Final Report to

Independent Pricing and Regulatory Tribunal

Review of Consumption for Sydney Water Corporation

3 March 2008

McLennan Magasanik Associates

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Project Team

Antoine Nsair

Lionel Chin

Michael Goldman

Melbourne Office
242 Ferrars Street
South Melbourne Vic 3205
Tel: +61 3 9699 3977
Fax: +61 3 9690 9881

Brisbane Office
GPO Box 2421
Brisbane Qld 4001
Tel: +61 7 3100 8064
Fax: +61 7 3100 8067

Email: mma@mmassociates.com.au
Website: www.mmassociates.com.au

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Version	Date	Comment	Approved
1.0	21 February 2008	For review by the Tribunal	A. Nsair
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LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
AIR	Annual information return
BASIX	Building Sustainability Index
DM	Demand management
DoH	Department of Housing
EDC	"Every drop counts"
EUM	End-use model
ISF	Institute of Sustainable Futures
LCD	Bulk litres per capita per day
LCDm	The metered litres per capita per day
LTWSR	Long Term Water Saving Rules
MMA	McLennan Magasanik Associates
STP	Sewage treatment plant
SWC	Sydney Water Corporation
WELS	Water Efficiency Labelling and Standards

EXECUTIVE SUMMARY

Review of Water Consumption Forecasts

The Independent Pricing and Regulatory Tribunal (Tribunal) is in the process of determining the prices that Sydney Water Corporation (SWC) will be allowed to charge for its monopoly services. As part of this investigation, SWC provided their forecast of water consumption to the Tribunal. This forecast was based on SWC's own assessment of a range of factors that affect demand.

The Tribunal initially engaged McLennan Magasanik Associates (MMA) to undertake an independent review of SWC's water consumption forecasts over the next five years, comment on the robustness of the approach used to develop these forecasts and provide advice as to the reasonableness of the assumptions used. The Tribunal required this consultancy to be delivered within an extremely tight timeframe, especially given the data intensive nature of the project.

On 17 December 2007, MMA delivered the Preliminary Report to the Tribunal.

The Preliminary Report provided the Tribunal with MMA's views on:

- SWC's forecasting methodology (including the use of baseline forecasts); and
- the reasonableness of water savings from water restrictions and demand management programs.

The Preliminary Report also included a recommendation that an independent forecast be undertaken that would not be based on the 426 Litres per capita per day (LCD) bulk water demand baseline estimated in the late 1990s by SWC.

MMA was of the opinion that developing a methodology that directly forecasts residential and non-residential water consumption is preferable and would avoid the concerns regarding the validity of the baselines. Accordingly, MMA recommended that the Tribunal consider commissioning an independent forecast of water consumption to address these issues.

As a result of the Preliminary Report, the Tribunal engaged MMA to develop an independent forecast of SWC's water demand.

This report sets out the results of both MMA's review (including the material previously discussed in the Preliminary Report) as well as the results of the subsequent independent forecast.

Baseline Methodology

The SWC forecasting methodology uses an estimate of 426 LCD for its bulk water baseline demand. The figure was derived for planning purposes and to assess the impacts of various options for demand management and supply augmentation. This estimate was determined based on actual consumption during the late 1990s when no drought restrictions applied. The estimate was obtained after correcting for weather conditions and is assumed by SWC to have remained stable over time.

The baseline consumption forecast for the residential sector was based on historical consumption data (pre 2003) and projections of dwellings growth for the relevant property types.

The forecast of baseline non-revenue water was based on historical estimates of non-revenue water, estimated savings from leak reduction programs to date and the growth in leakage estimated at 1 ML/day for each year in the SWC service area in the absence of leak reduction activities.

The baseline non-residential consumption is estimated as the difference between the baseline bulk consumption forecast based on the constant per capita baseline consumption figure of 426 LCD and the sectoral forecasts for residential properties and non-revenue water.

Baseline non-residential consumption	=	Baseline bulk consumption
	–	Baseline residential consumption
	–	Baseline non-revenue water

In MMA's view, there are potentially a number of limitations with SWC's approach to the forecasting of baseline consumption that may restrict its usefulness as a tool for demand forecasting. These limitations include:

- Estimating monthly population growth is difficult, which leads to errors in the LCD calculated for each month.
- Trends in the LCD mask a large number of other underlying trends, such as reductions in industrial demand and leakage.
- Estimate of the trend variable is not robust and is likely to change over time as the interplay of underlying trends change.
- Assuming that the average per capita consumption remains constant at 426 LCD implies that water consumption patterns remain constant relative to the population.
- Changes in the structure of industry resulting in:
    - the growth of service industries offset by the decline of manufacturing,
    - large decreases in industrial water demand over the last 20 years as industry moves to more water efficient means of production in response to water scarcity and pricing signals, and
    - the introduction of recycling water leading to lower potable water consumption in industry.

- The estimate of the trend in LCD is also highly sensitive to the specification of weather variables. The specification used by SWC was based on analysis undertaken by a weather correction model. Previous analysis by MMA indicated that even slight changes to this specification resulted in materially different trend parameters.

To overcome these major issues, a methodology that does not depend on a baseline estimated based on data from the late 1990s has been recommended and subsequently used by MMA.

