The Economics of Water Saving Technology In Victoria

Final Report

ATA Alternative Technology Association

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Contents

Executive Summary

The ATA has conducted a review of the economics of a variety of common water saving technologies in the Victorian water market. For each technology, this report has examined whether there is a business case (i.e. payback in the order of 10 years[1]) and what the key drivers/determinants are.

Context
Water bills have increased considerably across Victoria in the past three years and for 2013 will jump again for Melbournians. As the price of mains water increases, an incentive builds for people to install more efficient technology at the point of consumption to reduce their reliance on mains water.

We are not aware of any comprehensive economic review of demand side water technologies ever undertaken in Victoria. Marsden Jacob Associates (MJA) published a report[2] in 2007 that focussed on the economics of rain water tanks only.

Given water price increases over the past five or so years, it is timely that the economics of a range of demand side technology alternatives are considered.

Methodology
The economics to the consumer of a specific water saving technology depends on the volume of water saved, the price of the water saved and the technology's installed cost.

There are 16 water businesses operating within geographically defined areas of Victoria providing retail and distribution services of water supply and sewerage. Each water retailer has fixed fees and usage-based charges for water and sewerage, but a different price and tariff structure. Where volumetric sewerage fees apply, the charges are not metered, but rather deemed as a fixed fraction of water supplied.

Residential households currently experience an effective price of water (at the margin) ranging between $1.01 per kL (Lower Murray Water) and $2.36 (North East Water) in regional Victoria and $4.08-$4.62 in Melbourne. **Non-residential** water users face prices between $0.78 (Lower Murray Water) and $5.12 (Gippsland). Prices are expected to increase in line with CPI in most areas of the state over the next five years (2-3% a year).

Rebates are currently available for both households and small businesses. For the latter, we would expect the out of pocket costs of installing/upgrading technologies could be claimed as a business expense against taxable income. The result could be better paybacks than we have modelled.

Water Saving Technologies
There is a good business case for most households in Victoria for upgrading an old style, 12-litre single flush cistern to the highest efficiency 4.5L/3L **dual flush toilet**.

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[1] 'Business case' is obviously a subjective term, particularly for residential consumers not used to thinking in traditional project economic terms. However there is some evidence that a not-insignificant portion of residential consumers do respond to alternative and efficient technologies once they are confident of their initial capital outlay being returned within 10 years – cite solar photovoltaic and solar hot water investment trends since 2008.

[2] Marsden Jacob Associates for the National Water Commission, 'The Cost-Effectiveness of Rainwater Tanks In Urban Australia' March 2007.

Most households already have a dual flush toilet. The business case for upgrading to more efficient dual flush (a 9L/4.5L model) makes sense in Melbourne for households of two or more, and in larger households (4-5 people) in regional Victoria where the price of water is moderate.

For businesses upgrading from a 12-litre single flush, the payback period is within 10 years where there are four or more employees and water prices are high to moderate. There is little business case however for upgrading from 9L/4.5L to 4.5L/3L.

A low cost alternative in many situations is the **toilet water saving devices** which flush only for as long as the user holds down the button.

The economics of **composting toilets** is compared to an older style dual flush toilet (9L/4.5L). Composting toilets use no water for flushing. Generally a 20 year payback is approached for households of three people or more across Victoria except where water prices are very low.

The business case for upgrading to high efficiency **showerheads** (from 10 litre per minute flow to 5L) is compelling, with both water savings and energy (hot water) savings. Even cheap showerheads can be highly water efficient.

Consumer advocates Choice tested **washing machines** in 2013 and we have analysed their published data. The business as usual case is the purchase of a less efficient new washing machine, a 3 star top loader (with hot and cold connections). Choice assessed 10 such models costing on average $757, and using 108 litres of water per wash.

Front loaders are far more water efficient than top loaders, and they are more expensive. Choice assessed 13 'cold only' 4.5 star front loaders costing on average $1017, and using 53 litres of water per wash. Energy usage was a little higher than for top loaders.

The main drivers of the economic case are frequency of use, price of water and discount rate. Where usage approaches weekly, there is a business case for spending the extra $260 for a front loader, where the price of water is high, or if the price of water is moderate and a low discount rate applies. The business case hinges on a need to upgrade.

Dishwashers do not use much water. There is no correlation between the price of a dishwasher and its water use for the models tested by Choice. That is, higher priced dishwashers are not automatically more efficient.

The business as usual case is the purchase of the least efficient budget priced dishwasher (a $739 Dishlex, using 23 litres per wash). We have assessed how much extra one would pay to get an economic outcome (payback of 10 years) for one of the more efficient models (11 litres per use) tested by Choice.

The economics of spending extra varies according to the price of water and how frequently the machine is used. With daily use, and installation costs of $150, and assuming a 3% discount rate, it is worth pending an extra $179 at Melbourne average prices, and only an extra $42 where prices are low ($1.01) in regional Victoria.

The objective of water saving technology is often to limit overall ecological footprint. **Recirculators** certainly save water. However the water savings is overstated by some product information. 'On demand' hot water recirculator systems in retrofit circumstances use energy (pumps) to save energy (the embodied energy in the water in the process of heating to hot is recaptured).

Certainly there may be a business case for models of hot water recirculators that save energy (as well as water). However we are not convinced that enough technical detail is available to be able to make the assessment. If there proves to be demand for hot water recirculators, we would recommend further research to establish under what circumstances they save energy in net terms.

Hot water recirculators are bathed in apparent green washing about water savings, but appear to be another device privileging consumer comfort and convenience.

Greywater systems range considerably in complexity and price. The simplest and most cost effective models are greywater systems that divert to the garden only. There can be a business case if the garden can absorb the greywater the household can produce, but as the ATA has noted in the past, expert advice is recommended.

There are many factors affecting the cost effectiveness of **rainwater tanks**. If a tank is **plumbed indoors**, the main drivers of yield are roof area, annual rainfall, tank size, number of plumbing connections and household size. Tank installation costs include household plumbing and a water pump. In addition, there are ongoing costs for maintenance, energy cost and pump replacement.

We have developed a best possible case for indoor usage: a high rainfall suburb of Melbourne, big roof, big tank, big household (family of four) and high cost of water. This scenario, where the household is out of pocket by $1,950, yields a payback of 6 years for the cheapest tank.

Generally when water prices are high, a yield of around 85kL a year will produce a 10 year payback. Whereas where water prices are moderate, a yield of around 150kL is required to become economic. ATA's 'Tankulator' will help households calculate a reasonable yield for their situation.

Tanks installed for **outdoor use only** enjoy lower costs as there is no requirement for internal plumbing and, if well sited, gravity will assist (no pump needed). However less water is used from the tank, so the yield is lower. The key drivers of yield are roof size and tank size. The economics depend on how much water a garden can use and how much it would have been watered from the mains if there was no tank.

Again we have developed a best possible business case for outdoor usage. With the household out of pocket $1,850, its payback is eight years. In metropolitan areas there is a reasonable business case for tanks yielding more than 60kL per annum. Where water prices are moderate, the yield needs to be 100-120 kL a year to achieve a payback within 10 years.

1.0 Introduction

With assistance from the Victorian-based Consumer Utilities Advocacy Centre (CUAC), the Alternative Technology Association (ATA) conducted a review of the economics of a variety of common water saving technologies in the Victorian water market.

The research intended to understand the value proposition (in economic terms) of investing in and utilising demand side water technologies, from the perspective of the Victorian consumer. Both residential and commercial (small business) consumers have been considered in the analysis.

The technology options included in the report are:

- toilets;
- showerheads;
- washing machines;
- dishwashers;
- recirculators;
- greywater systems; and
- rainwater tanks.

We are not aware of any comprehensive economic review of demand side water technologies undertaken in Victoria. Marsden Jacob Associates (MJA) published a report[3] in 2007 that focussed on the economics of rain water tanks.

1.1 Project Context

It is a truism that water is precious. A marker of living in Victorian towns and cities is the availability of piped water.

The uptake of water savings technologies by Victorian households is already significant[4]. According to the Australian Bureau of Statistics[5], 67% of households have at least one water efficient showerhead; 89% have at least one dual flush toilet, 33% have a rainwater tank; and 26% use greywater in the garden.

An academic study from 2010 examined attitudes towards water conservation and actual water saving behaviours. It found what could generally be considered to be a disconnection:

> *"Australians generally have very positive attitudes towards water conservation and water saving appliances, however these positive attitudes are not consistently translated into actual behaviour. The main barriers to adoption of water conservation behaviours identified in the study are: the perception of inconvenience and impracticality, as well as costs associated with purchasing water saving appliances."*[6]

[3] Marsden Jacob Associates for the National Water Commission, 'The Cost-Effectiveness of Rainwater Tanks In Urban Australia' March 2007.

[4] The Office of Living Victoria has compiled detailed data on Melbourne's water use, including the uptake of water efficient appliances across the city. They intend to publish on this theme in the future.

[5] ABS Cat.No. 4602.0.55.003 & Cat.No. 4602.2.

[6] Dolnicar 2010.

In recent years water bills have increased considerably across Victoria. For the three years to 2011/12, bills increased 50-64% for Melbourne households and 16-46% for regional Victoria households[7]. In 2013/14 in Melbourne water bills will experience a jump again (17- 23% over inflation)[8], mostly attributable to the desalination plant[9].

As the price of mains water increases, an incentive builds for people to better translate their stated values into behaviours. The purpose of this report is to examine the cost effectiveness of water saving technology to Victorian consumers in light of current prices and expectations of price increases.

Besides cost-effectiveness of water saving technology, a household may have other criteria such as energy usage, convenience, simplicity, durability, repair-ability, and end of life recyclability of materials used. Such criteria are beyond the scope of this report.

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[7] Calculated from ESC 2012. Fixed and volumetric charges. Varies by water retailer.

[8] Calculated from ESC 2013 (1) pxxiv

[9] The Wonthaggi desalination plant attracts a security payment which Melbourne water businesses pay even when no water is ordered. This fixed charge is already reflected in water bills. If any water is ordered, both fixed and variable charges on water bills would rise. Reflecting a few years of good rains, Melbourne's dams are 78% full at the time of writing, giving the city a comfortable buffer. The State Government has signalled a zero water order in the next few years. In addition it is consulting on *Melbourne's Water Future*, a strategy for "a new and integrated water cycle management approach". This report assumes no water is ordered from the desalination plant. However, the price increases from any water that is ordered would add to the business case for water efficient technologies.

2.0 Project Methodology

Households that reduce their water use, pay less on the volume based charge. As such, the economics to the consumer of a specific water saving technology depends on:

- the volume of water saved;
- the price of the water saved; and
- the technology's installed cost.

The specific water saving technologies examined in this report are:

- dual flush toilets, water saver devices and compost toilets;
- showerheads;
- washing machines;
- dishwashers;
- recirculators;
- greywater systems; and
- rainwater tanks.

For each water saving technology, this report has attempted to examine whether there is a business case[10]; and what are the relevant key drivers and determinants.

2.1 Water Charges to Consumers

The Essential Services Commission (ESC) is the economic regulator of the water sector in Victoria.

There are 16 water businesses operating within geographically defined areas providing retail and distribution services of water supply and sewerage (see Figure 2.1). One of the ESC's roles is to determine the prices that these businesses can charge consumers for the delivery of reticulated water.

Each water retailer has a different price and tariff structure. All water businesses have fixed fees and usage-based charges for water and sewerage.

Water bills vary according to the following factors:

- Whether a property is **rented or owner-occupied**. Owner occupied properties are charged all relevant prices on one bill. Where a property is leased, two bills are generated. Landlords are charged for the fixed costs for water supply. Tenants are charged for the volume based costs of water. (However increasing fixed charges would be expected to translate into higher rents over time.)

