cost effectiveness of a residential rainwater tank compared with other water sources is dependent on both the yield of the rainwater tank (the amount of water collected and used in an average year) and the cost of the tank. Therefore there are a range of important factors that impact on the cost effectiveness of tanks, including:

- the rainfall at each specific location;
- climate change over time;
- the size of the roof collection area;
- the size of the tank;
- water usage patterns; and
- installation and operating costs.

We examine each of these factors in turn below.

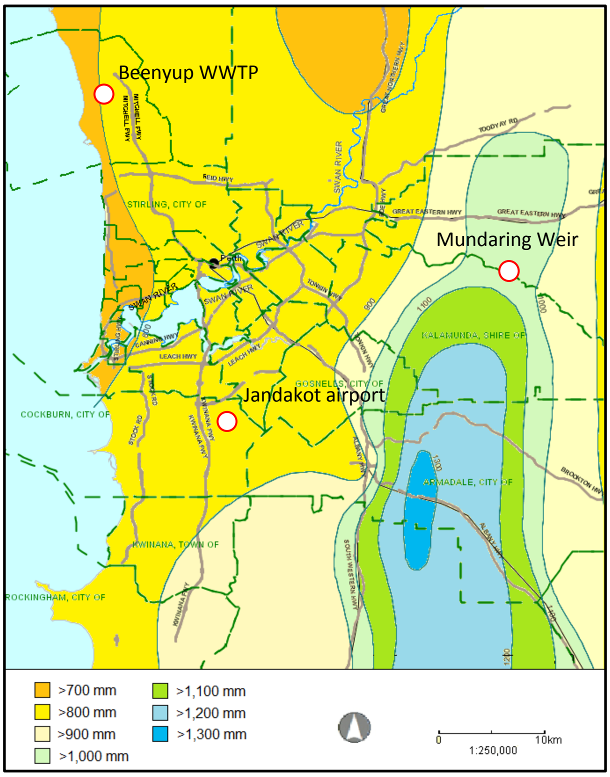
2.1 Rainfall

Rainfall in Perth varies greatly across the region and across time. For example, the Perth central metropolitan area has recorded a nominal average rainfall of around 750 mm since the weather station commenced operation.[3] By contrast, the Armadale Hills area has recorded an average rainfall of 1,300 mm. Isohytes (rainfall contours) for the Perth region are shown in Figure 1.

To reflect a relatively wide distribution of rainfall patterns, this investigation has therefore used rainfall data from regions in the north, south and east of Perth, in particular:

- Beenyup wastewater treatment plant (WWTP) - with an average annual rainfall of 757 mm;
- Jandakot airport - with an average annual rainfall of 852 mm; and
- Mundaring Weir - with an average annual rainfall of 1,036 mm.

Figure 1: Isohytes across the Perth Region



Source: Adapted from WA Atlas (2009)

Locations shown are approximate only.

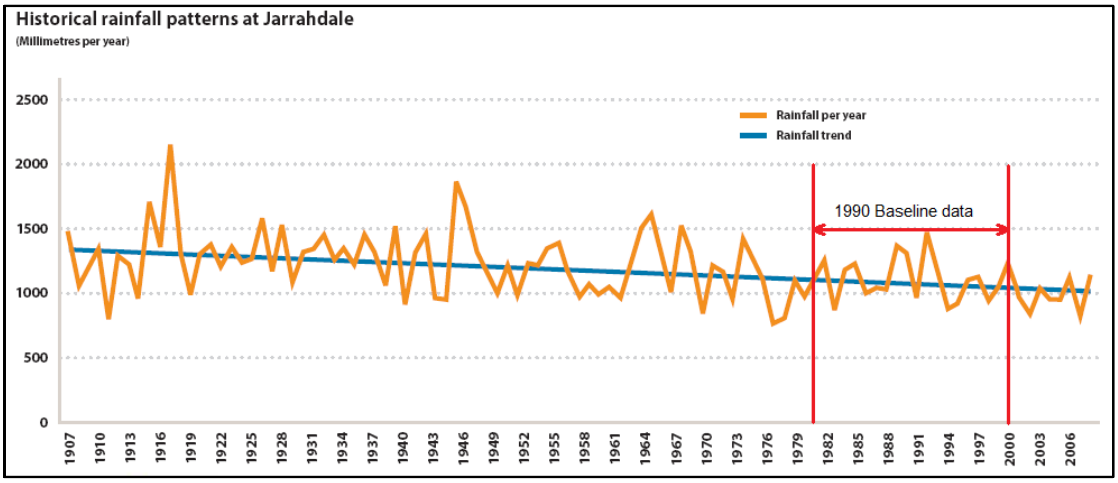
[3] Bureau of Meteorology – Perth Metro weather station for years 1993 – 2009.