Impact of Water Restrictions

MMA undertook an indicative assessment of the impact of water restrictions and is of the opinion that SWC's methodology provides a reasonable assessment of their impact. Our review indicates that restrictions have a significant impact on water consumption reasonably consistent with those determined by SWC.

The results obtained for Levels 2 and 3 restrictions are, however, contaminated by the presence of demand management programs and thus should only be seen as indicative at this stage of the analysis. While the higher levels of restrictions are found to reduce water consumption more than Level 1, the extent of the impact is ambiguous.

One challenge in undertaking an econometric multi-variate analysis is to adequately specify the savings from demand management measures to isolate the impact of different levels of restrictions.

Demand Management Programs

MMA conducted a detailed assessment of the impact of the various demand management programs initiated by various NSW government departments and SWC. In our view, most of the assumptions used by SWC in assessing the impact are reasonable and the methodologies used to estimate water savings are appropriate. In certain areas however, there are minor differences in opinion mainly regarding the speed at which certain measures will be taken up and in some cases the uncertainty over the ability to determine participant behaviour. Notwithstanding the conclusion that the SWC assumptions are reasonable, significant uncertainties still exist in determining a number of these estimates especially for some of the largest programs, in particular:

- Long-term water saving rules which are expected to save over 19 GL by 2011/12
- Recycled water estimated to save over 30 GL by 2011/12; and
- Active leak detection saving about 22 GL per annum over the regulatory period.

Preliminary Review of SWCs Water Consumption Forecast

Our initial review of the water savings under various demand management and restriction regimes indicates that SWC's forecast appears to be reasonable.

Where appropriate, MMA took a different view of the level of savings and included these into the preliminary forecast. This is shown in Exec Table 1. Table 1 also shows the difference between SWC's forecast and MMA's review of SWC's forecast. The forecasts provided by SWC do not exhibit any significant step changes from recent consumption history. In the previous three years, actual total water consumption averaged around 522 GL with 515 GL consumed in 2006/07. The 2007/08 forecast provided by SWC is within 2% of the average consumption over the last 3 years. Given the other uncertainties inherent in these forecasts, the differences between SWC's forecast and MMA's assessment were in our view immaterial.

Exec Table 1 Preliminary Forecast of Consumption, ML pa

		2008	2009	2010	2011	2012
	Bulk Baseline	673,877	678,243	684,486	690,743	698,575
less	Restrictions	97,564	74,083			
	LTWSR			35,040	27,432	19,190
DM Programs	WaterFix including DoH WaterFix	9,178	9,479	9,730	9,980	10,231
	DIY	739	875	904	933	948
	Washing Machine Rebate	1,597	2,022	2,022	2,022	2,022
	Rainwater Tank Rebate	1,847	2,421	3,019	3,641	4,288
	Love Your Garden	1,029	2,013	2,948	3,663	3,923
	Business Programs	13,386	17,026	21,247	24,652	26,846
	Small Business Retrofit		202	686	1,211	1,533
	Spray Valves Rebate	63	285	601	790	822
	Every Drop Counts in Schools	54	63	72	81	90
	Rainwater Tanks in Schools	41	68	115	163	186
	NSW Government Water Efficiency	94	283	471	565	565
	Recycled Water Savings	11,999	13,950	17,174	24,757	31,281
	WELS	581	1,959	4,667	8,146	11,857
	BASIX adjusted for recycled water saving	2,736	5,689	9,593	11,854	14,066
	Pilot water saving programs	166	339	473	505	521
	Active Leak Detection	21,171	21,901	21,901	21,901	21,901
	Pressure Management	1,122	2,813	3,986	4,956	5,276
	Improved Leak/Break Response times	730	730	730	730	730
Forecast water consumption (ML)		**509,781**	**522,043**	**549,107**	**542,761**	**542,299**
SWC forecast (ML)		**505,085**	**519,371**	**560,039**	**544,082**	**534,465**
Difference (ML)		**4,696**	**2,672**	**-10,932**	**-1,321**	**7,834**
Difference (%)		**0.9%**	**0.5%**	**-2.0%**	**-0.2%**	**1.4%**

Independent forecast

MMA conducted an independent forecast based on further information from SWC. While we requested detailed daily bulk water and monthly and quarterly consumption data for residential and non-residential demand, only bulk water data was made available within the time for the forecast to be undertaken. As a result, annual data for residential and non-residential demand were used which may have affected the robustness of the results.

Forecasting Methodology

MMA undertook the independent forecast based on a methodology that sought to isolate the impact of any demand management programs. This was accomplished by obtaining from SWC an estimate of the impact of all their demand management programs since inception and adding back the savings to the water consumption. The total consumption quantities were then converted to a per capita consumption amount by dividing by the population served by SWC. A regression model was then fitted with the per capita consumption as the dependent variable for each of the bulk water, residential and non-residential customer segments. The following independent variables were tested for significance:

- Seasonal index for each quarter
- Net evaporation rate (evaporation rate – rainfall) over a quarter
- Number of rain days (rainfall >1mm) over a quarter
- Number of day per quarter where temperature exceed 30°C
- Average marginal price of water
- Dummy variable encompassing period where Levels 1 – 3 restrictions apply
- Dummy variable encompassing period where Levels 2 – 3 restrictions apply
- Dummy variable encompassing period where Level 3 restrictions apply

As a result, some of these variables were found to be statistically not significant. The final regression models to predict the per capita consumption for each segment were then formed by including the statistically significant variables.. The predicted per capita consumption reflects consumption in the absence of the demand management programmes as the estimated impact of demand management programmes had already been added back into the water consumption data.