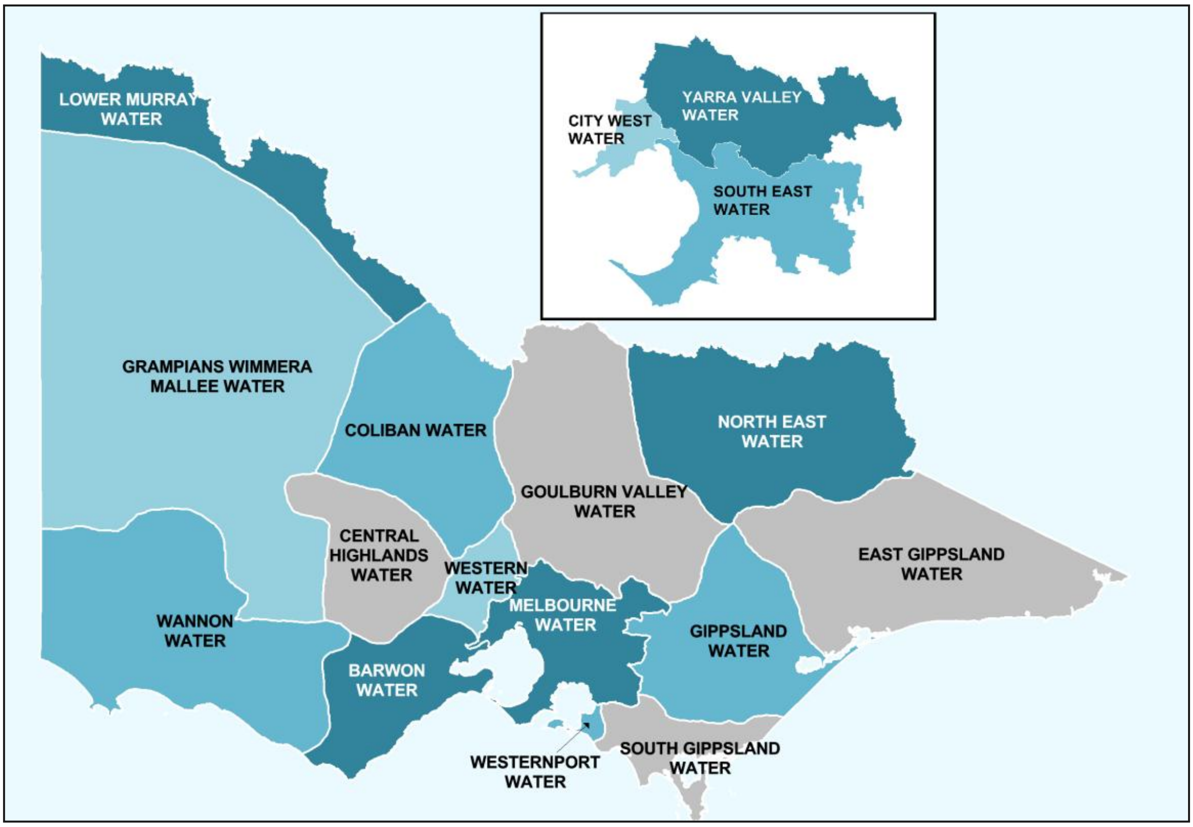
[10] 'Business case' is obviously a subjective term, particularly for residential consumers not used to thinking in traditional project economic terms. However there is some evidence that a not-insignificant portion of residential consumers do respond to alternative and efficient technologies once they are confident of their initial capital outlay being returned within 10 years – cite solar photovoltaic and solar hot water investment trends since 2008.

- **Water consumption** (for tenants and owner occupiers). Melbourne water retailers and a few regional ones, use an 'inclining block' tariff structure, where the usage price rises with the level of consumption.

- Some water retailers distinguish between different classes of water users – that is, whether the property is considered **residential or non-residential**. Typically non-residential water users are subject to higher quarterly fees. However generally the usage charge is the same or comparable to one of the blocks.

- **Sewerage charges**. All water retailers charge a fixed fee. Only in Melbourne do residential customers face additional variable charges. In regional Victoria, it is mainly non-residential users who pay usage related sewerage charges.

Figure 2.1: Victorian Water Businesses



Source: ESC 2012

Table 2.1 shows a summary of the indicative **volume based** prices for residential users across the different water retailers.

- In Regional Victoria, the supply price varies widely from $1.005 per kilolitre (kL) (Lower Murray Water) to a high of $2.36 (North East Water). Water supply prices are higher in Melbourne, varying from $2.75-$3.07 per kL.

- Regional households do not face volume based sewerage charges. In Melbourne, these charges vary from $1.78 to $2.09 per kL. However sewerage charges are calculated by a formula relating to how much water is supplied to the property and property type (house or unit).

The three Melbourne water retailers apply different formulas. **Appendix A** details how, for the purpose of this report, an average factor of 0.75 for sewerage volume (and hence price) is reasonable for houses. For a unit the factor varies from 0.82 to 0.85. Volumetric sewerage charges in Melbourne are considerable (indicatively adding another 50% to the water price).

- In some areas of the state, different prices are allowed for different areas. In this case, the prices shown are for the largest town.

Table 2.1: Indicative Residential Volumetric Pricing in Victoria ($/kL)

	2013 Financial Year Prices				Real growth allowed above CPI				
Water authority	**Supply**	**Sewerage**	**Houses[1]**	**Units[2]**	**2014**	**2015**	**2016**	**2017**	**Notes**
Melbourne									
City West Water	2.7486	1.7808	4.0842	4.2089	0%	0%	0%	0%	Block 2 441-880 litres/day
South East Water	3.0679	1.8155	4.4295	4.5566	0%	0%	0%	0%	Block 2 441-880 litres/day
Yarra Valley Water	3.0469	2.0908	**4.6150**	**4.7614**	0%	0%	0%	0%	Block 2 441-880 litres/day
Melbourne average	*2.9545*	*1.8957*	*4.3762*	*4.5089*					
Regional Victoria									
Barwon Water	2.2332	0			-1.60%	-1.60%	-1.60%	-1.60%	
Central Highlands Water	1.7243	0			0%	0%	0%	0%	Category 1, 0 to 175kL/a
Coliban Water	2.1464	0			3.00%	0.80%	0.00%	0.00%	Central region prices (Bendigo)
East Gippsland Water	1.8689	0			1.60%	1.60%	2.10%	2.60%	
Gippsland Water	1.8990	0			0%	0%	0%	0%	
Goulburn Valley Water	1.0900	0			0%	0%	0%	0%	
GWMWater	1.6288	0			0%	0%	0%	0%	
Lower Murray Valley Wate	**1.0050**	0			1.80%	1.80%	1.80%	1.80%	Third tier (block varies by seasor
North East Water	**2.3630**	0			-0.60%	-0.60%	-0.60%	-0.60%	
South Gippsland Water	2.0166	0			0%	0%	0%	0%	Murray Goulburn
Wannon Water	1.7794	0			-0.34%	-0.34%	-0.34%	-0.34%	Block A prices (Warrnambool)
Westernport Water	1.8510	0			0%	0%	0%	0%	
Western Water	1.9432	0			3.30%	3.30%	3.30%	3.30%	Block 2 441-880 litres/day
Regional Victoria - average	1.8114				*0.55%*	*0.38%*	*0.36%*	*0.40%*	

*1. Total for houses = Water Supply Charge + Sewerage Charge * 75%. See Appendix A*

*2. Total for units = Water Supply Charge + Sewerage Charge * 82%. See Appendix A*

Source: ESC price determinations; ATA

Table 2.2 shows indicative volume based prices for non-residential water users:

- In Melbourne water users serviced by City West Water pay $4.16 per kL, including sewerage charge. The other two water retailers have higher prices, at $4.6-4.7 per kL.

- Some water retailers in Regional Victoria have volumetric sewerage (or cistern) charges[11].

[11] Water retailers distinguish between sewerage charges and trade waste for commercial users. Trade waste is water used in industrial processes. This report deals only with sewerage.

- Again sewerage charges are calculated in a formula relative to volume of water supplied. Generally the factor for non-residential water users is 90%; however different discharge factors apply for different users in some areas (e.g. South Gippsland's 'cistern factors' ranging from 30% [sporting] to 80% [business, community services, education & religious purposes.])

- The effective cost of water (including sewerage) in Regional Victoria then varies from $0.78 per kL (Lower Murray) to $5.13 per kL (Gippsland Water). The second lowest price is $1.09 (Goulburn Water).

With such variation around the price of water in Victoria, clearly the location of the water user will be a key variable for the economics of water saving technology.

Table 2.2: Indicative Non-residential Volumetric Pricing in Victoria ($/kL)

	2013 Financial Year Prices			Real growth allowed above CPI				
Water authority	**Supply**	**Sewerage**	**Total[1]**	**2014**	**2015**	**2016**	**2017**	**Notes**
Melbourne								
City West Water	2.6002	1.7329	4.1598	0%	0%	0%	0%	
South East Water	3.0679	1.8155	**4.7019**	0%	0%	0%	0%	
Yarra Valley Water	2.7985	2.0300	4.6255	0%	0%	0%	0%	
Melbourne average	*2.8222*	*1.8595*	*4.4957*					
Regional Victoria								
Barwon Water	2.2332	1.8561	3.9037	-1.60%	-1.60%	-1.60%	-1.60%	
Central Highlands Water	1.7243	1.0089	2.6323	0%	0%	0%	0%	Category 1, 0 to 175kL/a
Coliban Water	2.1464			3.00%	0.80%	0.00%	0.00%	Central region prices (Bendigo)
		0.8302	2.8936	3.00%	3.00%	3.00%	0.00%	
East Gippsland Water	1.8689	0		1.60%	1.60%	2.10%	2.60%	
Gippsland Water	1.8990	3.5886	5.1287	0%	0%	0%	0%	Wastewater charged on non-resi
Goulburn Valley Water	1.0900	1.4858	2.4272	0%	0%	0%	0%	
GWMWater	1.6288	0		0%	0%	0%	0%	
Lower Murray Valley Wate	**0.7820**	0		1.80%	1.80%	1.80%	1.80%	
North East Water	**2.3630**	0		-0.60%	-0.60%	-0.60%	-0.60%	Major customers pay 0.9431
South Gippsland Water	2.0166	1.6619	3.3461	0%	0%	0%	0%	Murray Goulburn
Wannon Water	2.1363	0		-0.34%	-0.34%	-0.34%	-0.34%	Block A prices (Warrnambool)
Westernport Water	1.8510	0		0%	0%	0%	0%	
Western Water	1.9432	0		3.30%	3.30%	3.30%	3.30%	
Regional Victoria - average	*1.8217*			*0.73%*	*0.57%*	*0.55%*	*0.37%*	

1. The default Discharge Factor of 0.9 applies to sewerage volumes, except for South Gippsland Water which is 0.8

Source: ESC price determinations; ATA

Regarding the level of water prices, the ESC's stated principle is that volumetric charges should reflect long run marginal costs (ESC 2011). As to the rationale behind such significant variations in pricing across different parts of Victoria (and perhaps counter-intuitively, why metropolitan prices are significantly higher) is a relevant question – but one which does not form part of this research.

2.1.1 Price Growth

The ESC has approved prices for a five year period 2013-2018 and distinguishes between inflation and real growth. The relevant inflation measure is nominated as the Capital City Consumer Price Inflation (CPI).

Tables 2.1 and **2.2** show price growth allowed above CPI. Allowed price growth varies from -1.6% to 3.3% in regional Victoria. In Melbourne, no growth above inflation is allowed.

The main driver of growth in prices will therefore be CPI. The Reserve Bank of Australia (RBA) has a mandate to keep inflation at between 2% and 3%. Economists therefore expect inflation to average 2.5% over the medium term.

So water users will continue to see price rises, but only at the inflation rate. As such, this era of rapid growth in water bills should soon end.

2.2 Rebates

Rebates are currently available from the State Government's Living Water program. This report takes into account the existing rebates available for different technologies:

- For households, rebates are available for technologies including rainwater tanks connected to laundry and/or, greywater systems, showerheads, dual flush toilets, recirculators, washing machines, pool covers and a basket of small value water saving technologies.
- For small businesses (<50 employees), rebates of 50% up to $2,000 over three years are available for technologies including urinals and dual flush toilets, rainwater tanks (connected to toilet, laundry or other business use), greywater systems, pool covers, showerheads, dishwashers, washing machines, water data loggers, flow control devices and hot water recirculators.

Some water retailers have specific programs for working with large water users (e.g. schools).

2.3 Economic Modelling

In order to calculate water savings, it is necessary to establish a 'business as usual' case for each water-saving technology. Assumptions about the water savings will vary according to the technology under assessment, so is detailed separately as part of the next section.

Key economic determinants are the predicted growth in prices (discussed above) and the cost of the technology itself (along with installation). Other key determinants exist by technology type, as outlined in the following chapters.

The economics are presented as the 'payback' period using discounted cash flow. Payback (in years) using discounted cash flow recognises the time value of money with a discount rate[12]. Although interest rates are at all time lows at present, each individual and business will have a different discount rate.

Accordingly different discount rates are used in the summary tables for each technology to show sensitivity.

Here's how to read the summary charts:

- Know your cost of water at the margin. Refer to **Table 2.1** for an indication for residential properties; **Table 2.2** for non-residential water users; or check your latest water bill. Don't forget to take into account sewerage.

- The marginal cost of water includes sewerage charges where they are levelled volumetrically. As such, savings achieved by any of the demand side technologies will include volumetric (and therefore financial) savings on both mains water and sewerage.

- The same prices are used across all charts, representing a spectrum across Victoria. For **residential** water users the prices charted are a Melbourne average ($4.38 per kL), a regional Victoria high ($2.36 North East Water) and a regional Victoria low ($1.01 Lower Murray Valley). For **non-residential** water users the prices charted are Melbourne average prices ($4.50), a regional high (Barwon Water $3.90) and a regional low ($1.86 East Gippsland)[13].

- Choose a discount rate. It is envisaged that an individual with cash on hand would have a 3% discount rate, whereas someone with a mortgage would have 7%. Discount rates of both 10% and 20% are shown for businesses.

- The chart shows payback in years. If a line is not on the chart, the payback period is longer than the maximum shown.

[12] Time value of money is the principle that $100 in hand today is more valuable than $100 sometime into the future.

[13] There is one lower water price being Lower Murray Valley at $0.78 per kL, and one higher price is Gippsland, at $5.13 per kL.

