

**Water Saving Requirements for New Residential  
Buildings in Victoria:  
Options for flexible compliance**

**for**

**Department of Sustainability and Environment**

**by**

**George Wilkenfeld and Associates Pty Ltd**

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**GEORGE WILKENFELD AND ASSOCIATES Pty Ltd**  
**ABN 78 003 846 848**  
**ENERGY AND WATER POLICY AND PLANNING CONSULTANTS**  
PO Box 934 Newtown NSW 2042 Sydney Australia  
Tel (+61 2) 9565 2041 e-mail: [geosanna@ozemail.com.au](mailto:geosanna@ozemail.com.au)

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# Executive Summary

## *Background*

The Victorian Government water policy white paper, *Securing Our Water Future Together: Our Water Our Future* (2004), sets out a policy of sustainable urban water management. The objectives include reducing water consumption, reserving high quality potable water for purposes such as drinking and personal hygiene and using safe, alternative water resources such as rainwater and reused/recycled water for other purposes.

As part of this strategy, the Government has implemented a number of water and energy saving measures for Class 1 and 2 buildings connected to a new reticulated water supply:

- Flow rates to shower heads and taps to be between 7.5 and 9.0 litres/min (ie a rating of 3\* under the new WELS scale or AAA under on the old scale rating);
- Supply pressure to be no higher than 500 kPA.

In addition, new Class 1 dwellings are to be fitted with either a solar or heat pump water heater (to be gas-boosted where reticulated natural gas is available), or a rainwater tank (of not less than 2,000 litres, and supplied with runoff from not less than 50m<sup>2</sup> of roof area), plumbed to all sanitary flushing systems.

Since July 2005, it has been mandatory for all new homes built in Victoria to comply with the above measures. Two issues have emerged:

- There is a perceived lack of flexibility for home builders to undertake alternative measures which may save equal amounts of water at perhaps less cost; and
- The rainwater tank and the solar water heater alternatives serve different objectives, and both may be compromised by allowing what is in effect a random or price-driven choice between them. While the actual pattern of choice is uncertain, since there is no central data collection, indications are that about half of new homes are choosing rainwater tanks and half solar water heaters.

*Our Water Our Future* signalled the transition to a more flexible water-saving regime in the following terms (Action 5.41):

The statutory planning and building approvals systems will be aligned to support water conservation and enable the use of recycled water and alternative supplies. This will be done through existing Government initiatives in the first instance by...*reviewing the building approvals framework to provide for a consistent, performance-based approach to sustainable urban water management...*

A performance-based approach means that water savings measures and techniques would be assessed on the likely amount of water savings through water conservation,

reuse or recycling, rather than prescribing a particular product type. This approach allows solutions to be developed that fit individual circumstances and which foster innovation.

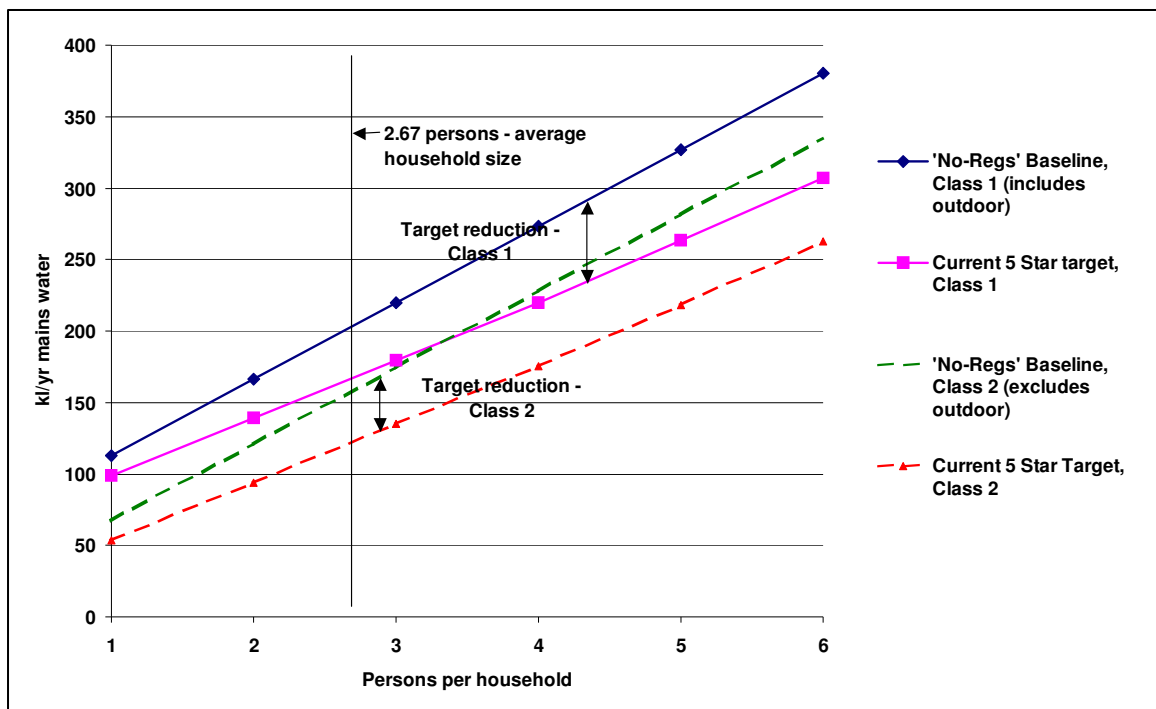
The key elements of such an approach may be described as ‘Program elements’ – which Victoria Government Agencies need to consider when deciding on the approach – and ‘Public Elements’ – which prospective homebuilders and product suppliers will need to access and use when applying a performance-based approach to building plans.

***This Study***

This study was commissioned by the Department of Sustainability and Environment (DSE) with the aim of exploring the options for a performance-based rather than a prescriptive approach to the water-saving measures required in new dwellings. The project was overseen by a Steering Group comprising representatives from DSE, the Building Commission (BC) and the Plumbing Industry Commission (PIC).

The study develops a model of household water use and uses it to estimate the average water use in new 5 Star houses (the ‘target’) and what water use would be in the absence of the 5 Star regulations (the ‘baseline’).

The difference between these two values represents the reductions in mains water supply which the current, prescriptive 5 Star regulations are achieving. Equivalent reductions, at least, would have to be achieved under a performance-based regime. The estimated baseline and target values are illustrated in Figure S1.



**Figure S1 Estimated water use baseline and water saving target**

For the average sized household (2.67 persons) in a Class 1 dwelling, the baseline is 202.5 kl/yr and the target is 166.7 kl/yr, a reduction of 35.8 kl./yr or 18%. For the same size household in a Class 2 dwelling, the baseline is 156.5 kl/yr, because it is assumed that there is no outdoor use of water. The reduction is the same (35.8 kl/yr), leading to target water consumption of 120.7 kl/yr (23% lower).

### *Permissible Compliance Options*

The study analyses a number of water-efficiency measures and alternative water supply options that could be used by building applicants to reach the necessary targets under a performance-based approach (including the current, prescriptive measures). The range of permissible options has been determined by considerations of three classes of risk:

- Compliance risk reflects the possibility that measures will not actually be implemented as stated on the building approval documentation. In general, measures that can be inspected at the time of completion and not easily reversed have the lowest compliance risk.
- Performance risk reflects the possibility that measures, even if installed as stated, will not yield the projected water savings, due to high variability in occupant behaviour or other factors.
- Persistence risk reflects the fact that in many cases a measure will have a service life of significantly less than 50 years, and if the entire product or key components are not replaced (or replaced with less water-efficient substitutes) the savings in the initial years will not be sustained for the entire 50 year period.

Following discussions with the Steering Group, the following classes of measures were excluded on the basis of unacceptable risk (even though they are admissible for gaining points towards compliance with the BASIX target in NSW):

- Clothes washers and dishwashers. The undertaking to install models above a given level of water-efficiency is considered to have an unacceptably high compliance risk, since units can easily be removed after inspection;
- Areas or styles of gardens or landscaping, or selection of 'water-efficient' plants. Gardens are rarely established at the time of building completion, and layouts, areas and plantings can all be easily changed. There is also a very wide range in garden irrigation technologies, management practices and water/plant/soil interactions. This combination of high compliance risk, high performance risk and high persistence risk makes it almost impossible to establish a reliable predictive link between likely irrigation water use and the information available to Building Surveyors or Building Inspectors.

However, the Steering Group requested that the potential for use of some water for garden irrigation should be taken into account in evaluating those alternative water supply measures where the initial application of the water is for indoor uses.

Despite this general assessment of risks, it should be open to applicants to demonstrate the likelihood that the excluded options, or other, novel options could be employed in

specific circumstances. It should also be open to applicants to comply using a simple ‘deemed to satisfy’ combination of measures – ie the current 5 Star measures including the rainwater tank.

### ***Compliance Combinations and Costs***

It is not possible to model all potential combinations of options. However, the following are likely to be the most popular, because they are easily understood and/or rely on one type of measure only:

- Compliance via water-efficiency measures only;
- Compliance via one type of alternative supply only;
- Compliance via ‘deemed to satisfy’ provisions.

Table S1 summarises the estimated costs and water savings from a number of combinations of options, as well as the current 5 Star measures. All combinations must meet or exceed the water saving target for a dwelling of that size. (The value of 35.8 kl/yr has been selected for illustration because it corresponds to the weighted average household size of 2.67 persons, although actual building applicants would obviously relate water savings to whole numbers of persons or bedrooms).

Some of the options have lower capital and operating costs than the current prescriptive measures, indicating that homeowners could achieve similar water savings at lower cost under a performance-based regime. They could also achieve the target water savings at *higher* cost if they wished to do so.

**Table S1 Typical Compliance Options and Costs**

	Alt supply connects to:	Initial capital cost(a)	NPV operating costs(b)	Lifetime NPV(c)	Total kl/yr savings	Hot water kl/yr savings	\$/kl savings(d)
Current 5 Star (e)	T only	\$1,260	\$625	\$1,885	35.8	19.3	\$1.06
Efficiency options only (f)	NA	\$1,030	\$346	\$1,376	35.9	21.5	\$0.77
Deemed to satisfy (g)	T only	\$2,260	\$1,180	\$3,440	44.5	19.3	\$1.55
Rainwater only (h)	T+CW	\$2,200	\$1,143	\$3,343	38.2	0.0	\$1.75
Reticulated recycled water (i)	T+CW	\$3,000	\$528	\$3,528	38.2	0.0	\$1.85
Greywater treated on-site (k)	T+CW	\$7,000	\$5,606	\$12,606	38.2	0.0	\$6.60

T = Toilet, CW = Clothes Washer (a) Cost premium compared with ‘no-regulations’ case (b) Net Present Value of energy and water charges, service costs and capital replacement costs over a 50 year period, using discount rate of 5.2%. (c) Sum of initial capital and NPV of lifetime operating costs. (d) Lifetime NPV divided by 50 year water savings. (e) Includes 50% of the costs and water savings of a rainwater tank meeting the 5 Star configuration, located in Melbourne. (f) Combination of 3\* showers and taps, 4.5/3 litres toilets and hot water recirculator. (g) As for (e), but with 100% of a rainwater tank. (h) 100m<sup>2</sup> roof area, 2,000 litres storage, located in Melbourne. Larger roof areas and storages would be required for rainwater-only compliance in areas with lower rainfall. (i) Likely to be used for garden irrigation as well, which would drop cost of water savings to \$1.00/kl. (k) Likely to be used for garden irrigation as well, which would drop cost of water savings to \$3.04/kl.

The above costs are calculated for Class 1 houses. The costs of communal alternative supply measures serving Class 2 apartment blocks may well be lower per dwelling. However, the important point is that building permit applicants can do their own cost

calculations and optimise their costs and benefits however they wish, so long as they achieve the mains water saving target.

The calculation of impacts of water-efficiency measures is relatively straightforward. It is likely that the same group of measures applied in a home of any size and occupancy will deliver roughly the same percentage water savings (provided that the measure is applied to every point of use, eg to every shower or every toilet). Therefore the selection of a compliance option based entirely on water-efficiency savings would probably not require the applicant to take account of the number of persons (or the number of bedrooms as a surrogate for probable household occupancy). The impacts of compliance entirely by dual pipe recycled water are almost as simple to calculate.

However, any compliance option which involves a rainwater tank would need to be backed by calculations covering location (for rainfall), roof drainage area, storage volume and actual volumes drawn off, which will depend on uses and projected household occupancy. Greywater options would be somewhat less complex, but would still require access to publicly available computation aids.

### ***Greenhouse Impacts***

It is calculated that the water-related requirements of the existing 5 Star measures are delivering greenhouse gas savings of about 545 kg CO<sub>2</sub>-e per annum per new house, compared with the 'no regulations' case. About half the saving comes from those houses which install a solar water heater as part of their compliance obligation ('component A'). The other half of the greenhouse savings ('component B') comes mainly from the hot water saved by the requirement to install 3\* shower heads. The 3\* tap and pressure limiting valve requirements make relatively little hot water savings.

(This estimate of 545 kg CO<sub>2</sub>-e savings is separate from the savings in greenhouse gas emissions that arise from reduced heating and cooling demand due to the 5 Star thermal performance requirements).

Although the Terms of Reference for this study required water savings to be analysed in isolation from the solar water heater impacts of 5 Star, there are in fact many strong links between the two. The selection of a water-saving target unavoidably raises the issue of whether the water-related greenhouse gas reductions being achieved under the present regime should also be preserved under any new regulatory regime.

If the selection of water-saving measures is made more flexible, and the sole performance criterion is potable water consumption, some householders will opt for measures which save cold water only (see Table S1). This would mean that the Component B of the water-related greenhouse savings would on average be reduced.

There would almost certainly be consequences for Component A as well. If the water-saving measures were made performance-based, it would be both inconsistent and impractical to preserve the existing rate of solar water heater installation in new homes by prescriptive measures. It would not be possible to specify or enforce a requirement that '50% of new homes must have a solar water heater'.

Increasing the solar water heater requirement by imposing it on *every* new Class 1 dwelling (in addition to a performance-based water saving target) would increase the compliance burden and cost compared with the present regime, and would almost certainly drive up the average price of new housing. All housing and planning industry stakeholders consulted expressed the view that, while they welcomed moves to make the 5 Star measures more flexible, they would strongly oppose any changes that led to an increase in compliance burden and cost.

If the option of forcing every new home to have a solar water heater were ruled out, the remaining options would be:

1. Abandon the mandatory solar water heater requirement without adding any new greenhouse requirement. This would almost certainly lead to a massive drop in solar water heater installations in new homes and to an increase in water heater-related greenhouse gas emissions compared with the present regulation.
2. Develop *both* water-heating related greenhouse targets *and* water use targets for new homes, and require them to be satisfied through performance-based choices about water efficiency, alternative water supply and water heater type and efficiency – ie limit the compliance options to the water supply and water heating systems.
3. Develop a performance-based greenhouse target for the dwelling as a whole, and allow it to be satisfied by any combination of measures bearing on thermal performance and energy-using equipment: water heaters, space heaters or cookers. This is essentially the approach used in the NSW BASIX regime.

The further exploration of these options is beyond the scope of the present study. However, they will need to be resolved before further development of the performance-based approach. Even though the present regime may not have been the most effective and cost-effective means of pursuing both water-saving and greenhouse-reducing objectives for new homes in Victoria, it has the advantage of simplicity and familiarity. Transition to a performance-based regime which achieves equivalent water and greenhouse savings at equal or lower cost will not be a simple matter. There may be some arguments for leaving the regime as it is.

### ***External and seasonal water uses***

The occupants of virtually every home will use water in similar ways for the indoor end uses: drinking, cooking, personal washing, clothes washing and toilet flushing. It is therefore possible to estimate an average water consumption and to set a reduction target for all new homes that covers those end uses. Outdoor and seasonal uses, on the other hand, are not present in all homes, and if present are subject to high variability.

Measures which *only* target garden irrigation (as distinct from the possible irrigation use of alternative water supplies installed primarily to meet indoor water demand) should not be part of a performance-based regime, because there is no reliable way to assess their impacts.

The other significant seasonal uses of water are for swimming pools, spas and evaporative coolers.

There are at least two possible approaches for a swimming pool which forms part of a building application:

- require design features which will tend to reduce the pool's on-going water loss and hence on-going top-up requirements (the approach taken in BASIX); or
- require water savings equivalent to the volume of the pool (or some multiple of it).

Victoria has already adopted the second approach (offsetting water savings) in the Permanent Water Saving Rules. When a new swimming pool is part of a building application, it may be efficient to integrate the Water Conservation Plan (WCP) with the performance-based water saving measures.

This could be done by increasing the water-saving target by the volume of the swimming pool averaged over a period of, say, 10 years. For example, the target for a 4-person house is a reduction of 53.5 kl/yr in mains water use from the 'no regulations' baseline. If the building application included a 60,000 litre pool, say, the target could increase by 6 kl/yr to 59.5 kl/yr. .

Similarly, the water-saving target for a home where it is intended to install an evaporative cooler could also be increased to offset at least a part of the projected water consumption. However, as many (perhaps most) evaporative coolers will be installed without the need for a building permit, the effectiveness of this approach is limited. Furthermore, it could drive more householders to refrigerative air conditioning, which would exacerbate peak loads on the electricity system. The Commonwealth Water Efficiency Labelling and Standards (WELS) scheme may be a more effective way to increase the water-efficiency of evaporative coolers.

### ***Record Keeping***

At present it is relatively easy to verify compliance with the 5 Star water-saving measures on site, even though the only relevant information recorded on the building approval documentation is the fact that the building surveyor has determined that the plan complies. Where compliance is performance-based, however, it is essential to have the actual details on the building documentation, otherwise an inspector will not know which measures or products to look for.

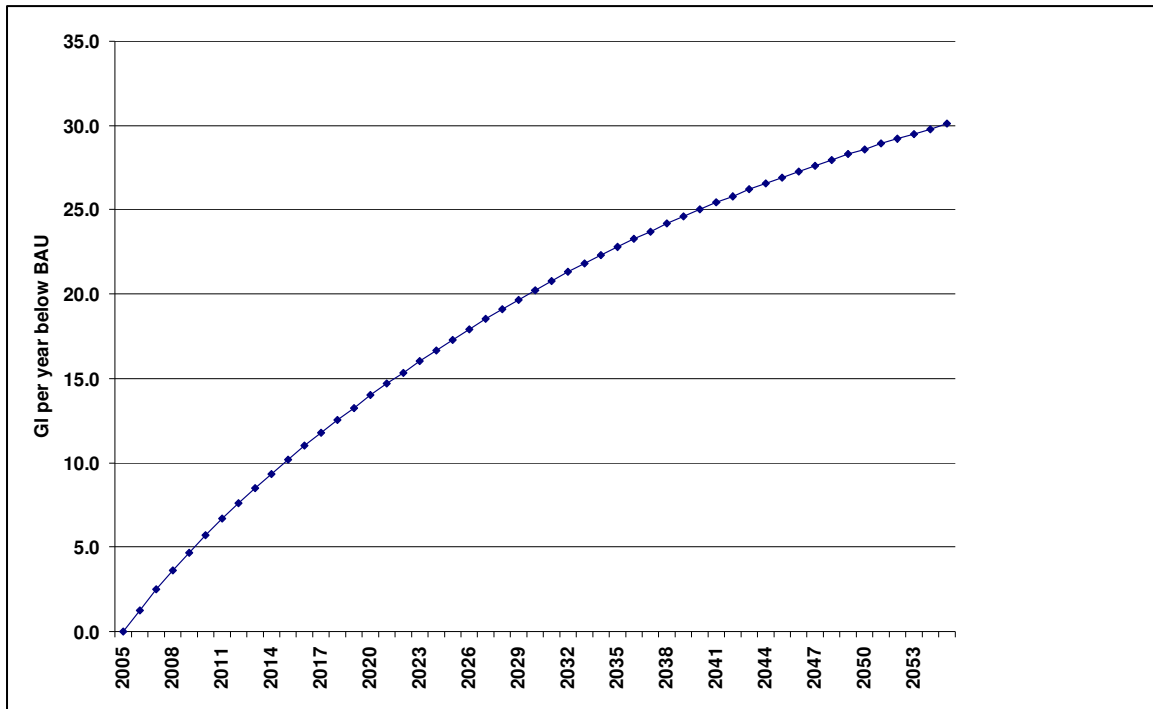
Therefore, some means of recording the compliance details on approval documentation and preserving them all the way through the building certification process is essential to underpin the operation of a performance-based approach.

### ***Projected Water Savings for Victoria***

It is estimated that the total annual water savings from the current 5 Star measures (or performance-based measures of equivalent stringency) will reach 30 GL/yr by 2055, and that the cumulative savings from 2005 to 2055 will total 950 Gl. (See Figure S2. Note that this only applies to new dwellings to be constructed after 2005, which by

2055 will represent about 45% of the Victorian housing stock. The water use of the surviving pre-2005 dwelling stock has not been modelled, since it will be unaffected by water saving measures applied to new construction).

**Figure S2 Projected water savings from 5 Star or equivalent measures, Victoria 2005-2055**



### *Conclusions*

1. A performance-based approach to incorporating water-saving measures in new dwellings to be built in Victoria appears to be a feasible alternative to the present approach.
2. A performance-based approach would allow homebuilders a wider range of options for meeting or exceeding the level of water savings being achieved at present.
3. There is a wide range in the costs of options. Combinations which meet the water reduction target may have higher or lower capital costs, higher or lower net present value of lifetime operating costs and higher or lower costs per kl of potable mains water savings than the present regulated measures.
4. It is possible to set a hypothetical ‘no-measures’ starting point from which building applicants can determine the measures needed to reach their water-saving targets. However, many home builders would incorporate some water-saving measures even without regulation, so the actual water savings will be somewhat lower than the hypothetical savings.
5. The current 5 Star measures are achieving significant reductions in greenhouse gas emissions from water heating, as well as reductions in the consumption of potable

mains water. These two elements of the 5 Star regulations are so closely linked that it is not possible to move from the present regime to a performance-based regime in either without significantly affecting the other.

6. A performance-based approach would be more complex, for both governments and home building applicants, than the current 5 Star approach. There is a need for appropriate 'program elements' to support policy-makers and administrators, and for appropriate 'public elements' to assist building applicants, homebuilders and product suppliers.
7. The water use modelling developed for the present study could provide the basis for a computation aid for building applicants. However, considerable work is required to make any such aid user-friendly, and to integrate it with administrative, compliance checking and data collection requirements.
8. There is a case for retaining 3\* shower heads as the sole mandatory requirement, because they represent by far the most cost-effective way to achieve water savings. The WELS scheme is considering making a 3\* rating a mandatory requirement for shower heads sold, but because of compliance issues it would be less effective than the present Victorian 5 Star regulations in achieving this objective for new homes.
9. Industry stakeholders would welcome greater flexibility for home-builders in complying with water-saving measures, provided that building costs are not increased.
10. For many products, including non-fixed water-using appliances and fixed appliances purchased after initial construction, water savings and increases in water-efficiency will need to rely on other approaches such as WELS.