2.2 Climate Change Scenarios

Perth's annual rainfall varies greatly from year to year, however the average rainfall for Perth has decreased steadily over the past 100 years. This decrease may represent a significant and permanent change in climate for the south-west of Western Australia and the trend may continue further in the future.

For the purposes of comparison, CSIRO has adopted the average rainfall over the twenty year period from January 1980 to December 1999 as the baseline for the consideration of climate change scenarios. This data is referred to as the 1990 baseline and various reductions in rainfall are then considered from this baseline. Figure 2, below, shows the historic rainfall for Jarrahdale in Perth's south east over a 100 year period and the 1990 baseline data.

Figure 2: Historic Rainfall Patterns for Perth Region



Source: Adapted from Water Corporation Directions For Our Water Future - Draft Plan

As future rainfall patterns are uncertain, we have modelled residential rainwater tank yields based on a number of different scenarios:

- the 1990 baseline for each location – that is, an assumption that rainfall will recover from the lower levels experienced over the past decade and return to the 1980-1999 average;
- an 8% reduction below the 1990 baseline – assuming that rainfall continues at the same (lower) levels that have been experienced in recent years; and
- a 20% reduction below the 1990 baseline – based on a continuing trend of reduced rainfall over time.

2.3 Roof sizes and the area of rainfall collected

The average floor size for new homes built in Perth is currently around 257 square metres[4] for a separate dwelling (ie not townhouses, villas or apartments). As single storey, separate

[4] ABS – unpublished data derived from building approvals

houses are by far the most common form of dwelling in Perth, we have focussed on these for our analysis.

Residential rainwater tanks typically collect water from only one roof downpipe, and therefore will collect water from only one half of the roof area or less. There are methods whereby the entire roof of a house can be used to capture rainwater (such as "wet charged systems"), however installation using these methods is relatively uncommon and involves greater expense to the homeowner.

For this analysis, we have considered three different sized areas for rainfall collection:

- 250 m^2 – assuming that all of the roof area of an average sized house is captured;
- 125 m^2 – assuming that half of the roof area of an average sized house is captured; and
- 50m^2 – assuming that only a portion of the roof area can be captured.

2.4 Rainwater Tank Size

A vast array of rainwater tanks are available in Australia, these include a range of sizes from a few hundred litres to 50,000 litres and a range of shapes including slim line tanks and bladders that can be installed under the house. For residential rainwater tanks the limiting factors on tank size are likely to be total cost (including purchase price and installation) and the tank footprint – the amount of garden area the householder is willing to sacrifice to install the tank.

The data on tank sizes sold in Perth is limited – however, data from Victoria indicates that the most common tank size sold is around 2,000 litres.

For the purpose of modelling we have considered two sizes of tank:

- 2,000 litres – considered to be an average residential rainwater tank; and
- 5,000 litres – considered to be a large residential rainwater tank.

2.5 Water usage

Domestic water use in Perth varies greatly from one home to another depending on a range of factors such as family size, garden area, domestic appliances and personal preferences. The average water use for a Perth home is 270 kilolitres per year.[5] Of this, 53% is used within the home (equating to 390 litres/day) and 43% is used in the garden or other outdoor uses.

To model the drawdown of water from rainwater tanks, we have considered the water use for an average household based on three scenarios:

- outdoor use only (see below for details);
- outdoor use and indoor use for the laundry and toilet only (outdoor use + 193 l/d); and
- outdoor use and indoor use for the laundry, toilet and the hot water system (outdoor use + 247 l/d).

[5] Water Corporation, based on information supporting *Options For Our Water Future*, April 2008

As health authorities typically discourage the use of rainwater tanks for drinking water where a reticulated scheme supply is available, and the current exercise relates specifically to households connected to the IWSS, we have assumed that water from rainwater tanks will not be used for drinking and will not be plumbed to cold water taps in the bathroom.

While each of the above scenarios has been modelled to demonstrate the cost effectiveness of residential rainwater tanks over a range of scenarios, we note that only a small portion of tanks in Perth are actually connected for internal use.[6]

2.5.1 Outdoor usage

While indoor water use is relatively constant throughout the year, outdoor watering is focussed around the summer period with a reduced watering rate in spring and autumn and negligible watering undertaken in winter. For this reason we assumed watering every 3, 4 or 5 days during various times of the year (assuming watering restrictions are lifted in the future), as shown in Table 1.