Forecast total consumption, for each segment, was then estimated based on the expected population served by SWC and by subtracting the forecast impact of demand management activities.

Bulk Water Forecast

The base demand for bulk water was calculated based on the results of the regression analysis. The values of the forecast variables applied to the analysis are based on data supplied by SWC and the Australian Bureau of Metrology.

The regression results produced the expected per capita bulk consumption per day under the various restriction regimes. The regression for bulk water demand produced the following equation with an adjusted R^2 of 0.8.

$$LCD = 440.01 + 0.062149*Evap - 1.347*Temp - 36.58*Price - 34.139*L1 - 27.125*L2$$

Where

LCD =	Dependent Variable - Litres per Capita per Day
$Evap$ =	Net evaporation rate (evaporation rate – rainfall) over a quarter
$Temp$ =	Number of days per quarter where temperature exceed 30°C
$Price$ =	Average marginal price of water
$L1$ =	Dummy variable encompassing period where Levels 1 – 3 restrictions apply
$L2$ =	Dummy variable encompassing period where Levels 2 – 3 restrictions apply

The estimated daily per capita bulk consumption was multiplied by the expected population served by SWC to produce the bulk base demand. This bulk base demand is an indication of the climate corrected demand based on average weather conditions in the absence of any demand management measures but includes the impact of restrictions that are expected to apply in 2008 (level 2) and 2009 (level 1). As restrictions are progressively relaxed, it can also be expected that water consumption behaviour is unlikely to change immediately. This had been factored into the forecast by allowing the effect of any relaxation of restrictions to decay at a 50% rate over 6 months (September and December quarters).

From the base demand, savings from the demand management programmes were subtracted. The savings from demand management programmes discussed earlier were adjusted to take into account the lower assumed baseline per capita consumption. This adjustment was made because base per capita consumption is lower than that assumed during the Preliminary Report. With lower per capita consumption, it is likely that the opportunities for savings under the demand management programmes would be reduced. As a result, savings from the demand management programmes were lower than those arrived at in the Preliminary phase.

Residential Demand

The estimate of the residential demand was similarly based on using regression results to estimate the residential sector base per capita water consumption. As the regression analysis was conducted using annual data, the quarterly forecast variable for net evaporation was not used but annual average daily net evaporation rate was used instead.

The regression analysis indicated that Net Evaporation rates are a significant explanatory variable of residential demand. Other climatic variables are not significant. The regression analysis also found that while restrictions do impact consumption, there was no statistically significant difference between the impact of different levels of restrictions on consumption. As a result, combined restrictions were assumed to apply till June 2009.The final model used, with an adjusted R^2 of 0.85 was:

LCD = 234.28 + 0.017653*Evap – 32.271*L1

The resulting estimated daily per capita residential demand was then multiplied by the estimated population to determine the estimated base residential demand. This produced a climate corrected demand under restrictions prior to the application of demand management measures. Savings from demand management programmes targeted at the residential sector were then subtracted from the base annual demand after adjustments were made to the saving expected due to the lower base demand.

The resulting regression equation indicates that per capita residential consumption has declined significantly from the level assumed by SWC even after taking into account the impact of restrictions and demand management programs. This indicates that there has been significant behavioural change that has occurred since SWC first estimated their base consumption. This is likely to have occurred as a result of the publicity of the need to save water and the change in public consciousness due to the impact of the long drought.

Non-Residential Demand

Again the estimation of the non-residential demand was based on the non-residential demand regression results to estimate the base per capita consumption from the non-residential sector. As weather conditions were not shown to affect non-residential demand significantly, no weather variables were included in the forecasting equation. Different restriction levels were however shown to be significant and were included. The following is the final regression model for the non-residential sector with an adjusted R^2 of 0.86:

LCD = 113.79 – 8.5687*L1 – 6.6591*L2

The estimated non-residential per capita demand was then multiplied by the estimated SWC population to determine the estimated base non-residential demand.

Savings from demand management programmes targeted at the non-residential sector were then subtracted from the base annual demand to produce the forecast non-residential demand.

The MMA forecast of non-residential water consumption is higher than SWC's forecast. This could reflect the more recent higher economic growth of the Sydney economy resulting in higher water consumption despite the measures taken by businesses to reduce consumption. However, as with the residential water consumption forecast, some caution should be applied to the sectorial consumption forecast as only annual data was used in the regression analysis due to the lack of data available at the time of the analysis.

Conclusion

The resulting demand forecasts for each of the sectors are shown in Exec Table 2. Also shown in Table 2 is the comparison with SWC's forecast and the difference. MMA's forecast of non-revenue water is simply the difference between bulk water consumption and the sum of residential and non-residential consumption.