### ***Recommendations***

In the event that the Victorian Government proceeds to implement a performance-based approach to water savings measures in new homes, it is recommended that:

1. Home builders should be able to select from an extensive range of pre-assessed and approved measures, product categories and product models to meet their water saving targets.
2. The agency or agencies administering the program should develop and maintain registers of:
  - permissible measures;
  - required product characteristics; and
  - actual models and their projected water saving impacts.
3. There should be 3 modes of compliance:
  - a 'deemed to satisfy' compliance option incorporating all the present measures (including a rainwater tank for Class 1 buildings);

- a default computation method (based on the model developed for this study, or similar), made available for public use; and
  - an alternative approach, with the onus on the proponent to demonstrate water savings equal to or greater than the other compliance modes, using the default computation method or an acceptable alternative.
4. The evaluation of methods or products proposed for registration should take into account compliance risk, performance risk and persistence risk
  5. The computation method and the registers and lists of approved products and methods should be closely integrated, either via a downloadable software package or (ideally) on an internet site.
  6. If an internet-based compliance tool is developed, consideration should be given to integrating the application and verification process with it. This would also be a powerful and cost-effective means of tracking the actual options selected by homebuilders.
  7. The following classes of measure should be excluded altogether on the basis of unacceptably high risk:
    - Non-fixed water-using appliances such as clothes washers and dishwashers
    - Garden area, layout and planting
    - Measures which *only* target garden irrigation (as distinct from the possible irrigation use of alternative water supplies installed primarily to meet indoor water demand).
  8. The use of untreated greywater for toilet flushing or garden irrigation should be either heavily discounted or excluded altogether on the basis of its high performance risk.
  9. Where swimming pools are part of the original building application, the Water Conservation Plans currently required with applications to fill the pool should be combined with overall water-saving target.
  10. Where evaporative coolers are part of the original building application, an offset for the projected water consumption should be combined with the overall water-saving target.
  11. Any adjustment to the other elements of the 5 Star measures, ie those related to energy use and greenhouse emissions from water heating and, possibly, other fixed appliances installed at time of construction, should be resolved before any changes are made to the water-savings compliance regime.

\*\*\*\*\*

## Glossary

5 Star	The current suite of mandatory water-saving measures applying to new Class 1 and Class 2 dwellings constructed in Victoria
3*	A 3 star water-efficiency rating under the new mandatory WELS scheme (ratings may range from 0* to 6*)
6/3	Dual flush toilet suite with 6 litres full flush and 3 litres reduced flush (4.5/3 and other configurations also available)
AAA	A water-efficiency rating under the voluntary labelling scheme now being phased out (ratings may range from A to AAAAA)
BAU	'Business-as-usual'
BC	Building Commission
BCA	Building Code of Australia
CW	Clothes washer
DSE	Department of Sustainability and Environment
DW	Dishwasher
Gl	giga-litre; 10 <sup>9</sup> litres
HH	Household
IWH	Instantaneous water heater
kl	kilo-litre; one thousand litres
kPa	kilo-Pascal; a unit of pressure
NPV	Net Present Value
PIC	Plumbing Industry Commission
PRV	Pressure reducing valve
RWT	Rainwater tank
SEAV	Sustainably Energy Authority of Victoria (now Sustainability Victoria)
T	Toilet
WCP	Water conservation plan
WELS	Water Efficiency Labelling and Standards
WSAA	Water Services Associating of Australia
VCEC	Victorian Competition and Efficiency Commission
YVW	Yarra Valley Water

# 1. BACKGROUND

## Policy Context

In July 2004 the Victorian Government released a water policy White Paper, *Securing Our Water Future Together: Our Water Our Future* (DSE 2004). In addition to addressing issues such as pricing, governance, water allocation, rural water use and environmental protection, the White Paper sets out a policy of sustainable urban water management. This covers:

- Achieving a long-term balance between water demand and supply;
- Reducing water consumption;
- Using water that is fit for purpose, ie using potable (drinking quality) water for purposes such as drinking and personal hygiene and using safe, alternative water resources such as rainwater, reused/recycled water and groundwater for other uses, and
- Considering the whole water cycle, which requires managing the impact of urban water use on the catchments from which it is extracted, and the environment to which it eventually goes.

The Government has set a target to reduce per capita drinking water consumption in Melbourne by 15 per cent by 2010 compared to the 1990s average. This requires a permanent reduction from 423 to 360 litres per person per day (this covers all uses of water, not just household use). Regional urban water authorities have adopted similar targets (DSE 2005).

Average mains water consumption in Melbourne has been below the 1990s average of 423 litres per capita in every year since 1998, and in 2004/05 it was 330 litres, or 22% below the 1990s average. However, this was recorded under water restrictions, which were in place between November 2002 and 28 February 2005. With the lifting of restrictions and the introduction of Permanent Water Saving Rules, some previously banned or limited activities are now permitted, so water consumption may rise. Although market research undertaken during restrictions indicates that people were doing more than required and some of this behaviour change is likely to persist (DSE 2005), other measures are necessary to reinforce water-conservative behaviour and to ensure that it becomes permanent.

Additional measures already taken include:

- The incorporation of additional information and usage feedback on water accounts.
- Permanent Water Saving Rules, which took effect in Melbourne in March 2005, and which were to be implemented in other Victorian water authority areas by the end of 2005.

- The Water Smart Gardens and Homes Rebates Scheme, which commenced in January 2003, offered rebates to purchasers of AAA rated shower heads, clothes washers and dishwashers, rainwater tanks and other selected products thought to reduce household water use. By the end of 2005, over \$7m in rebates been distributed. (The program is still continuing, but now excludes clothes washers and dishwashers).
- The implementation of a national mandatory Water Efficiency Labelling and Standards (WELS) scheme in Victoria and in other States, covering shower heads, toilets, clothes washers, dishwashers, taps, urinal equipment and flow control devices.

These measures rely on a mix of information, behavioural change, product selection, product design and regulation to achieve water savings. The effectiveness of some information-only measures may decline as soon as the program finishes. Measures which encourage or reward the purchase of a more water-efficient device than would otherwise be the case will produce water savings at least for the service life of that device, while minimum water efficiency standards – as is the case for toilets under WELS – will result in water savings from every product sold, now and in the future.

The incorporation of water-efficiency measures and alternative means of supply into new buildings, both residential and non-residential, is another strategy to encourage permanent and irreversible reductions in potable water use. This is the subject of the present study.

## Current 'Five Star' Regulations

The origins of the present water-efficiency regulations in Victoria are linked to the history of thermal performance standards. Regulations for the insulation of new dwellings came into operation on 18 March 1991 via the Building Control Act.

In 2000 the then Sustainable Energy Authority of Victoria (SEAV) commissioned a review of the effectiveness of the regulations (EES 2000). In 2002 SEAV commissioned a study of the costs and benefits of introducing mandatory thermal performance standards, based on the achievement of specified ratings using the FirstRate and NatHERS thermal simulation software.

Following these studies, the Victorian government decided in 2003 to implement a minimum 4 star rating requirement for new dwellings to be constructed from July 2004, and a minimum of 5 stars for dwellings constructed from July 2005. This was a significant increase in thermal performance standards from the 1991 insulation regulations, which were roughly equivalent to 2.2 stars on the NatHERS rating scale.

The government also decided to implement a number of additional water and energy saving measures for Class 1 and 2 buildings connected to a new reticulated water supply:

- Shower flow rates to be between 7.5 and 9.0 litres/min (ie shower heads must be 3\* under the new WELS rating or AAA under the old rating);
- Supply pressure to be no higher than 500 kPA (ie a pressure reducing valve must be fitted where supply pressure is higher); and
- Flow rates to taps over basins, kitchen sink and laundry troughs to be between 7.5 and 9.0 litres/min (ie all must be 3\* under the WELS rating – taps for different applications had different A ratings).

In addition, new Class 1 dwellings were to be fitted with either:

- A solar or heat pump water heater (to be gas-boosted where reticulated natural gas is available), or
- A rainwater tank (of not less than 2,000 litres, and supplied with runoff from not less than 50m<sup>2</sup> of roof area), plumbed to all sanitary flushing systems.

These proposals were the subject of a *Regulatory Impact Statement* published by the Plumbing Industry Commission (PIC 2003), supported by a *Benefit-Cost Analysis* prepared by the Allens Consulting Group (Allens 2004). They were implemented in July 2004 by means of the *Plumbing (Water and Energy Savings) Regulations 2004* made under sections 221ZZZV and 262 of the Building Act 1993 and, in the case of the solar water heater or rainwater tank option, via Practice Notes referenced in clause Vic 1.2.2(a)(ii) of Volume Two of the Building Code of Australia (BCA) 2005.

The '5 Star' thermal performance requirements and the water and energy saving measures were phased in between 1 July 2004 and 1 July 2005. During that period various combinations of thermal performance rating and water saving measures were permitted, as set out in the Building Commission Practice Notes 2004-55 and 2005-55. A further variation was the acceptance of connection to a dual-pipe recycled water supply (where available), plumbed to all sanitary flushing fixtures plus outdoor supply, as an alternative to a rainwater tank for Class 1 dwellings.

Since July 2005, it has been mandatory for all new homes built in Victoria to comply with the above measures. Two issues have emerged:

- There is a perceived lack of flexibility for home builders to undertake alternative measures which may save equal amounts of water at perhaps less cost; and
- The rainwater tank and the solar water heater alternatives serve different objectives. The achievement of the government's water saving objectives (and indeed greenhouse objectives) is compromised by allowing what is in effect a random or price-driven choice between them. Furthermore, the actual pattern of choice is uncertain, since there is no central data collection.

*Our Water Our Future* addressed these issues with Action 5.41:

The statutory planning and building approvals systems will be aligned to support water conservation and enable the use of recycled water and alternative supplies. This will be done through existing Government initiatives in the first instance by:

- reviewing the Victorian Planning Provisions to ensure consistency with the Government's policy for sustainable urban water management;
- *reviewing the building approvals framework to provide for a consistent, performance-based approach to sustainable urban water management [emphasis added];* and
- requiring water authorities, drainage authorities and catchment management authorities to work with local government in the development of local planning policies that are consistent with sustainable urban water management.

User-friendly tools, training and education, including Water Sensitive Urban Development Guidelines, will be developed to support the implementation of these changes. (DSE 2004).

In October 2005 the Victorian Competition and Efficiency Commission published its final report on housing regulation in Victoria, which among other matters reviewed the 5 Star measures (VCEC 2005). Two of the recommendation were:

### **Recommendation 5.3**

That the implementation of the 5 Star scheme be more clearly related to the Victorian Government's energy efficiency objectives. The choice of a rainwater tank in lieu of a solar water heating system should be removed and substituted

with the choice of an alternative high efficiency water heating system. In addition, the scheme should incorporate more flexibility through the accreditation and use of more contemporary software packages.

#### **Recommendation 5.4**

That the water saving regulation in the 5 Star scheme be more clearly related to the Victorian Government's water efficiency objectives via the removal of the tradeoff between water saving and energy saving measures. Further, rainwater tanks should not be included in any mandated choice. Rather, individual consumers should be left to decide whether they would invest in this facility on its own merits as a water saving measure.

In April 2006 the Victorian Government responded to the specific recommendations of the VCEC in the following terms:

#### **Response to Recommendation 5.3: Supported-in-part**

The Victorian Government regards the 5 Star scheme as an important initiative towards achievement of its energy efficiency objectives. Consumers already have considerable flexibility in meeting their obligation. Nevertheless, the Government is actively pursuing further progress in these areas, such as the imminent introduction of the AccuRate software package and *the development of performance-based measures for achieving its sustainability objectives.*

#### **Response to Recommendation 5.4: Supported-in-part**

The Victorian Government considers that the 5 Star scheme (including its water saving elements) is clearly aligned with the Government's objectives for energy efficiency and water conservation. Nevertheless, the Government supports developing greater clarity around the purpose of the objectives of the scheme with a view to providing consumers with greater flexibility for achieving water saving. The issues surrounding mandated choices will be considered in *the further development of performance-based measures.* (Victoria 2006, emphases added).

## **A Performance-based Approach**

A performance-based approach means that water savings measures and techniques would be assessed on the likely amount of water saved through water conservation, reuse or recycling, rather than prescribing a particular measure or product. This approach allows solutions to be developed that fit individual circumstances and which foster innovation.

The key elements of such an approach may be described as ‘Program elements’ – which Victoria Government Agencies need to consider when deciding on the approach – and ‘Public Elements’ – which prospective homebuilders and product suppliers will need to access and use when applying a performance-based approach to building plans.

### **Program Elements**

#### ***Baseline and target water use***

The baseline is the starting point for calculating the water reduction impacts of a performance-based approach, and the target is the level of water use that needs to be achieved. The target water use is by definition lower than the baseline.

In the present prescriptive approach the baseline and target only need to be considered at the aggregate level, for the whole of Victoria, during the process of developing the measures and forecasting their impacts (PIC 2003, Allens 2004). Presumably, a target level of reduction in water use below a baseline was one of the factors determining the list of prescriptive measures ultimately selected – had a higher level of water savings been desired, more measures would have been prescribed.

In a prescriptive approach, however, baselines and targets have no part in the determination of individual building approvals. So long as each dwelling has the full complement of prescribed water-saving measures and – for Class 1 dwellings – either a rainwater tank/recycled water connection or a solar water heater, it complies with the 5 Star water-saving requirements. No further information about the dwelling or possible additional water-saving measures is required to determine compliance.

If a performance-based approach is adopted, it will need to be applied at the building approval level. In effect, each new dwelling will have a water consumption baseline and a target, and it will be up to the building permit applicant to select a mix of measures which will in combination be sufficient to achieve the target. The selected list will then need to be recorded on the approval documentation so that the presence of all measures in the completed dwelling can be verified.

#### ***Approved products and measures***

A flexible approach does not imply the allowance of an infinite range of possibilities for water saving. New products are constantly appearing on the market – often with exaggerated or entirely speculative estimates of water saving – and it would be unworkable to permit them to be all used at their claimed face value towards meeting the water-saving target. This would compromise the operation of the scheme. The

range of compliance options would be so wide as to make verification expensive and potentially unworkable, and the acceptance of untested water saving claims would dramatically reduce the probability that the Government's water reduction objectives would be met. Therefore a process for evaluating products and measures, and assigning an agreed water-saving value to them, is an essential element of a performance-based approach to water saving.

It is usually more efficient to approve product types, or specify product performance limits, than to approve specific models, unless there is a pre-existing list or register of the products in question. The *Plumbing (Water and Energy Savings) Regulations 2004* specify that shower heads and taps must have a flow rate of 7.5 to 9.0 litres per minute. As it happens, this corresponds to the flow rates of showers and taps rated 3\* under the WELS scheme, which commenced in July 2005. All shower heads on sale in Australia will need to be registered with the WELS regulator by July 2006. If the requirement in the Victorian Regulations were restated as 'shower heads and taps must have a WELS rating of 3\*', the list of complying models would be accessible from the WELS website<sup>1</sup>.

The same Regulations specify that 'the maximum static pressure at an outlet, other than a fire service outlet, within a building must not exceed 500kPa.' It is up to the plumber to determine whether a pressure reduction valve is required to achieve this, and if so what characteristics the valve should have – ie should it have a fixed setting (of 500kPa or some lower value), or should it be adjustable, and if so over what range. If the upper end of the range exceeds 500 kPa, there is a risk that the Regulations could be breached.

The Regulations define a complying rainwater tank as 'a tank or a number of connecting tanks designed to collect rainwater from roof catchments for sanitary flushing in a building'. They also specify minimum roof catchment area (50m<sup>2</sup>), tank volume (2,000 l) and the following installation requirements:

- An 'automatic or manual interchange device that allows alternate use of water from the rainwater tank or the reticulated water supply', 'to ensure that there is a continual supply of water for sanitary flushing'; and
- A suitable backflow prevention device, 'to protect the potable water within the reticulated water supply'.

A performance-based approach would presumably allow the use of a wider range of product types, and/or a wider range of performance, size and installation characteristics. However, the characteristics required of permitted devices would still need to be clear.

The range of permissible product types and characteristics would most likely need to be pre-determined by the administrators, so that applicants know what they can use. There may be a tension between the need to specify the characteristics of devices in detail,

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<sup>1</sup> A cross-reference of this type would also invoke the other performance characteristics of WELS-rated products, such as stability of flow rate at a range of pressure levels or droplet distribution characteristics for shower heads.

and the objective of maintaining the high degree of flexibility which is after all the aim of changing from a prescriptive to a performance-based approach.

The levels of approval may be:

- Generic, ie all products of a defined type are permissible. This would be an option if there is a clear published definition of the product in question, eg in an Australian Standard;
- Performance-based, ie all products of the defined type are permissible, provided they meet stated performance requirements (eg size, possessing some defined feature such as ‘demand activated’ rather than continuously operating); or
- Model-specific, ie with manufacturer names, model numbers and perhaps an estimated water saving for each model.

In practice it may be necessary to have a mix of these levels of approval: generic for products which are clearly defined and covered by a published Standard, more detailed performance specification where there are no Standards and an approved model list for novel products which have been assessed by the administrator (or some expert body advising the administrator). Over time, as a class of products develops and become standardised, it may move from an approved list to a more generic approval.

Section 14 of the Victorian Building Act 1993 already provides for the approval or accreditation building products and systems:

14. Accreditation of building products

(1) A building product, construction method, design, component or system connected with building work and accredited by the Building Regulations Advisory Committee or any other person or body prescribed for the purposes of this section is accredited for the purposes of this Act and the building regulations.

(2) The accreditation is subject to any conditions or variations imposed by the Building Regulations Advisory Committee or the prescribed person or body from time to time and remains in force until the accreditation is revoked by the Committee, person or body.

***Methods of calculation of water use***

For the prescriptive approach, it is not necessary for building applicants to concern themselves with the projected water savings attributed to any given measure. However, calculations of this type are central to the performance-based approach.

The ‘back-end’ calculation engine (typically a spreadsheet) needs to incorporate base data and algorithms which reflect the best available information about the water use of a typical ‘base case’ dwelling with the physical dimensions, number of occupants and other key characteristics of the proposed dwelling. The spreadsheet should also include values or formulae which can be used to calculate water use impact of the measures and devices selected by the applicant. It should also account for interactions between

devices. For example, as more water-saving measures are selected, the scope for further reductions in potable water use through the use of alternative water supplies will decline.

Calculating the impacts of water efficiency measures on projected water demand is considerably less complex than calculating the impact of building design on thermal performance and hence on heating and cooling energy demand. Unlike thermal performance modelling, where only a handful of models are widely used and accepted for regulatory purposes, the relative simplicity of water modelling has enabled many interested parties to construct their own models. These differ not so much in the method of calculation as in the input assumptions, and whether these are based on actual field observations, laboratory tests of products or some other set of parameters.

The accepted method of calculating compliance with the thermal performance aspects of Victoria's 5 Star building requirements is the FirstRate thermal simulation software program, which is publicly available from Sustainability Victoria for a fee of \$300. This is not the only acceptable means of demonstrating compliance – the NatHERS program, which is similar to FirstRate in its structure but differs in the way data are entered, is also acceptable. In theory, any calculation method meeting the requirements of the Australian Building Codes Board Protocol (ABCB 2005) is acceptable. This Protocol states:

To ensure that software used to demonstrate compliance with the BCA energy efficiency measures is of an appropriate standard, this Protocol defines minimum requirements for software and training of its users. It also provides a process for demonstrating the acceptability of new software and revisions to existing software.

At present, the only method of calculating the performance of water saving measures which has regulatory force anywhere in Australia is the software which underpins the NSW BASIX program. Access to the BASIX software has been requested, but at the time of writing it had not been made available.

### ***Compliance and verification***

A key administrative issue is the 'modes' of compliance to be permitted, and the means of ensuring compliance with whatever mode has been selected. At least three compliance modes are possible:

- 'deemed to satisfy' using a predetermined set of options;
- demonstrating performance using the standard method of calculation, and selecting from the approved list of options; and
- demonstrating performance using novel calculation methods or options.

It is likely that stakeholders will wish to retain the option of complying as they do now, with the same set of measures. Many builders are familiar with the existing measures and have incorporated them into their home designs, and will value stability over flexibility, at least in the beginning. Therefore it may be desirable to designate the

existing prescriptive water-saving measures (including the rainwater tank for Class 1 dwellings) as deemed to satisfy, without the need to use a calculation method.

The proportion of building applicants using a flexible performance-based method would be expected to increase over time as people become more familiar with it, especially if it offered compliance at lower cost.

It would also be advisable to offer the option of demonstrating compliance with new products not yet approved or using new data or methods of calculation, as is the case with 5 Star thermal performance. This would enable product suppliers or building designers to demonstrate that new approaches would meet the water-reduction target, and would provide an important avenue for new products to be added to the 'approved' list.

At present it is relatively easy to verify compliance with the 5 Star water-saving measures on site, even though the only relevant information recorded on the building approval documentation is the fact that the building surveyor has determined that the plan complies. An inspector can check the shower head and tap flow rates (or accept their WELS labelling as sufficient evidence), check the supply pressure (or accept the presence of a PRV as sufficient) and check for either a rainwater tank or a solar water heater meeting the specified criteria.

Where compliance is performance-based, however, it is essential to have the actual details on the building documentation, otherwise an inspector will not know which measures or products to look for, especially if the selected mode of compliance is the third, innovative route.

**Therefore, some means of recording the compliance details on approval documentation and preserving them all the way through the building certification process is essential to underpin the operation of a performance-based approach.**

## **Public Elements**

The public elements of a performance-based approach are those which home-builders, prospective homebuilders and other interested parties will encounter.

### *Calculation of performance*

The 'front end' of the calculation engine is the interface between the user and the formulae. If designed for general users (as distinct from trained or expert users, as is the case with FirstRate) it should be user-friendly. The user should be prompted for the necessary input information, should be able to select from a menu of clearly presented options and should be made aware when the projected water savings from the selections meet the target. This can be done by indicating actual litres of water (as in the VicBEST rating tool currently under development), as a graphic of progress towards a 'percentage reduction' target (as in the BASIX rating tool used in NSW), or by some other means.

It is matter of policy whether to make the underlying algorithms and savings estimates public. The BASIX scheme in NSW does not make the calculation algorithms publicly

available, although it is possible to infer them (approximately) by systematically working through the front-end using different input settings.

Users could be led through the calculation in a number of ways. The simplest option from the user's viewpoint may be a checklist, with a number of points next to each option. The user would need to select enough measures for the points total to reach some predetermined value. Although this is simple for the user, the calculations behind the points weightings would still need to be complex, and product interactions would be more difficult to signal to users than with an fully interactive method.

Alternatively, the calculation method could be made available as a software package (free, or at a price like FirstRate) or accessed via the internet, as with BASIX. The internet option has several advantages over distributed software. Users could be made aware of new products as soon as they are approved, without the time lag of software updates, and the compliance details for each building approval could be automatically recorded for later verification if required, without the extra step of transferring details from a paper form or a software report to a central register.

### ***Advisory information***

Most users will require some assistance to arrive at a mix of measures which will reach the performance target, especially if the menu of options is wide and they interact in complex ways. Examples of typical complying combinations will be helpful advice.

This advice can be given as a separate manual (in paper form or downloadable) or embedded in distributed software or web-based applications as prompts and help pages. Indeed, the same information can be presented in a number of ways so that it reaches all possible users. A unique advantage of web-based advisory information is that it can be instantly updated, and also linked to supplier sites or the WELS product register.

The advisory information can extend beyond compliance requirements and products to more general water conservation information. All prospective building applicants will come into contact with the public compliance elements, and for those home builders who wish to do more than the minimum this would be an ideal place to present a wider range of water-saving options and measures.

## **This Study**

This study was commissioned by the Department of Sustainability and Environment (DSE) with the aim of exploring the options for a performance-based rather than a prescriptive approach to the water-saving measures required in new dwellings.

The project was overseen by a Steering Group comprising representatives from DSE, the Building Commission (BC) and the Plumbing Industry Commission (PIC).

## **Terms of Reference**

The terms of reference require a report to the Steering Committee which:

- a) Provides a summary (and detailed supporting analysis) of the results of an assessment of water consumption and savings for new Class 1 and 2 residential buildings and the variables that affect these consumption levels. This will be a desk-top review based on publicly available information (which the consultant will be expected to identify) and existing reports such as papers prepared for the implementation of 5 Star. Data will include the likely uptake (based on consultation with stakeholders such as developers, Building Commission, building surveyors and PIC) of the various compliance options for the water component of the 5 Star standards;
- b) Identifies a broad range of potential water conservation options for new residential buildings (including products and combinations of products that are part of the building fabric), refines (based on analysis and stakeholder consultation) the list of potential water conservation options and identifies those which merit further investigation;
- c) Evaluates the feasibility of these options in terms of water savings as part of Class 1 or 2 building fabric, including technical issues and other benefits (such as to receiving waters) associated with each technology;
- d) Presents the information about the technologies
  - Textually
  - In a tabular format building on the provided proforma for the DSE Sustainability Assessment tool [ie VicBEST]
  - As a comparison (tabular and textual) of the cost, potable water use and savings (per house, for Melbourne, large regional town, small regional town, and Victoria), water bill reduction and energy bill reduction, of the current 5 Star options and the other technologies identified. This will be applied for Class 1 and 2 buildings, different home sizes, geographic locations, and the cost of those savings now and projected over the next 50 years; and
  - As summary cost curve(s), showing reductions in dwelling water consumption for different classes of building as a function of cost. More than one curve may be required to clearly communicate this for variables such as building class, building size, geographic location etc;

- e) Assesses the feasibility of using the WELS Scheme, or a similar national Scheme or Standard, as the basis for product inclusion in the sustainability assessment tool; and
- f) Reports on consultation with stakeholders about the findings of the water consumption and cost analysis of different technologies.