In addition, we assume that watering would not occur during or immediately following a significant rain event.

The volume of water used in each watering session was then adjusted to ensure consistency with the total average outdoor water use recorded over an average year (143 kilolitres).[7]

Table 2: Outdoor watering regime

Month	Watering every ... days*
January	3
February	3
March	4
April	5
May	5
June	-
July	-
August	-
September	5
October	5
November	4
December	4

** Days after last watering or 5mm of rain*

2.6 Costs

The costs to install and operate a rainwater tank include the costs of purchase, installation, internal plumbing, pumping costs and maintenance costs. We consider each of these in more detail below.

2.6.1 Purchase and installation costs

The cost to purchase, install and connect a residential rainwater tank will vary greatly depending on a range of factors including the type of tank, the accessibility of the house for installation and the tank's use (e.g. connected internally or used for garden watering). The cost of retrofitting a tank for internal use in an existing house is typically more expensive than installation in a new house due to the ease of access that is afforded during the construction of the house.

6 In 2008/09 13% of rainwater tanks receiving a rebate in WA were plumbed into the house.

7 Water Corporation, based on information supporting *Options For Our Water Future, April 2008*. When modelled daily, after accounting for the assumed watering pattern and periods in which rain delays watering, the average volume used for garden watering day is 2,200 litres per watering day.

In order to produce a reliable range of costs under a variety of circumstances, the Water Corporation sought advice on likely costs from industry experts. This information is summarised in Table 3 and is set out in full in Appendix 1. The costs shown are considered to represent installation under relatively favourable circumstances and could be significantly higher depending on a number of factors, including the location of the tank compared with the water services to be provided (e.g. toilet, laundry, hot water system), the particular plumbing requirements of the property and price fluctuations based on the trade industry cycle.

Table 3: Purchase and installation costs

Tank Size	Water Usage	Total Cost *	
		New house	Existing house
2kL	Outdoor use only	$1,450 - $2,250	$1,450 - $2,250
	Outdoor + Indoor (toilet/laundry)	$2,750	$3,250
5kL	Outdoor use only	$1,900 - $2,700	$1,900 - $2,700
	Outdoor + Indoor (toilet/laundry)	$3,200	$3,700
	Outdoor + Indoor (toilet/laundry + hot water systems)	$3,200	$3,900

Source: Water Corporation in consultation with Waterwise plumbers

** Costs shown represent relatively favourable circumstances and should not be used as a guide for specific properties. To obtain prices for a specific property, please consult an industry representative.*

2.6.2 Operating and maintenance costs

The use of a rainwater tank will also accrue operating costs such as electricity for use of a pump and maintenance costs, such as clearing of gutters and cleaning the rainwater tank. The scale of these costs is the matter of some debate between industry experts and estimates vary between from few dollars a year[8] to as much as $100 a year[9]. The key difference rests on assumptions regarding the level of maintenance required to keep gutters and tanks in good working order and the degree to which this maintenance would be undertaken as part of normal household upkeep.

In our modelling, we have assumed that the majority of maintenance would be required regardless of tank installation, but have included a nominal estimate of $20 per year ($200 over the course of ten years) for one or more of the following additional services: tank desludging, pump servicing (excluding pump replacement), gutter maintenance (above that conducted for normal household maintenance, potentially including gutter guards or tree-lopping) and/or chlorine for disinfection.

[8] Coombes and Kuzcera (2003)

[9] Melbourne Water and Hunter Water

2.7 Scenarios

In undertaking a full analysis of residential rainwater tanks in Perth we considered a total of 162 individual scenarios, based on combinations of the factors shown in Table 4. Other assumptions are set out in more detail Appendix 1.