Exec Table 2 Forecast of Consumption, ML pa

	2009	2010	2011	2012
MMA Forecast				
Bulk Water Forecast	508,072	533,061	526,334	515,504
Residential Water Forecast	319,823	331,796	335,727	340,639
Non-residential Water Forecast	138,084	145,793	136,394	129,366
Non-Revenue Water Forecast	50,165	55,472	54,213	45,499
SWC Forecast				
Bulk Water Forecast	519,371	560,039	544,082	534,465
Residential Water Forecast	327,010	358,996	355,144	352,907
Non-residential Water Forecast	131,489	140,515	130,994	124,603
Non-Revenue Water Forecast	60,872	60,528	57,944	56,955
Difference				
Bulk Water Forecast	-11,299	-26,978	-17,748	-18,961
Residential Water Forecast	-7,187	-27,199	-19,417	-12,268
Non-residential Water Forecast	6,595	5,278	5,400	4,763
Non-Revenue Water Forecast	-10,707	-5,056	-3,731	-11,456

The comparison shows that MMA's independent forecast for bulk water and residential water consumption is lower then SWC's forecast. This is largely the result of the lower base per capita consumption used in MMA's forecast resulting from a different baseline. While SWC's baseline forecast is derived from the period during the late 1990s when no restrictions applied, MMA's base is derived from 1993 through to 2007 with the impact of demand management and restrictions isolated. SWC's baseline is thus derived without using the most recent consumption data from 2000 to 2007. MMA's base includes more recent data and would have captured the effect of the recent behavioural change of consumers. The change in water consumption behaviour could be the result of the success of public education regarding the need to conserve water and the long drought.

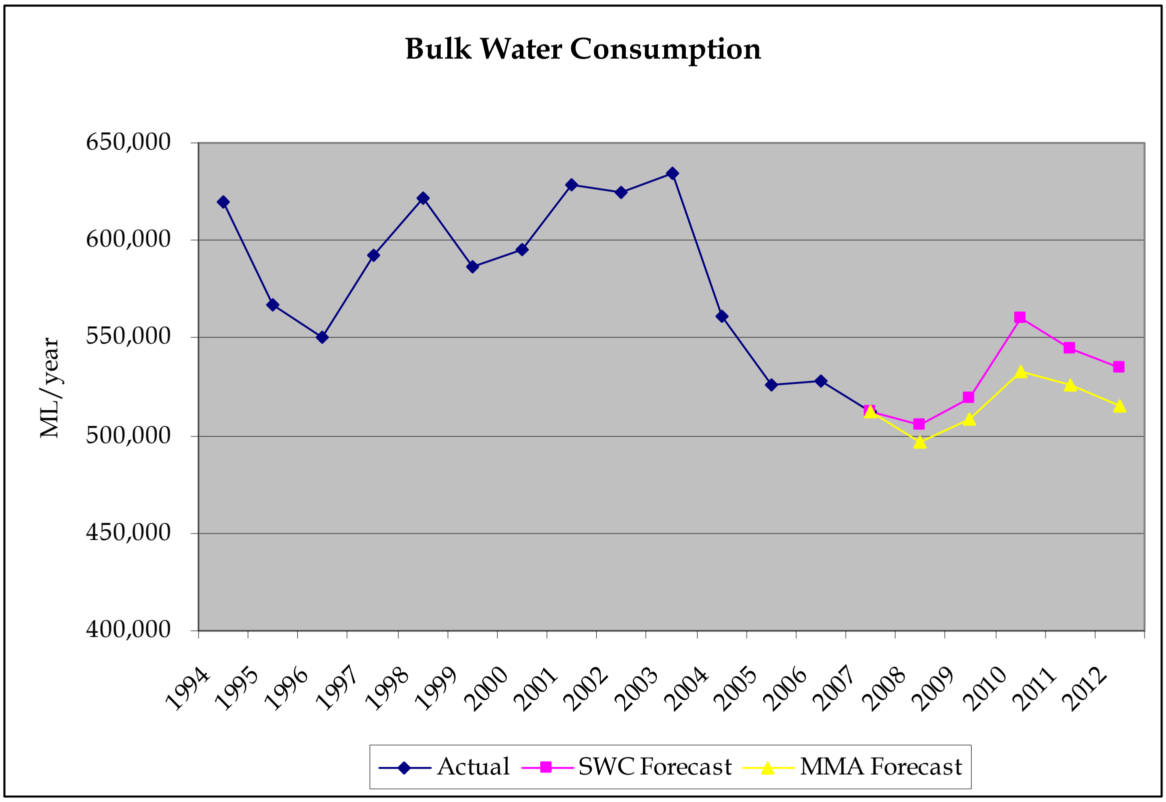
The higher MMA forecast of non-residential water consumption is likely a reflection of recent high growth of the Sydney economy despite the measures taken by businesses to reduce consumption. As SWC's methodology in forecasting non-residential water is based on the residual after subtracting residential and non-revenue water from its baseline bulk water forecast, the SWC non-residential forecast reflects the consumption pattern during the late 1990s which is likely to have changed since. However, as with the residential water consumption forecast, some caution should be applied to the non-residential forecast as only annual data was used in the regression analysis due to the lack of data available at the time of the analysis.

MMA's non-revenue water forecast is the residual after subtracting residential and non-residential water consumption from bulk water consumption forecast. It is lower than

SWC's forecast and reflects the lower per capita consumption. With lower bulk consumption, it can be expected that losses, metering errors and other sources of non-revenue water will also be lower.

A chart of the actual bulk water consumption together with the SWC and MMA forecasts is shown in Exec Figure 1.