The present report addresses the above terms of reference. In effect, it covers the 'Program Elements' of a performance-based approach to water-saving measures in new homes, as described in the previous section.

The terms of reference also call for the preparation of an 'advisory manual' for the general public, describing options to reduce residential water consumption and no less than two hypothetical case studies (covering each of the two building classes). In effect, this covers one of the 'Public Elements' of a performance-based approach to water-saving measures in new homes, as described in the previous section. The 'advisory manual' is a separate document.

The project scope focuses on products, fixtures, devices and design features built in to the fabric of new Class 1 buildings (single-family detached and attached houses) and new Class 2 buildings (apartments).

Appliances that are not part of building fabric (eg clothes washers) are outside the scope, as are land use, statutory planning decisions and subdivision design, unless these are relevant to the building fabric.

## **Structure of This Document**

Chapter 2 describes the method of calculation developed for analysing the baseline water use in new Class 1 and 2 dwellings, estimates the water and energy savings being achieved by the existing prescriptive 5 Star measures and proposes targets for a performance-based approach. Indoor and outdoor water use are treated separately,

Chapter 3 reviews the major options which could be included in a performance-based approach and estimates their capital and operating costs, the reduction in potable water achieved over their service life, and their cost-effectiveness.

Chapter 4 estimates the water savings and costs associated with various combinations of water-saving and alternative supply measures, projects the impacts for new housing to be built in Victoria over the next 50 years, and presents general findings and conclusions.

## **Sources of Information**

Reliable information on how water is actually used in Victorian households, as opposed to estimates based on assumptions, is relatively scarce. Discussion with stakeholders indicated that the most comprehensive and up to date source of information on water use in single dwellings in Victoria is the *Yarra Valley Water 2004 Residential End Use*

*Measurement Study* (Roberts 2005). Similar research on water use in multiple dwellings is planned but has not yet been undertaken.

The study determines mathematical relationships between the number of persons in the household and the daily and annual consumption of water for specific end uses. These relationships were explored in detail with the report's author, and are used as the basis for the modelling in the present report.<sup>2</sup>

Of the many other documents consulted, the ones which proved most useful for this study are listed in the references.

DSE made the current development version of the VicBEST spreadsheet model available. Although a separate calculation model was developed for the present study, based largely on the YVW studies, some of the data, such as rainfall in various parts of Victoria, were taken from VicBEST, which is a good compilation of the relevant data from primary sources.

The characteristics of various products and devices were generally taken from product literature and from supplier websites.

Several individuals were also consulted (see Appendix 1). Their assistance and co-operation is gratefully acknowledged, as is the assistance of the DSE project managers and the members of the Steering Group.

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<sup>2</sup> The formulae are incorporated in a spreadsheet DSE 2005 V2.xls.

## 2. Water Use Baseline and Target

### Principles of Establishing a Baseline

#### Water

There are, conceptually, four ‘regulatory categories’ of homes covered in the study, with respect to water consumption:

- Existing homes – these are not of course subject to regulations regarding new home construction, but provide one possible benchmark or reference point for estimates of projected water savings;
- New homes – no water saving regulations. These can no longer be built, because of the *Plumbing (Water and Energy Saving) Regulations 2004*, but provide a second benchmark for estimates of projected water savings;
- New homes – ‘5 Star’ regulations. These meet the *Plumbing (Water and Energy Saving) Regulations 2004*, and the additional Practice Note measures, and provide a third benchmark for estimates of projected water savings;
- New homes – Proposed regulations. These would meet whatever mains water saving targets might be adopted following the present study.

In each regulatory category there are two further ‘compliance dimensions’: a ‘worst case’ in which all homes just meet the minimum requirements and a ‘probable case’ reflecting the likelihood that many homes would incorporate some measures beyond those required by regulation.

For example, even if there were no water saving regulations, new homes would have at least a 6/3 litre toilet (because WELS has now effectively removed all models with larger flush volumes from the market), and many would voluntarily buy a 4.5/3 litre toilet. Similarly, even without regulations, many new homes – perhaps the majority – would have 3 star showers and taps, and some would have a rainwater tank.

The combination of the four regulatory categories and two compliance dimensions creates the eight Cases summarised in Table 1. (They are each given a letter and a number for ease of reference in the text).

Each Case is defined by its estimated mix of fixtures of varying levels of water-efficiency. The share of water heater types in each Case also needs to be estimated, because there are complex interactions between water use, water heating energy and greenhouse gas emissions which would need to be recognised in any transition to a new regulatory arrangement.

The existing regulations (Case C2) have resulted in reductions in water use, water heating energy and greenhouse gas emissions compared with what would have occurred without them (Case B2). Following discussions with DSE, the main principle

adopted was that **the target for mains water use in new homes under any changed regulations should be no higher than the mains water use being achieved under the present regulations – ie Case C2.**

**Table 1 Regulatory and Compliance categories**

Compliance dimension		Existing homes	New homes – no water saving regs	New homes – 5 star regs	New homes – proposed regs
Worst case water fixtures	Toilet Showers Taps Rainwater tanks	<b>Case A1</b> 11 litre All 0* All 0* No RWT	<b>Case B1</b> 6/3 All 0* All 0* No RWT	<b>Case C1</b> 6/3 All 3* All 3* No RWT	<b>Case D1</b> Mix of measures which exactly achieve water saving target
Probable mix of water fixtures	Toilet Showers Taps Rainwater tanks	<b>Case A2</b> Mix 11 to 6/3 Mix 0* to 3* Mix 0* to 3* Some RWT	<b>Case B2</b> Mix 6/3, 4.5/3 Mix 0* to 3* Mix 0* to 3* Some RWT	<b>Case C2</b> Mix 6/3, 4.5/3 All 3* All 3* 50% RWT (a)	<b>Case D2</b> Mix of measures which slightly exceed water saving target
Probable market share of water heaters	Electric Natural Gas, LPG Solar	<b>Case A2</b> 29% 69% 1% (b)	<b>Case B2</b> 17% 79% 4% (c)	<b>Case C2</b> 7% 43% 50% (d)	To be determined

(a) Consensus of PIC, BC and other stakeholder estimates (b) From ABS 46020, 2005 (c) Author estimates, based on trends. (c) Table 8.

## Solar and Greenhouse

The selection of a water-saving target unavoidably raises the issue of whether the water-related greenhouse gas reductions being achieved under the present regime should also be preserved under any new regulatory regime.

The consensus among stakeholders suggests that about 50% of new homes being built comply with the 5 Star measures via installing a rainwater tank, and 50% by installing a solar water heater.<sup>3</sup>

This means that the 5 Star water-saving measures are also achieving greenhouse gas reductions (quite apart from any greenhouse savings associated with the 5 Star thermal performance measures), in the following ways:

- a) Water heating is being supplied at a lower greenhouse gas-intensity in Case C2 compared with Case B2, due to the much increased share of solar water heaters (50% vs an estimated 4%); and
- b) Less hot water is required in Case C2 compared with Case B2, due to the water-savings measures. Over 90% of the hot water savings come from the requirement to have a 3\* shower.

These emissions reductions are quantified in a later section (see Table 9).

<sup>3</sup> The PIC estimates about 50% RWTs, the BC about 40%, and builders, building industry associations and water authority estimates range from ‘nearly all solar water heaters’ to ‘nearly all RWTs’.

If the selection of water-saving measures is made more flexible, and the sole performance criterion is potable water consumption, some householders will opt for measures which save cold water only. This would mean that component (b) of the water-related greenhouse savings would on average be reduced.

There would almost certainly be consequences for component (a) as well. If the water-saving measures were made performance-based, it would be both inconsistent and impractical to preserve the existing rate of solar water heater installation in new homes by prescriptive measures. It would not be possible to specify or enforce a requirement that '50% of new homes must have a solar water heater' (short of telling every second building applicant that their house had been selected to have a solar water heater!).

Increasing the solar water heater requirement by imposing it on *every* new Class 1 dwelling (in addition to a performance-based water saving target) would increase the compliance burden and cost compared with the present regime, and would almost certainly drive up the average price of new housing. All housing and planning industry stakeholders consulted expressed the view that, while they welcomed moves to make the 5 Star measures more flexible, they would strongly oppose any changes that led to an increase in compliance burden and cost.

If the option of forcing every new home to have a solar water heater were ruled out, the remaining options would be:

1. Abandon the mandatory solar water heater requirement without adding any new greenhouse requirement. This would almost certainly lead to a massive drop in solar water heater installations in new homes and to an increase in water heater-related greenhouse gas emissions compared with the present regulation. (Perhaps this could be ameliorated by making rebates for solar installation available to new home builders, but at a cost to the taxpayer).
2. Develop *both* water-heating related greenhouse targets *and* water use targets for new homes, and require them to be satisfied through performance-based choices about water efficiency, alternative water supply and water heater type and efficiency. It is possible that many homebuilders would opt for high-efficiency gas water heaters and higher water savings rather than for solar, and there will be a reduction in solar water heater installations in new homes. This would lead to a greater reduction in water use, while matching the existing greenhouse savings (possibly at lower lifecycle cost).
3. Develop a performance-based greenhouse target in addition to the performance-based water-saving target, and allow it to be satisfied by any combination of measures bearing on fixed or hard-wired energy-using equipment: water heaters, space heaters or cookers. Such a '5 Star Greenhouse' requirement could either be completely independent of both the 5 Star thermal performance target (which is satisfied by building design factors, not equipment choice) and the new water saving target, or it could be linked to them computationally, so designs with higher thermal performance or lower hot water use will have less demanding starting points from which to achieve their greenhouse target. This is essentially the approach used in the NSW BASIX regime.

If a solar water heater were 'Deemed to Satisfy' the greenhouse requirement, many homebuilders would opt for this, while others would choose to comply through a combination of high-efficiency gas water heaters and space heaters.

The further exploration of these options is beyond the scope of the present study. However, the energy and greenhouse reductions from the existing 5 Star water-saving measures – including the effect of the solar water heaters – are estimated, and the potential impacts on those reductions by a move to a more flexible compliance regime are also estimated.

This will give a guide to Victorian government policy-making, by indicating the magnitude of compensating greenhouse reductions that would need to be achieved by other measures (eg options 2 and 3 above).

## **Shower Heads and WELS**

Of the mandatory requirements under the present 5-Star water-saving regime, the largest single contributor to both indoor water savings and greenhouse savings is the 3\* shower. A completely flexible regime would allow compliance without 3\* showers, or even without any measures bearing on hot water at all, so it would carry the risk that a large part of the existing greenhouse benefits would be lost, or would have to be made up by other measures.

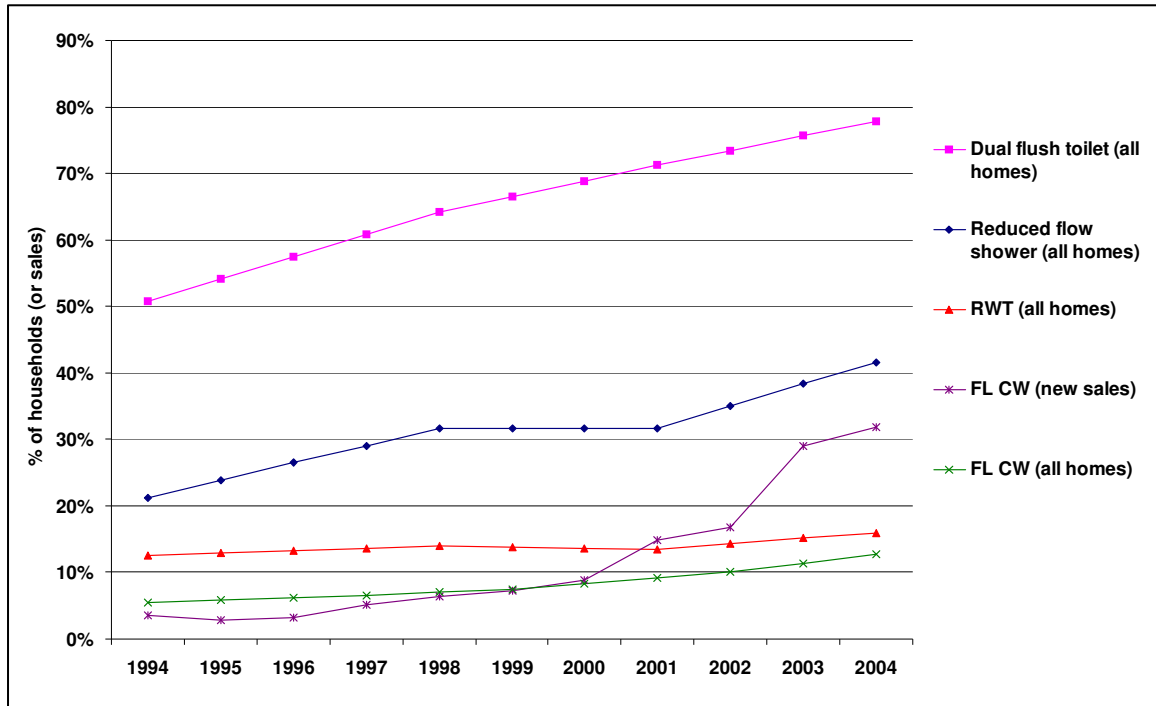
Even if the mandatory requirement were removed, a high proportion of new dwellings would still be fitted with 3\* showers (7.5 - 9.0 litres/min), and some with even lower flow showers, which are currently excluded by the regulations. The share of all Victorian homes fitted with at least one 'reduced flow' shower has been rising steadily, to over 40% in 2004 (Figure 1), even before the 5 Star regulations came into effect. However, the ABS data do not distinguish between new homes and existing homes. It is possible that, without the 5 Star regulations, the 3\* share of showers in new homes would have been lower than in existing homes.

Without a mandatory 3\* shower head requirement, the main support for the adoption of 3\* shower in new homes in Victoria would be the national WELS scheme, plus any rebates that may be offered by the water authorities (rebates for 3\* showers do not at present need to be offered for new homes). WELS labelling on its own does not prevent the sale or installation of any type of shower head, but will change buyer preferences over time. In modelling carried out before Victoria adopted its 5 Star regulations, the introduction of WELS labelling was projected to increase the share of 3\* or better showers installed in new homes, from an estimated worst case of about 12% in 2005, to 40% by 2011 and 55% by 2021 (Figure 2).

The 5 Star regulations have forced the 3\* adoption rate to 100% of new homes connected to a mains water supply. It is estimated that about 5% of new homes built in Victoria are off the line of water mains, so the 5 Star regulations are forcing 3\* shower adoption in the other 95% of new homes. If the 3\* showers became optional rather than required, the installation rate for low-flow showers could drop by up to 40 percentage points, from 95% of new homes to as low as 55% in 2021, the expected WELS-induced rate (this includes units with flow less than 7.5 l/min, which the present regulations exclude). However, if 3\* showers remain a popular element in a

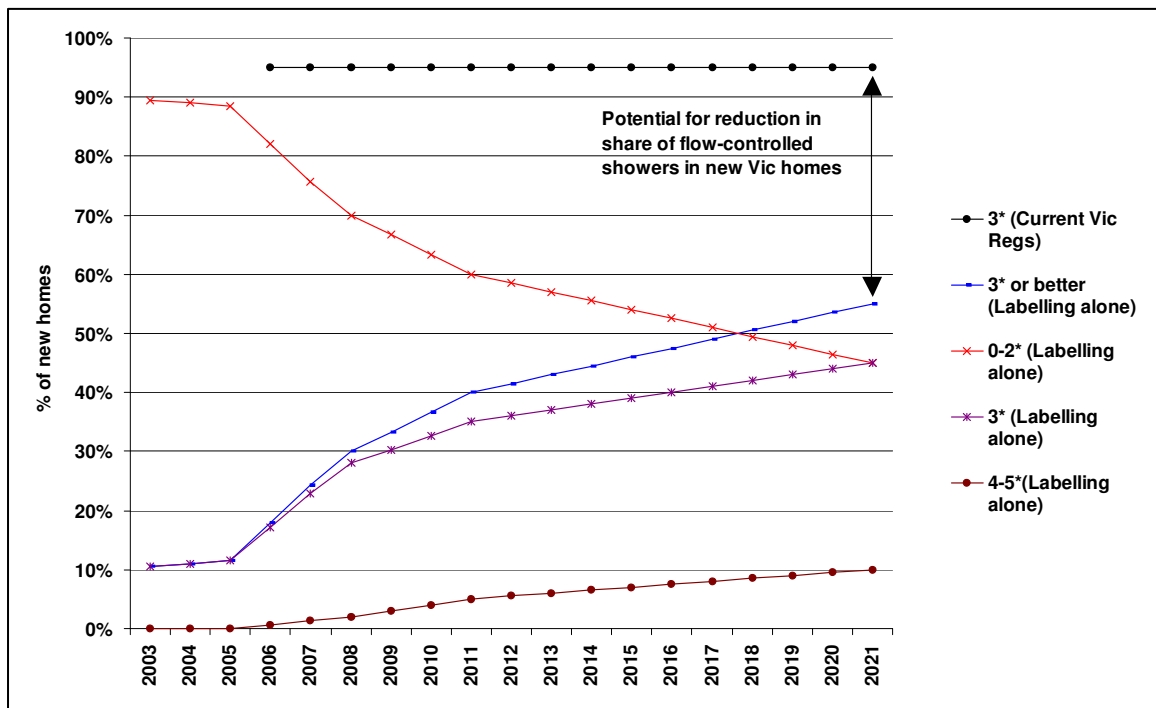
performance-based compliance regime, the fall in installation rate may be less – say 20% rather than 40%. If so, the 3\* shower rate installation rate in new homes would still be about 75%.

**Figure 1 Ownership of Water-Saving Devices, Victorian Households**



Source: ABS and GfK

**Figure 2 Potential Reduction in 3\* Shower Installation in New Homes, Victoria**



Source : WELS impact projections form GWA 2004

This may be considered a reasonable outcome. However, it would mean that about 20% of new homes could suffer a significant increase in their greenhouse gas emissions compared with the present regime – how significant depends on the actual pattern of compliance, and whether any compensating greenhouse targets are adopted.

If this risk were considered unacceptable, the mandatory 3\* shower requirement could be retained, and the means of achieving the *remainder* of the water saving target could be left flexible. This approach could be justified on the grounds that the installation of 3\* shower heads compared with a 0 to 2\* shower heads is almost universally cost-effective, even for single person households. This is not the case for the other elements of the prescriptive 5 Star package – 3\* taps, pressure limitation, solar water heaters or rainwater tanks, where cost-effectiveness is marginal at best.

Whatever actions Victoria takes, the Commonwealth may make water efficiency standards (WES) mandatory for shower heads under the WELS legislation. A recent study of the issue concluded that:

WES are definitely feasible for clothes washers and toilet equipment, and would be feasible for shower heads if new types could be developed to cater for low-pressure installations. These three products account for the great majority of indoor water use in homes.

WES are not considered feasible and/or worthwhile for taps, dishwashers, urinal equipment or flow controllers. (GWA 2005)

The proposed WES levels for showers were 3\* on the WELS rating scale - ie a flow rate of no more than 9 l/min (at a water supply pressure of 250 kPa).

The adoption of national WES for clothes washers or toilets would have an *indirect* bearing on Victorian performance-based regulations. The 'no (Vic) regs' water use starting point would be lower. Therefore, the same absolute reduction in water use would result in a lower outcome, or the reduction target could be relaxed somewhat and still arrive at the same water use outcome.

The adoption of national WES for shower heads would have a *direct* effect, in that 3\* shower heads would become a part of the mix of water-saving compliance measures for every new home in any case. Therefore the additional water savings to be achieved by a flexible combination of other measures would be considerably reduced.

In conclusion:

- There is a case for retaining 3\* shower heads as the sole mandatory requirement;
- Even if Victorian regulations do not retain 3\* shower heads as a mandatory requirement, it is possible that the Commonwealth WELS scheme will commence to do so. This would require adjustment of a Victorian performance-based regime.

## End Uses

Indoor and outdoor water use in new homes are modelled separately. The main factors bearing on indoor use are the number of persons per household and the number and type of water using appliances such as clothes washers and dishwashers. The physical form of the dwellings – whether detached or attached, house or apartment – or the location in Victoria or indeed in Australia, have relatively little impact. Indoor water consumption per household and per capita is remarkably similar across Australia (GWA 2005a).

Outdoor use (sometimes also called ‘seasonal’ use) is dominated by garden irrigation. Irrigation water demand depends on a combination of many factors including the area of garden or planter boxes, the planting style, the irrigation technology, user habit and behaviour and, of course, soil moisture and rainfall. Irrigation water use can vary widely, even for gardens of apparently similar area and style in the same suburb.

### Indoor use

A general household model of end uses and alternative supply options was constructed for this project. The structure of the model is illustrated in Figure 4.

The model generates daily and annual indoor water uses based on:

- The number of persons per household;
- The daily water use per capita for each end use, based on the relationships observed in the *Yarra Valley Water 2004 Residential End Use Measurement Study* (Roberts 2005); and
- The flow rate and water-efficiency characteristics of fixtures and fittings.

The assumptions for each end use are described below.

The default setting is for all end uses to be satisfied by potable mains supply, but the model also permits various patterns of alternative supply sources: rainwater, recycled water and greywater. These are described in detail in Chapter 3.

### *Toilet Flushing*

Toilet flushing water consumption is calculated from an observed average of 4.2 flushes per person per day (Roberts 2005) and the observed ratio of 50% partial and 50% full flushes, rather than the 80% partial to 20% full flush ratio assumed in the Australian Standard AS/NZS 6400. According to Roberts, the ratio of full flushes increases as the flush volume declines. This would be consistent with the greater use of repeat flushing to clear the pan. However, recent tests with new 4.5/3 litre designs indicate an improvement in performance, and a lower rate of full flushing than for 6/3 designs. This performance improvement would further increase the actual water savings from 4.5/3 toilets, but has not been taken into account for the time being.

## **Showers**

Shower water use is based on an observed average of 7.1 minutes per shower and 0.9 showers/person/day (Roberts 2005). Actual shower flow rates are far lower than the maximum flow rates of the fittings. The following are used:

- For 3\* showers (nominally less than 9 l/min): 7.0 l/min
- For 1-2\* showers (nominally 9-16 l/min): 8.0 l/min
- For 0\* showers (nominally greater than 16 l/min): 10.5 l/min.

## **Taps**

Tap use is based on an observed base consumption of 19 litres/HH/day plus 23 litres/person/day, for 3\* (formerly AAA) fittings (Roberts 2005). The allocation between kitchen, bathroom basin and laundry use, and between volumetric and free flow, is estimated from GWA (2004). Table 2 indicates these estimates applied to a 3 person household: 54% of tap water use is free flow, while 46% is volumetric.

Roberts (2005) observes that, as for showers, the actual flow rates for taps are far lower than the maximum flow rates, because users rarely open the taps fully:

This is an important finding in the context of demand management because it confirms that the widespread adoption of flow control valves in the residential setting is highly unlikely to result in reduced water usage since the vast majority of use is already occurring well below the maximum flow rates limited by flow control valves (Roberts 2005).