3.0 Toilets

3.1 Dual Flush Toilets - Residential

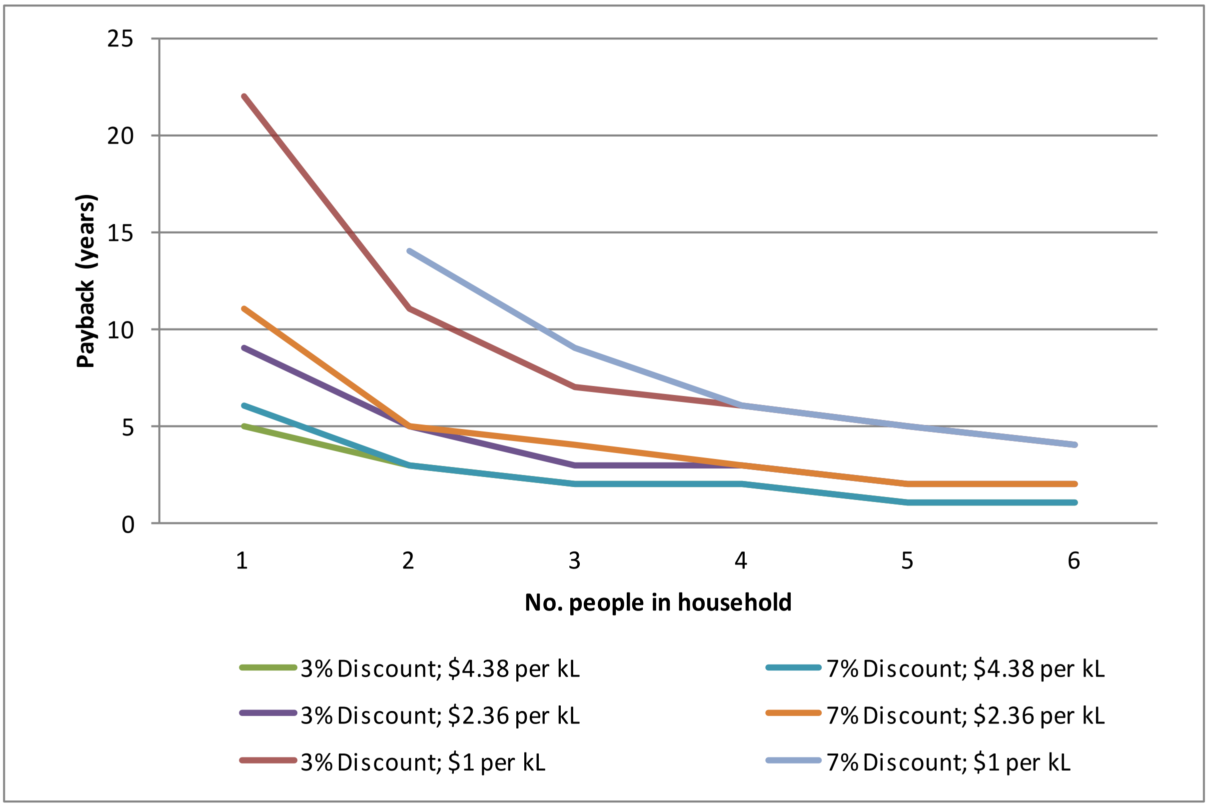
Business as Usual
There are two business-as-usual cases for toilets. The first case considered is the replacement of an older style, 12-litre single flush cistern. However the majority of households already have a dual flush toilet. The second business as usual case is an upgrade from an older 9L/4.5L model. The most water efficient model is 4.5L/3L dual flush.

Discussion
Toilets vary in price from $180 to more than $800. We have allowed $200 for plumbing expenses. In Victoria, a rebate of $100 is available for households upgrading to a more efficient dual flush toilet.

Findings: Business as Usual – 12L Single Flush
There is a good business case for most households in Victoria for upgrading to a dual flush toilet from an old style, 12-litre single flush cistern to the highest efficiency 4.5L/3L dual flush toilet. The efficiency gain is 8.7 litres or 73%. Even for a single person household (with seven flushes a day), the payback is about five years at average Melbourne prices.

Chart 3.1 shows the payback in years for a range of water prices and two discount rates.

Chart 3.1: Residential Payback - Out of Pocket $450; from 12L to 4.5L/3L

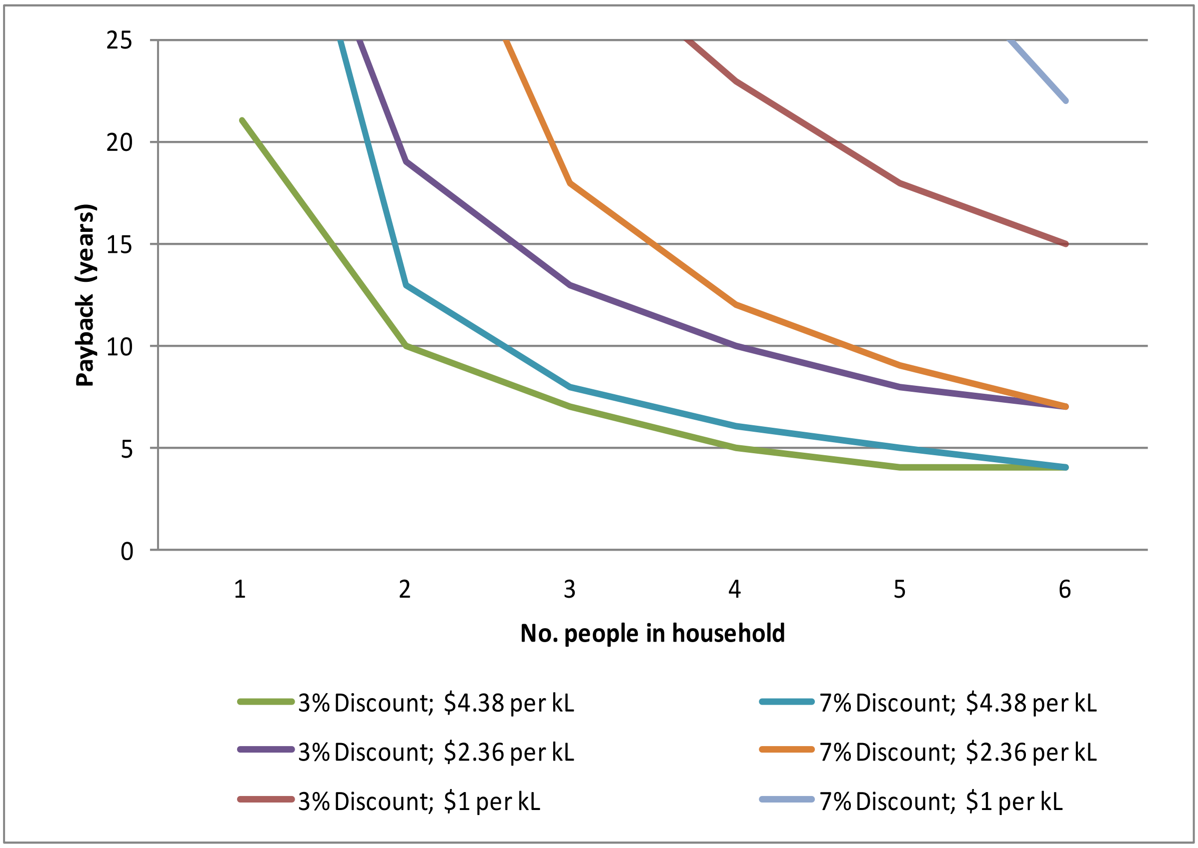


Findings: Business as Usual – 9L/4.5L Dual Flush
For households with a 9L/4.5L model toilet, the efficiency gains are still impressive (39%). But the economics of upgrading will depend on its usage – in large part determined by household size.

If a householder is out of pocket by $450 after installation, the payback ranges from 21 years for a single person household to four years for a five person metropolitan household.

Chart 3.2 shows there is a business case in Melbourne for households of two or more, and in larger households of regional Victoria where the price of water is moderate.

Chart 3.2: Residential Payback - Out of Pocket $450; from 9L/4.5L to 4.5L/3L



Some water companies are offering deals making it cheap and easy to upgrade to highly efficient (4.5L/3L) dual flush toilets. At its cheapest the household would be out of pocket $300. With this offer, payback periods reduce. In this case the payback period ranges from 14 years for a single person household, to three years for a five person household in Melbourne.

3.2 Dual Flush Toilet – Non-Residential

Business as Usual
As with residential, we consider two business as usual cases; from a 12L single flush and from a 9L/ 4.5L dual flush model.

Discussion
State Government rebates available to small business will cover 50% of the installed cost of water efficient technology, including dual flush toilets. Other incentives may be available to other water users. There may be economics of scale for purchases of toilets and/or plumbing.

We would expect the cost of installed toilets could be claimed as a business expense against taxable income. The result would be better paybacks than shown in the charts below.

Findings
The main driver of the economics is the number of users – modelled as Full Time Equivalent Employees per toilet. The business payback is shown in **Chart 3.3** (upgrading from 12L) and **Chart 3.4** (9L/4.5L).

Chart 3.3: Payback for Non-residential - Out of Pocket $275; from 12L to 4.5L/3L

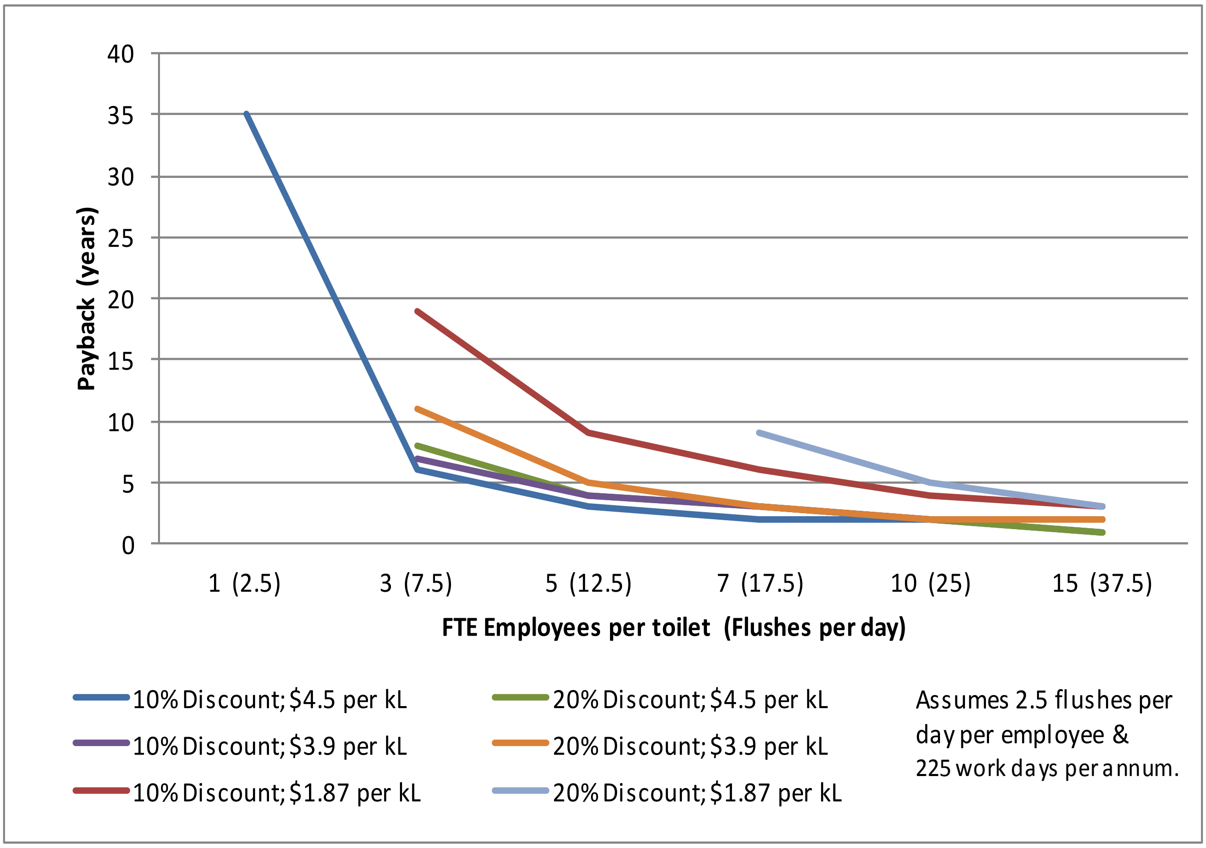
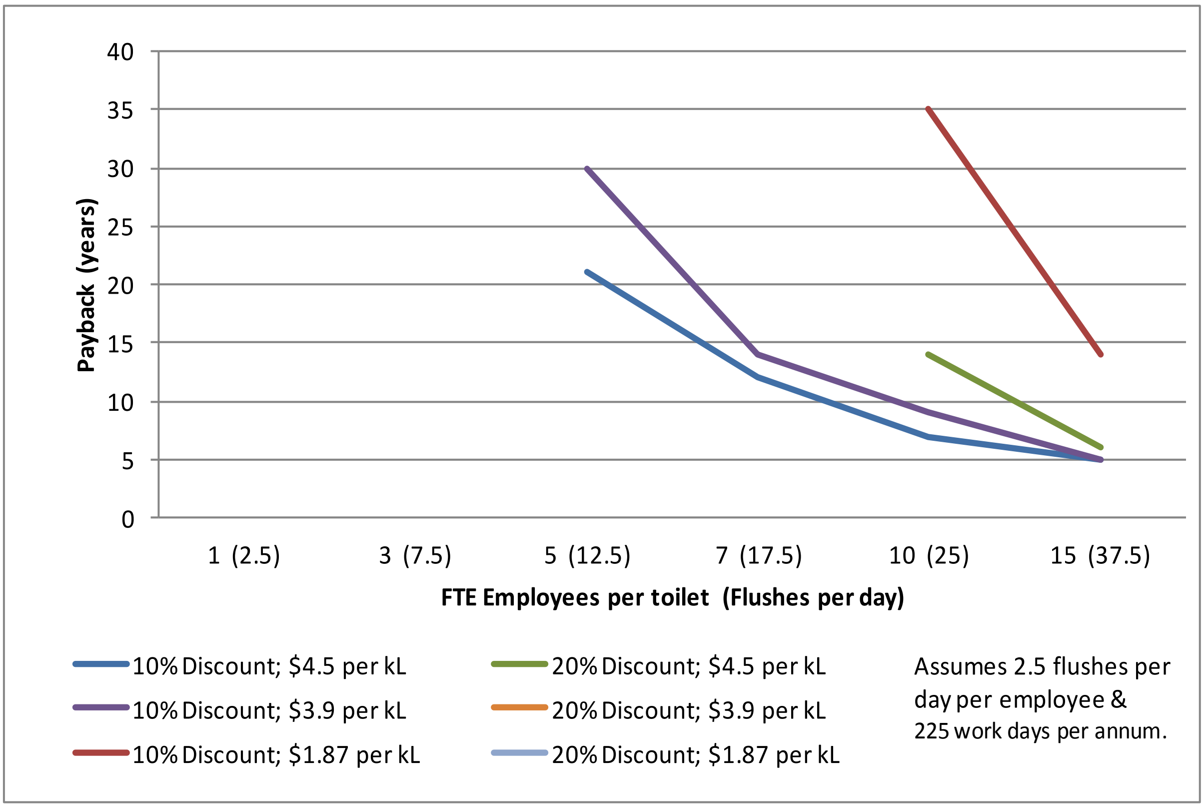