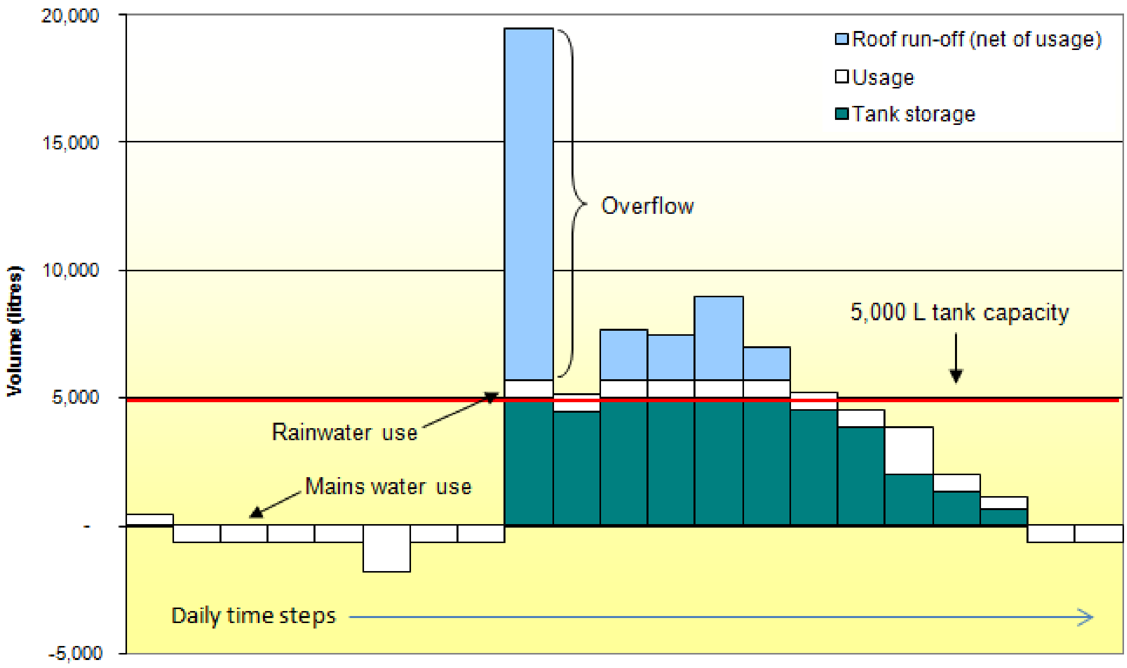
Table 4: Summary of factors modelled

Rainfall from 3 Locations:	Beenyup, Jandakot, Mundaring
3 climate scenarios:	Reduction from 1990 Baseline - 0%, 8%, 20%
2 tank sizes:	2,000 litres and 5,000 litres
3 usage regimes:	Outdoor only, indoor excl hot water, indoor incl hot water
3 roof collection area:	$50m^2$, $125m^2$, $250m^2$
Total scenarios = 3 x 3 x 2 x 3 x 3 = 162 individual scenarios	

3. Yield and cost modelling

MJA's rainwater tank yield modelling calculates the daily inflows to, and outflows from, a rainwater tank on a daily basis over a 20 year period. The rainfall is based on actual rainfall data, adjusted for different climate conditions, with water use based on the three scenarios outlined in the previous section. The modelling determines the level of water that would be stored in the tank each day, including periods in which the tank would run dry and others in which the tank would overflow. The model is depicted diagrammatically in Figure 3.

Figure 3: Example of daily water balance in a 5,000 litre rainwater tank



The volume of rainwater used will vary from year to year depending on the amount of rainfall and the timing of the rainfall across the year. From this information we have calculated the average yield of the rainwater tank under each of the climate change scenarios, described in section 3.1. The combination of the cost and yield information provides the cost of the water per kilolitre, as set out in section 3.2.

3.1 Rainwater tank yields

The modelled rainwater tank yields vary from around 10,000 litres per annum to around 76,000 litres per annum under the various scenarios considered. The full results for the rainwater tank yields under each of the scenarios are provided in Appendix 2.

Unsurprisingly, the largest yield is estimated for a large tank (5,000 litres), collecting water from a large roof area (250m^2) in a high rainfall area in Mundaring with no reduction in rainfall for climate change. However, from these results it is possible to identify the importance of each factor affecting residential rainwater tank yields in Perth.

The results demonstrate that three factors have a significant impact on rainwater tank yields:

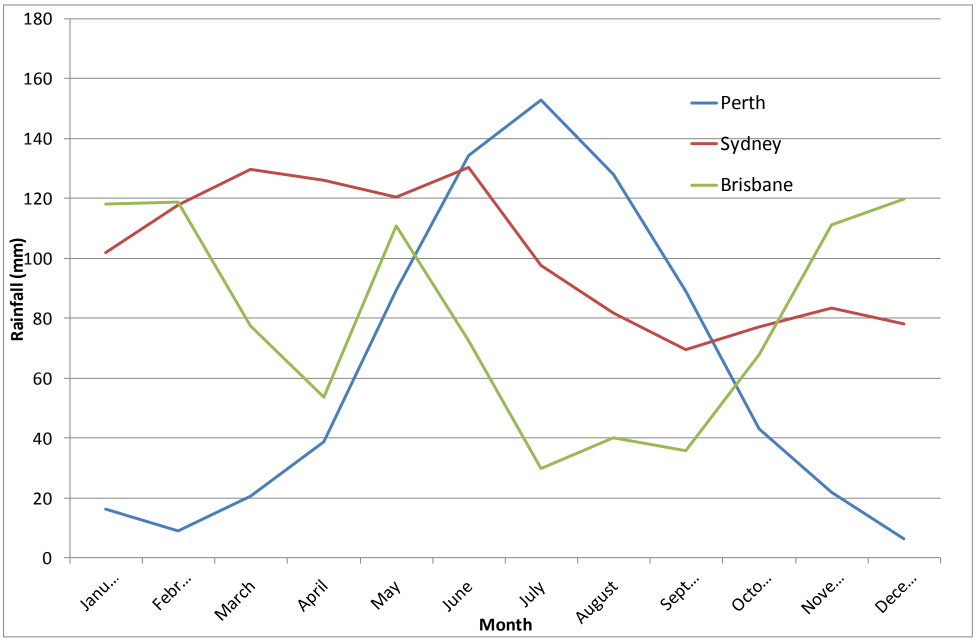
- roof size used to capture the rain;
- water usage regime (having some level of internal water use); and
- tank size.

In contrast, the remaining factors – those affecting rainfall – have a significantly lower impact on the rainwater tank yields, that is:

- location; and
- a reduction in rainfall from the 1990 baseline.

Perth's weather patterns of wet winter and dry summer result in the rainwater tanks being full or close to full for much of the winter and empty or close to empty for most of the summer. This can be compared to other Australian cities – particularly Brisbane and Sydney, where the rainfall is higher, but more importantly is relatively consistent across the year. Annual rainfall patterns for Perth, Sydney and Brisbane are shown in Figure 4.

Figure 4: Comparison of rainfall patterns



Source: Bureau of Meteorology

3.2 Rainwater tank costs per kilolitre

To derive the cost per kilolitre, the present value cost over the life of the assets (i.e. the cost after adjusting for the time value of money) is divided by the present value of the volume. This method of calculating unit costs is common in the water industry and allows for comparison against water sources of substantially different scales such as desalination and water recycling.

The modelled rainwater tank costs vary from $4.10 to $17.00 per kilolitre depending on the installation costs and the yield of the tank.

Because the yield of tanks that are connected for indoor use are higher than those used exclusively for outdoor use, the unit costs are lower, as shown in Table 5.

Table 5: Costs per kilolitre – 2,000 litre tank

	Base line rainfall	-8% rainfall	-20% rainfall
Outdoor only	$6.80 - $14.80	$6.90 - $15.50	$7.10 - $17.00
Outdoor + Low indoor	$5.30 - 10.60	$5.50 - $10.60	$5.60 - $11.20

Source: MJA analysis

Table 6 Costs per kilolitre – 5,000 litre tank

	Base line rainfall	-8% rainfall	-20% rainfall
Outdoor only	$5.10 - $12.90	$5.20 - $13.60	$5.50 - $15.00
Outdoor + Low indoor	$4.50 - $10.50	$4.70 - $11.30	$4.90 - $12.90
Outdoor + High indoor	$4.10 - $10.60	$4.20 - $11.50	$4.40 - $13.30

Source: MJA analysis

4. Impact of residential rainwater tanks on the IWSS

4.1 Comparison of rainwater tank costs to other water sources

For each scenario the cost of water provided by residential rainwater tanks can be compared to alternative sources of water. The Water Corporation's *Water Forever* planning initiative has identified a range of water supply and demand options that could potentially be available for the Integrated Water Supply Scheme (IWSS) over the next 50 years, including:

- water use efficiency (in many cases less than $1.50 per kilolitre);
- groundwater sources (in many cases less than $1 per kilolitre);
- industrial water recycling ($1 - $2 per kilolitre);
- water recycling through groundwater replenishment ($1.50-$3.00 per kilolitre); and
- desalination ($2 - $3 per kilolitre)

The Water Corporation also calculates a Long Run Marginal Cost of new water sources, which reflects the long term cost (or cost saving) of adding (or deducting) demand from the IWSS. The Long Run Marginal Cost is calculated as the change from a baseline (or "business as usual") scenario that assumes a combination of relatively certain new water sources will be developed to meet demand. The Long Run Marginal Cost for the IWSS has been estimated at $1.15-$1.60 per kilolitre, which can be used as a benchmark against which to compare potential new water sources.