The average flow rate for 3\* taps (nominally 7.5 – 9.0 l/min) is estimated to be 3.0 l/min, and the average for 2\* and less is estimated to be 3.5 l/min. The installation of 3\* taps and pressure limitation impacts on free flow use water use only, not on volumetric use.

**Table 2 Estimated tap use characteristics, 3 person Household**

	Kitchen	Laundry	Basin	Total	kl/yr
Base usage (litres/day)	15.2	3.8	0.0	19.0	6.9
Personal usage (litres/cap/day)	6.9	4.6	11.5	23.0	8.4
Total use, 3-person HH (litres/day)	35.9	17.6	34.5	88.0	32.1
Free flow %	50%	20%	75%	54%	NA
Free flow usage (litres/day)	18.0	3.5	25.9	47.3	17.3
Volumetric usage (litres/day)	18.0	14.1	8.6	40.7	14.8

Source : Author estimates based on GWA (2004)

## **Baths**

Where a bath is present in the home, bath usage is estimated at 0.5 baths per person per week at 120 litres per bath. This is all volumetric use, ie it is unaffected by tap flow rate.

### ***Clothes Washers***

Almost every house will have a clothes washer. The estimated base usage is 2.4 uses per week for a single person household, plus 1.6 uses per week per additional person (Roberts 2005). The water consumption is calculated from the number of weekly uses and an assumed water usage per cycle.

The average usage per cycle in existing homes reflects the existing mix of top and front loading machines and their average water use. ABS data indicate that in 2004 about 13% of Victorian households had a front loader clothes washer, but sales data collected for the national energy labelling program indicate that about 32% of clothes washers sold in Victoria in calendar 2004 were front loaders (Figure 1). Some of the surge in front loader sales in 2003 and 2004 was due to the availability of rebates, which were discontinued (for clothes washers and dishwashers) at the end of 2005. It is assumed that the market share of front loaders will remain at their present levels even without rebates, due to the support of WELS labelling, which becomes mandatory in mid 2006.

It is estimated that 35% of householders moving into new dwellings will purchase (or bring with them) a front loader, with an average consumption of 70 litres per cycle, and 65% will have a top loader, with an average consumption of 120 litres per cycle.

This indicates a weighted average of 103 litre per cycle in new homes, compared with an average of 143 litres per cycle in existing homes (Roberts 2005).

### ***Dishwashers***

The estimated base usage for dishwashers is 2.7 uses per week for a single person household, plus 0.7 uses per week per additional person (Roberts 2005). Although less than half of Victorian household had a dishwasher in 2005 (ABS 4602.0), it is assumed that all new homes will be equipped with one. The average water use per cycle for dishwashers sold in 2004 was only 18 litres, compared with 103 litres for clothes washers, so the presence of a dishwasher has a much lower impact on household water use. Roberts (2005) reports average water use of 24 litres per cycle for existing dishwashers.

## **Outdoor and seasonal use**

Outdoor water use is sometimes called ‘seasonal’ water use, because unlike indoor water use, which is fairly constant all year round, it peaks in summer and drops dramatically in winter.

Nevertheless, it is necessary to estimate a ‘standard’ water consumption for garden irrigation, to be used in all scenarios, to add to the indoor water use estimates in order to estimate and project total household water consumption.

It is also necessary to estimate the extent to which seasonal uses can ‘soak up’ rainwater, greywater or recycled water, because the economics of these alternative supply options often rely on displacement of a greater volume of mains water than can

be achieved in indoor uses alone, especially as the indoor fittings become more water-efficient.

The ability of tanks to collect rainwater (or stormwater) depends on regular draw-off, and the ability of the garden to act as a rainwater sink helps this. Therefore a detailed rainwater fill-discharge and garden irrigation model has been developed, based on the monthly rainfall values in the VicBEST spreadsheet and on Hallman et al (2003).

### ***Garden Irrigation***

Garden irrigation is the most common form of outdoor water use. About 80% of Australian households have a garden which they water, and a further 5% have a garden which they claim not to water. Of the other 15%, most live in apartments (GWA 2005).

The ABS Water Accounts indicate that in 2001 average outdoor water consumption per Victorian household was 86.5 kl/yr. The great majority (over 80kl/yr) was irrigation, and the balance was swimming pool and spa top-up, evaporative coolers, car washing and other miscellaneous uses. The Yarra Valley Water study recorded about 56 kl/yr of seasonal outdoor uses, but that was partly during a period of Stage 2 water restrictions.

The long term demand for irrigation in new detached dwellings is likely to be significantly lower than the present average, because garden areas are getting smaller. The typical greenfield development site is now about 600m<sup>2</sup> compared with the traditional (¼ acre) site of about 1,000m<sup>2</sup>. At the same time, houses and paved areas are getting larger. An increase in house plus paved area from 200m<sup>2</sup> to 250m<sup>2</sup> would reduce the residual irrigable area by more than half, from 800m<sup>2</sup> to 350m<sup>2</sup>.

The irrigation load in new homes assumed for modelling purposes is 123 litres per day per dwelling (45 kl/yr). This provides only part of the garden water requirement – the rest is supplied by natural rainfall. The pattern of irrigation demand varies not just with temperature but also with cloud cover, humidity and likely sequences of wet days and other factors. Figure 3 illustrates how irrigation and rainfall typically combine to supply garden water needs in the eastern suburbs of Melbourne.

### ***Other Uses***

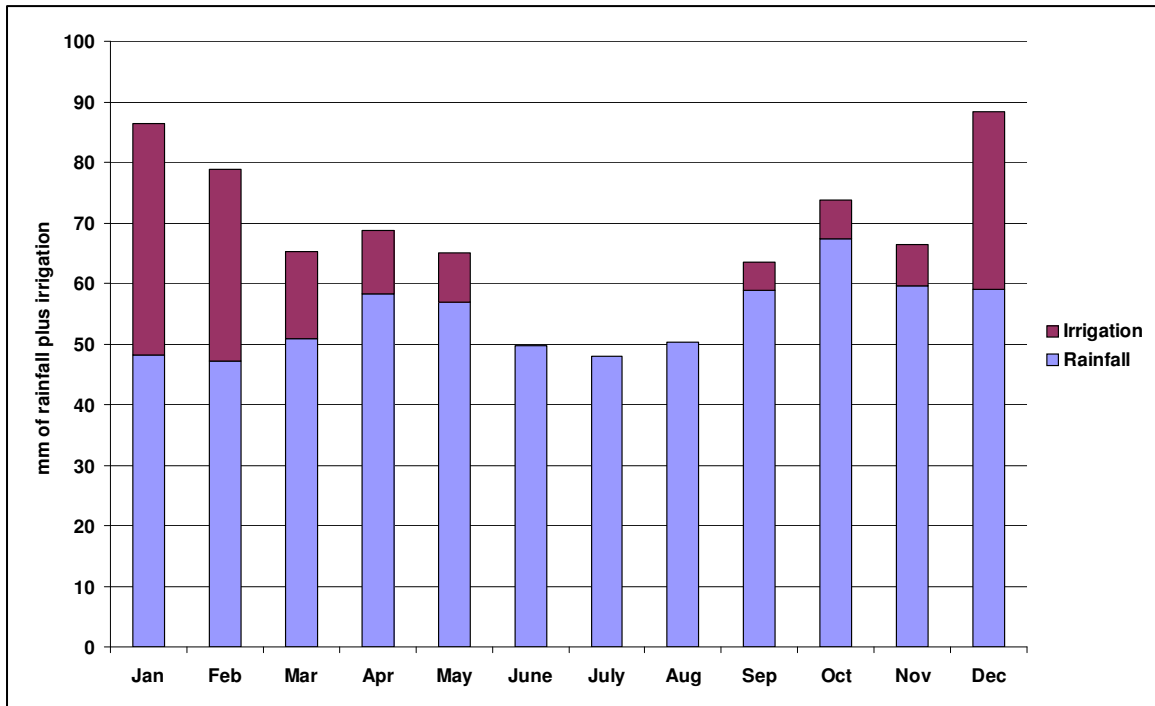
The other potential outdoor and seasonal water uses are much less common than garden irrigation: about 18% of Victorian households have an evaporative cooler, and 6% have a swimming pool.

The annual water use of evaporative coolers is uncertain. Roberts (2005) reports that evaporative cooler usage is negligible when the daily maximum temperature is less than about 25°C, but then rises rapidly with the temperature. The average use on the days when the cooler was utilised was 155 litres, with significantly higher usage on weekend days than on week days. The average rate of water use during operation was 1.5 litres/min, but the range was very wide, from 0.2 to 13 litres/min.

A separate estimate, by a manufacturer, is that the average evaporative cooler in Melbourne uses about 13.4 kl/yr, of which 7.3 kl (54%) is actually evaporated to give

the cooling effect and the other 6.1 kl (46%) is lost (or 'bled') as part of the reservoir water management process.<sup>4</sup> For modelling purposes, it is estimated that the presence of an evaporative cooler accounts for 18 kl/yr, of which 10 kl is used in cooling and 8 kl is lost.

**Figure 3 Typical natural rainfall and irrigation demand for gardens, Melbourne**



Source: Author estimates based on Hallmann et al (2003)

Swimming pools and spa pools are significant consumers of water. Although swimming pools are rarely emptied completely, they are subject to water loss through evaporation and have to be topped up regularly in hot weather. Water is also lost to the drain during the filter cleaning and backwashing process. A typical 50kl swimming pool in Melbourne may need 20 to 30 kl of top-up water in a typical year – in hotter parts of Victoria, the full volume of the pool may be lost each year (AGO 2004).

A recent study by BIS Shrapnel (2005) found that 30% of Victorian swimming pool owners have a spa pool built in to the swimming pool, and a further 14% have a separate spa, with an average volume of 3,700 litres. The number of spa pool owners *without* a swimming pool as well is not known.

Spa pools are much smaller and generally lose very little water to evaporation, either because they stand empty or, if they are left full, they are often covered to conserve heat. However, many are emptied and refilled on a regular basis. BIS Shrapnel found that spa pool owners in Victoria refilled their pools 7.5 times per year on average – this implies an annual water use of 28 kl per year, comparable to the annual water demand of a full size swimming pool.

As evaporative coolers and swimming pools are relatively uncommon, and can be added at any time, not just at construction, it may not be appropriate to treat them in the

<sup>4</sup> [www.savewater.com.au](http://www.savewater.com.au)

same way as other water uses in the determination of a baseline and a performance target. However, if a prospective homeowner indicates an intention to install an evaporative cooler or a pool, water reductions of a similar percentage as for other uses can be factored in to the performance target.

## **Pressure Limitation**

The current 5 Star regulations include the requirement to limit supply pressure to 500kPa. The justification for this is based on the results of a 2002 study by South East Water Limited and the Plumbing Industry Commission (PIC 2004, Appendix 1). Customers in areas of high supply pressure (average 800 kPa) were offered a Pressure Reduction Valve (PRV) and 207 accepted. About three quarters of the PRVs installed were set to 350 kPa and a quarter to 500 kPa.

Water consumption was monitored for 12 months, and compared with the corresponding quarter in the preceding year. The savings estimates were complicated by the fact that water restrictions were in place for part of the post-installation period. The water savings attributed to the presence of a PRV are unclear. One part of the Regulatory Impact Statement states ‘the impact of reducing the water pressure resulted in an overall reduction of 3-4% of water consumption’ (p19) while another part states ‘3 to 4% of decreased water consumption can be attributed to pressure reduction’ (p35, emphasis added). The latter implies that 96-97% of the apparent fall in water use was due to other factors, presumably the restrictions on garden watering.

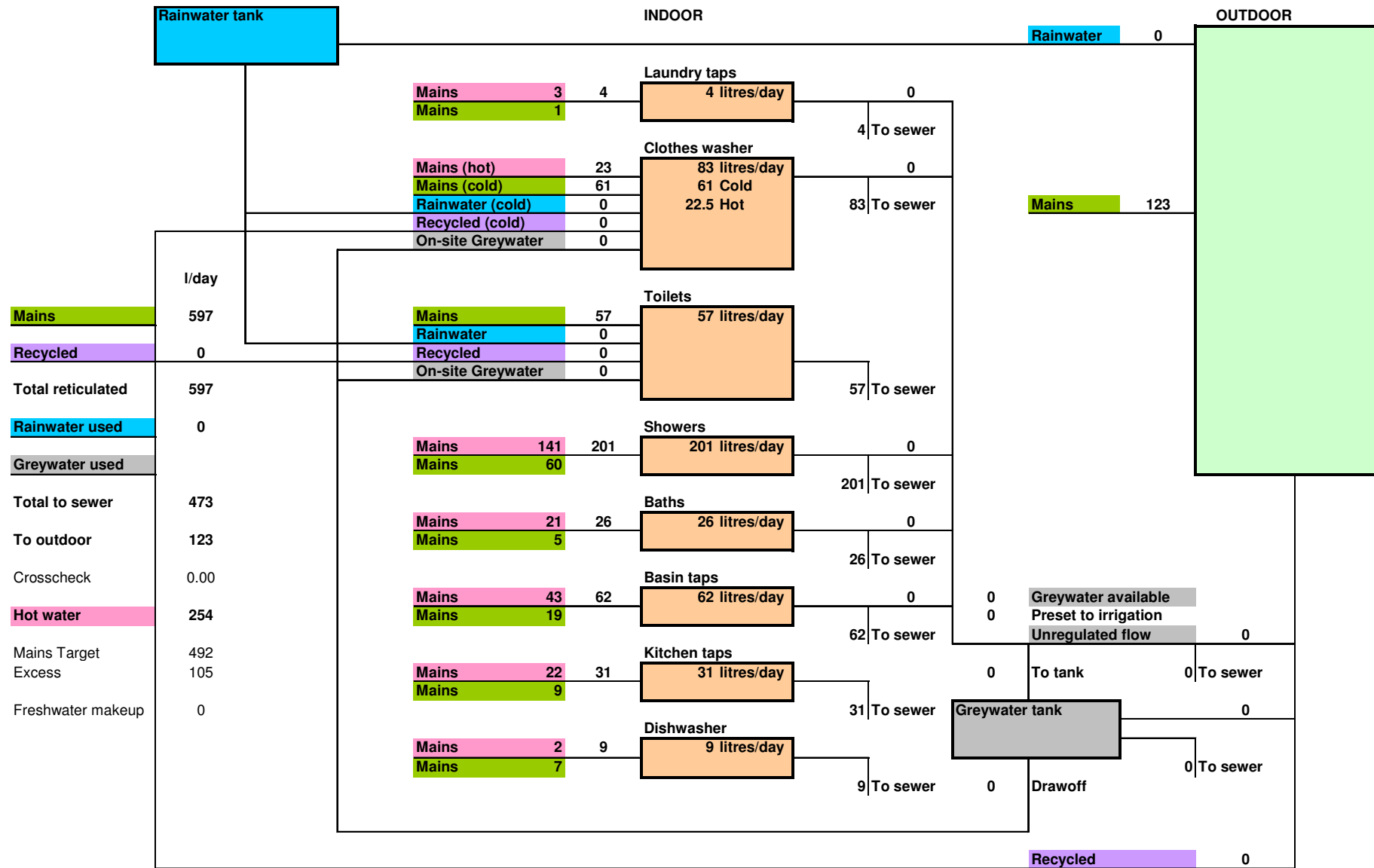
Also, homes were selected for PRV installation because they had high water supply pressures – the benefits in a randomly selected group of homes with typical or average supply pressures would be less. Another uncertainty is the share of homes involved which already had flow controllers on their showers or taps (3\* fittings already have flow controllers fitted). For those homes, the additional benefits of a PRV would mainly show up as a reduction in water flow to the garden when hand-held hoses are used (which was indeed the case in most of the PRV households).

The RIS points out that PRVs have benefits in terms of reducing water hammer and, possibly, in reducing the risk of pipe leakage and extending the service life of water heaters, clothes washers and dishwashers. However, such benefits cannot be brought to bear in the present study, which deals with water use only. Therefore the options for PRVs under a performance-based regime are:

- Abandon the PRV requirement;
- Retain it as mandatory requirement for new houses on the basis of its benefits other than water savings (assuming these can be quantified); or
- Attribute a reduction in water use to the presence of a PRV. This is the only way in which PRVs would remain part of the range of possible options for a performance-based regime, so this is the approach adopted in the present study. Where there is no PRV, the water consumption of mains-supplied free-flow uses not subject to flow control (ie 0\* rated showers and taps, and garden irrigation) is increased by

2%. If these uses are met by alternative supply sources, the volumes used are not increased.

**Figure 4 Schematic Diagram of Household Water End Use and Alternative Supply Flow Model**



## Estimated Baseline and Target

### Water

The baseline ('no regulations', or Case B1) water consumption for new homes, modelled using the assumptions and estimates described previously, is summarised in Table 3. Case B1 ('no regulations') homes lack the water-saving measures incorporated in 5 Star homes, including pressure limitation, so a small 'pressure penalty' applies. The usage for households of various sizes is indicated, as well as the weighted average household of 2.67 persons.

**Table 3 Estimated Baseline ('no regulations') annual water consumption, new houses built in Victoria**

Persons	Case B1 Base Usage kl/yr	Case B1 Pressure Penalty kl/yr	Case B1 Total kl/yr(a)	Case B1 Base Indoor (b) kl/yr
1	111.5	1.6	113.1	67.2
2	164.4	2.2	166.6	120.7
3	217.3	2.8	220.1	174.2
4	270.2	3.4	273.6	227.7
5	323.1	4.0	327.1	281.2
6	376.1	4.5	380.6	334.7
2.67(c)	199.8	2.7	202.5	156.6

(a) Corresponds to Case B1 in Table 1. (b) Subtracting estimated outdoor usage of 45.9 kl/yr (including pressure penalty) for all household sizes (c) Weighted average HH size.

The estimated average water consumption of new Class 1 and Class 2 homes with the 5 Star water-saving measures (Case C1) is summarised in Table 4. The base usage is lower than in Case B1 because the showers and taps are 3\* instead of 0\* – all other fittings are identical with the 'no-regulations' case. Also, there is no pressure penalty, because PRVs are installed where supply pressure exceeds 500 kPa.

**Table 4 Estimated annual water consumption, new 5 Star homes built in Melbourne**

Persons	Case C1 Max 5 Star Total kl/yr(a)	50% RWT Saving(b) kl/yr	Case C2 5 Star; 50% with RWT kl/yr(c)	5 Star Indoor(d) kl/yr	% of Baseline		Target Saving kl/yr(e)	
					Class 1	Class 2	Class 1	Class 2
1	102.0	3.4	98.6	53.6	87%	90%	14.5	11.0
2	146.0	6.9	139.1	94.1	84%	88%	27.5	20.6
3	190.0	10.3	179.6	134.6	82%	86%	40.5	30.1
4	233.9	13.8	220.1	175.1	80%	85%	53.5	39.7
5	277.9	14.5	263.4	218.4	81%	85%	63.7	49.3
6	321.8	14.5	307.4	262.4	81%	85%	73.3	58.8
2.67(f)	175.5	8.8	166.7	121.7	82%	87%	35.8	27.0

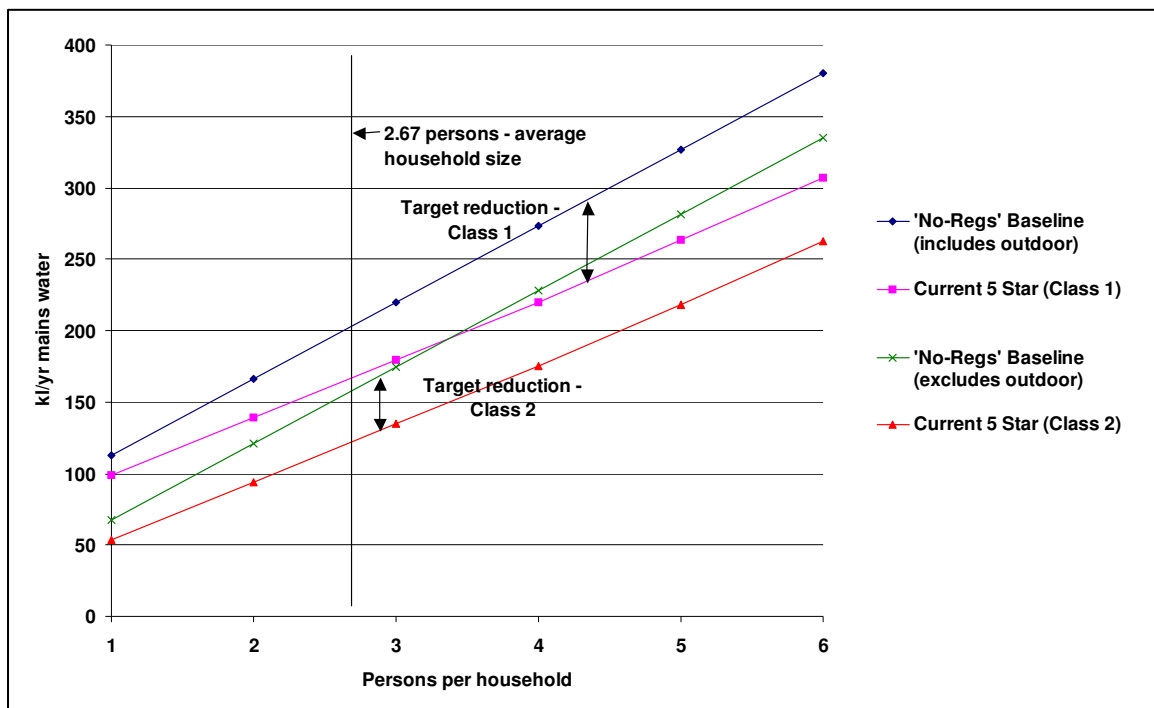
(a) Corresponds to Case C1 in Table 1. (a) 50/2000 RWT, toilet savings only, Melbourne rainfall values (c) Corresponds to Case C2 in Table 1; all 6/3 toilets and RWT installed in 50% of cases. (d) Subtracting estimated outdoor usage of 45 kl/yr (no pressure penalty) (e) Comparing Case C2 'total' water use with Case B1 in Table 3. (f) Weighted average HH size.

Where there is no rainwater tank requirement, the ‘average’ household (2.67 persons) in the average 5 Star home uses 175.5 kl/yr compared with 202.5 kl/yr for the ‘no-regs’ equivalent. This represents a saving of 27.0 kl/yr, or 13% of mains-supplied water. This is the reduction which would have to be achieved in Class 2 homes under a performance-based compliance regime, if the objective that mains water consumption should be no higher than under the present 5 Star regime is to be met.

For Class 1 homes, we know that in 50% of cases there are additional water savings from the presence of a rainwater tank. This is reflected in Case C2 in Table 4. The ‘average’ household (2.67 persons) in the average 5 Star house uses 166.7 kl/yr compared with 202.4 kl/yr for the ‘no-regs’ equivalent. This represents a saving of 35.8 kl/yr, or 18% of mains-supplied water.

The relationship between baseline and target mains water use for Class 1 and Class 2 dwellings is illustrated in Figure 5.

**Figure 5 Proposed Baselines and Targets for Class 1 and Class 2 Dwellings**



It is also possible to compare the modelled target values for new houses with the average water consumption observed in existing houses in the Yarra Valley Water supply area (Table 5 and Figure 6). The most reliable comparison is for indoor water use – the outdoor water use estimated by Roberts (2005) is subject to high uncertainty. On this measure, the average new 5 Star house uses about 28% less mains water for indoor uses than the average existing house, and about 26% less mains water overall.

Figure 7 illustrates the end uses of mains water in the average existing house (Case A2 in Table 1), the ‘no-regulation’ new house (Case B1) and the 5 Star Case (Case C1). The effect of using rainwater for toilet flushing in 50% of 5 Star houses is also

illustrated. (In the houses where RWTs are actually present, of course, they supply all of the toilet flushing requirement).