Chart 3.4: Payback for non-residential - Out of Pocket $275; from 9L/4.5L to 4.5L/3L



3.3 Toilet Water Saver Devices

A very cheap water saving alternative to changing toilet units is a device which flushes for only as long as the button is held down[14]. This device costs around $10 and appears very easy to install and could be especially helpful for renters (who pay volume charges) with landlords (paying fixed charges) reluctant to upgrade toilets.

Business as Usual

The business as usual case, against which the installation of a toilet water saver is being considered, is a 12 litre single flush cistern.

Discussion

If used on a 12-litre single flush toilet (assuming a half flush equals 6 litres and the toilet is being flushed seven times a day) the water savings are 12.3kL a year per person.

These devices work on most, but not all, cisterns and are typically accompanied by explanatory material to advise the user on correct usage.

Figure3.1: A Toilet Water Saver

[14] For example, http://www.enviroshop.com.au/shop/Toilet_Water_Saver.html

Findings

At average Melbourne prices the value of that water saved in 2013/14 is $54 in a single person household. That is, within one year the device has paid for itself many times over.

Even where water prices are the lowest in Victoria, (Goulburn Valley $1.09 per kL), the water savings are $13 for a single person household. Installing a toilet water saver device could be an alternative to installing a more water efficient toilet. Some behaviour change will be required of users however.

3.4 Compost Toilets

Business as Usual

The business as usual case, against which the installation of a compost toilet is being considered, is an older style dual flush toilet (9L/4.5L).

Discussion

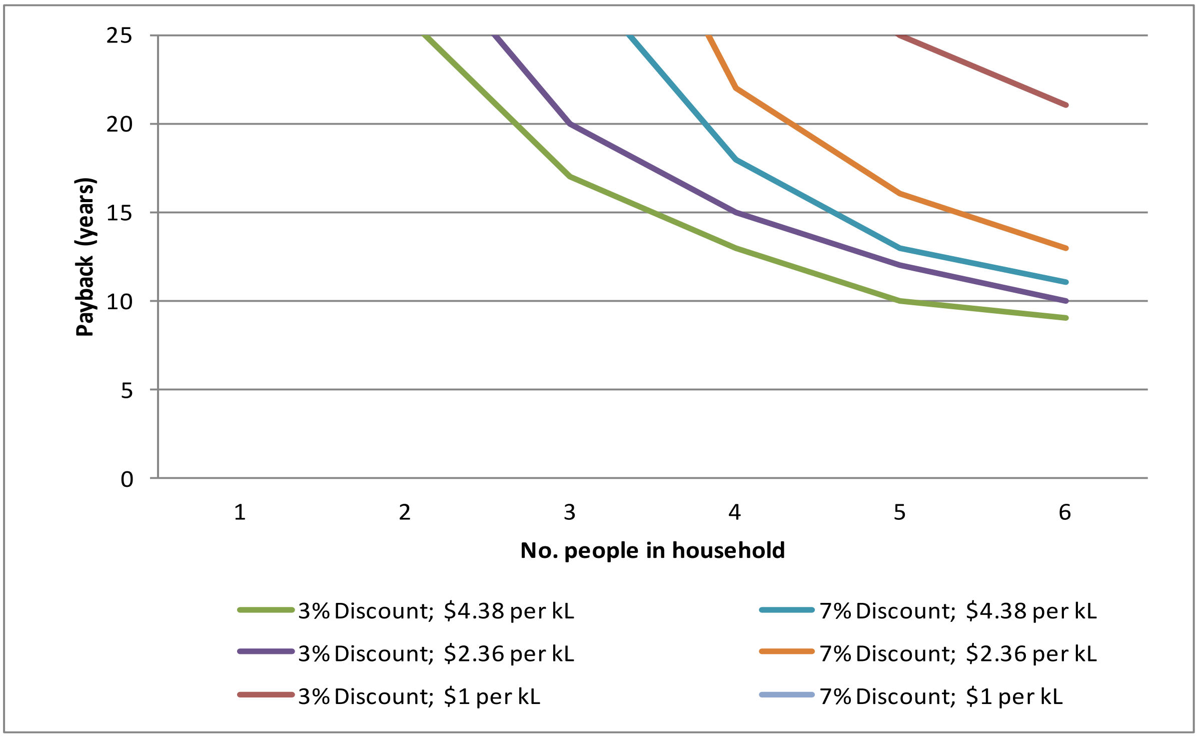
A composting toilet uses no water for flushing. Consequently the water savings is an average of 5.4 litres per use, and 14kL a year per person. At Melbourne average prices water savings are $60 per person per year.

Findings

The price of commercial waterless compost toilets varies according to capacity. Prices for a permanent compost toilet for 3-4 people appear to start at $3,000. Add 10% for larger composting chambers suitable for servicing 5-6 people.

If out of pocket by $3,000, the payback for a family of four in Melbourne would be 13 years (assuming a discount rate of 3%). Generally a 20 year payback is approached for households of three people or more across the state except where water prices are very cheap.

Chart 3.5 Residential payback (out of pocket $3,000; from 9L/4.5L to 0L)



4.0 Showerheads

Business as Usual
The business as usual case, against which the installation of an efficient showerhead is being considered, is upgrading from a 10 litre per minute flow.

People are encouraged to test the flow of their existing showerhead. The only equipment needed is a bucket, a set of scales and a timer (remembering that 1 litre of water weighs 1 kilogram).

Discussion
New showerheads range in price from $16 to $945. Many water retailers offer schemes for free showerhead replacements. There appears to be no correlation between showerhead water efficiency and price.

A new showerhead of 5 litres per minute is a 50% saving. The potential savings to the household depends on how many showers are taken and their duration. Daily 4 minute showers over a full year amounts to water savings of 7.3kL per person.

The savings are not just in water, but also energy (not needing to heat so much water). A clear majority of Victorian homes heat water with gas. We have estimated the cost of heating water, based on the operating costs of gas storage or gas instantaneous systems using a first principles approach, as explained in Appendix 2.

Reducing flow saves an estimated 0.37 cents per litre in energy. Forecasts vary widely, but gas prices are expected to jump by 50% to 2020, with the opening of the gas export market increasing domestic prices to world levels.

A rebate is available at present in Victoria for showerheads that use 9 litres or less a minute. For domestic water users, the rebate is $10 for showerheads that cost between $30 and $100 and $20 for more expensive showerheads.

Another good efficiency measure is to take showers at less than maximum pressure.

Findings
There are very good economics for changing over inefficient showerheads.

At average Melbourne water prices (including sewerage) a four person family taking daily four minute showers will save around $128 in water and $108 in gas in the first year.

In metropolitan areas the payback is around four years even for a single person household that buys a relatively expensive $250 showerhead. Even in areas of Victoria where water prices are lowest, the payback for a single person household is six years.

Chart 4.1 shows the residential payback in years by the main drivers, being price of water, discount rate and number of people in the household. In all scenarios modelled there is a solid business case for improving efficiency of showerheads. Of course, it is not necessary to outlay $250, and a cheaper model improves the economics even more.

The business payback is shown in **Chart 4.2**. Businesses are considered less likely to buy an expensive model, and it has been modelled on a $50 outlay (including 50% rebate). All scenarios enjoy a payback within 2 years.

Chart 4.1: Residential Payback - Out of Pocket $230; from 10L per minute to 5L

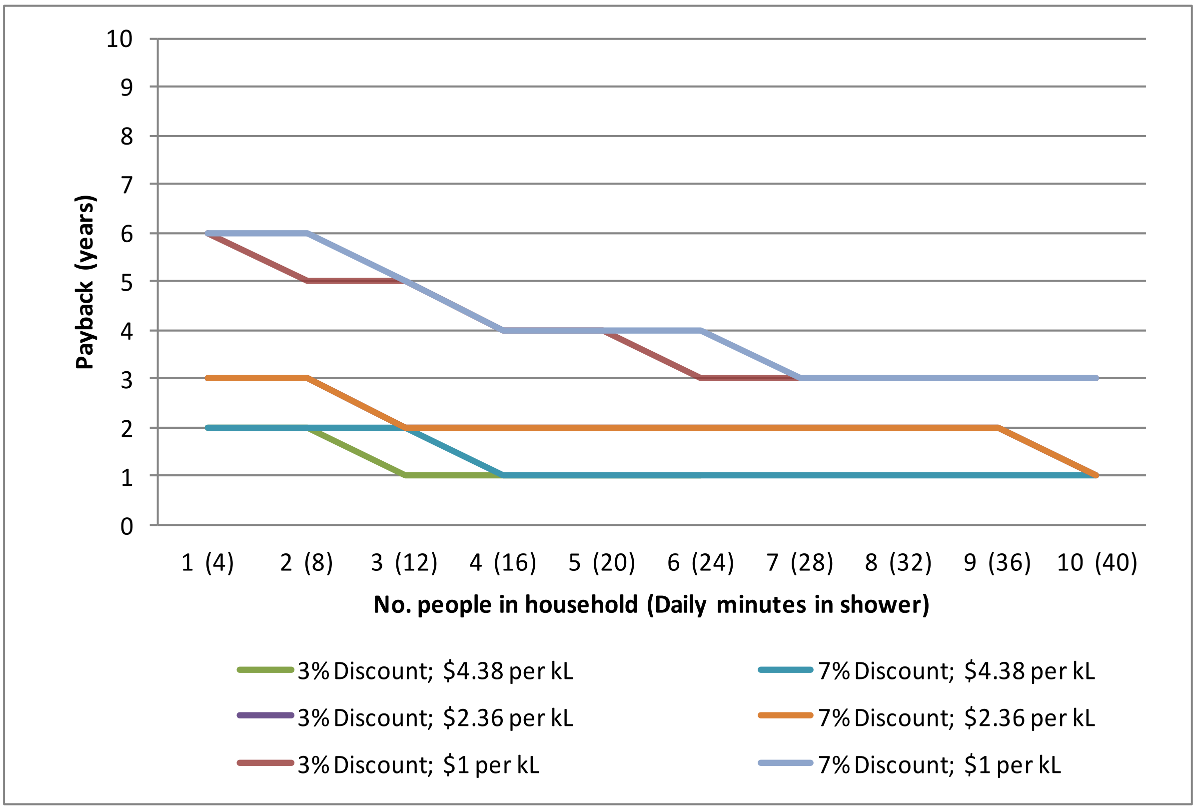
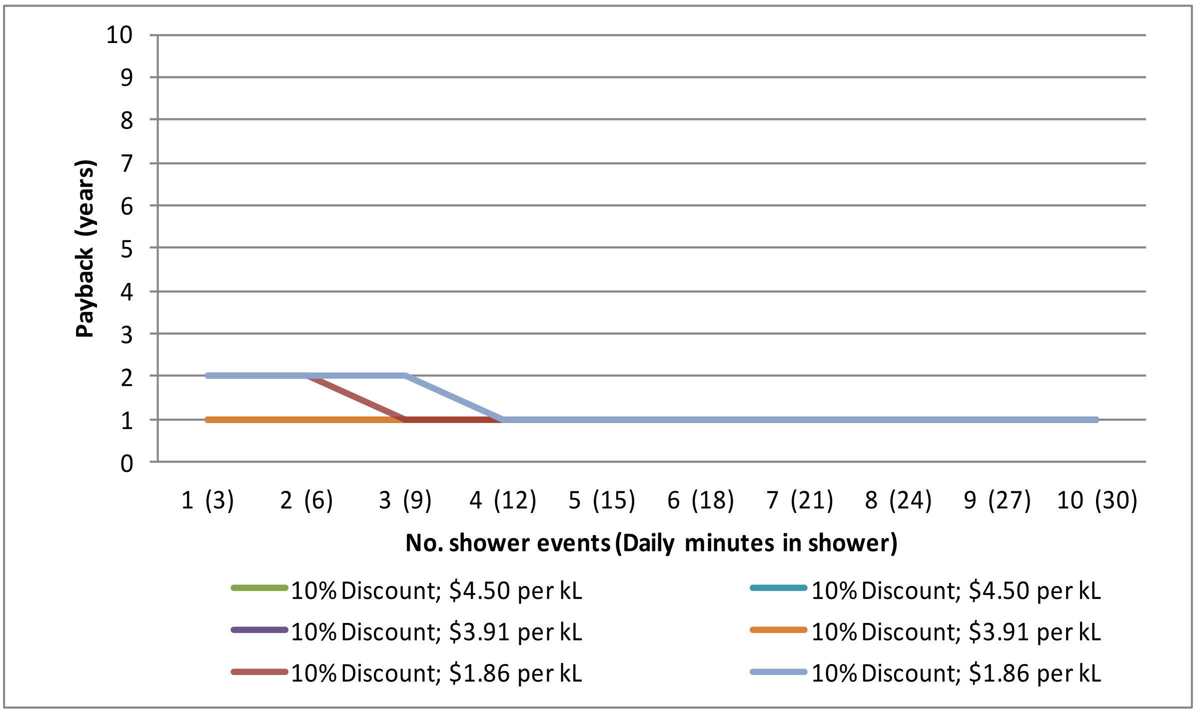