Exec Figure 1 Bulk Water Consumption, ML pa



1 INTRODUCTION

The Independent Pricing and Regulatory Tribunal (Tribunal) is in the process of determining the prices that Sydney Water Corporation (SWC) will be allowed to charge for its monopoly services. As part of this investigation, SWC provided their forecast of water consumption to the Tribunal. This forecast was based on SWC's own assessment of a range of factors that affect demand. The Tribunal initially engaged McLennan Magasanik Associates (MMA) to undertake an independent review of SWC's water consumption forecasts over the next five years, commenting on the robustness of the approach used to develop these forecasts and provide advice as to the reasonableness of the assumptions used. The Tribunal required this consultancy to be delivered within an extremely tight timeframe. This was especially so given the data intensive nature of the project. On 17 December 2007, MMA delivered the Preliminary Report to the Tribunal representing our best endeavours to meet the Tribunal's objectives in reviewing SWC's water consumption forecasts within the timeframe.

The Preliminary report provided MMA's views on:

- SWC's forecasting methodology (including the use of baseline forecasts) and
- the reasonableness of water savings from water restrictions and demand management programs.
- and a recommendation that an independent forecast be undertaken that is not dependent on the 426LCD bulk water demand estimated in the late 1990s.

The methodology used by SWC depends heavily on the reasonableness of the baseline. This in turn depends on the stability of the per capita water consumption over time. The recommendation was taken because MMA had a number of concerns regarding the validity of the 426 LCD. These include:

- the relatively short period in the late 1990s that was used to determine the per capita baseline bulk water consumption. MMA was not confident that the assumptions from the late 1990s were still valid.
- The non-residential baseline is used as a balancing item to ensure consistency with the bulk baseline determined by multiplying 426 LCD by population. We were uncertain that this was appropriate as the non-residential sector is a major consumer and is a significant contributor to SWC's revenue.

We were of the opinion that a methodology that directly forecasts non-residential water consumption is preferable and avoid the concerns regarding the validity of the baselines. Accordingly, we recommended that the Tribunal considered commissioning an independent forecast of water consumption to address these issues.

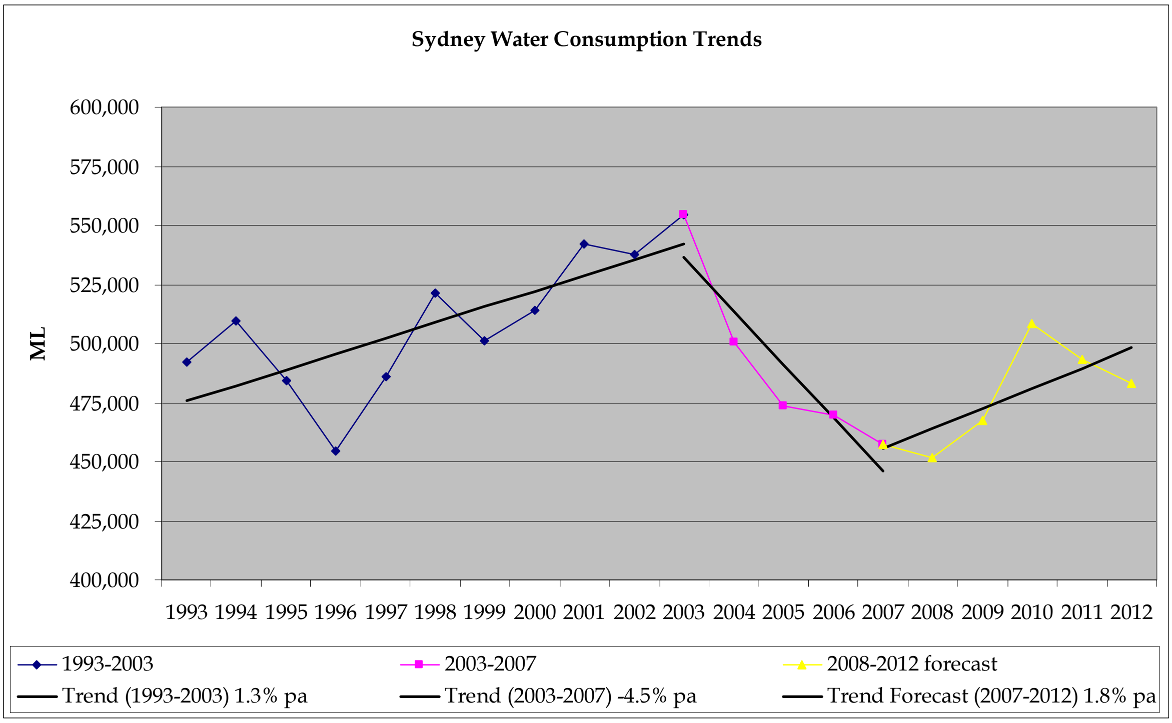
As a result of our recommendation, the Tribunal engaged MMA to develop an independent forecast of SWC's water demand. This report sets out the results of both MMA's initial review as well as the results of the subsequent independent forecast.

1.1 Overview of SWC Water Consumption

Demand for water in Sydney over the last decade and a half exhibits two distinct trends. Between 1993 and 2003 water consumption grew by about 1.3% pa as the city entered and then came out of a period of water restrictions. From 2003 to 2007 during the current drought conditions, consumption declined by around 4.5% pa due largely to the re-imposition of increasingly severe water restrictions. Sydney Water Corporation is forecasting that in the forecast period between 2008 and 2012, with the commissioning of the desalination plant, the level of water restrictions will be relaxed initially to level 1 (from the current level 3) in 2008/09 and subsequently to "permanent water saving measures" from 2009/10 onwards. These trends are shown in Figure 1-1.