**Table 5 Estimated annual indoor water consumption, existing houses and new 5 Star houses built in Melbourne**

Persons	Existing houses(a)	Baseline case(b)	5 Star; 50% with RWT(c)	5 Star compared with existing	
				%	kl/yr saving
1	90.7	67.2	53.6	-41%	37.1
2	141.4	120.7	94.1	-33%	47.3
3	183.3	174.2	134.6	-27%	48.7
4	220.3	227.7	175.1	-21%	45.2
5	254.2	281.2	218.4	-14%	35.8
6	285.6	334.7	262.4	-8%	23.3
2.67(d)	170.1	156.7	121.7	-28%	48.5

(a) From Roberts (2005). Outdoor and seasonal use uncertain. (b) From Table 3. Note that Base Case is a hypothetical 'no-regs' worst case, so is higher than the actual average for existing homes for larger households. (c) From Table 4. (d) Weighted average HH size.

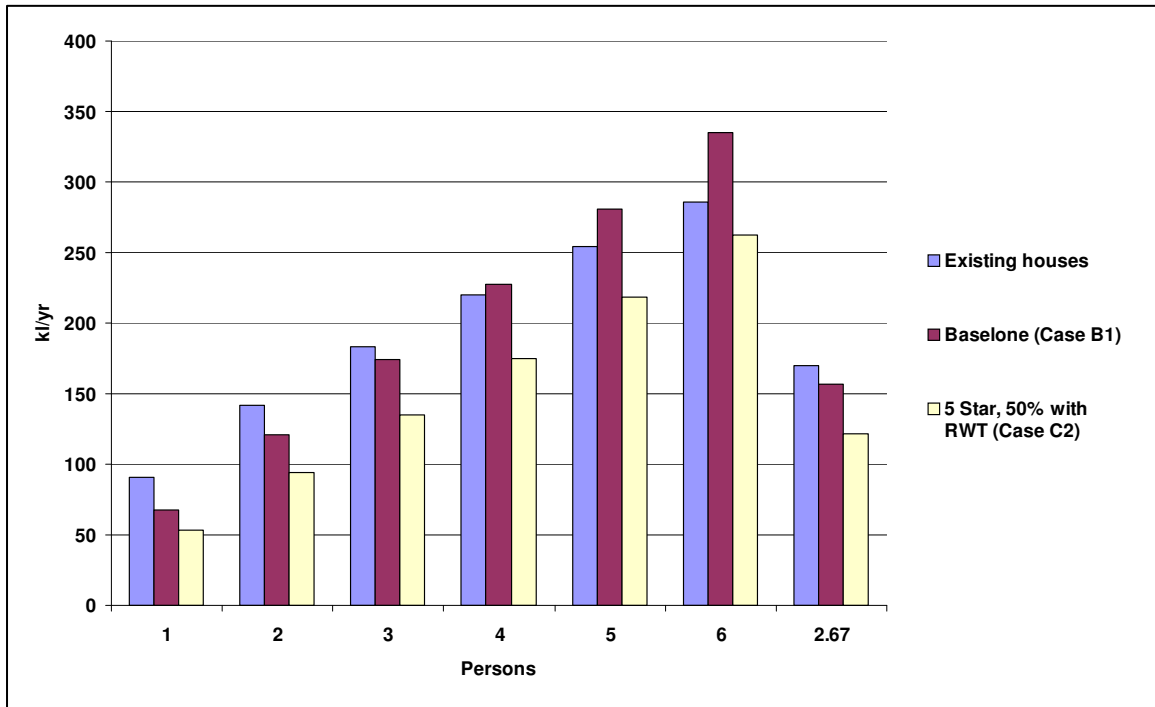
Table 6 summarises the data from the previous tables in relation to an 'average' household size of 2.67 persons. The baseline is Case B1 (202.5 kl/yr potable mains-supplied water) and present regulations are delivering 166.7 kl/yr (Case C2). This means that the target reduction below baseline is 35.8 kl/yr, and this becomes the 'minimum compliance' target for the proposed performance-based approach (Case D1). However, we know that even without regulations at all, new homes would be using less water than Case B1 (ie they would be built to Case B2) and that many homes will be more water efficient than the new regulations will require (ie they will be built to Case D2). This is taken into account in Chapter 4, where total water reductions for Victoria are projected.

**Table 6 Regulatory and Compliance categories: Water use of average size (2.67 person) household**

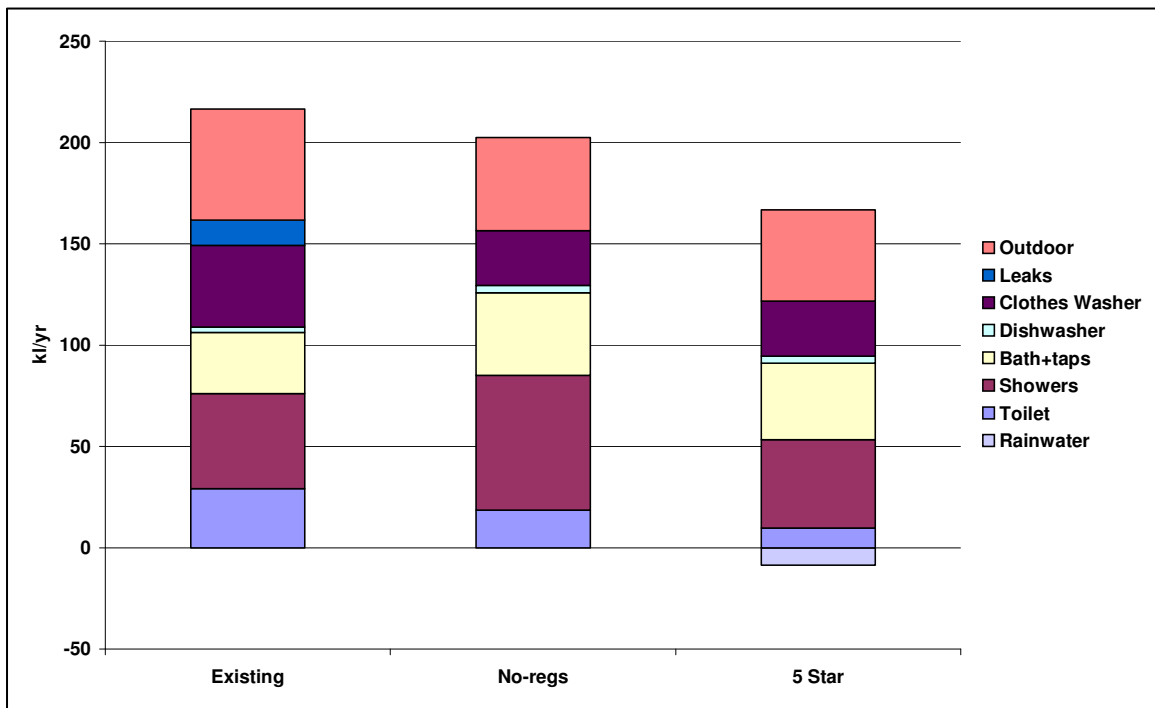
Compliance dimension		Existing homes	New homes – no water saving regs	New homes – 5 star regs	New homes – proposed performance-based
Minimum compliance case		<b>Case A1</b>	<b>Case B1</b>	<b>Case C1</b>	<b>Case D1</b>
	Indoor kl/yr	NA	156.6	130.5	NA
	Outdoor kl/yr	NA	46.9	45.0	NA
	Total kl/yr	NA	202.5	175.5	166.7
Actual/probable case		<b>Case A2</b>	<b>Case B2</b>	<b>Case C2</b>	<b>Case D2</b>
	Indoor kl/yr	170.1	NA	121.7	NA
	Outdoor kl/yr	57.9	NA	45.0	NA
	Total kl/yr	216.0	190.9 (a)	166.7	NA

(a) See Table 20

**Figure 6 Indoor mains water use in existing houses, new 'no regulation' houses and new 5 Star houses, Melbourne**



**Figure 7 End use of water use in existing house, new 'no regulation' house and new 5 Star house, Melbourne (2.67 person)**



## Greenhouse

The current 5 Star measures lead to significant savings in hot water in all new homes, as well as changes in the energy used for water heating in the Class 1 homes which adopt a solar water heater rather than a rainwater tank. The following section quantifies these effects.

Each form of water heating has different energy and greenhouse characteristics, as indicated in Table 7. Electric water heaters convert virtually all the electricity supplied to heating the water. There are also standing losses associated with retaining hot water until it is used, and these are slightly different for peak and off-peak units, but these standing losses are not included in Table 7 since they would be little different for a house with a low-flow shower than with a high-flow shower. The effect of flow rate would be to draw off more hot water during each shower, and hence require more energy to be transferred to the water. Because they exclude standing loss effects, the efficiencies in Table 7 are 'marginal' rather than average – they represent the energy and emissions associated with using or saving an extra litre of hot water at the margin.

Because of the high emissions intensity of electricity supplied in Victoria, electric-boosted solar water heaters have a higher intensity per litre than conventional gas water heaters. This is the reason for the 5 Star requirement that solar water heaters in gas-reticulated areas must be gas-boosted; otherwise there would be an increase rather than a decrease in emissions compared with the most likely alternative. However, solar-electric water heaters are obviously much less emissions-intensive than conventional electric heaters, so lead to significant greenhouse savings in non-gas areas (provided they do not displace LPG water heaters).

**Table 7 Estimated marginal efficiency and greenhouse gas-intensity of water heater types**

Type	Efficiency (a)	kg CO <sub>2</sub> -e/ kWh (b)	kg CO <sub>2</sub> -e/ MJ (b)	kg CO <sub>2</sub> -e/ litre (c)
Elec (Peak)	100%	1.47	0.408	0.051
Elec (OP)	100%	1.47	0.408	0.051
Natural Gas	80%	0.23	0.064	0.010
LPG	80%	0.24	0.067	0.011
Solar-elec	285%	1.47	0.408	0.018
Solar-gas	200%	0.23	0.064	0.004

(a) Ratio of energy into water to electricity or gas supplied. (b) From AGO Factors and Methods 2005

(c) Based on temperature rise of 30°C, 4.186 kJ/°C

It is necessary to estimate the share of different water heater types in new houses, with and without the 5 Star measures. Table 8 indicates the existing water heater mix, which is dominated by conventional gas, and the estimated mix in new homes with and without the 5 Star regulations. Without 5 Star, it is expected that there would be an increase in solar water heater takeup, but only to about 5%, not the 50% apparently being achieved via 5 Star. Given the constraint that solar must be gas-boosted where there is gas reticulated, about three quarters of the solar water heaters being installed in new homes would have to be gas-boosted, because so much of new construction is in gas-supplied areas.

It is assumed that some conventional electric water heaters would continue to be installed in those new homes which select a rainwater tank.

**Table 8 Estimated mix of water heater types**

	All existing Homes (a)	New homes No regs(b)	New homes With 5 Star regs (b)
Elec (Peak)	8.5%	3%	2%
Elec (OP)	20.6%	14%	5%
Natural Gas	67.9%	78%	42%
LPG	1.4%	1%	1%
Solar-elec	0.7%	3%	13%
Solar-gas (c)	0.3%	1%	37%
Wood	0.6%	0	0
<b>Total</b>	<b>100.0%</b>	<b>100%</b>	<b>100%</b>
Solar (all)	1.0%	4.0%	50.0%
Elec (all)	29.8%	20.0%	20.0%
Gas (all)	68.2%	79.0%	79.0%
Wtd kg CO <sub>2</sub> -e/kl(c)	21.9	17.2	11.7

(a) ABS 4602.0 (b) Author estimates (c) Includes small proportion of solar-LPG in areas not reticulated with natural gas. (d) Applying emission factors in Table 7.

From the mix of water heaters, it is possible to calculate a weighted marginal emissions intensity of hot water supplied. This is about 21.9 kg CO<sub>2</sub>-e/litre in existing homes. It would be 17.2 in new houses without the 5 Star regulations, largely because of the loss of market share by conventional electric water heaters to conventional gas. It is estimated to be 11.7 kg CO<sub>2</sub>-e/litre for new houses due to the 5 Star induced takeup of solar water heaters.

The current 5 Star water-saving measures result in about a 26.1 kl/yr saving in indoor water use from showers and taps. About 70% of the water savings (18.4 kl) is hot water. If this were heated by the mix of water heater types in the 'no regulations' case, the saving would be 316 kg CO<sub>2</sub>-e per year. If it were heated by the water heater mix being achieved by the 5 Star measures (ie 50% solar) the savings are only 215 kg CO<sub>2</sub>-e per year. The combined emissions savings being achieved by both the water saving measures and the 50% solar uptake is estimated at 545 kg CO<sub>2</sub>-e per year.

**Table 9 Emission savings due to 5 Star water saving measures and solar water heater requirements**

		Total kl/yr(a)	Hot water		No-regs water heaters		5-Star water heaters		Saving kg CO <sub>2</sub> -e/yr
			%(b)	kl/yr	kg CO <sub>2</sub> -e/kl(c)	kg CO <sub>2</sub> -e/yr	kg CO <sub>2</sub> -e/kl	kg CO <sub>2</sub> -e/yr	
No regs	Showers	66.7	70%	46.7	17.2	802	11.7	546	
	Taps	18.7	72%	13.5	17.2	232	11.7	158	
	<b>Total</b>	<b>85.4</b>	<b>71%</b>	<b>60.2</b>	<b>17.2</b>	<b>1034</b>	<b>11.7</b>	<b>704</b>	
With 5 Star water saving measures	Showers	43.6	70%	30.5	17.2	524	11.7	357	
	Taps	15.7	72%	11.3	17.2	194	11.7	132	
	<b>Total</b>	<b>59.3</b>	<b>71%</b>	<b>41.8</b>	<b>17.2</b>	<b>718</b>	<b>11.7</b>	<b>489</b>	
Saving		26.1	70%	18.4		316		215	<b>545(d)</b>

(a) Weighted average of 2.67 person/HH (b) Calculated from modelling (c) See Table 8 (d) Combined saving from both water saving and solar water heater effects (926-426=499).

These are significant values for the remainder of the analysis. Any set of water saving measures which meets the performance-based water-saving target but which achieves less than 18.4 kl of hot water savings (standardised to a 2.67 person HH) will be saving less greenhouse gas emissions than are being saved by the current requirements. Therefore the hot water impacts of each group of measures will need to be assessed.

Also, given the difficulty of ensuring a 50% solar target, or indeed any other target mix of water heaters under a performance-based requirement, a further element of the current 545 kg CO<sub>2</sub>-e/yr greenhouse savings may be at risk.

# 3. Potential Measures to reduce household water use

## The Approach

### Key Attributes of Measures

The essence of performance-based approach to water saving in new homes is to define the starting point, the reduction target, a list of potential water saving measures and the projected water savings from each. Building applicants can then reach the water saving target by whatever combination of means they wish. In general, these fall into two main categories – measures which increase the efficiency of water usage and/or decrease consumption, and those which substitute other sources of supply for potable mains water.

This section proposes an initial list of permissible measures and the projected water savings from each, or if this is uncertain the way in which the water savings could be calculated. The water savings in each case are estimated in relation to the weighted average of 2.67 persons per household in a Class 1 home with a garden, for which the starting point is 202.5 kl/yr, and the target is 166.7 kl/yr, a saving of 35.8 kl/yr (Table 6).

The following attributes are estimated for each measure:

- (a) The likely reduction in the annual consumption of mains-supplied water;
- (b) The share of water savings likely to be hot water, and so having water heating energy and greenhouse implications;
- (c) The initial capital cost, and the capital cost of regular replacement of essential components over a planning horizon of 50 years. It is assumed that components are replaced at the end of their service life such that the measure retains its initial level of performance over the full 50 years;
- (d) Operating costs, including energy, servicing and maintenance;
- (e) The Net Present Value (NPV) of the initial capital cost, capital replacements and operating costs over a 50 year service life, using a discount rate of 5.2%. This is the discount rate and planning horizon adopted by DSE and used in other recent water policy studies (eg WaterSmart 2006)<sup>5</sup>;
- (f) The NPV per kl of total mains water savings over a 50 year operating life.

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<sup>5</sup> WaterSmart (2006) states 'The metric determined by the Department of Sustainability and Environment is the net present cost over 50 years, divided by the cumulative volume saved over 50 years. The discount rate used was 5.2%' (p8).

The \$/kl NPV of measures is of most interest to policymakers, who wish to assess the likely economic burden on homebuilders and occupants of establishing a performance-based compliance regime, and how this may differ from the current prescriptive regime.

It will be of less interest to building permit applicants, who are likely to select their basket of measures based on the least initial capital cost required to reach the target, and – in the case of project builders – on the marketability of the measures to prospective buyers. Running costs are likely to be a secondary consideration, and the future costs of capital replacement are not likely to figure at all.

## **Risk**

There are at least three main classes of risk associated with each measure: compliance risk, performance risk and persistence risk.

Compliance risk reflects the possibility that measures will not actually be implemented as stated on the building approval documentation. In general, measures that can be inspected at the time of completion and not easily reversed have the lowest compliance risk. (Compliance risk is also related to the availability and cost of complying equipment. For example, as WELS takes effect it may eventually become as easy to buy a 3\* rated tap set as a 0\* rated set).

Performance risk reflects the possibility that measures, even if installed as stated, will not yield the projected water savings, due to variations in occupant behaviour or other factors.

Persistence risk reflects the fact that in many cases a measure will have a service life of significantly less than 50 years, and if the entire product or key components are not replaced (or replaced with less water-efficient substitutes) the savings in the initial years will not be sustained for the entire 50 year period. All measures, including the current 5 Star measures, carry risks of this kind. For example, there appears to be nothing to prevent a householder replacing a solar water heater with a conventional type when the unit fails, or having toilets plumbed directly to the mains supply once the pumps attached to a rainwater tank need replacement.

Persistence risk could be reduced by programs which encourage, or offer financial incentives for householders to maintain the water-efficiency of installed measures through proper maintenance and replacement. However, the possible existence or success of such programs in the future is difficult to factor in when assessing the likely performance of a set of measures to be incorporated into a building today. Therefore it has been assumed that all measures will be maintained and/or renewed for the full 50 year period, ie there is no distinction between measures on the basis of persistence risk.

With respect to performance risk, there appears to be a clear hierarchy. The least performance risk is with plumbed fixtures and fittings which save water as a byproduct of normal, universal household activities – showering, toilet flushing, tap use and clothes washing – and which do not require special actions or behaviours to realise their water-saving potential. Examples are low-flow shower roses and dual pipe recycled water connections.

There is a moderate level of performance risk with products which are hard-plumbed and hard-wired, but where the realisation of the water-saving potential still relies on special action by the occupants, or on naturally variable factors such as rainfall. Examples include demand-activated water recirculators, where users must press a button to ensure that the initial flow of water is at the required temperature; there is a risk that some users will not do this, and run the first flow to waste. The use of rainwater to displace mains water also carries a moderate level of performance risk due to natural rainfall variability, but this can be reduced by adequate storage volume.

The highest level of performance risk is where the water savings rely on products which are easily removable, or on behaviour that is highly variable. Examples include pool covers, which may never actually be used even if installed, and garden irrigation, where there is almost an infinite range in behaviours and water/plant/soil interactions.

Following discussions with the Steering Group, the following classes of measures have been excluded on the basis of unacceptable compliance risk (even though they are admissible for gaining points towards compliance with the BASIX target in NSW):

- Clothes washers and dishwashers. The undertaking to install models above a given level of water-efficiency is considered to have an unacceptably high compliance risk, since units can easily be removed after inspection (even though the performance risk is low and the persistence of the savings is assured at least for the life of the appliance). Also, the WELS program should separately lead to increases in the average water-efficiency of all new clothes washers and dishwashers sold;
- Areas or styles of gardens or landscaping, or selection of 'water-efficient' plants. Gardens are rarely established at the time of building completion, and layouts, areas and plantings and can all be easily changed. There is also a very wide range in garden irrigation technologies, management practices and water/plant/soil interactions. This combination of high compliance risk, high performance risk and high persistence risk makes it almost impossible to establish a reliable predictive link between likely irrigation water use and the information available to Building Surveyors or Building Inspectors.

However, the Steering Group has requested that the potential for use of some water for garden irrigation should be taken into account in evaluating those alternative water supply measures where the initial application of the water is for indoor uses. Therefore the presence of a 'garden' (perhaps defined as a minimum area of unpaved, potentially plantable area) will be a necessary factor in such cases. Beyond that, the area, style or actual plants used should not matter for the purpose of compliance.

As it happens, this issue has not arisen in the present report. As the proposed water use targets would have to be achieved with indoor water use alone, the outdoor water use benefits of a measure would not enter the compliance evaluation. However, they may determine the attractiveness and ranking of measures for home builders who are planning to plant gardens. Leaving decisions about garden design and watering to home builders (in the light of their knowledge of permanent water saving measures and expectations of possible future restrictions on outdoor water use) is consistent with the more flexible approach proposed.



## Increasing Efficiency of Use

The range of technical options which reliably increase the efficiency of water use in typical dwellings is fairly limited. Of course, householders can use the same equipment in more or less water-efficient ways – eg by varying their shower times or selecting water-saver settings on appliances – but that applies to all technical options and is beyond the scope of the present study.

For products always present in dwellings, such as showers, taps and toilets, only the cost difference, or premium, of the water-efficient version compared with the base version needs to be taken into account. For optional products such as hot water recirculators, the entire capital and installation cost needs to be taken into account.

### Indoor

#### Showers

As the baseline case assumes that showers have no flow controls, flow-controlled shower heads should be part of the menu of permitted water-efficiency measures. It would also be logical to include the option of a wider range of flow rates than the current prescriptive 3\* shower heads (nominal flow rate of 7.5 to 9.0 l/min), ie:

- 2\* shower heads (with a nominal flow rate of 9.0 to 12.0 l/min; these will still be available under the WELS scheme, but will have to be labelled); and
- 4\* or higher rated shower heads, in the event that these are introduced to the market (ratings higher than 3\* are not currently available under AS/NZS 6400.2005, pending resolution of performance issues). Such shower heads would have a flow rate of less than 7.5 l/min.

There are several AA rated shower heads (corresponding to 2\*) currently registered under the WSAA voluntary labelling program, and these still represent a reduction in flow rate compared to uncontrolled showers. However, 1\* showers should not be given water saving credits, since AS/NZS allows them a flow rate up to 16 l/min, which is as high as many non-flow-restricted showers.

The estimated average flow rates (based on observations in Roberts 2005) and annual water savings compared with the baseline are summarised Table 10. The table also summarises the estimated cost premium for two shower heads in the dwelling.

**Table 10 Shower heads – estimated water savings and costs**

Shower head rating	Flow rate for modelling (l/min)	Annual kl/yr used (2.67 pers/HH)	Annual kl/yr savings cf baseline	Capital cost premium (2 heads/HH) \$
0* (baseline)	10.5	66.7(a)	NA	NA
2*	8.0	49.8	16.9	20
3*	7.0	43.6	23.1	30
4* or higher	6.3	39.2	27.5	45

(a) Includes 2% loading if no pressure limitation on house supply.

It is estimated that the shower heads last 25 years, and so have to be replaced once over the 50 year projection cycle. There are no other operating or service costs. The cost of mains water savings over 50 years is a very low \$0.03 to \$0.04/kl (see Table 16). As 70% of the water savings is hot water, there are also significant energy and greenhouse savings.

### ***Taps***

The baseline case assumes that taps have no flow controls, so flow-controlled taps should be part of the menu of permitted water-efficiency measures. As the measured reduction in water use in homes equipped with low-flow taps is low, only 3\* or higher-rated categories should be given any credit for water savings.

The estimated average tap flow rates (based on observations in Roberts 2005) and annual water savings compared with the baseline are summarised Table 10. There are no savings associated with volumetric (fill) uses. The table also summarises the estimated additional costs of installing four sets of 3\* taps in the dwelling (kitchen, 2 bathrooms and laundry) It is estimated that the taps last 25 years, and so have to be replaced once over the 50 year projection cycle. There are no other operating or service costs. The costs of mains water savings over 50 years is \$0.68/kl (see Table 16). As 71-72% of the water savings is hot water, there are also significant energy and greenhouse savings.