Therefore, at a unit cost of $4 to $17 per kilolitre, residential rainwater tanks represent a relatively high cost source of water compared with the Long Run Marginal Cost of new water sources, and also with the cost of many of the individual new water source options identified in *Water Forever* planning.

Importantly, we note that rainwater tanks may provide other intangible benefits that are not captured in this analysis, but would form part of a broader sustainability analysis, such as that undertaken by the Water Corporation for the *Water Forever* program.

4.2 Impact of widespread uptake

In addition to modelling the yield of individual rainwater tanks it is possible to determine the impact that the widespread uptake of residential rainwater tanks would have on demand for reticulated water supplies over an extended period.

To consider the potential uptake, we have considered the following three scenarios:

1. "current scenario", that is, the State Waterwise rebate is removed on 30 June 2009 and the federal rebate is introduced. As each of the rebates are approximately the same order of magnitude, we assume that the take-up rate is essentially unaffected;
2. introduce the federal rebate and continue with the State rebate. While recent surveys have indicated that rebates form a relatively small proportion of an individual's decision to purchase a rainwater tank in WA, it is expected that a

doubling of the rebate would result in some increased take-up over time.[10] For the purposes of this study, we have tested the sensitivity of an additional take-up rate of 10%, 20% and 30% from current reported levels; and

3. all new houses install a tank that is plumbed into the house and existing houses continue to retrofit tanks at the current rate (for the purposes of this study we assume that all of the current uptake is attributable to retrofitting, which will result in a slight overestimate of aggregate yield).

The overall impact on the IWSS modelled by MJA assumes that the number of dwellings will grow (on average) in proportion to the growth in population assumed in the *Water Forever Draft Plan, February 2009*.[11] The distribution of roof sizes across Perth was calculated with reference to Australian Bureau of Statistics floor size data, adjusted for assumptions regarding the number and distribution of multi-storey homes. Each of these scenarios was then extend to years 2015 and 2030 based on the rainwater tank yield developed for each roof area.

The modelling shows that if the existing scenario were to continue then the use of residential rainwater tanks would reduce the demand on reticulated water supplies by around 0.1 gigalitres (GL) per annum by 2015 and 2.3 GL by 2030. To place the results in context, the current Perth reticulated water system supplies around 280 GL. Water requirements are expected to increase by a further 120GL by the year 2030.[12]

If all new houses were required to install rainwater tanks, the total volume from new houses would be approximately 2.8 GL by 2015 and 11.6 GL by 2030. If we assume that all current take-up is attributable to retrofitting of existing homes, and that this take-up rate would also be maintained, then the total volume of new and existing properties would be 2.9 GL by 2016 and 13.9 GL by 2030.

The full results of this modelling are provided in Table 1, with assumptions shown in Appendix 1.

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10 Over 85% of rainwater tanks installed last year were for outdoor use only and therefore received a rebate of only $50, compared with a rebate of $600 that could have been accessed if the tank were connected for indoor use. This fact suggests that the federal rebate (which is also for internal use) may also result in a relatively modest increase in the number of tanks installed.

11 p. 29

12 Water Corporation, *Water Forever, Directions For Our Future, Draft Plan, February 2009,* p. 29

Table 7: Predicted water savings under various scenarios

Scenario	2015	2030
Scenario 1: Current scenario	(GL)	(GL)
a. Current rate of uptake continues	0.116	2.253
Scenario 2: Both state rebate and federal rebate		
a. Current uptake +10%	0.127	2.478
b. Current uptake +20%	0.139	2.704
c. Current uptake +30%	0.151	2.929
Scenario 3: Regulated take-up		
a. All new properties install rainwater tanks plus continued retrofitting to existing properties	2.902	13.858

Source: MJA analysis

5. Findings and conclusions

The results of the analysis of the cost of, and yield from, residential rainwater tanks installed in Perth are summarised in Table 8.

Table 8: Summary of results

	Outdoor use only		Outdoor + indoor	
	2,000 L	5,000 L	2,000 L	5,000 L
Costs				
Cost of tank and pump (approx)	$800-1,600	$1,250-2,050	$1,800	$2,250
Plumbing and installation (approx)	$650	$650	$950-1,450+	$950-1,650+
Operating and maintenance (approx)	$20 pa	$20 pa	$20 pa	$20 pa
Unit costs	$7 - $17/kL	$5 - $15/kL	$5 - $11/kL	$4 - $13/kL
Residential rainwater tank yields				
Annual yield	10-26 kL	14-42 kL	25-59 kL	27-76 kL
Proportion of average annual consumption	4-10%	5-16%	9-22%	10-28%
Saving to household water bill *	$8-22 pa	$12-35 pa	$21-49 pa	$22-63 pa
Maximum impact on IWSS yield at 2030				
All new properties install rainwater tanks plus continued retrofitting	14 GL (14 billion litres)			

* Based on the current Water Corporation price of 82.8 cents per kilolitre for usage between 150 and 350 kL per year (the highest pricing tier for a "typical" residential property).