With a growing population, water consumption may be expected to continue to increase in the future.

Figure 1-1 Trends in Water Consumption

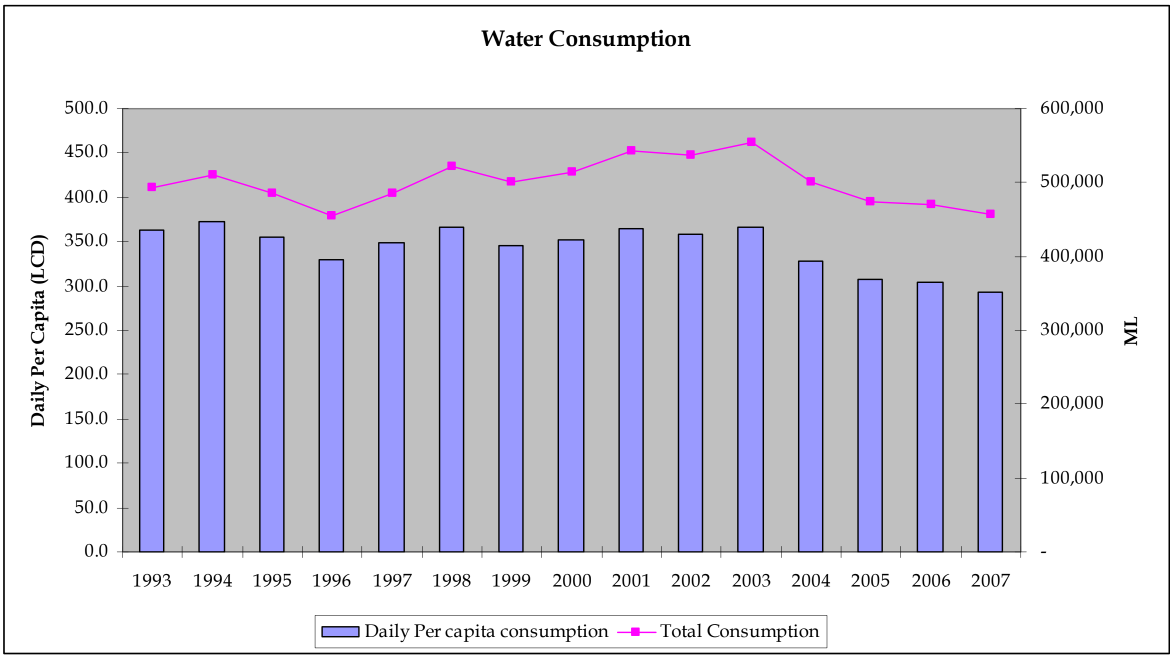


Source: SWC 2007 AIR and SIR submission to the Tribunal

1.2 Trends in water consumption

Water usage in Sydney has grown only marginally over the longer term, despite a growing population and economy (see Figure 1-2). Based on data from 1993, the long-term trend indicates a growth in consumption at less than 1% per annum. The low growth rate has been driven by a sharp decline in the per capita consumption as well as the effect restrictions have had since 2003.

Figure 1-2 Water usage in Sydney



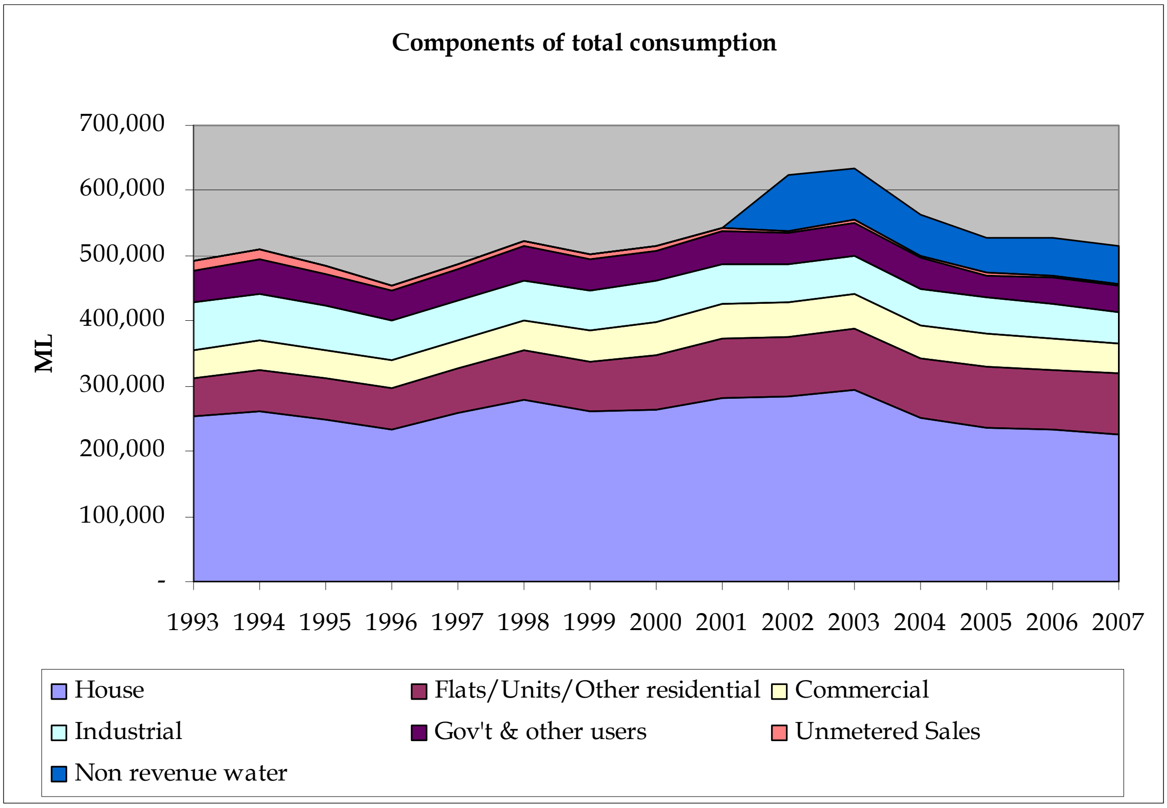
Source: SWC 2007 AIR and SIR submission to the Tribunal