**Table 11 Taps– estimated water savings and costs**

Shower head rating	Flow rate for modelling (l/min)	Annual kl/yr used (2.67 pers/HH) free flow+volume	Annual kl/yr savings cf baseline	Capital cost premium (4 tapsets/HH) \$
0* (baseline)	3.5	18.7(a) + 22.0	NA	NA
3*	3.0	15.7+22.0	3.0	80

(Includes 2% loading if no pressure limitation on house supply)

### ***Lower toilet flush volumes***

Selection of a 4.5/3 litre (4\*) dual flush toilet design instead of a 6/3 litre (3\*) model would reduce annual water use for flushing. The estimated reduction is sensitive to assumptions about the ratio of full to partial flushes and whether these would be the same for toilets of all flush volume configurations.

Table 12 indicates the estimated water use for dual flush toilets, as assumed in the relevant Australian Standard, and as observed in the field. Roberts (2005) reports that 6/3 toilets appear to be full-flushed 70% of the time, rather than the 20% assumed in the Standard. This may indicate a general design problem with the trap, so that the larger flush volumes are needed to clear it. Yarra Valley Water and the sanitary-ware manufacturer Caroma are conducting a trial of 4.5/3 litre models, and YVW reports that the full-flush ratio has fallen to 50%.<sup>6</sup> This implies that improvements in bowl and trap

<sup>6</sup> P. Roberts, pers comm January 2006

design mean that users are selecting full flush less often, but still more often than assumed in the Standard.

Using the 20% full flush ratio in the Standard indicates an average water saving potential of only 1.2 kl/yr (14.7-13.5; Table 12). A 50/50 ratio indicates a water saving of 3.1 kl/yr (18.4-15.3), and this is used for modelling purposes. If the additional reduction in full flush ratio due to design improvement is factored in, the saving could be as high as 5.6 kl/yr (20.9-15.3).

**Table 12 Estimated annual water use for toilet flushing**

Type	% of flushes full	% of flushes partial	Annual kl/yr used (2.67 pers/HH)	Annual kl/yr savings cf baseline
6/3 litre dual flush (3*)	20% (a)	80% (a)	14.7	NA
4.5/3 litre dual flush (4*)	20% (a)	80% (a)	13.5	NA
6/3 litre dual flush (3*)	70% (b)	30% (b)	20.9	NA
6/3 litre dual flush (3*)	50% (c)	50% (c)	18.4(d)	NA
4.5/3 litre dual flush (4*)	50% (c)	50% (c)	15.3	3.1

Assumptions: 4.2 flushes per day per person (a) Assumed in AS/NZS 6400 (b) Observed (Roberts 2005) (c) Assumed for modelling (d) Used as baseline

It is estimated that the average purchase price premium for 4 star models over 3 star models is about \$60 at present (GWA 2005). Assuming an average of two toilet suites per new dwelling, the initial capital cost premium would be \$120. It is assumed that this premium will halve after 25 years,.

Unlike taps and shower roses, there are few additional components or extra materials involved in producing higher rated toilets. The current costs premium largely reflects the amortisation of the costs of changes in production . It is assumed that this premium will fall by 75% over the next 10 years as more production switches over to 4\* models. It is also assumed that toilets have a 25 year service life – probably due to bathroom remodelling or home renovation rather than mechanical failure. There are no other operating or service costs.

The costs of mains water savings over 50 years is a low \$0.83/kl (see Table 16). As none of the water savings is hot water, there are no energy or greenhouse savings.

### ***Waterless toilets***

‘Waterless’ toilets are dry sanitation systems that do not use water to treat or transport human waste. They do not require water for flushing and are not connected to the sewer – indeed the addition of water would disrupt the decomposition of waste.

There are several types available, including

- continuous composting: the waste is deposited in a single container, decomposes as it moves slowly through the container and is then removed as compost from the end-product chamber.

- batch composting: two or more containers are alternated, so the 'active' container is being filled while the waste pile in the 'fallow' container/s has time to compost without the risk of re-contamination.

Waterless toilets are not direct substitutes for conventional toilets. They require regular maintenance (by the householder or a contractor), including movement or rotation of the bins, removal of the compost and (in some designs) the addition of supplementary material to the waste to aid decomposition. They may also incur energy costs for ventilation fans (typically a 5W fan using about 44 kWh/yr), and possibly for electric heaters to aid decomposition in colder areas. The cost of waterless toilets can range from \$1,500 to \$5,000 per unit depending on design.<sup>7</sup> This does not include the cost of installation or the additional building costs to accommodate the chamber/s under the toilet. The service life of individual components varies with the design but many items would need replacement over a 50 year period.

The costs of a conventional WC pan and cistern and the associated plumbing work would be avoided, but in sewered areas a sewer connection would probably still be required.

However, waterless toilets are most often used in areas where water availability is limited and/or waste disposal is costly. This generally means unsewered areas not served by reticulated water supply. In such cases there would be no mains water savings, since any water used by a flushing toilet would presumably come from an alternative non-mains supply such as rainwater.

This makes it difficult to envisage a situation where a waterless toilet would actually lead to mains water savings. Nevertheless, if a homebuilder chose to install one or more composting toilets *in a house with access to reticulated water*, then the toilet would represent a nominal mains water saving of 18.4 kl/yr compared with baseline toilet flushing use (see Table 12).

The costs of mains water savings, if such savings are achievable at all, would depend on wide range of factors. Table 12 gives an estimate of nearly \$ 6.5 per kl, based on the following indicative estimates:

- Initial cost premium of \$2,000 compared with the conventional WC alternative;
- Annual running cost for a 5W fan plus an annual expert maintenance call costing \$200;
- Replacement of bins, fans and other items after 25 years, at a total costs of 50% of the initial capital cost.

This does not place any value on the compost produced, which may represent either a desirable byproduct or a disposal burden, depending on the householder's situation and viewpoint. Nor does it place any monetary value on the cost of the householders' time for routine maintenance, etc.

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<sup>7</sup> <http://www.greenhouse.gov.au/yourhome/technical/fs27.htm>

### ***Hot Water Recirculators***

When users turn on a hot tap, some time elapses before the water flow reaches an acceptable temperature. This period depends on:

- The temperature of the water in the pipe between the water heater and the draw-off point, which will depend on the interval since the previous drawoff and the rate of heat loss from the pipe; and
- The volume of water between the water heater and the drawoff point, which will depend on the length and diameter of pipe.

The time delay is highly variable, depending on the type of water heater, the distance to the outlet and the pattern of drawoffs, but a range between about 15 seconds and 3 minutes is common. At a flow rate of 7 litres/min, say, this delay would represent between 2 and 21 litres from a cold pipe start. The user may either let the sub-temperature water run to waste (usually the case for showers) or may accept it (as is often the case for filling baths and sinks, and when dishwashers and clothes washers call for hot water).

If the water heater is of the 'instantaneous' (IWH) type there will be a further time delay of 15 to 30 seconds (2 to 3.5 litres at 7 litres/min), the interval between the flow starting and the heat exchanger reaching the target temperature. On the other hand, IWHs do not lose water through reheat expansion, unlike storage water heaters, which typically lose 4 to 6 litres daily. (Some older designs of IWH require relatively high flow rates to activate the burner, and so are incompatible with low-flow fittings).

Thus there are four distinct sources of water loss (and energy loss, if the water lost has been heated):

- The expansion loss from storage type water heaters (all energy types);
- The water lost in frost protection (some designs only, in frost-affected areas only);
- The heat up loss from instantaneous water heaters (all energy types); and
- Dead run loss (all energy and system types).

There is very little actual measurement of these losses in the field, although there is no doubt they are significant. Most estimates are based on limited laboratory tests and on computer modelling. A large number of households would need to be monitored to get a representative sample, because of the very wide range of plumbing layouts and user behaviours. Typical estimates of the average water loss in Australian homes range up to 30 kl/HH/yr, but the high end estimates tend to illustrate extreme cases, and assume that all sub-temperature water runs to waste.

For modelling purposes, a representative average loss of about 8.6 litres/person/day has been estimated, with a 0\* shower. This amounts to 8.4 kl/yr for a 2.67 person household. For a 3\* shower, the estimate falls to 6.8, kl/yr.

There are several types of products available for reducing waiting time and water losses, through one or more of the following strategies:

- Keeping hot water circulating through a loop at all times through pumping or natural thermosyphon action, so that whenever hot water is required there is almost no waiting time. This strategy tends to be very energy-intensive, because of the constant pump operations and heat losses from the loop, and tends to be reserved for commercial uses such as hotels;
- Restricting the period of pumped circulation to the main water use periods, with a time clock. The operation can be further restricted by a temperature switch, so that if the water in the loop is hot from a recent drawoff the pump ceases operation;
- Conscious on-demand pump circulation: users press a button to activate the pump, and either wait for a light to indicate that hot water is available at the tap or know that hot water will be available within, say, 1 to 2 minutes. In the interim, the pump circulates water via a return loop through the water heater to bring it up to temperature;
- Automatic diversion of sub-temperature water into the cold water supply, so water only comes out of the hot tap when it reaches temperature. The diverted water can go back into the mains cold supply (if permitted), to flexible bladders or to a rainwater tank, if installed. Some designs work via pressure differentials only, while others require pumps.

All general-purpose recirculators (serving more than one drawoff point) are likely to save about the same amount of water if applied to a given household plumbing layout, but there are major differences in capital cost and energy use.

The California Energy Commission (CEC) has concluded that the only recirculator option that would lower the hot water system operating cost, compared with no system, would be the demand-controlled pump. This is the only design given 'sustainability points' in the NSW BASIX rating system (GWA 2005a).

In theory automatic diverters will have the highest probability of water savings (ie the lowest performance risk), since sub-temperature hot water will not be available. However, there may be complications of cold water balance and loss, if the cold tap can be turned on during the period that supply is being diverted from the hot tap.

Several manufacturers of gas water heaters offer on-demand recirculators purpose-designed to interface with the electronic controls of their products. These would add about \$800 to the initial cost, if installed at the time of construction.<sup>8</sup>

The costs of mains water savings would depend on wide range of factors. Table 12 given an estimate of about \$2.64 per kl, based on the following indicative estimates:

- Initial cost of \$800 for the pump unit and controllers at two showers;

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<sup>8</sup> Rinnai, personal communication

- Annual standby electricity costs for 1W per controller and running costs for a 30W pump running only during diversions. This amounts to only a few minutes per day, so the pump is relatively lightly loaded and should last for as long as the water heater.
- Replacement of the pump every 12 years (when the water heater needs replacement, so there are no extra callout costs), at 30% of the initial capital cost (ie \$240).

About 50% of the water savings by a recirculator will be 'hot', since the water flow discarded would have started cold and would have had to rise to temperature to be accepted – ie the temperature rise in the discarded water would have averaged about 50% of the rise needed to make the temperature acceptable.

### ***Pressure Reduction***

The PIC (2004) estimates that the cost of a pressure limiting valve is \$150. It is assumed that valves will have to be replaced every 25 years. The water savings attributed to pressure limitation are estimated at 2.6 kl/yr for a 2.76 person household (Table 3). This indicates a cost of \$1.46 per kl savings (Table 12). It is estimated that about half the water saved is hot.

## **Outdoor and Seasonal**

The occupants of virtually every home will use water in similar ways for each of the indoor end uses: drinking, cooking, personal washing, clothes washing and toilet flushing. It is therefore possible to estimate an average water consumption and to set a reduction target for all new homes that covers those end uses. Outdoor and seasonal uses, on the other hand, are not present in all homes, and if present are subject to high variability.

### ***Garden Irrigation***

Measures which *only* target garden irrigation (as distinct from the possible irrigation use of alternative water supplies installed primarily to meet indoor water demand) should not be part of a performance-based regime, because there is no reliable way to assess their impacts.

The most effective means of containing garden watering demand are the Permanent Water Saving Rules restricting watering times and requiring trigger nozzles to be fitted to hand-held hoses.

The Smart Approved WaterMark labelling, which covers an increasing number of irrigation system components, should also contribute to the adoption of more water-efficient irrigation products and practices.

### ***Swimming Pools***

There is a range of possible approaches to a swimming pool which forms part of a building application.

- require design features which will tend to reduce the swimming pool's on-going water loss and hence on-going top-up requirements; or
- require water savings equivalent to the volume of the pool (or some multiple of it).

The NSW BASIX scheme takes the former approach. It gives credit for the installation of a retractable pool cover, for a shade cloth or solid structure over at least 50% of the pool surface, and for a solid fence or 'dense vegetation' to shelter the pool from the direction of the prevailing winds. Although all of these measures represent good practice in pool design and management, the performance risk in relation to actual water savings is high – for example, there is no way of ensuring that shade cloth will not be removed, that the pool cover will be used, or that a vegetation barrier will be correctly sited and maintained.

Victoria has already adopted the second approach (offsetting water savings) in the Permanent Water Saving Rules, which state that:

Before filling a new pool or spa that has a capacity of 2000 litres or more, customers need to complete a Water Conservation Plan (WCP) application and submit it to their government water retailer for approval.

The WCP requires customers to identify areas where they can make savings both inside and outside their home, to offset the volume of water required to fill the pool or spa. For example, savings can be made by installing AAA rated shower heads and dual flush toilets. Previous water savings will also be considered.

Water saving activities agreed in the WCP should be in place before construction of the pool is complete. Random auditing will be undertaken to ensure the water saving activities are implemented.

A WCP application can be obtained from your government water retailer. New pools or spas that hold less than 2000 litres of water can be filled without a WCP application being lodged (*Permanent Water Saving Rules: Fact Sheet - Pools and Spas*).

When a new swimming pool is part of a building application, it may be efficient to integrate the WCP with the performance-based water saving measures.

This could be done by increasing the water-saving target by the volume of the swimming pool averaged over a period of, say, 10 years. (This still under-states the on-going water impact of a pool, which may lose half to all of its volume each year). For example, the target for a 4-person house is a reduction of 53.5 kl/yr in mains water use from the 'no regulations' baseline (Table 3). If the building application included a 60,000 litre pool, say, the target would increase by 6 kl/yr to 59.5 kl/yr.

This would require the installation of more water-efficiency measures, or for greater alternative supply capacity. Consideration should also be given to the possibility for using the alternative water supply for pool filling and top-up, although this may be restricted to rainwater (Table 14).

## *Evaporative Coolers*

Unlike swimming pools, fixed evaporative coolers may not need building approval, even if installed at the time of building construction.<sup>9</sup> If so, then building regulations could not include the water consumption of evaporative coolers within a performance-based water saving target.

The WELS scheme is likely to be the most effective approach to promoting greater water-efficiency in evaporative coolers, and this product has been recommended for inclusion in the next phase of the WELS scheme (GWA 2005a). The main characteristics which influence the water use of different models are:

- The mode of management and replacement of the water in the reservoir;
- The volume of the reservoir sump; and
- The pattern and frequency of reservoir dumping.

For example, a unit with a constant ‘bleed’ rate from the reservoir will use more water than one which monitors water quality and only dumps water when necessary, and a unit with a large volume sump which empties after each operating session will use more water than one with a small sump which empties every two days. These factors can be used to develop a water-efficiency rating scale.

If the water consumption of evaporative coolers installed at the time of construction *can* be included in the proposed performance-based regulatory regime, the options for dealing with them would be:

- require new evaporative coolers to have a minimum level of water-efficiency on the WELS rating scale (this relies on the development of national WELS labelling for evaporative coolers – it would be onerous and inconsistent with the WELS regime for Victoria to develop a rating scale on its own); or
- as with swimming pools, increase the home water-saving target by a proportion of the annual estimated water use of the evaporative cooler. For modelling purposes, it is estimated that the presence of an evaporative cooler accounts for 18 kl/yr, of which 10 kl is used in cooling and 8 kl is lost. The water saving target of the home could be increased by, say, half the estimated loss (4 kl/yr). This would require the installation of more water-efficiency measures in the home, or greater alternative supply capacity. Consideration should also be given to the possible use of alternative water supply for evaporative coolers (the recent report *A Framework for Alternative Urban Water Supplies* (DSE 2006) is silent on this). Rainwater would certainly be suitable, and Class A recycled water may be suitable, subject to assessment of the risks.

If the water saving burden created by including evaporative coolers in building applications were too onerous, home-owners would have an incentive to simply install the coolers later, after the home had been completed and inspected. If controls on cooler installation in existing dwellings were to be retained (or newly imposed), with

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<sup>9</sup> Portable evaporative coolers definitely do not need building approval, so cannot be covered.

planning requirements analogous to swimming pools, householders would have a greater incentive to install refrigerative air conditioning instead. Although these do not use water, they will contribute to peak electricity demand, and so exacerbate the already serious peak demand problems which the Victorian electricity system experiences each summer.

In fact, refrigerative air conditioners have already gained market share from evaporative coolers in Victoria, and this trend is projected to accelerate. The historical capital cost advantage of evaporative coolers over air conditioners is rapidly eroding. Between 2001 and 2004 the annual sales of evaporative coolers in Victoria remained constant at about 30,000, while the annual sales of refrigerative air conditioners (nationally) increased at 12% per annum, from 580,000 to 810,000 (GWA 2005a).

ABS data (4602.0) indicate that the ownership of evaporative coolers in Victoria increased steadily from about 17% of households in 1994 to 30% in 2002, but then plateaued to reach 31% in 2005. It is likely that the ownership rate has peaked and will now decline, as it has already begun to do in WA and SA, which have historically been the other major evaporative cooler markets in Australia.

**Table 13 Summary of water efficiency measures, recycled and greywater options**

Measure	Initial capital cost (a) A	Annual operating cost (b)	Annual service cost(c)	Capital replacement period	% initial capital cost (d)	NPV recurrent costs (e) B	NPV cap replacement (f) C	Total NPV(g) D	Total kl/yr saving (h) E	Total hot water kl/yr savings	NPV \$/kl savings (i)
2* shower roses	\$20	\$0	\$0	25 yrs	100%	\$0	\$5	\$25	16.9	11.8	\$0.03
3* shower roses	\$30	\$0	\$0	25 yrs	100%	\$0	\$8	\$38	23.1	16.2	\$0.03
4* shower roses	\$45	\$0	\$0	25 yrs	100%	\$0	\$12	\$57	27.5	19.3	\$0.04
3* taps	\$80	\$0	\$0	25 yrs	100%	\$0	\$21	\$101	3.0	2.1	\$0.68
4.5/3 litre toilet	\$120	\$0	\$0	25 yrs	25%	\$0	\$8	\$128	3.1	0.0	\$0.83
Waterless toilet	\$2,000	\$8	\$200	25 yrs	50%	\$3,688	\$268	\$5,955	18.4	0.0	\$6.47
HW recirculator	\$800	\$3	\$0	12 yrs	30%	\$60	\$249	\$1,108	8.4	4.2	\$2.64
Pressure reduction	\$150	\$0	\$0	25 yrs	100%	\$0	\$40	\$190	2.6	1.3	\$1.46
Recycled water – T only	\$2,800	\$14	\$0	50 yrs	100%	\$254	\$0	\$3,054	18.4	0.0	\$3.32
Recycled water – T + CW	\$3,000	\$30	\$0	50 yrs	100%	\$528	\$0	\$3,528	38.2	0.0	\$1.85
Recycled water – T + CW + I	\$3,000	\$65	\$0	50 yrs	100%	\$1,150	\$0	\$4,150	83.2	0.0	\$1.00
Greywater – T + CW	\$7,000	\$33	\$200	12.5 yrs	100%	\$4,125	\$1,481	\$12,606	38.2	0.0	\$6.60
Greywater – T + CW + I	\$7,000	\$72	\$200	12.5 yrs	100%	\$4,164	\$1,481	\$12,645	83.2	0.0	\$3.04

Source: Author estimates (a) For shower rose, taps and toilets, which are installed in all homes, only the cost premium compared with lowest-capital cost option is give. For other products and options, the initial capital cost covers initial purchase and installation. (b) Energy and recycled water charges, if applicable (c) Inspection or maintenance. (d) Cost of replacing capital items as a % of initial capital cost. (e) NPV (at 5.2% discount rate) of 50 year stream of operating and service costs. (f) NPV (at 5.2% discount rate) of capital replacement costs incurred over 50 years. (g) Sum of values in columns A, B and C. (h) Estimated saving if measure applied on its own to a house with baseline water efficiency characteristics, with 2.67 occupants. Some measures interact, which means their combined water savings is somewhat less than the sum. These interactions need to be modelled for all measures selected together. (i) \$ value in column D divided by 50 times kl/yr value in column E.

## Alternative water supply options

The three most widely available alternatives to reticulated potable water ('mains') supply for single dwellings are rainwater tanks, reticulated recycled water and greywater (ie water that is recycled on the same site).

For apartments, individual rainwater tanks or greywater reuse is not practical, but there may be opportunity for collection of rainwater and stormwater in communal tanks. While reuse of untreated greywater may not be possible, communal collection and treatment of greywater may be economic.

## Uses of alternative water

While there is broad agreement across Victoria on the way in which alternative water supplies may be used, there have been considerable differences in the detailed conditions imposed by various local authorities and water supply authorities. This has hampered the development of some alternative supply options. In February 2006 DSE published a discussion paper, *A Framework for Alternative Urban Water Supplies* (DSE 2006) as part of an effort to standardise the rules for alternative water use. The options for alternative water use covered in this study are consistent with the proposals in the DSE discussion paper.

No alternative supply is recommended without reservation for all household uses. Rainwater is of course routinely used in rural areas for all purposes, but there is some risk that pollutants (eg from motor vehicle exhausts or solid fuel heaters) and pathogens (from animal and bird droppings) could be washed into the tank. For this reason, public health authorities do not recommend that rainwater be used for drinking or food preparation where reticulated drinking water is available.

According to DSE (2006) all forms of alternative water supply should generally be usable for toilet flushing, garden irrigation and cold supply to clothes washer (although untreated greywater must be used within 24 hrs or dumped to sewer, and if used in gardens should be distributed by subsurface irrigation and in conditions where nutrients or toxins cannot accumulate or be washed from the site).

**Table 14 Usage and benefits of alternative water supply options, Class 1 dwellings**

	End use	Rainwater tank	Recycled (Class A)	Greywater untreated	Greywater treated
Least sensitive	Toilet flushing	Yes	Yes	Yes	Yes
	Garden irrigation, car washing	Yes	Yes	Yes	Yes
	Cold supply to clothes washer	Yes	Yes	Yes	Yes
	Swimming pool and spa pools	Yes	No	No	No
	Evaporative coolers, fountains	Yes	Possible	No	No
	Cold water supply to dishwasher	Yes (a)	No	No	No
	Personal washing (hot & cold)	Yes (a)	No	No	No
Most sensitive	Drinking, cooking (hot & cold)	Yes (a)	No	No	No
Stormwater retention		Yes	No	No	No
Sensitivity to management and regular drawoff		High	No	Medium	Low

Consistent with (DSE 2006); (a) Where a reticulated drinking water supply is available, it is recommended that the supply be used for this purpose

The use of rainwater collected (from a range of roof areas) in tanks (of a range of volumes) for supplying one or more of toilet, clothes washer cold supply and garden irrigation has been modelled. The possibility of supply to hot water has also been modelled, although it appears to conflict with the requirement that 'where a reticulated drinking water supply is available, it is recommended that the mains supply be used for this purpose.' If only a single water heater is installed, it must be assumed that water passing through it could be used for drinking or food preparation. The alternative would be two water heaters: mains-fed for the kitchen and rainwater-fed to all other outlets.

For household water use modelling purposes, dual pipe recycled, treated greywater and untreated greywater could all *in theory* be directed to toilet use first, then clothes washer, then irrigation (although some householders may not wish to use untreated greywater for clothes washing, even if permitted).

Nevertheless, there are important qualitative and quantitative differences between these alternative supply sources:

- Dual pipe recycled water is essentially unconstrained in its availability, and there is no significant health risk from poor on-site maintenance;
- The availability of on-site treated greywater is constrained by the volume produced and the capacity of the treatment and holding tanks, and there is some health risk from poor on-site maintenance. If both the laundry and the bathroom waste are connected the greywater availability will obviously be higher (it is recommended that kitchen waste not be connected);
- The availability of on-site untreated greywater is also constrained by the volume produced, and the need to empty the tank every 24 hours further limits the options for balancing supply with time-specific demands such as toilet flushing and clothes washing. Also, there is some health risk from inappropriate or excessive use of untreated greywater in garden irrigation.