Chart 4.2: Business Payback - Out of Pocket $50; from 10L per minute to 5L



5.0 Washing Machines

Consumer advocates Choice tested washing machines in 2013[15]. This section draws on their performance and pricing research.

Business as Usual
The business as usual case is the purchase of a less efficient new washing machine, a 3 star top loader (with hot and cold connections). Choice assessed 10 such models costing on average $757, and using 108 litres of water per wash.

Discussion
Choice found washing machines vary considerably in price from $329 to $2599, and water efficiency varied from 38 litres to 166 litres per use.

As with dishwashers below, how much water a washing machine is rated for is not a particularly good indicator for how much water they are going to use. 37% of the machines tested by Choice use 20%+ more water than rated.

Choice reports "It's in manufacturers' interest to represent their washing machines as being capable of the biggest possible load. Water and energy efficiency labels are based on the water and energy used per kilogram of washing, so the higher the machine's claimed capacity is, the higher its star rating." However Choice found what the manufacturers claim to be a full load is around double what customer's think is a full load.

Front loaders are far more water efficient than top loaders, and they are more expensive. The top loaders are all rated 2.5-4 stars for water and front loaders are all 4-4.5 stars. For the most part the star ratings separates front from top loaders.

The alternative to the business as usual case is the purchase of a more water efficient machine, a 4.5 star front loader. Choice assessed 13 'cold only' models costing on average $1017, and using 53 litres of water per wash. However the machines that use water more efficiently also use more electricity.

All top loader machines connect to both hot and cold water to operate. Some front loaders have their own heater and connect only to cold water pipes. However Choice tested on a normal cycle with cold water, to reflect people's usual habits. So the increased energy use is independent of the need to heat water.

Findings
A new washing machine that is 51% more efficient with its water usage will save 14kL of water a year if used five times a week. At average Melbourne prices, that is a saving of $63 in the first year, offset by an additional $7 spending on electricity. Still, the question is, is it rational to spend more and get a more water efficient machine that will save $55 a year?

The payback is 6 years with a 7% discount rate. If a 10 year payback is acceptable one can spend an additional $423 (purchase a $1,180 washing machine).

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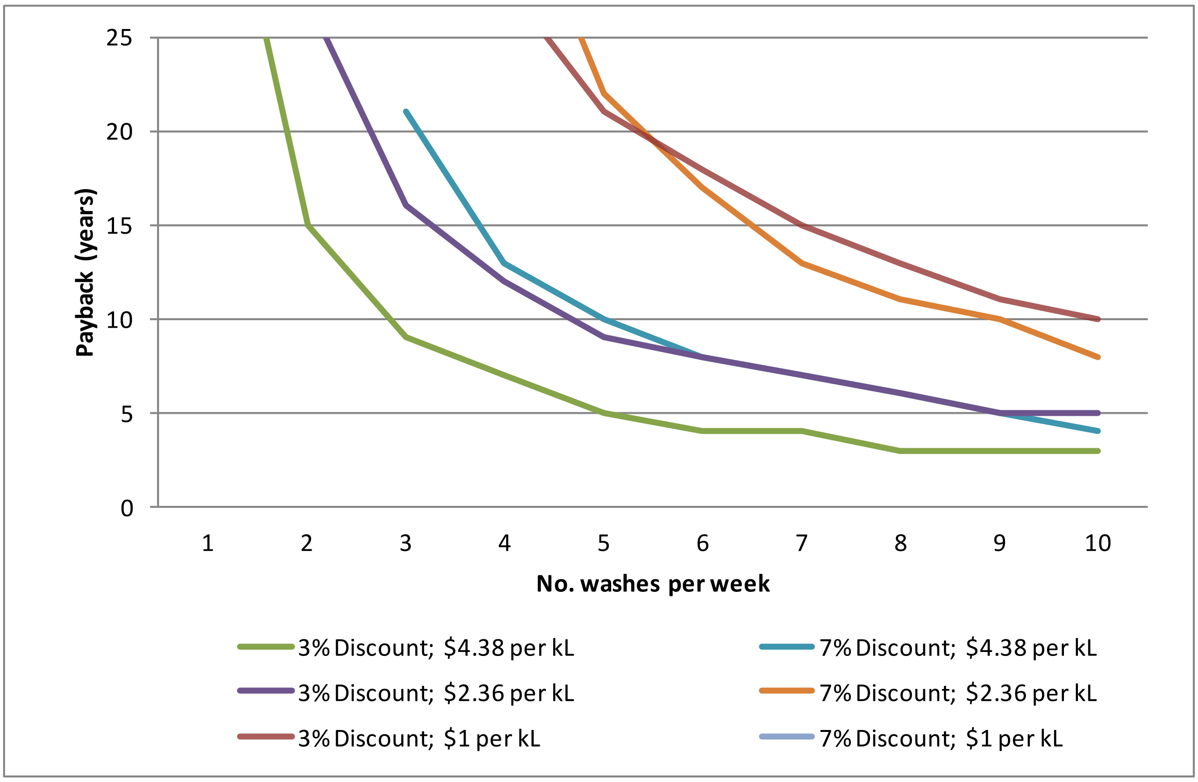
15 http://www.choice.com.au/reviews-and-tests/household/laundry-and-cleaning/washing-and-drying/washing-machines-review-and-compare.aspx Accessed 7th October 2013.

Chart 5.1 Residential Payback - Spend Extra $260; from 3 star (108L per wash) to 4.5 stars (53L)



A washing machine rating 5 stars for water will qualify for a $150 rebate (when used for domestic purposes) if it also has at least 4 stars for energy. Only one machine that Choice tested qualifies, a Bosch model which retails at $1399.

With the rebate, an additional $492 is payable by the consumer. It saves 67 litres per use, using the same base case as above (compared with the 3 star top loader). With five washes a week, that water savings amounts to 17 kL each year. At Melbourne average prices the water savings are $76 in the first year. Electricity costs are about the same. The payback is 8 years (at a 7% discount rate).

These calculations assume the use of cold water for all washes. For people who regularly use warm or hot water when washing, the energy cost savings may be far greater when choosing a water efficient front loading machine compared to two-inlet top loader. That is, unless their current hot water heating source is solar or an efficient electric heat pump.

Is there a business case to upgrade from an existing 3 star top loader washing machine if it still works? The cost would then be the outlay of $1,017. The economics will depend on the existing machine's water and electricity usage.

For simplicity we will assume the same efficiency gains with near daily use (first year: water +$63 but electricity -$7). At average Melbourne water prices, the payback is 37 years (at a 7% discount rate), well beyond the probable lifetime of the machine. The business case hinges on a need to upgrade.

6.0 Dishwashers

Consumer advocates Choice tested dishwashers in 2013[16]. This section draws on their performance and pricing research.

Business as Usual

The business as usual case is the purchase of a least efficient budget priced dishwasher. (The model is a Dishlex, priced at $739, which used 23 litres of water). We have assessed how much extra one would pay to get an economic outcome (payback of 10 years).

Discussion

New dishwashers do not use much water. The least efficient dishwasher tested by Choice used 23 litres per cycle and the most efficient 8 litres. It is a sizeable difference (65%). But over a year with one daily use, that 15 litre difference adds up to only 5.5 kL. Even with water (and sewerage) at $4.40 per kL, the additional cost is only $23 (in 2013/14).

Choice tested dishwashers varying in price from $599 to $3699. However there is no correlation between the price of a dishwasher and its water use for the units tested by Choice. That is, higher priced dishwashers are not automatically more efficient.

According to Choice, "For the mandatory energy and water labels (the star rating stickers on the machines), the test is done on any program nominated by the manufacturer as long as it's stated in the product literature that it's designed to wash a normally soiled load at rated capacity**.**"

Their customers may use the machine differently. Choice reported the results of the "normal" or "auto" program, as surveys of Choice members say that is actually how most people use their dishwashers.

The official water labelling varies from a low of 6.7 litres per use to a high of 17.8 litres. In Choice tests a significant minority (22%) of dishwashers used considerably more water (>20%) than labelled. The dishwashers that use the least water are not necessarily the most energy efficient too.

Findings

Choice assessed 7 machines that used 11 litres or less (ranging from $599 to $1299). Such a machine would save 52% of water compared with the 23 litre base case model. Payback periods will vary according to installed cost of the new machine, frequency of use, discount rate applied and variable cost of water. The higher the cost of water, the higher the ongoing savings from lower running costs.

With daily use, installation costs of $150, and assuming a 3% discount rate, **a payback period of 10 years** is achieved when a more efficient (11 litres per use) machine is purchased from the additional spend of:

- +$179, with average Melbourne prices ($4.38 per kL);
- +$96 where prices are moderate ($2.36 per kL) in regional Victoria; and
- +$42 where prices are low ($1.01) in regional Victoria.

If a consumer purchases a dishwasher for its water efficiency, it would be advised to follow the manufacturer's instructions for the most efficient water use.

[16] http://www.choice.com.au/reviews-and-tests/household/kitchen/dishwashers/dishwashers-review-and-compare.aspx Accessed 9th September 2013.

7.0 Recirculators

Definition[17]:

> *"**Hot water recirculation systems** circulate the water in the hot water pipes back to the water heating system until the hot water at the fixture reaches the set temperature. All of the water is saved.*
>
> ***On-demand** hot water recirculation systems are triggered by operation of the hot water tap, a switch or a sensor. There is a moderate amount of additional energy for the circulation pumping.*
>
> ***Continuous or timed** hot water recirculation systems circulate the water continuously or for a period of time each day that is set on a timer."*

This report examines the business case for an 'on-demand' type system, because both continuous and timed systems have detrimental impacts on energy consumption.

Business as Usual
The business as usual case is no recirculator.

Discussion
'On demand' hot water recirculator systems use energy to save energy. In retrofit circumstances, recirculators need electricity for pumps to exceed mains pressure to push the water back into the cold pipe. Energy is saved because the embodied energy in the water in the process of heating to hot is recaptured. But is it a net savings or expense?[18]

An article in Automated Builder[19] claims that hot water losses in pipes accounts for 20% of domestic hot water heating. However it would seem to be quite complicated – as an article in World Plumbing Review[20] says:

> *"The elements in a building that can affect the efficiency of a hot water system include the water heater, piping, fixtures, fittings, appliances and behaviour."*

The water savings is overstated by some product information. For example, Reece (selling the Vada V30-RC) claims an annual 20 kL saving, which assumes that it takes 3 minutes for the shower to come to temperature (27 litres) before the customer starts showering.

The promised benefit is consumer convenience. Here is one example of how recirculators are promoted: "Fast track the hot water to your outlet, so it's there and ready whenever you turn on the tap"[21].