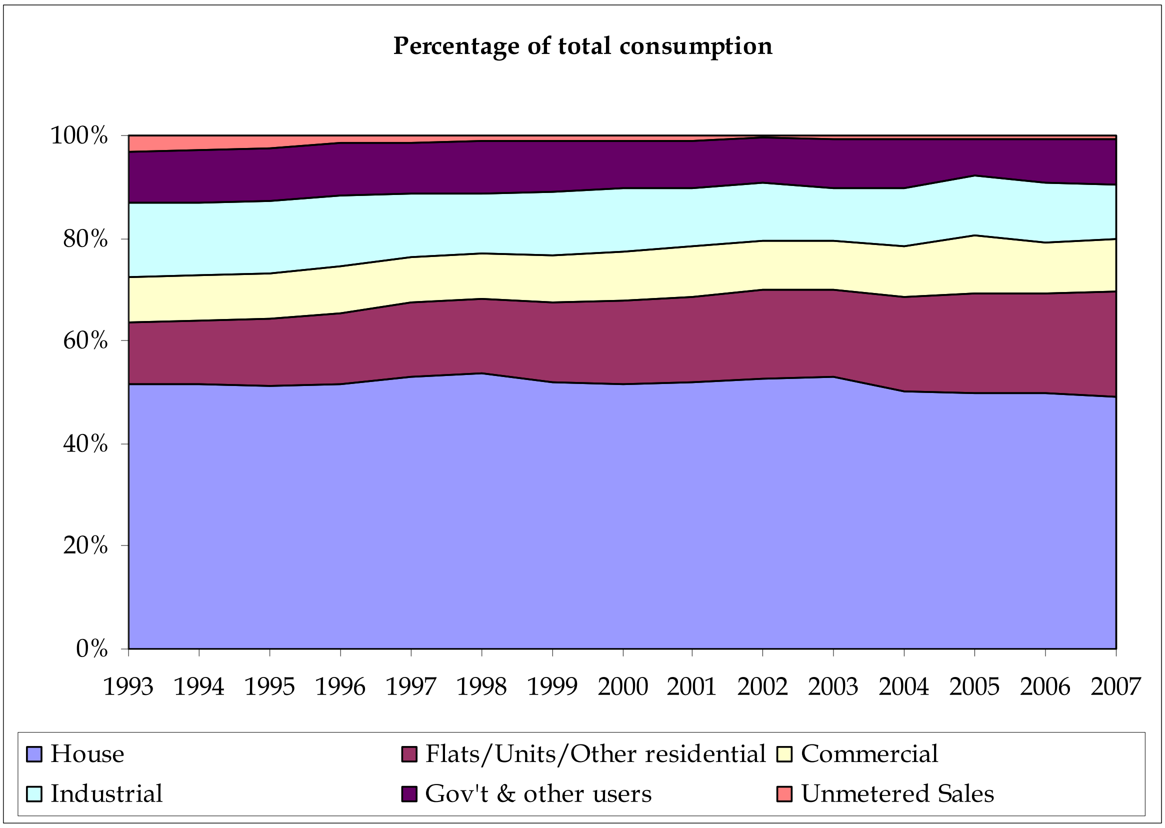
There are different recent trends in water use by customer segments (see Figure 1-3). Since 2000, while water use has increased for the residential sector, the increase is due to a rise in consumption in flats and units. Consumption in houses has fallen from over 50% of total consumption (peaking at 60% in 2003) to around 46% in 2006. Consumption in flats and units on the other hand has been steadily increasing since the early 1990s from just over 10% to almost 20% in 2006. SWC is expecting that this increase in consumption from flats and units will continue during the next regulatory period. SWC also forecasts that consumption from houses will recover to the low 50% level as water restrictions are eased and population growth continues.

In total, the residential sector now accounts for over 65% of total water consumption and is expected to exceed 70% by about 2010. Population growth and the changes to household formation patterns mean that the importance of the residential sector will continue to grow.

In the non-residential sector, consumption by the commercial and government and other users segments have been relatively stable. The major consumption change in this sector is from the industrial users whose share of consumption has fallen from around 15% in the early 1990s to around 10% in 2006. This decline is expected to continue as water efficiency measures increase and with the greater use of recycled water.