Given the limitations on the contributions that *untreated* greywater can make to indoor water demand, and the unacceptably high performance risk of measures which serve only, or predominantly, to offset garden irrigation, it is recommended that untreated greywater options not be permitted as part of a performance-based water saving regime. Alternatively, if they are to be permitted, the calculated water savings should be heavily discounted (eg by 50%).

Untreated greywater options have not been modelled.

It is understood that some developers are negotiating the use of dual pipe recycled water in evaporative coolers and water features, which are more sensitive uses because droplets can be aerosolised, and in swimming pools, where there is both body contact and the possibility of drinking. If the approach is adopted that where evaporative coolers or swimming pools are installed, a given percentage reduction in their 'base' mains water use is required, the use of recycled water would obviously meet this.

## ***Considerations in Class 2 Dwellings***

In a performance-based approach, Class 2 dwellings would also be able to use alternative water supply as an adjunct, or even a complete alternative, to water-efficiency measures within dwellings. (Targets or measures for water use in communal garden areas or communal facilities such as swimming pools have not been considered in this study, since they do not figure in the current 5 Star regime).

Dual pipe recycled water could easily be used for toilet flushing and clothes washer cold supply in dwellings in Class 2 buildings in the same way as in Class 1 buildings. However, space constraints in multi-dwelling buildings would probably mean that rainwater, stormwater and greywater systems would be communal rather than separate.

*A Framework for Alternative Water Supplies* (DSE 2006) proposes that communally collected rainwater should be useable for the same purposes as rainwater collected in single-house tanks. However, it proposes that the use of communal stormwater and greywater for toilet flushing and clothes washer cold supply should be subject to 'control' – ie the building proponent would need to demonstrate that the health risks of supplying such water to individual dwellings were adequately addressed. The costs of ensuring that this is so may be prohibitive, but if that is the case the applicant can choose to meet the target by water-saving measures – either the same ones as are currently required, or on an alternative set which meets the performance target.

## **Rainwater**

Rainwater tanks may be used as one of the additional compliance options for the present 5 Star requirements. The other alternatives are the installation of a solar water heater and the use of reticulated recycled water if available.

The minimum storage volume for compliance is 2,000 litres, supplied by not less than 50m<sup>2</sup> of roof area, and the rainwater tank must be plumbed to supply all toilets in the house. In nearly all cases this means installing a pump, because gravity feed is hard to arrange. The installation of first flow diversion devices is also recommended, so roof pollution is not washed into the tank. Valves must be installed at various points to bring backup mains water to the toilets in case the tank runs dry and to protect against the risk that rainwater could backflow into the mains.

There is considerable difference in estimates of rainwater tank costs (Table 15). The typical cost, based on the price of labour and components, is in the range \$2,300 to \$3,700, although some builder charges for the rainwater tank option are higher or lower than this range. The costs do not include the cost of roof guttering and plumbing, which would need to be provided in any case, or of any design or construction costs associated with arranging the roof layout to maximise water flow to the tank.

One benefit of a rainwater tank compared with recycled or greywater is the capability to reduce the flow of roof runoff to the stormwater system during rain, provided that the tank is not already full. Whether it is likely to be full depends on the rate of collection, the capacity of the tank and the rate of drawoff. If the drawoff is used only for indoor purposes (toilet flushing and clothes washer cold supply) the rate of drawoff is fairly constant from month to month, but if the water is also used for irrigation the

rate of drawoff can vary considerably from month to month, and the tank may be regularly emptied in the summer.

**Table 15 Estimates of rainwater tank costs**

	Estimate 1 (a) \$	Estimate 2 (b) \$	Used for modelling \$
Tank (2250 litre, delivered)	550	760	760 (c)
Plumbing work (1 connection)	270	480	350 (d)
Pump	350	900	800
Electrical work	100	150	150
Total	1270	2290	2060

(a) Hallman et al (2003) (b) HIA, personal communication, February 2006 (c) Estimated price function for tanks = \$200 + volume (litres) x \$0.25 (d) Estimated \$200 per additional connection.

Figure 3 illustrates the approximate seasonal irrigation requirement for a garden in Metropolitan Melbourne, and the share made up by natural rainfall and by irrigation. Rainfall accounts for virtually the entire water requirement from May to November, but additional irrigation provides about a third of the water in the other 6 months.

If the irrigation water comes from a variable source such as a rainwater or greywater tank, householders are likely to vary the irrigation drawoff according to their judgement about the health of the plants and their own tolerance for variation in plant condition (eg many are willing to accept brown lawns during dry spells) and according to water availability. Many householders will choose not to water once the tank is empty, or may be prevented from doing so by restrictions on the use of mains water. Therefore the use of rainwater and greywater for irrigation and the consequent impact on the home's demand for mains water is highly uncertain.

Table 16 summarises the costs and estimated savings from various rainwater tank configurations in Melbourne (average annual rainfall 652 mm) and Mildura (average annual rainfall 195 mm). Various combinations of roof area drained, rainwater tank volume and end uses (toilet, clothes washer cold supply, irrigation and hot water supply) are tested.

Where rainwater is used for indoor toilets and clothes washing only, the limiting factor is either the drawoff (ie no more mains water can be saved than is used) or the rainwater collection capacity (ie no more mains water can be used than rainwater is collected). Where rainwater is also used for irrigation, however, the mains water impact varies. (The irrigation drawoff modelled is equivalent to 45.9 kl/yr, on the profile illustrated in Figure 3). Rainwater is 'spilled' in the months when the catchment exceeds the empty volume remaining in the tank, after all drawoffs are accounted for. While many cases lead to significant spillage in Melbourne, there is almost no spillage in Mildura.

In general:

- There is no advantage to a larger tank if toilet flushing is the only use
- A rainwater tank can meet the water saving target on its own, if it supplies both the toilet (a 6/3 litre model) and the cold supply to the clothes washer, provided

that the roof area catchment is large enough. The cases where the mains water savings meet or exceed the target for the average size household (2.67 persons) are shaded in Table 16.

- For the average size household, 100m<sup>2</sup> of roof area coupled to a 2,000 litre or larger tank is sufficient in Melbourne, but in Mildura a 225m<sup>2</sup> roof area supplying a 5,000 litres tank is the minimum required.

The costs of rainwater tank installations of given configurations are likely to be fairly similar throughout Victoria, so the NPV of mains water savings depends largely on the availability of rainwater. For the cases listed in Table 16, the NPV of mains water savings for installations in Melbourne range from \$ 0.66 to \$ 3.38/kl, but for the same configurations in Mildura the range is \$ 2.08 to \$ 8.72/kl.

If different configurations of roof area, rainwater tank volume and end uses are to be permitted application towards a performance-based target (and in some cases the only measure), then building applicants will need to have access to fairly sophisticated modelling.

The mains water saved by rainwater tanks is cold water only. Given that many configurations of rainwater tank can meet the performance requirement on their own, the total greenhouse savings from the present prescriptive measures may be foregone entirely.

**Table 16 Summary of mains water savings from rainwater tanks**

Roof (m <sup>2</sup> ) & tank (l)	End uses served	Initial capital cost	Annual operating cost	Capital replacement	NPV operating cost	Total NPV (50 yrs)	Mains kl/yr saving(a) Melb	Rain kl/yr spilled Melb	NPV \$/kl savings Melb	Mains kl/yr saving (a) Mildura	Rain kl/yr spilled Mildura	NPV \$/kl savings Mildura
50/1000	T only	\$ 1,750	\$2	\$31	\$1,013	\$2,793	18.4	9.4	3.04	8.3	0.0	6.73
	T + CW	\$ 1,950	\$4	\$64	\$1,013	\$3,026	27.8	0.0	2.18	8.3	0.0	7.29
50/2000	T only (b)	\$ 2,000	\$2	\$31	\$1,080	\$3,110	18.4	9.4	3.38	8.3	0.0	7.49
	T + CW	\$ 2,200	\$4	\$64	\$1,080	\$3,343	27.8	0.0	2.41	8.3	0.0	8.06
	T + CW + I	\$ 2,400	\$8	\$139	\$1,080	\$3,618	27.8	0.0	2.60	8.3	0.0	8.72
100/2000	T only	\$ 2,000	\$2	\$31	\$1,080	\$3,110	18.4	37.2	3.38	16.6	0.0	3.75
	T + CW	\$ 2,200	\$4	\$64	\$1,080	\$3,343	38.2	17.4	1.75	16.6	0.0	4.03
	T + CW + I	\$ 2,400	\$8	\$139	\$1,080	\$3,618	53.6	2.0	1.35	16.6	0.0	4.36
	T + CW + HW	\$ 2,400	\$12	\$205	\$1,080	\$3,684	55.6	0.0	1.33	16.6	0.0	4.44
150/2000	T only	\$ 2,000	\$2	\$31	\$1,080	\$3,110	18.4	65.0	3.38	18.4	6.5	3.38
	T + CW	\$ 2,200	\$4	\$64	\$1,080	\$3,343	38.2	45.2	1.75	24.9	0.0	2.69
	T + CW + I	\$ 2,400	\$8	\$139	\$1,080	\$3,618	64.7	18.7	1.12	24.9	0.0	2.91
	T + CW + HW	\$ 2,400	\$12	\$205	\$1,080	\$3,684	83.4	0.0	0.88	24.9	0.0	2.96
200/2000	T + CW	\$ 2,200	\$4	\$64	\$1,080	\$3,343	38.2	73.0	1.75	32.1	1.1	2.08
	T + CW + I	\$ 2,400	\$8	\$139	\$1,080	\$3,618	72.3	38.9	1.00	32.3	0.8	2.24
	T + CW + HW	\$ 2,400	\$12	\$205	\$1,080	\$3,684	111.6	0.0	0.66	33.2	0.0	2.22
100/3000	T + CW	\$ 2,450	\$4	\$64	\$1,146	\$3,660	38.2	17.4	1.92	16.6	0.0	4.41
	T + CW + I	\$ 2,650	\$8	\$139	\$1,146	\$3,935	54.6	1.0	1.44	16.6	0.0	4.74
	T + CW + HW	\$ 2,650	\$12	\$205	\$1,146	\$4,001	55.6	0.0	1.44	16.6	0.0	4.82
	T + CW + HW + I	\$ 2,850	\$16	\$280	\$1,146	\$4,276	55.6	0.0	1.54	16.6	0.0	5.15
150/3000	T + CW + I	\$ 2,650	\$8	\$139	\$1,146	\$3,935	65.7	17.7	1.20	24.9	0.0	3.16
	T + CW + HW	\$ 2,650	\$12	\$205	\$1,146	\$4,001	83.4	0.0	0.96	24.9	0.0	3.21
	T + CW + HW + I	\$ 2,850	\$16	\$280	\$1,146	\$4,276	83.4	0.0	1.03	24.9	0.0	3.43
200/3000	T + CW + I	\$ 2,650	\$8	\$139	\$1,146	\$3,935	73.3	37.9	1.07	33.2	0.0	2.37
	T + CW + HW	\$ 2,650	\$12	\$205	\$1,146	\$4,001	111.6	0.0	0.72	33.2	0.0	2.41
	T + CW + HW + I	\$ 2,850	\$16	\$280	\$1,146	\$4,276	111.2	0.0	0.77	33.2	0.0	2.58
200/5000	T + CW + I	\$ 3,150	\$8	\$139	\$1,280	\$4,569	75.3	35.9	1.21	33.2	0.0	2.75
	T + CW + HW	\$ 3,150	\$12	\$205	\$1,280	\$4,635	111.3	0.0	0.83	33.2	0.0	2.79
	T + CW + HW + I	\$ 3,350	\$16	\$280	\$1,280	\$4,910	111.2	0.0	0.88	33.2	0.0	2.96
225/5000	T + CW	\$ 3,350	\$4	\$64	\$544	\$3,958	38.2	86.9	2.07	36.5	0.8	2.17
Max							111.6	86.9	3.38	33.2	6.5	8.72
Min							18.4	0	0.66	8.3	0	2.08

Source: Author estimates (a) RWT applied on its own to a house with baseline water efficiency characteristics, with 2.67 occupants. (b) Current prescriptive measure

## Reticulated Recycled Water

The water savings from recycled water are more predictable than from rainwater, because roof area, storage volume and drawoff patterns have no influence on recycled water use. There is a direct substitution of recycled water for mains water in the connected uses: irrigation, toilet flushing and (where permitted) cold supply to the clothes washer.

Where recycled water is available from a local wastewater treatment plant, the capital costs of connecting it for all permitted uses is estimated at about \$ 3,000 (Table 17). As the connection comes from the street, there is virtually no extra cost to connect it to garden taps (these must have distinct colouring and removable handles).

**Table 17 Estimated costs of recycled water supply (per site)**

Reticulation Infrastructure	\$ 1,500
Meter, service to house, outdoor taps	\$ 900
Toilet connections (2)	\$ 400
Clothes washer connection	\$ 200
Total	\$ 3,000

Unlike rainwater, recycled water is not free. Users generally pay the water authority about \$0.78/kl, corresponding to the lowest marginal tariff for freshwater. Given that most new dwellings would fall into the middle tariff (currently about \$0.92/kl in Melbourne) rather than the top rate (\$1.36-1.44), the savings from substituting a kl of recycled water for mains water would be only about \$0.14/kl.

Recycled water reticulation infrastructure is more durable than rainwater tanks, since it essentially consists only of pipes in the ground like mains water infrastructure. If a 50 year service life is assumed, then the cost of saving mains water through by this means ranges from a NPV of \$ 3.32/kl savings for low usage (toilet only) to about \$ 1.00/kl savings (toilet, clothes washer and garden irrigation). The NPV of capital costs and water charges over a 50 year period are summarised in Table 13.

The mains water saved by recycled water is cold water only. Given that recycled water can meet the performance requirements on its own, the total greenhouse savings from the present prescriptive measures may be foregone entirely.

## Greywater

The 'no regulation' house generates nearly 3 times as much greywater as would meet the target for mains water saving (Table 18). This ratio would fall if water-efficient clothes washers and shower heads were used, but the bathroom alone would still provide more than enough greywater for toilet flushing and clothes washer cold supply.

One way of estimating the costs of saving mains water through the use of treated greywater is to compare the equipment required with rainwater tank systems serving the same end uses. There are several greywater treatment systems, but most use more

than one tank (at least one system has up to three). While the combined volume may be similar to a rainwater tank serving a similar demand, the costs are far higher. Plumbing costs are also higher, since the laundry and bathroom sub-floor wastes need to be diverted to the greywater system (with overflows to the sewer, the cost of which cannot be avoided). There are also a sanitisation unit, a controller and a pump, all of which require power supplies. The total installed cost of a system can be \$7,000 or more.<sup>10</sup>

Annual or even biennial service calls are also recommended; indeed some suppliers will only sell a system if the householder enters a service agreement. An annual service cost of \$200 has been estimated.

It is estimated that pumps and other electrical components have to be replaced every 12.5 years, and at 25 years other components to the value of half the initial capital cost must be replaced.

Table 13 summarises the estimated NPV of the cost of a typical treated greywater system. The cost is essentially the same whether the system serves only the toilets and the clothes washer cold supply (which would save sufficient mains water to meet the performance-based requirement) or whether it serves garden irrigation as well. The only difference is slightly higher electricity consumption to cover the additional sanitisation and pumping. Given that there is almost no extra cost, almost all users would choose the latter option, giving a cost of \$3.04 per kl savings.

**Table 18 Greywater supply and demand, average size household**

	Supply		Demand	
	l/day	kl/yr	l/day	kl/yr
Clothes washer	17	6.1	NA	NA
Laundry tub	74	27.1	NA	NA
Bathroom	217	79.3	NA	NA
Toilet	NA	NA	54	19.8
Clothes washer (cold supply)	NA	NA	50	18.4
<b>Totals (indoor only)</b>	<b>308</b>	<b>112.5</b>	<b>105</b>	<b>38.2</b>
Garden irrigation use	NA	NA	123	45.0
<b>Total all uses</b>	<b>308</b>	<b>112.5</b>	<b>228</b>	<b>83.2</b>

House with baseline water efficiency characteristics, with 2.67 occupants

<sup>10</sup> <http://www.aquareviva.com.au/prices.asp>

## 4. Findings and Conclusions

### Compliance Options and Costs

#### Options

A performance-based compliance regime adds additional measures to the existing ones and allows flexibility in the way building applicants combine measures, so long as they meet the water saving target. Building designers and applicants will need to consider:

- Which water-efficiency measures, if any, to adopt;
- Which alternative supply measures, if any, to adopt;
- If using alternative supply measures, the catchment (ie roof area, greywater sources), the storage volume and the end uses;
- If combining water-efficiency and alternative supply measures, the preferred balance between them.

It is not possible to model all combinations of options. However, the following are likely to be the most popular, because they are easily understood and/or rely on one type of measure only:

- Compliance via water-efficiency measures only;
- Compliance via one type of alternative supply only;
- Compliance via 'deemed to satisfy' provisions.

Under the current prescriptive compliance regime, under which 50% of houses have rainwater tanks, Class 1 dwellings incur an average capital cost of about \$ 1,260 to satisfy the 5 Star water-saving requirements. (The average Class 1 dwelling also incurs half the capital cost of a solar water heater, but that is excluded from the present calculations). The measures yield average mains water savings of 35.8 kl/yr compared with the 'no-regulations' case, at a NPV cost of \$ 1.06/kl savings. This is the benchmark against which the other compliance options are assessed (Table 19).

Under a flexible regime, the average house can reach its water saving target of 35.8 kl/yr through water-efficiency measures alone. Table 19 shows that the combination of 3\* showers and taps, a 4.5/3 toilet and a hot water recirculator (but no pressure limiting valve) will achieve the target at a lower capital cost (\$1,030) and a lower cost of savings (\$0.77/kl savings). This combination also has greater hot water savings than the benchmark, so there is no risk of increasing greenhouse emissions from water heating.

It is suggested that there be a 'deemed to satisfy' option of the existing prescriptive measures plus a rainwater tank. This would advantage builders who are familiar with the current regime and have incorporated rainwater tanks into their designs, and do not

wish to use unfamiliar water-efficiency measures such as hot water recirculators. The use of this option would lead to 25% higher water savings than the target, and the same hot water savings, so there would be no greenhouse penalty. However, the capital cost (\$2,260) would be \$1,000 higher than the benchmark, and the cost of savings also higher (\$1.55 per kl savings).

It is also possible to satisfy the requirements through the use of alternative supply measures alone, although none of the water saved would be hot water, so there would be significant greenhouse penalties.

Table 19 indicates that, in Melbourne, a 2,000 litre rainwater tank supplied by 100m<sup>2</sup> roof area and connected to all toilets and to the clothes washer cold supply would be adequate to meet the water saving target, at a similar capital cost to the 'deemed to satisfy' option (but twice the cost of the water efficiency-only option).

The cost of rainwater-only compliance in the parts of Victoria with low rainfall would be much higher, and many houses would lack the very large roof catchment areas required. However, they would have the option of efficiency-only compliance.

Dual pipe recycled water offers compliance costs comparable to rainwater, despite the fact that the water must be purchased. The water saving target can be met if recycled water is used for toilets and clothes water cold supply only, at a cost of \$1.85 per kl mains drinking water savings. However, if the supply is also used for garden irrigation, the cost falls to \$1.00 per kl savings.

Treated greywater appears to be the highest cost compliance option, because of the high capital cost and the annual service costs. The water saving target can be met if treated greywater is used for toilets and clothes water cold supply only, at a cost of \$6.60 per kl mains drinking water savings. However, if the supply is also used for garden irrigation, the cost falls to \$3.04 per kl savings.

The above costs are calculated for Class 1 houses. If the target savings for Class 2 dwellings were lower, more combinations of water-efficiency measures would deliver the target saving and the costs may be lower. The costs of communal alternative supply measures serving apartment blocks may also be lower per dwelling. However, the important point is that building applicants can do their own cost calculations and optimise their costs and benefits however they wish, so long as they achieve the mains water saving target.

## **Calculation aids for Applicants**

The calculation of impacts of water-efficiency measures is relatively straightforward. It is likely that the same group of measures applied in a home of any size and occupancy will deliver roughly the same percentage water savings (provided that the measure is applied to every point of use, eg to every shower or every toilet).

Therefore the selection of a compliance option based entirely on water-efficiency savings would probably not require the applicant to enter the number of persons (or a number of bedrooms as a surrogate for probable household occupancy). The selection of compliance entirely by dual pipe recycled water is almost as simple to calculate.

However, any compliance option which involves a rainwater tank would need to be backed by calculations covering location (for rainfall), roof drainage area, storage area and actual volumes drawn off, which will depend on uses and projected household occupancy. Treated greywater options would be somewhat less complex, but would still require access to publicly available computation aids.

**Table 19 Summary of typical compliance combinations and options**

Combination	Measures	Alt supply connected to:	Initial capital cost	Annual energy, water cost	Annual service cost	NPV operating cost	NPV capital replace	Total NPV	kl/yr savings mains	kl/yr savings hot water	NPV \$/kl savings
Benchmark: Existing 5 Star average	3* shower roses		\$30	\$0	\$0	\$0	\$8	\$38	23.1	16.2	\$0.03
	3* taps		\$80	\$0	\$0	\$0	\$21	\$101	3.0	2.1	\$0.68
	Pressure Limiting Valve		\$150	\$0	\$0	\$0	\$40	\$190	2.6	1.3	\$1.46
	Combined efficiency		\$260	\$0	\$0	\$0	\$70	\$330	26.9(a)	19.3(a)	\$0.25
	50% RWT	T only	\$1,000	\$1	\$0	\$15	\$540	\$1,555	8.8	0.0	\$3.53
	<b>Total cost of compliance</b>		<b>\$1,260</b>	<b>\$1</b>	<b>\$0</b>	<b>\$15</b>	<b>\$609</b>	<b>\$1,885</b>	<b>35.8</b>	<b>19.3</b>	<b>\$1.06</b>
Water Efficiency measures only	3* shower roses		\$30	\$0	\$0	\$0	\$8	\$38	23.1	16.2	\$0.03
	3* taps		\$80	\$0	\$0	\$0	\$21	\$101	3.0	2.1	\$0.68
	4.5/3 litre toilets		\$120	\$0	\$0	\$0	\$8	\$128	3.1	0.0	\$0.83
	Recirculator		\$800	\$3	\$0	\$60	\$249	\$1,108	8.4	4.2	\$2.64
	<b>Total cost of compliance</b>		<b>\$1,030</b>	<b>\$3</b>	<b>\$0</b>	<b>\$60</b>	<b>\$286</b>	<b>\$1,376</b>	<b>35.9(a)</b>	<b>21.5</b>	<b>\$0.77</b>
Deemed to Satisfy	Combined efficiency		\$260	\$0	\$0	\$0	\$70	\$330	26.9	19.3	\$0.25
	100% RWT	T only	\$2,000	\$2	\$0	\$31	\$1,080	\$3,110	17.6	0.0	\$3.53
	<b>Total cost of compliance</b>		<b>\$2,260</b>	<b>\$2</b>	<b>\$0</b>	<b>\$31</b>	<b>\$1,149</b>	<b>\$3,440</b>	<b>44.5</b>	<b>19.3</b>	<b>\$1.55</b>
Rainwater only	<b>Total cost of compliance</b>	T + CW	<b>\$2,200</b>	<b>\$4</b>	<b>\$0</b>	<b>\$64</b>	<b>\$1,080</b>	<b>\$3,343</b>	<b>38.2</b>	<b>0</b>	<b>\$1.75</b>
	100m <sup>2</sup> roof, 2000 l tank (b)										
Recycled water only	<b>Total cost of compliance</b>	T + CW	<b>\$3,000</b>	<b>\$30</b>	<b>\$0</b>	<b>\$528</b>	<b>\$0</b>	<b>\$3,528</b>	<b>38.2</b>	<b>0</b>	<b>\$1.85(c)</b>
Greywater only	<b>Total cost of compliance</b>	T + CW	<b>\$7,000</b>	<b>\$33</b>	<b>\$200</b>	<b>\$4,125</b>	<b>\$1,481</b>	<b>\$12,606</b>	<b>38.2</b>	<b>0</b>	<b>\$6.60(d)</b>
	Treated										

Source: Author estimates: Estimated additional costs and saving for house with 2.67 occupants. (a) Some measures interact, which means their combined water savings is somewhat less than the sum. (b) This combination is adequate in Melbourne, but not in lower rainfall part of Victoria, where cost of rainwater only option would be much higher. (c) The use of recycled water for irrigation as well adds no capital cost and reduces the cost per kl savings to \$1.00. (d) The use of greywater for irrigation as well adds very little capital cost and reduces the cost per kl savings to \$3.04

# Total Savings for New Homes

## Projections of new home Construction

The projected rate of new home construction in Victoria depends on a wide range of variables, including:

- Population growth
- Changes in household size; households are getting smaller, so the growth rate in household numbers is more rapid than the population growth rate;
- The rate of demolition of existing homes.