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17 https://www.basix.nsw.gov.au/basixcms/basix-help-notes/water/fixtures-2/hotwater-recirculation.html

18 A US study has claimed that recirculators save energy by recapturing the energy expended in the process of raising the water's temperature.

19 Automated Builder magazine, August 2007, 'US Manufacturer wins the top two major awards in Australia for saving energy and water'.

20 World Plumbing Review, Issue 1 2008, 'Structured Plumbing offers real benefits'

21 http://www.build.com.au/hotwater/hot-water-system-types/instant-hot-water-enhancements/hot-water-recirculation-systems

The objective of water saving technology is often to limit overall ecological footprint. A recirculator delivers genuine but limited water savings at the probable cost of higher energy usage and so on balance may increase the ecological footprint.

Alternatively a grey water diverter may be able to make use of this water, particularly if the water flowed to a water tank.

Findings
Recirculators are relatively expensive. The consumer group Choice says it came across products at $450-900 plus installation.

Certainly there may be a business case for models of hot water recirculators that save energy (as well as water). However we are not convinced that enough technical detail is available to be able to make the assessment. More research (and ideally trials) in the Australian context would be needed to be definitive.

Maybe some people use specific hot water recirculators and save water and energy. However technology is not values neutral. How technology is used is mediated by cultural values and norms.

Hot water recirculators are bathed in apparent green washing about water savings, but appear to be another device privileging consumer comfort and convenience (“hot water exactly when you want it – no more waiting!”).

8.0 Greywater

Greywater systems range considerably in complexity and price. The simplest and most cost effective models are greywater systems that divert to the garden only. More expensive systems treat the water, but the cost generally starts at $5,000. A rebate of $500 is available for an EPA compliant model.

8.1 Greywater Diversion to Garden

Business as Usual
The business as usual case is no greywater system.

Discussion
There are 24 companies on the EPA's website selling compliant diversion only greywater systems[22]. Only 6 of those systems were in the Renew Buyers Guide of Jan/March 2008 (providing data and analysis useful for this economic exercise). These 6 varied in price (in 2008) from $251 to $1,900.

Greywater systems have to be connected to the sewer system. Whether greywater goes onto the garden or out to the sewer will depend on how much greywater is produced and how much greywater the garden can absorb.

How much greywater the garden can absorb depends on the size of the garden, soil type, moisture levels and type of vegetation. ATA's 2005 Greywater Project found "diversion systems are difficult to get right. Expert advice is required to marry greywater output with the water needs of a garden."

The 'water saved' is the mains water that would have been used on the garden in the absence of the greywater system.

In 2008 the consumer group Choice said with prices of mains water so low, a greywater system might only be economic if the value of the garden is more than 10% of the house. Choice reports the average Australian produces 100 litres of greywater daily, which will water 35 sqm of lawn/garden a week (assuming loamy soils). A water efficient household might generate less.

Water users would be forgiven for thinking that a greywater system might reduce volumetric sewerage charges. Indeed in practice it undoubtedly does reduce water flow out the sewerage network. However, volumetric sewerage is not metered but calculated as a fraction of the volume of water supplied to the property. Water retailers do not know which households save how much greywater. So, a greywater system will not of itself generate savings from lower sewerage charges.

Findings
For the purposes of this report, we have assumed that the household has a big garden that can absorb most the greywater produced annually (100% in Summer and Autumn, 50% in Spring and 0% in Winter) and that in the absence of a greywater system, they would have watered the garden from the mains at 75% of this volume.

A household of four will be saving 68 kL a year. If they were $1,000 out of pocket after installing the system (allowing for a $500 rebate) and facing metropolitan prices of water and sewerage, the payback would be about 4 years.

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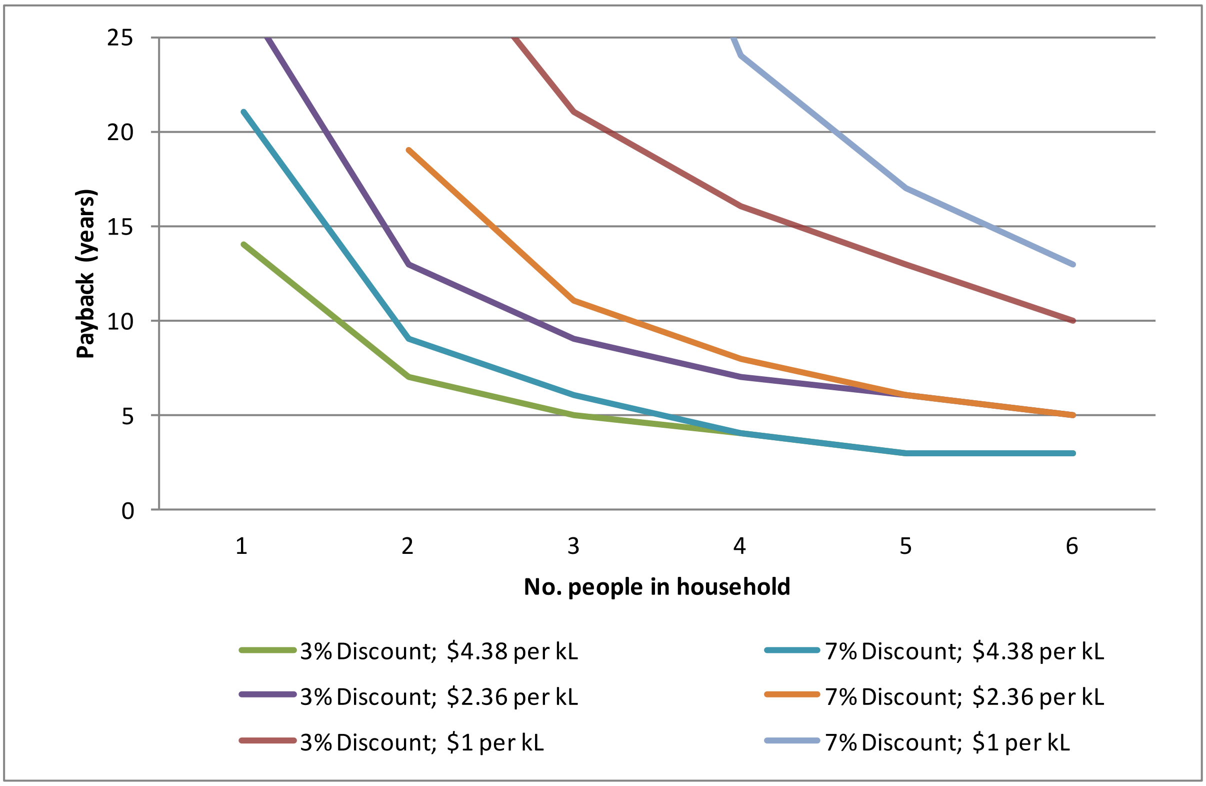
[22] http://www.water.vic.gov.au/saving/home/greywater/rebates Accessed 12th September 2013

Chart 8.1 – Out of pocket $1,000; watering from the mains at 75%



9.0 Rainwater Tanks

There are many reasons to have a rain water tank, including reducing water bills, mitigating costs and impacts of any water restrictions, for drinking water, easing the burden on public water supply and help avoid environmental impact of building new water sources. This report looks only for where a private business case exists for the installation of a rainwater tank.

Business as Usual
The business as usual case is no rainwater tank.

Method
There are many factors driving the cost effectiveness of rainwater tanks to consumers. Marsden Jacob Associates (MJA) wrote a report titled "The Cost-Effectiveness of Rainwater Tanks in Urban Australia" in 2007. They said "the cost efficiency of a tank is directly related to the whole of life cost and the yield that can be drawn from the tank over time."

Figure 9.1: Factors affecting Cost Effectiveness

Yield	Costs
Household factors: roof collection area, tank size, no. occupants in house (for indoor use) *Locational factors:* annual rainfall, impact of climate variability/climate change, rainfall pattern *Water usage*: number of plumbing connections, garden capacity to absorb	*Installation costs:* tank cost, tank installation and fittings, concrete slab / tank stand, household plumbing (for indoor use), water pump *Ongoing costs:* energy costs, maintenance, pump replacement *Avoided costs:* cost of mains water and sewerage charges

Source: MJA 2007, ATA

The ATA's ' Tankulator' calculates how much rainwater can be harvested from a roof anywhere in Australia over one, three or five years based on rainfall figures from the nearest Bureau of Meteorology station, the roof type and size, and flushing and overflow capabilities.

We have used the Tankulator to calculate the water use and rainwater yield, then have undertaken the economic modelling in Excel.

Lifetime costs
Costs are based on the price guides provided at tankulator.ata.org.au for different tank materials. The cheapest tank is round and plastic. Its price varies according to its size.

Additional costs (pump, plumbing and installation) have been taken from the MJA report, noting their caution: "costs are likely to be underestimated as the cost of incidental expenditure, such as mains water switching devices, "first flush" diversion systems and concrete slabs, were not specifically requested when obtaining quotes for tank installation."

MJA's costs were based on a survey of more than 20 rainwater tank suppliers. They found the quotes for the tanks to be quite standard, but installation and plumbing to vary considerably. They said "the high variability of the total cost underscores the importance of individual circumstances in determining the cost efficiency to the individual property owner.

Recognising the elapsed time between MJA's 2007 report and now, an inflation factor has been introduced, ranging from 0% for the pump to 4% pa for the plumbing:

- Any pump that is needed will have to be replaced every 10 years. The electricity the pump uses has not been modelled. Usually if it is not a pressure pump, the energy consumption will be negligible. If however a pressure pump is required such as for indoor plumbing, then the energy cost may be material.

- Operating and maintenance expense is complex. The MJA 2007 report makes an allowance of $20 per year "for one or more of the following services: tree-lopping, tank desludging, pump servicing (excluding pump replacement), additional gutter maintenance, gutter guards and/or chlorine for disinfection." There is also a small expense related to the size of the tank. This modelling has used $25 a year. We would agree with MJA's observation "The operating cost variation is significant and resolution of the actual cost would require monitoring and surveying of a number of residential properties with rainwater tanks."

How the rainwater tank will be used has a strong bearing on the total installed cost. MJA noted:

> *"Water from rainwater tanks can be used solely for outdoor garden use or can also be used internally. This choice has a material effect on a tank's yield and costs. For example, internal use (and in many cases garden use) typically requires the services of a plumber and the installation of a water pump, both of which are key drivers of cost. "*

Three tiers of rebates to offset the cost of a new rainwater tank are currently available in Victoria to domestic water users. The level of support varies from $850 to $1,500, depending on the size of the tank and the number of indoor connections. No rebate is available for rainwater tanks only plumbed outdoors.

9.1 Plumbed Indoor

The MJA report that found when tank water is plumbed indoors, the key drivers of yield were roof area, annual rainfall, tank size and number of occupants.

Findings
We have developed a best possible case for indoor usage: a high rainfall suburb of Melbourne, big roof, big tank, big household (family of four) and high cost of water.

The modelled scenario was a household of four in Belgrave, using the average Victorian's 150 litres per day (no additional seasonal usage), with all connections (toilet, bathroom, kitchen, laundry and garden). If there is no water in the tank, mains water can be used.

In an average year for rainfall this household would use 144kL of tank water (and 75kL of mains water). The installed cost of a round plastic 5kL tank with a pump is $3,450. With connections indoor the household can also claim the $1,500 rebate, so are $1,950 out of pocket. Their savings on water bills in the first year would be $612. Their payback would be 6 years.

Does size matter? The household's total water consumption is independent of the size of the tank. Their water demand is serviced from either the tank, if water is available, or the mains. If the tank is small, rainfall needs to be more frequent to avoid exhausting it; larger tanks can avoid exhaustion even during longer periods without rain.