Based on the findings from this study, a number of important conclusions regarding residential rainwater tanks and their impact on the IWSS can be drawn. We consider these in turn below.

5.1 Rainwater tank yields

While there are a large number of factors that influence the yield of a residential rainwater tank, three factors have a significant impact on rainwater tank yields in Perth:

- roof size used to capture the rain;
- water usage regime (in particular, the level of internal water use); and
- the size of the tank installed.

The modelling demonstrates that a residential rainwater tank in Perth can provide as little as 10,000 litres per annum or as much as 76,000 litres per annum, depending on the combination of influencing factors for a particular property. This volume equates to between 4% and 28% of an average household's water use.

5.2 Rainwater tanks costs

The cost per kilolitre of water provided by residential rainwater tanks varies inversely with the yield of the tank, as the majority of costs associated with a tank (such as installation and maintenance) are fixed. Therefore, because the yield of a tank varies considerably based on the particular circumstances of each property, the unit cost also varies substantially.

We estimate that the cost of water from residential rainwater tanks in Perth will typically vary between $4 and $17 per kilolitre. However, even at the lower end of this range, the water from rainwater tanks is relatively expensive in comparison to alternative sources for supplying the IWSS.

5.3 Impact of residential rainwater tanks on drinking water supplies

This study also undertook modelling of the impact of residential rainwater tanks in reducing the demand for reticulated water supplies. We considered three different rainwater tank uptake scenarios, based on various levels of incentive or regulatory enforcement, and measured the impact at both 2015 and 2030. We found that rainwater tanks could provide between 0.1 and 2.9 gigalitres by 2015, and between 2.3 and 13.9 gigalitres per year by 2030, depending on the level of rebate or regulation.

We note that the volume of water available from rainwater tanks in the short term is relatively small compared with many of the larger scale water supply options currently being considered. However, in the longer term (2030), as the number of installations cumulatively increase, rainwater tanks could contribute a total volume of between 2% and 12% of the supply-demand gap of 120 GL.

Appendix 1: Assumptions for cost and yield modelling

Installation cost estimates

Assumptions regarding installation costs are shown in Table 9. As noted in the main report, the costs shown are considered to represent installation under relatively favourable circumstances and could be significantly higher depending on a number of factors, including the location of the tank compared with the water services to be provided (e.g. toilet, laundry, hot water system), the particular plumbing requirements of the property and price fluctuations based on the trade industry cycle.

Table 9: Summary of installation costs

Size	Use	Tank ($) *	Pump ($)*	Deliver +Install ($) *	Plumbing ($) *		Total Cost ($) *	
					New house	Existing house	New house	Existing house
2kL	Outdoor use only	800	0 – 800	650	0	0	1,450 - 2,250	1,450 - 2,250
	Outdoor + Internal (toilet/laundry)	800	1,000	650	300	800	2,750	3,250
5kL	Outdoor use only	1,250	0 – 800	650	0	0	1,900 – 2,700	1,900 – 2,700
	Outdoor + Internal (toilet/laundry)	1,250	1,000	650	300	800	3,200	3,700
	Outdoor + Internal (toilet/laundry + hot water systems)	1,250	1,000	650	300	1,000	3,200	3,900

Source: Water Corporation

** Costs shown represent relatively favourable circumstances and should not be used as a guide for specific properties. To obtain prices for a specific property, please consult an industry representative.*

Other cost and yield assumptions

In addition to variables and assumptions set out in the body of the report, our modelling of residential rainwater tank yields and costs was based on the assumptions shown below.