In general, the rate of new home construction must be sufficient to meet the absolute increase in home numbers plus the replacement of existing dwellings that are demolished.

The above factors are subject to both short term and long term variations. Population growth varies with natural increase, international migration and interstate movement, all of which are sensitive to a range of social and economic factors, as well as to State and Federal government policy. Consequently, home building is a notoriously cyclic industry.

The estimates prepared for this study necessarily combine data from a number of sources, which are not completely consistent with one another.

The number of building permits issued by the Building Commission in each of the years 1999-2006 is published on the BC's website. 'Domestic' (presumably Class 1) permits are further divided into new building applications and renovations, but 'residential' (presumably Class 2) permits are not. An average of 35,600 permits for new domestic construction were issued in each year of the period, about 38% of all domestic permits issued. The other domestic permits issued covered extensions and alterations, re-erections, changes of use and demolitions. The reported demolition rate was about 4200 per year, less than 0.25% of the Victorian housing stock.

The BC does not report the share of 'residential' permits that are for new construction or the number of dwelling units covered by each permit. Assumptions that 60% of 'residential' permits are for new buildings, and that there 6 homes per application on average, indicates about 6,200 new apartments per year. This would indicate that about 16% of the dwellings built in Victoria each year are apartments, compared with about 12% nationally (ABS 4137).

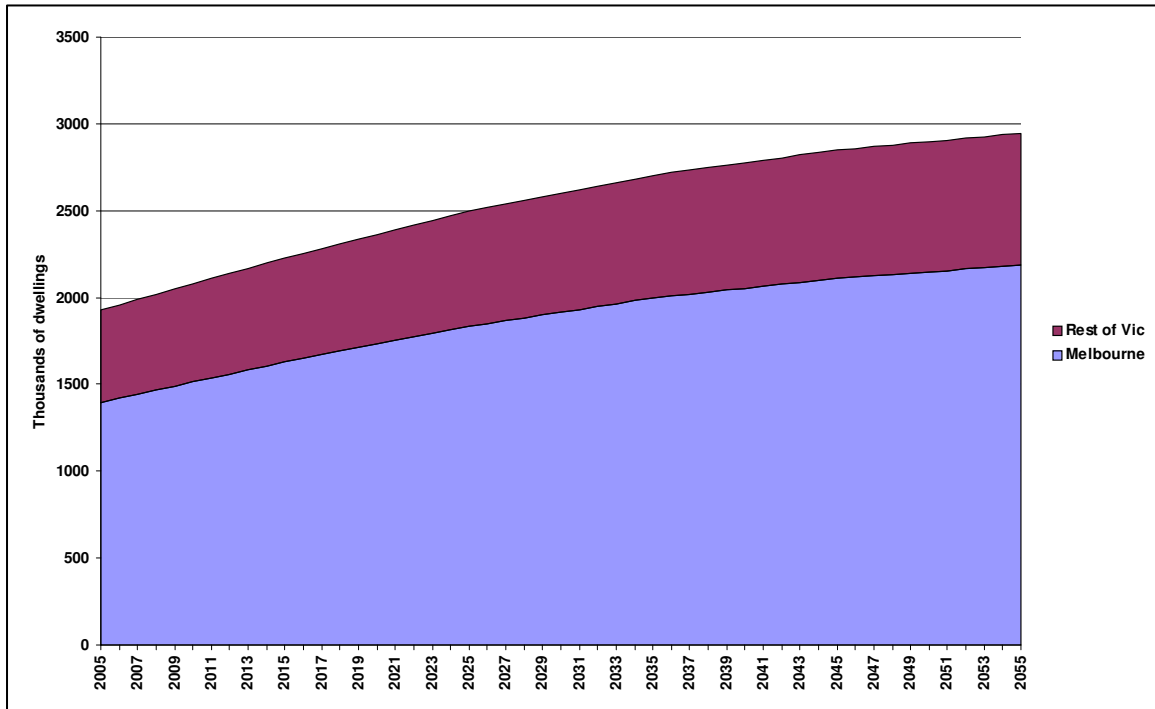
Projected population and household numbers for Melbourne in 2025 and 2055 were obtained from WaterSmart.<sup>11</sup> Projected population and household numbers for Victoria as a whole (to 2021) were taken from ABS 3236.0. The projected number of dwellings in Melbourne and the rest of Victoria is indicated in Figure 8. Household size is projected to decline from an average of 2.53 in 2005 to 2.20 in 2055. The national

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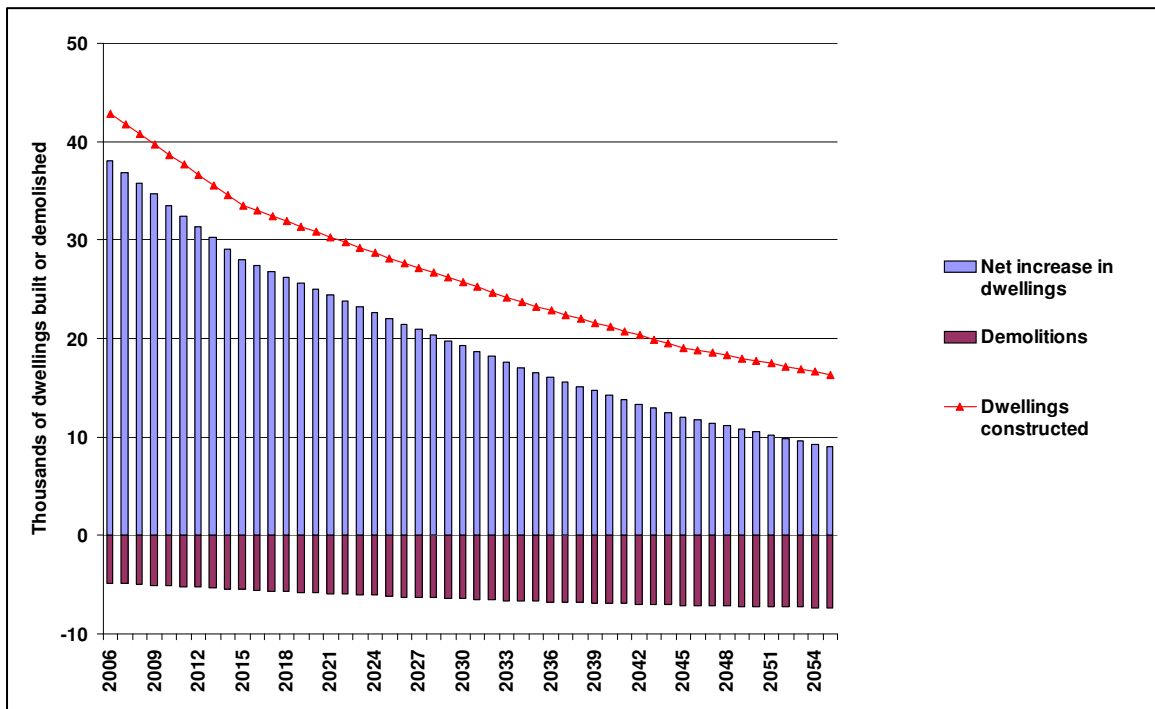
<sup>11</sup> Keith Johnson, Technical Manager, Water Supply – Demand Strategy for Melbourne, pers comm March 2006.

average size of households purchasing new dwellings in 2004 was 2.85 (ABS 4137), somewhat higher than the average size for all households.

**Figure 8 Projected total household numbers, Victoria 2005-2055**



**Figure 9 Projected dwelling construction and demolition rates, Victoria 2005-2055**



The number of new dwellings required to meet the growth in Victorian household numbers and balance the current demolition rate of 0.25% is illustrated in Figure 9. Because the projected population and household growth rate declines rapidly, the construction rate also falls, from about 43,000 dwellings per annum in 2005 to 16,000 by 2055. This rate could increase significantly if the demolition rate were to increase.

## Projected Average and Total Water Use

On average, a household living in a home incorporating the 5 Star water saving measures will consume 35.8 kl/yr less mains-supplied potable water than one living in a 'baseline' house (the difference between Case B1 and Case C2 in Table 6). However, many new homes would still incorporate 3\* showers and rainwater tanks even without the 5 Star measures. This is represented by Case B2 in Table 6. Therefore the actual water savings will be somewhat less than the hypothetical maximum water savings.

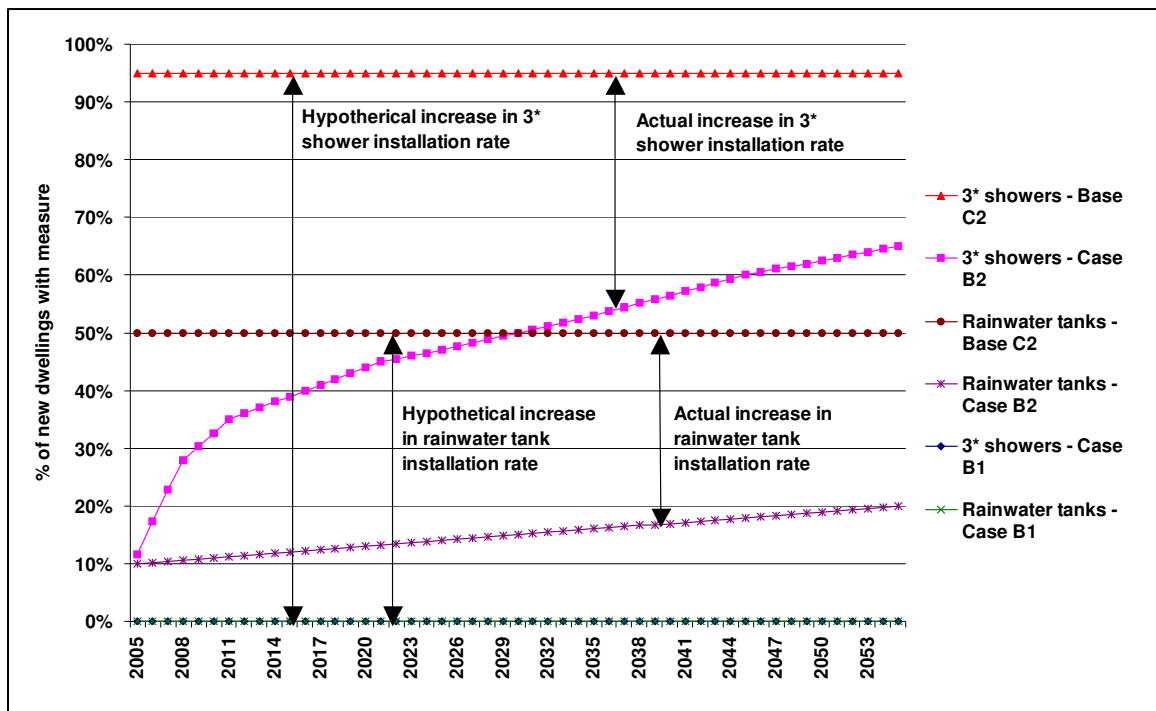
Figure 10 compares the installation rates for 3\* showers and rainwater tanks under the 5 Star measures with those which would most likely have occurred anyway (Case B2). There would have been a significant increase in the take-up of 3\* showers in any case, due to the introduction of mandatory WELS labelling for shower heads in mid 2006 (Figure 2). However, WELS alone cannot ensure that 3\* showers are selected for all new dwellings in Victoria – only the current 5 Star regulations can do that.

Similarly, rainwater tanks were already installed in 16% of Victorian homes even before the introduction of the 5 Star measures (Figure 1). Many rainwater tanks are installed some time after initial construction, so it is assumed that the rate of installation in new homes would be somewhat lower in the absence of the 5 Star regulations (say 10%) but would rise over time with growing public awareness of water shortages. With the 5 Star regulations, the RWT installation rate is about 50%.

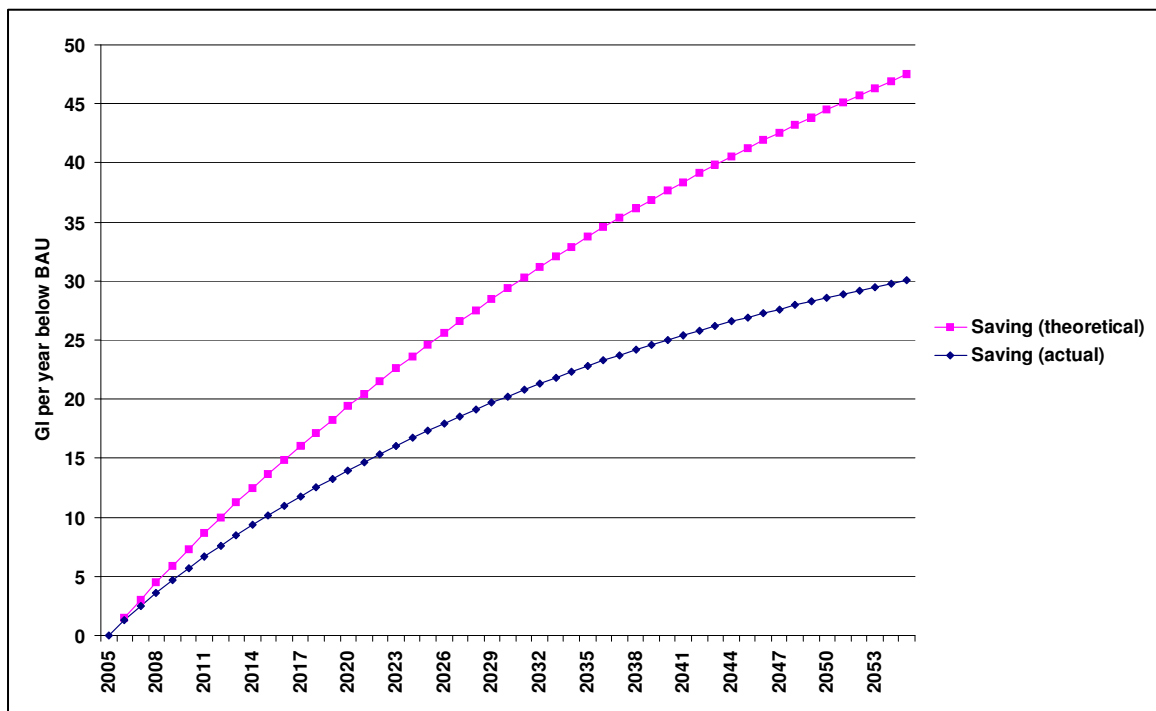
The 3\* shower and RWT installation rates are the most significant factors requiring adjustment of the hypothetical impacts, and have been explicitly modelled. The following factors are much less significant:

- The installation rate of pressure reducing valves in new homes is assumed to be close to zero without the 5 Star regulations, so the actual PRV water savings from the 5 Star regulations (small though they are) are likely to match the hypothetical savings;
- The installation rate of 3\* taps in new homes is assumed to be moderate without the 5 Star regulations, but the actual water savings from installing 3\* taps are so small that no adjustment has been made;
- There will be some take-up of products rated more highly than the mandated minimum (eg 4.5/3 toilets rather than 6/3 toilets), with or without the 5 Star regulations. However, if it is assumed that this additional voluntary water saving would be the same in each case, it is not necessary to adjust comparisons between the two cases because the *difference* in water use will be unaffected.

**Figure 10 Projected change in installation rate for 3\*showers and rainwater tanks**



**Figure 11 Projected reduction in mains-supplied potable water use, new dwellings constructed in Victoria, 2005-2055**



Combining the projected actual savings for new homes built in Victoria each year (Figure 10) with the projected number of homes built (Figure 9) produces a projection of the total savings in mains-supplied potable water consumption by new dwellings (Figure 11). It is assumed that the annual mains water use of each year’s cohort of new dwellings remains constant throughout the cohort’s service life.

It is estimated that the total annual water savings from the current 5 Star measures (or performance-based measures of equivalent stringency) will reach 30 GL/yr by 2055, and that the cumulative savings from 2005 to 2055 will total 950 Gl. (Note that this only applies to new dwellings to be constructed after 2005, which by 2055 will represent about 45% of the Victorian housing stock. The water use of the surviving pre-2005 dwelling stock has not been modelled, since it will be unaffected by water saving measures applied to new construction).

The maximum theoretical hypothetical savings, corresponding to an average 35.8 kl/yr for every new home built, are also shown for illustration. For the entire period 2005-2055, the actual water savings by the 5 Star measures (or their equivalent) will be about two thirds of the hypothetical maximum savings. The other third would have been achieved anyway, though the voluntary takeup of 3\* showers and RWTs illustrated in Figure 10. Therefore the average savings achieved will be 24.2 kl/yr per new dwelling constructed, not 35.8 kl/yr.

The Victorian Government has set a target to reduce per capita drinking water consumption in Melbourne by 15 per cent by 2010 compared to the 1990s average. This requires a permanent reduction from 423 to 360 litres per person per day (this covers all uses of water, not just household use).

It is estimated that the existing 5 Star water saving measures are delivering a reduction of about 51 litres per person per day in the homes where they apply. This would be equivalent to 80% of the total 63 litres per capita reduction required (Table 20). However, the measures only affect new dwellings constructed since the 5 Star regime commenced in July 2004, not the existing dwelling stock. By the end of 2010, only about 8.5% of Melbourne dwelling will have been constructed after 2005, so the maximum impact of the 5 Star measures will be 8.5% of 80% (7%) of the Government's water saving target for Melbourne – the other 93% will need to be achieved by other means.

**Table 20 New house water consumption compared with Government target for Melbourne**

	kl/yr	l/day/HH	l/pers/day Residential (e)	l/pers/day Total
Existing homes	216.0 (a)	592	222	423
Theoretical new 'no-regs' home	202.5 (b)	555	208	NA
Actual 'no-regs' home	190.9 (c)	523	196	NA
With regulations	166.7 (d)	457	171	360
Actual saving cf existing	49.4	135	51	63
	23%	23%	23%	15%

(a) Case A2 in Table 6 (b) Case B1 in Table 6 (c) 166.7 + 24.2 (see text) (d) Cases C2 and D1, Table 6.

(e) Assuming 2.67 persons per household

# Conclusions and Recommendations

## Conclusions

1. A performance-based approach to incorporating water-saving measures in new dwellings to be built in Victoria appears to be a feasible alternative to the present approach.
2. A performance-based approach would allow homebuilders a wider range of options for meeting or exceeding the level of water savings being achieved at present.
3. There is a wide range in the costs of options. Combinations which meet the water reduction target may have higher or lower capital costs, higher or lower net present value of lifetime operating costs and higher or lower costs per kl of potable mains water savings than the present regulated measures.
4. It is possible to set a hypothetical 'no-measures' starting point from which building applicants can determine the measures needed to reach their water-saving targets. However, many home builders would incorporate some water-saving measures even without regulation, so the actual water savings will be somewhat lower than the hypothetical savings.
5. The current 5 Star measures are achieving significant reductions in greenhouse gas emissions from water heating, as well as reductions in the consumption of potable mains water. These two elements of the 5 Star regulations are so closely linked that it is not possible to move from the present regime to a performance-based regime in either without significantly affecting the other.
6. A performance-based approach would be more complex, for both governments and home building applicants, than the current 5 Star approach. There is a need for appropriate 'program elements' to support policy-makers and administrators, and for appropriate 'public elements' to assist building applicants, homebuilders and product suppliers.
7. The water use modelling developed for the present study could provide the basis for a computation aid for building applicants. However, considerable work is required to make any such aid user-friendly, and to integrate it with administrative, compliance checking and data collection requirements.
8. There is a case for retaining 3\* shower heads as the sole mandatory requirement, because they represent by far the most cost-effective way to achieve water savings. The WELS scheme is considering making a 3\* rating a mandatory requirement for shower heads sold, but because of compliance issues it would be less effective than the present Victorian 5 Star regulations in achieving this objective for new homes.
9. Industry stakeholders would welcome greater flexibility for home-builders in complying with water-saving measures, provided that building costs are not increased.

10. For many products, including non-fixed water-using appliances and fixed appliances purchased after initial construction, water savings and increases in water-efficiency will need to rely on other approaches such as WELS.

## **Recommendations**

In the event that the Victorian Government proceeds to implement a performance-based approach to water savings measures in new homes, it is recommended that:

1. Home builders should be able to select from an extensive range of pre-assessed and approved measures, product categories and product models to meet their water saving targets.
2. The agency or agencies administering the program should develop and maintain registers of:
  - permissible measures;
  - required product characteristics; and
  - actual models and their projected water saving impacts.
3. There should be 3 modes of compliance:
  - a 'deemed to satisfy' compliance option incorporating all the present measures (including a rainwater tank for Class 1 buildings);
  - a default computation method (based on the model developed for this study, or similar), made available for public use; and
  - an alternative approach, with the onus on the proponent to demonstrate water savings equal to or greater than the other compliance modes, using the default computation method or an acceptable alternative.
4. The evaluation of methods or products proposed for registration should take into account compliance risk, performance risk and persistence risk
5. The computation method and the registers and lists of approved products and methods should be closely integrated, either via a downloadable software package or (ideally) on an internet site.
6. If an internet-based compliance tool is developed, consideration should be given to integrating the application and verification process with it. This would also be a powerful and cost-effective means of tracking the actual options selected by homebuilders.
7. The following classes of measure should be excluded altogether on the basis of unacceptably high risk:
  - Non-fixed water-using appliances such as clothes washers and dishwashers
  - Garden area, layout and planting

- Measures which *only* target garden irrigation (as distinct from the possible irrigation use of alternative water supplies installed primarily to meet indoor water demand).
8. The use of untreated greywater for toilet flushing or garden irrigation should be either heavily discounted or excluded altogether on the basis of its high performance risk.
  9. Where swimming pools are part of the original building application, the Water Conservation Plans currently required with applications to fill the pool should be combined with overall water-saving target.
  10. Where evaporative coolers are part of the original building application, an offset for the projected water consumption should be combined with the overall water-saving target.
  11. Any adjustment to the other elements of the 5 Star measures, ie those related to energy use and greenhouse emissions from water heating and, possibly, other fixed appliances installed at time of construction, should be resolved before any changes are made to the water-savings compliance regime.

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## **Appendix 1 Persons and organisations consulted**

All meetings completed unless otherwise indicated

### **Department of Sustainability and Environment, Water Sector Group**

Les Walker  
Louise Appleyard

### **Building Commission**

Robert Enker

### **Australian Institute of Building Surveyors**

Maryanna Grzan, President

### **Urban Development Institute of Australia**

Chris Mc Neill, Assistant Director

### **Housing Industry Association Limited**

Janine Nechwatal, Assistant Director Planning & Environment

### **Master Builder Association**

Rick Traficante, Urban & Regional Planner

### **Yarra Valley Water**

Peter Roberts, Demand Forecasting Manager  
Trevor Pearson, Urban Development Manager  
Mon Gan, Urban Development Manager

### **Dennis Family Corporation**

Martin Williams, Sustainability Manager

### **Water Supply-Demand Strategy for Melbourne (WaterSmart)**

Keith Johnson, Technical Manager

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