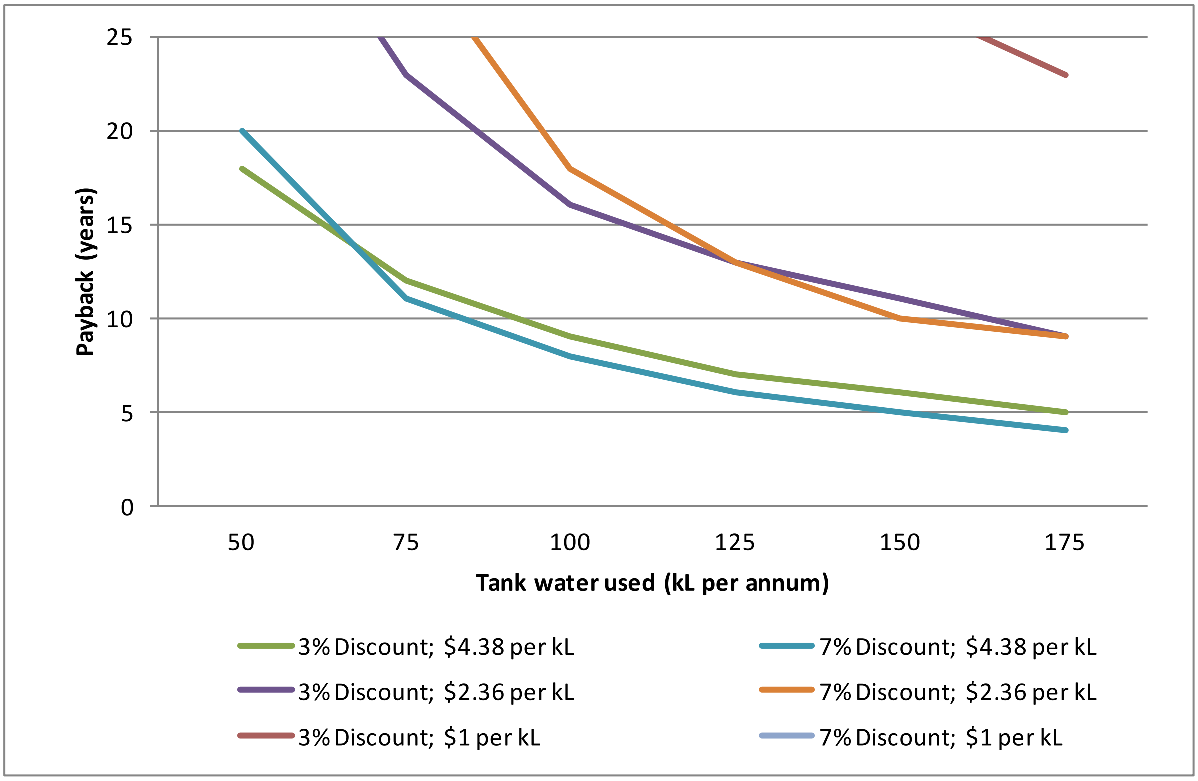
Switching from a 5kL to a 10kL tank in an average rainfall year would see the household use only 4% more tank water (150kL). A plastic 10kL tank is suggested to be 50% more expensive than a 5kL one. In financial terms only, in an average year there is little advantage for outlaying the extra funds.

The Tankulator can also calculate yield with different rainfall data – whether an average year, the driest year or wettest year. In the driest year there would be more times when the tank is dry, and the household would only use 105kL from the rainwater tank.

Chart 9.1 shows how payback varies according to yield with different water prices and discount rates. It shows that when water prices are high, a yield of around 85kL a year will produce a 10 year payback. Whereas where water prices are moderate, a yield of around 150kL is required to become economic.

The 'Tankulator' will help households calculate a reasonable yield for their situation.

Chart 9.1 5kL plastic tank in high rainfall area ($1,950 out of pocket), plumbed internally



The modelled scenario was chosen as a best case, with the lowest capital outlay for the highest yields. Some households will spend more on a rainwater tank, either for a slim-line model or different materials (e.g. steel). **Chart 9.2** shows how the payback period changes as Capital Expenditure (CAPEX) increases for a given yield with internal plumbing.

At Melbourne prices and assuming a 144kL yield, a household could be out of pocket by $4,000 (after the rebates) and still have a 10 year payback. At lower water prices, the payback period is greater than 10 years.

Chart 9.2 Payback in years by CAPEX sensitivity, plumbed internally

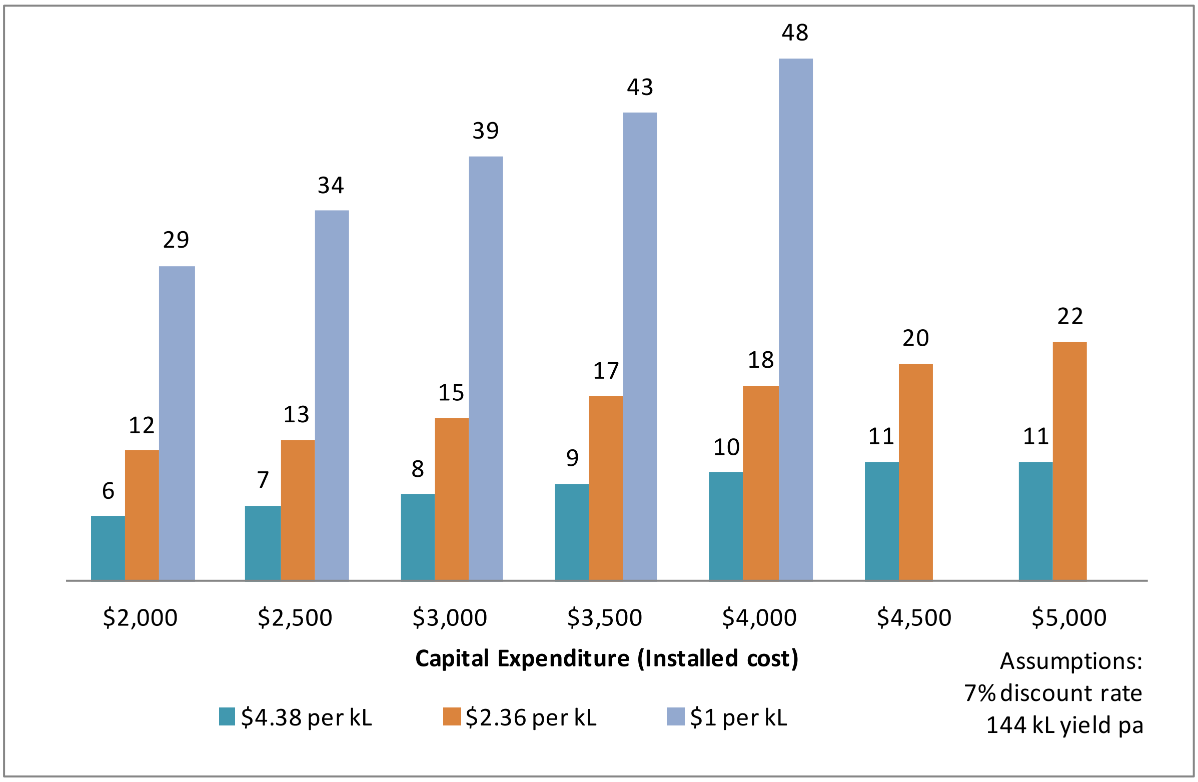
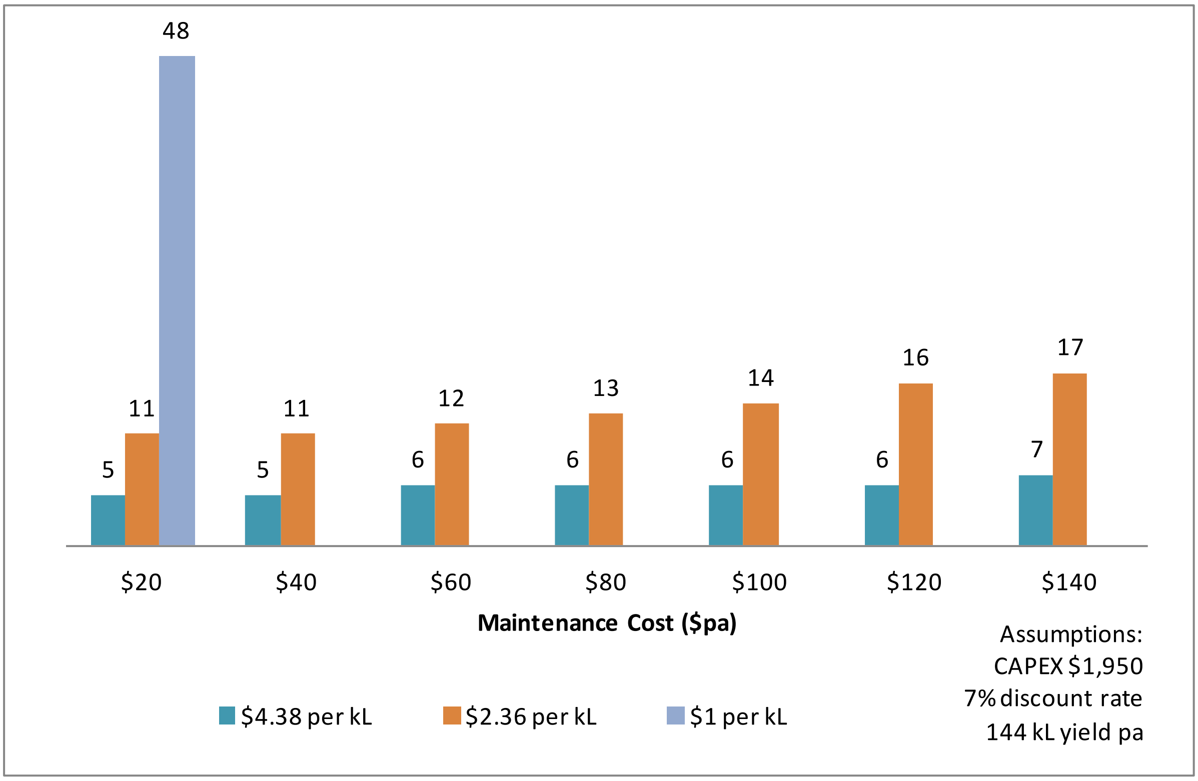


Chart 9.3 shows the model is not particularly sensitive to higher maintenance costs.

Chart 9.3 Payback in years by maintenance cost, plumbed internally



For clarification, the 48 year payback is the quickest payback achieved for a $1,950 tank (fully installed, 7% discount rate, 144 kL pa yield) with a cost of mains water of $1 per kL and an annual maintenance cost of $20.

For annual maintenance costs higher than this, the payback where the cost of mains water of $1 per kL is significantly longer than 48 years and has not been highlighted on the graph.

9.2 Plumbed Outdoor

Compared with scenario of a rainwater tank for indoor usage, costs are lower when a tank is installed for use just on the garden. There is no requirement for internal plumbing and a pump may not be required if the tank is sited so that gravity can assist. However less water is used from the tank, so there is a lower yield.

The MJA report found when the tank water is just used outdoors with the assistance of gravity, the key drivers of yield are roof size and tank size. They said "Comparatively little watering is required during winter due to the higher rainfall and significantly cooler temperatures."

Findings
As with greywater systems, it becomes a question of how much water a garden can use and how much it would have been watered from the mains if there was no tank. The 2005 ATA Greywater report found that expert advice was required to match a diversion greywater system to a garden's needs.

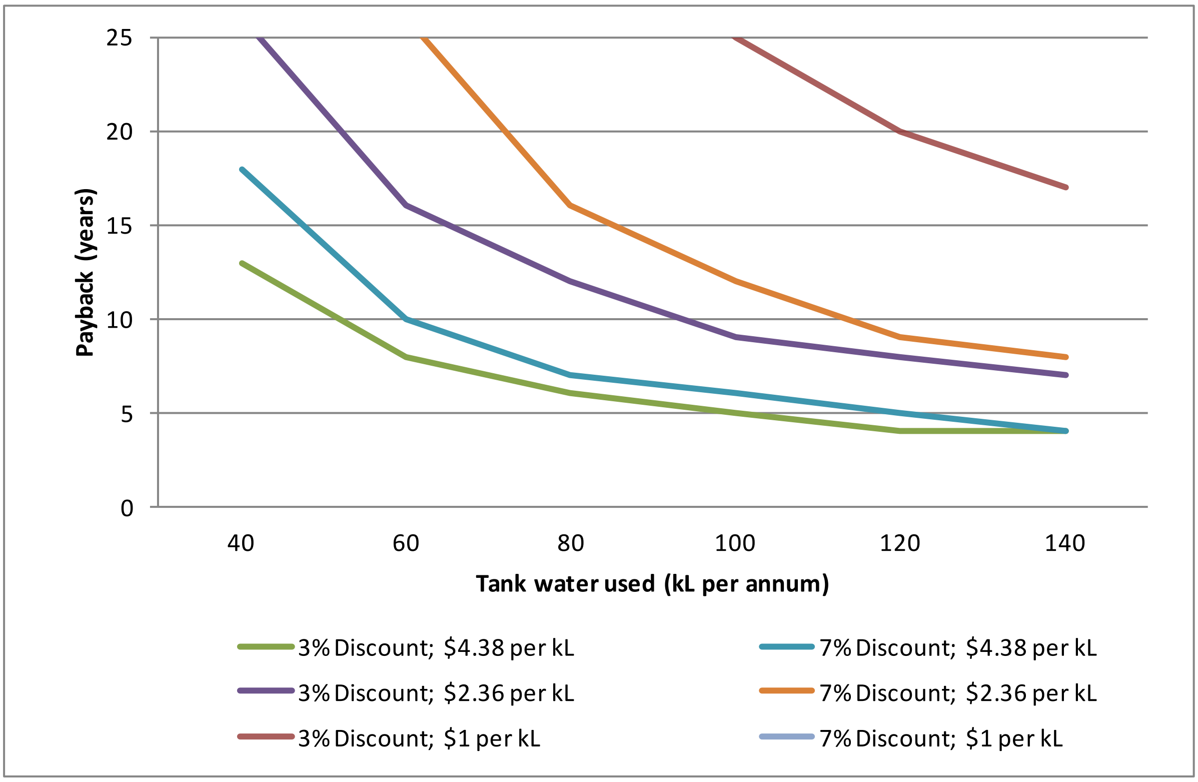
We have developed a best possible case for outdoor usage. No indoor plumbing or pump required reduces costs. Yield is high, buoyed by the tank's location in a high rainfall area. Tankulator's default 22% or 130 litres a day was used on the garden. We have allowed for an additional 100 litres a day in the three months of summer.