Modelling assumptions				
Rainwater collection assumptions				
Collection ratio	95%			
Absorption	0.5	mm		
First flush system	20	litres		
Daily water use occurs prior to rainfall (and therefore prior to tank overflows)				
Capital cost assumptions				
Discount rate	6%	real pre-tax		
Tank life	25	years		
Pump life	10	years		
Installation and plumbing cost	10%	every	25	years
Operational and Maintenance cost assumptions				
Pumping cost – indoor	$0.050	/kL		
Pumping cost - outdoor only	$0.025	/kL		
Maintenance	$20	pa		

Impact or rainwater tank yield assumptions

In addition to variables and assumptions set out in the body of the report, our modelling of the impact of rainwater tank yields on the IWSS was based on the following assumptions:

Variable	Assumption
Roof collection area	Based on ABS floor size data, adjusted for multi-storey properties where floor size is greater than 200m^2. Roof capture area assumed to be half of total roof area available.
Tank size	2,000 litres for roof sizes below 150m^2 5,000 litres for roof sizes above 150m^2
Rainfall	Based on rainfall at Jandakot (as the most representative of the selected sites for the Perth metropolitan area).
Climate Change	-8% from 1990 baseline
Proportion of properties using rainwater internally	13% based on current uptake 100% for scenarios in which all new homes are required to install tanks
Number of new properties	Number of new properties available to install rainwater tanks each year based on the number of properties per capita from 2006 census (437,302 properties and population of 1,445,078 in 2006[13] for Perth) multiplied by estimates of population growth shown in Water Forever Draft Plan, February 2009 (1,720,000 in 2010 increasing to 2,310,000 in 2030.

[13] ABS, 2006 Census Quickstats: Perth (Statistical Division)

Appendix 2: Residential Rainwater Tank Yields

Results: 2,000 litre tank

1. Beenyup

0% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	12,023	18,822	24,537
Low indoor	29,273	41,365	49,035
High indoor	30,839	46,610	55,134

-8% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	11,478	18,144	23,726
Low indoor	27,659	40,326	47,940
High indoor	28,874	45,384	53,948

-20% climate

	$50m^2$	$125m^2$	$250m^2$
No indoor	10,427	17,037	22,720
Low indoor	24,831	38,483	46,277
High indoor	25,627	43,158	52,080

2. Jandakot

0% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	12,895	20,209	26,092
Low indoor	31,985	44,124	52,322
High indoor	34,921	49,731	58,987

-8% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	12,218	19,492	25,580
Low indoor	30,631	42,865	51,228
High indoor	32,980	48,297	57,713

-20% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	11,200	18,679	25,070
Low indoor	28,166	40,863	49,811
High indoor	29,687	45,898	55,982

3. Mundaring

0% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	13,637	20,914	26,147
Low indoor	32,340	44,158	51,566
High indoor	35,319	49,479	57,746

-8% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	13,086	20,374	25,695
Low indoor	31,043	43,186	50,663
High indoor	33,527	48,348	56,717

-20% climate

	$50m^2$	$125m^2$	$250\ m^2$
No indoor	11,937	19,250	24,606
Low indoor	28,683	41,145	48,821
High indoor	30,330	46,079	54,695

Marsden Jacob Associates

Results: 5,000 litre tank

1. Beenyup

0% climate

	50m²	125m²	250 m²
No indoor	16,434	27,900	37,745
Low indoor	32,695	50,416	63,713
High indoor	33,623	56,020	70,354

-8% climate

	50m²	125m²	250 m²
No indoor	15,622	26,759	36,424
Low indoor	30,387	48,684	61,877
High indoor	31,030	54,183	68,458

-20% climate

	50m²	125m²	250 m²
No indoor	14,167	24,616	34,551
Low indoor	26,651	45,731	58,940
High indoor	26,800	50,906	65,288

2. Jandakot

0% climate

	50m²	125m²	250 m²
No indoor	17,610	29,244	39,938
Low indoor	35,938	53,365	67,412
High indoor	38,550	59,439	74,657

-8% climate

	50m²	125m²	250 m²
No indoor	16,655	28,103	38,839
Low indoor	34,084	51,523	65,631
High indoor	36,157	57,389	72,663

-20% climate

	50m²	125m²	250 m²
No indoor	15,306	26,400	37,350
Low indoor	30,935	48,603	62,886
High indoor	31,754	54,045	69,464

3. Mundaring

0% climate

	50m²	125m²	250 m²
No indoor	18,361	31,236	41,696
Low indoor	36,809	54,504	69,113
High indoor	39,435	60,285	76,151

-8% climate

	50m²	125m²	250 m²
No indoor	17,475	29,979	40,754
Low indoor	35,001	52,719	67,481
High indoor	36,889	58,402	74,312

-20% climate

	50m²	125m²	250 m²
No indoor	15,873	27,733	38,700
Low indoor	31,561	49,504	64,158
High indoor	32,722	54,995	70,680