With the purchase and installation of a 5kL tank, the household will be out of pocket $1,850, with no rebate available. The household would use 57kL in an average rainfall year on the garden, with a payback of eight years (3% discount rate), boosted by paying the highest price for water in the state.

In the driest year, the usage falls to 50kL and the payback is 10 years. (However, the rainwater tank may allow the household to avoid water restrictions impacting the garden.)

Chart 9.4 shows how the payback varies according to the tank's yield and different water tariffs and discount rates. In metropolitan areas there is a reasonable business case for tanks yielding more than 60kL per annum. Where water prices are moderate, the yield needs to be 100-120 kL a year to achieve a payback within 10 years.

Chart 9.4 5kL plastic tank in high rainfall area ($1,850 out of pocket), plumbed outdoors



10.0 Conclusions

This report has assessed the business case for water saving technologies. It bears re-iterating that we do not consider economics should be our only motivation. Reducing our ecological impact and increasing water security are considered worthwhile motivations in and of themselves.

We note incentives are misaligned in the rental market, except to the extent that water efficiency can be reflected in rents. The landlord pays the fixed charges of a water bill and the tenant the variable costs. Further research into the topic of additional financial incentives for landlords in retrofitting water efficient technology may be warranted.

If there proves to be demand for hot water recirculators, we would also recommend further research to establish under what circumstances, if any, they save energy in net terms.

Appendix A – Volumetric Sewerage Charges in Melbourne

For sewerage disposal all Melbourne residential water users pay a fixed and volumetric sewerage charge. The three water retailers all calculate the volumetric charge with a formula based on the amount of water supplied.

For South East Water the calculation is straightforward at 75% of the water supplied to houses (85% for units).

For City West Water and Yarra Valley Water, the variables are:

- A discharge factor of 0.9 for the first 125 kL a quarter. Above this threshold, lower discharge factors are applied.
- Whether the property is a house or unit.
- A seasonal factor, which for houses range from 1.0 in Winter months to January factors of 1.45 for City West and 1.58 for Yarra Valley. Lower seasonal factors apply to units, reaching in January 1.30 for City West and 1.20 for Yarra Valley.

A model of monthly water use was built for this project, showing an indicative volume of sewerage the three Melbourne water retailers would charge for. We tested for sensitivities on average per capita daily use, seasonal use and household size. Our conclusions were:

- The 125 kL per quarter threshold is a lot of water. In 2012 the average Melbourne household average was billed for 142 kL for the year[23]. A family of 5 would have to use 47% more water (per capita) to reach the 125 kL per quarter threshold, even allowing for extra Summer usage.
- Although the methodologies and factors were all a bit different for the three Melbourne retailers, the resulting volume of sewerage is not very sensitive. For houses a volume of sewerage is calculated at 0.74-0.75 of the volume of water supplied. For units it is 0.82 to 0.85 of the volume of water supplied.

The price of water for Melbourne residents is the price charged for its supply and a sewerage charge. For the purposes of this report, to add to the price of water supplied by 0.75 for sewerage charge is reasonable for houses. For units a factor of 0.82 is applied to be conservative.

As an aside, the ESC ruling shows that households can apply to their water retailer for a custom sewerage factor. It would be interesting, but probably outside the scope of the project, to know a little more about that option.

[23] Essential Services Commission 2012

Indicative Sewerage Model

Quantity carried away by metropolitan water businesses

House or unit	House
Av household size	**5.0**

		Water supplied				**City West Water** VW * SF * DF volume of water * seasonal factor * discharge factor				**Yarra Valley Water** VSr = VW * SF * DF volume of water * seasonal factor * discharge factor				**South East Water** Actual Metered Volume of Water Supplied x Return Rate		
	Days	litres per person		per hhld												
Month	in month	per day	for month	litres	kL	VW	SF	DF	ewerage Vol.	VW	SF	DF	ewerage Vol.	WS	RR	ewerage Vol
Jan	31	300	9,300	46,500	46.5	46.5	1.45	0.9	28.86	46.5	1.58	0.9	26.57	46.5	0.75	34.88
Feb	28	230	6,440	32,200	32.2	32.2	1.45	0.9	19.99	32.2	1.58	0.9	18.40	32.2	0.75	24.15
Mar	31	220	6,820	34,100	34.1	34.1	1.30	0.9	23.61	34.1	1.43	0.9	21.54	34.1	0.75	25.58
Apr	30	200	6,000	30,000	30.0	30.0	1.30	0.9	20.77	30.0	1.18	0.9	22.98	30.0	0.75	22.50
May	31	200	6,200	31,000	31.0	31.0	1.20	0.9	23.25	31.0	1.08	0.9	25.95	31.0	0.75	23.25
Jun	30	200	6,000	30,000	30.0	30.0	1.00	0.9	27.00	30.0	1.00	0.9	27.00	30.0	0.75	22.50
Jul	31	200	6,200	31,000	31.0	31.0	1.00	0.9	27.90	31.0	1.00	0.9	27.90	31.0	0.75	23.25
Aug	31	200	6,200	31,000	31.0	31.0	1.00	0.9	27.90	31.0	1.00	0.9	27.90	31.0	0.75	23.25
Sep	30	200	6,000	30,000	30.0	30.0	1.10	0.9	24.55	30.0	1.08	0.9	25.12	30.0	0.75	22.50
Oct	31	220	6,820	34,100	34.1	34.1	1.10	0.9	27.90	34.1	1.18	0.9	26.12	34.1	0.75	25.58
Nov	30	230	6,900	34,500	34.5	34.5	1.40	0.9	22.18	34.5	1.33	0.9	23.43	34.5	0.75	25.88
Dec	31	250	7,750	38,750	38.8	38.8	1.40	0.9	24.91	38.8	1.43	0.9	24.47	38.8	0.75	29.06
Year		221		403,150	403.2	403.2			298.81	403.2			297.38	403.2		302.36
Victorian av		151				Sewerage factor			0.74	Sewerage factor			0.74	Sewerage factor		0.75
		+47%														

Moving Quarterly Volume Supplied

Jan	119.8	**Block**		
Feb	117.5	Quarterly equivalent		125
Mar	112.8	Maximum modelled		120
Apr	96.3			
May	95.1			
Jun	91.0			
Jul	92.0			
Aug	92.0			
Sep	92.0			
Oct	95.1			
Nov	98.6			
Dec	107.4			

Indicative Sewerage Model

Quantity carried away by metropolitan water businesses

House or unit		Unit	
Av household size		2.0	

						City West Water				Yarra Valley Water				South East Water		
		Water supplied				VW * SF * DF				VSr = VW * SF * DF				Actual Metered Volume of Water Supplied x Return Rate		
	Days	litres per person		per hhld		volume of water * seasonal factor * discharge factor				volume of water * seasonal factor * discharge factor						
Month	in month	per day	for month	litres	kL	VW	SF	DF	ewerage Vol.	VW	SF	DF	ewerage Vol.	WS	RR	ewerage Vol
Jan	31	151	4,681	9,362	9.4	9.4	1.30	0.9	6.48	9.4	1.20	0.9	7.02	9.4	0.85	7.96
Feb	28	151	4,228	8,456	8.5	8.5	1.30	0.9	5.85	8.5	1.20	0.9	6.34	8.5	0.85	7.19
Mar	31	151	4,681	9,362	9.4	9.4	1.20	0.9	7.02	9.4	1.20	0.9	7.02	9.4	0.85	7.96
Apr	30	151	4,530	9,060	9.1	9.1	1.10	0.9	7.41	9.1	1.10	0.9	7.41	9.1	0.85	7.70
May	31	151	4,681	9,362	9.4	9.4	1.00	0.9	8.43	9.4	1.00	0.9	8.43	9.4	0.85	7.96
Jun	30	151	4,530	9,060	9.1	9.1	1.00	0.9	8.15	9.1	1.00	0.9	8.15	9.1	0.85	7.70
Jul	31	151	4,681	9,362	9.4	9.4	1.00	0.9	8.43	9.4	1.00	0.9	8.43	9.4	0.85	7.96
Aug	31	151	4,681	9,362	9.4	9.4	1.00	0.9	8.43	9.4	1.00	0.9	8.43	9.4	0.85	7.96
Sep	30	151	4,530	9,060	9.1	9.1	1.00	0.9	8.15	9.1	1.00	0.9	8.15	9.1	0.85	7.70
Oct	31	151	4,681	9,362	9.4	9.4	1.10	0.9	7.66	9.4	1.10	0.9	7.66	9.4	0.85	7.96
Nov	30	151	4,530	9,060	9.1	9.1	1.10	0.9	7.41	9.1	1.10	0.9	7.41	9.1	0.85	7.70
Dec	31	151	4,681	9,362	9.4	9.4	1.20	0.9	7.02	9.4	1.20	0.9	7.02	9.4	0.85	7.96
Year		151		110,230	110.2	110.2			90.45	110.2			91.48	110.2		93.70
	Victorian av	151				Sewerage factor			0.82	Sewerage factor			0.83	Sewerage factor		0.85
		+0%														
Moving Quarterly Volume Supplied																
Jan					27.8	**Block**										
Feb					27.2	Quarterly equivalent		125								
Mar					27.2	Maximum modelled		28								
Apr					26.9											
May					27.8											
Jun					27.5											
Jul					27.8											
Aug					27.8											
Sep					27.8											
Oct					27.8											
Nov					27.5											
Dec					27.8											

Appendix B – Gas Heating Hot Water

We have estimated the cost of heating water, based on the operating costs of gas storage or gas instantaneous systems using a first principles approach.

- Hot water generally comes out of the shower at 42 degrees[24]. About two-thirds of the water is supplied from the hot water tap and is mixed with cold water. We assume the mains input water is about 15 degrees in temperature.
- In theory it takes 4.18 kJ of energy to heat one litre of water one degree Celsius.
- Allowance has to be made for account piping losses, cylinder losses (for storage hot water) and the thermal efficiency of the heat exchanger (for hot water). We have allowed for thermal efficiency of 60% for storage gas and 75% for instant gas.
- Quotes from the website 'Your Choice' for a hypothetical Melbourne customer yielded gas prices from the major retailers between 1.82 and 2.07 cents per megajoule (mJ).
- At an average 1.96 cents per mJ, the current 'marginal cost' for gas hot water is 0.37 cents per litre for gas storage and 0.29 centres per litre for instantaneous gas systems.

This cost is the operational cost only and disregards capital costs associated with the system.

Specific Heat Capacity	4.18	kJ to heat one litre of water one degree Celcius
Degrees to heat	27	Ambient average to shower temp (i.e. from say 15 degrees to 42 degrees)
End use heating	112.86	kJ per litre
	Storage gas	**Instant gas**
Thermal efficiency	60%	75%
Gas demand heating kJ per litre	188.1	150.5
Heating (gas) mJ per litre	0.188	0.150
Gas price - c per MJ	1.96	
Hot water c per litre	**0.37**	**0.29**

24 http://www.dier.tas.gov.au/energy/using_energy_efficiently_and_minimising_costs/appropriate_choice_of_energy_source/cost_of_a_shower Accessed 18 September 2013.

References

Australian Bureau of Statistics, Cat.No. 4602.0.55.003 - Environmental Issues: Water use and Conservation, Mar 2010

Australian Bureau of Statistics, Cat.No. 4602.2 - Household Water and Energy Use, Victoria, Oct 2011

ATA 2005, Greywater Project Report (for Smart Water Fund), November 2005

ATA 2008, Greywater System Buyers Guide, Renew Magazine 102, Jan-March 2008.

Choice, 2008, Guide to Greywater Systems, http://www.choice.com.au/reviews-and-tests/household/energy-and-water/saving-water/greywater-systems.aspx Jan 2008. Accessed 12th September 2013.

Choice, 2013, Dishwasher Reviews http://www.choice.com.au/reviews-and-tests/household/kitchen/dishwashers/dishwashers-review-and-compare.aspx, July 2013. Accessed 9th September 2013.

Choice, 2013, Washing Machine Reviews http://www.choice.com.au/reviews-and-tests/household/laundry-and-cleaning/washing-and-drying/washing-machines-review-and-compare.aspx, August 2013. Accessed 7th October 2013.

Dolnicar, S. & Hurlimann, A. (2010). Australians' Water Conservation Behaviours and Attitudes. Australian Journal of Water Resources, 14 (1), 43-53.

Essential Services Commission, 2011, 2*013 Water Price Review – Tariff Issues Paper*, July 2011.

Essential Services Commission 2012, Performance of Victorian urban water and sewerage businesses 2011-12, December.

Essential Services Commission 2013 (1), Price Review 2013: Greater Metropolitan Water Businesses — final decision, June.

Essential Services Commission 2013, 2013 Water Price Review Final Decisions Determination, June.

Marsden Jacob Associates 2007, The Cost-Effectiveness of Rainwater Tanks In Urban Australia, National Water Commission, March 2007.

Office of Living Victoria 2013, Melbourne's Water Future, Consultation Draft, July 2013.