Figure 1-3 Trends in water use by customer segment, ML





*Source: SWC 2007 AIR and SIR submission to the Tribunal - (*Data for non revenue water only commences frm 2002)

1.3 Average consumption

After a period of water restrictions (from late 1994 to late 1996), the quantity of water consumed in SWC's service area increased from around 455 GL pa in 1996 to around 550 GL pa in 2003. In litres per capita per day (LCDm[1]) terms, total metered consumption increased from about 325 LCDm to 363 LCDm over the same period. From 2003 onwards however, per capita consumption has fallen significantly to around 290 LCDm. This is shown in Figure 1-2. The decline in usage may be attributable to:

- impact of restrictions
- increasing drought awareness and educational programs
- increasing use of dual-flush toilets
- improving water efficiency for showerheads and water using appliances
- trends towards smaller property lot sizes and garden area in single dwelling housing
- changes in the industrial property mix including a decline in high water use by heavy industries
- improved water efficiency and recycling by industry
- implementation of user pays pricing
- demand management programs.

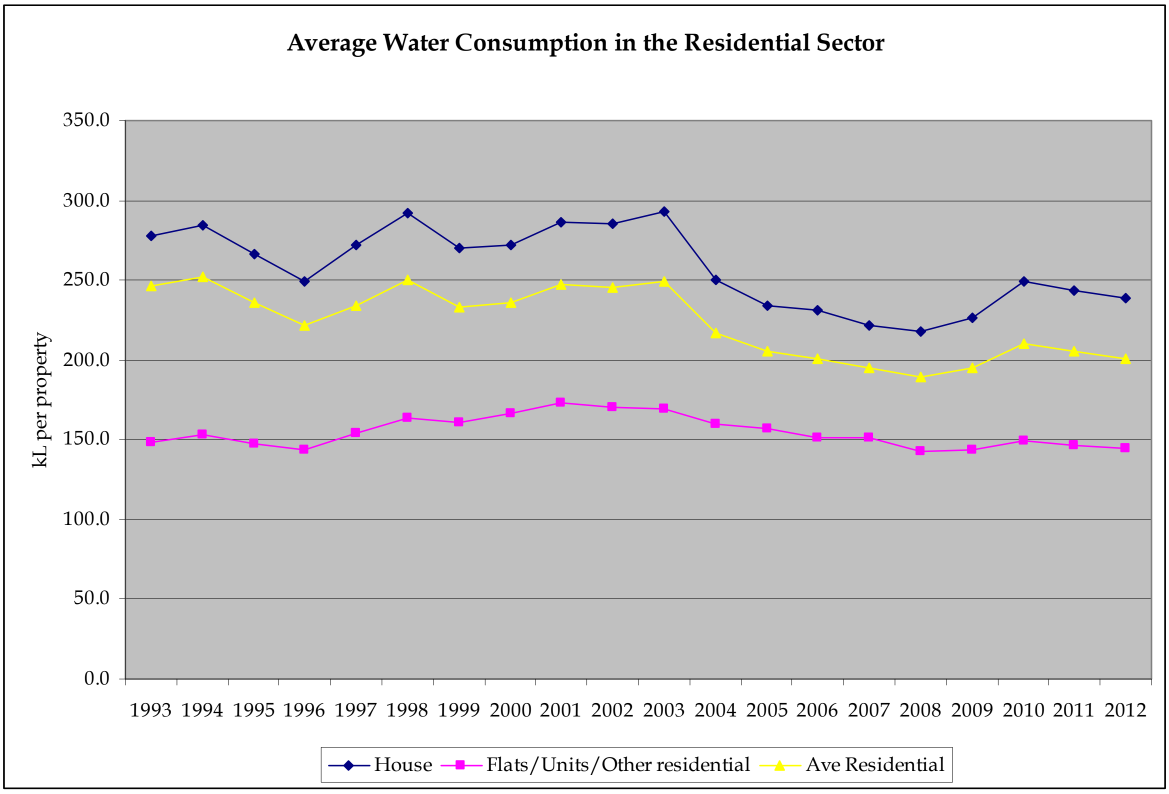
The period from November 1996 to October 2002, when no restrictions applied, was used to estimate the base level of daily per capita bulk water consumption on a weather corrected basis. This baseline was set at 426 LCD. This baseline level was agreed to by a number of relevant state government agencies on the basis of separate analysis and is used across the NSW government of water demand and supply planning purposes for consistency. It reflects the level of water consumption that would apply in the absence of any water conservation initiative that had been implemented since 1999. It should be noted that the water saving programs implemented prior to that period have already been incorporated into the baseline estimate.

This estimate of average litres consumed per capita per day is a weather corrected estimate of the average daily consumption and is used to represent current trends in water use. This estimate covers potable water releases and does not include the reuse of recycled water or wastewater. This quantity was also used in the development of the Metropolitan Water Plan.

[1] The metered litres per capita per day (LCDm) is used in this place to distinguish it from LCD which is the bulk litres per capita per day used in other parts of this report.

MMA had undertaken a review of the methodology of how this estimate was derived in an earlier report to the Tribunal[2] and we do not intend to repeat the analysis in this review. Suffice to say, the earlier report concluded that MMA's estimate of the average LCD is slightly higher than the 426 LCD assumption used in SWC forecasts however, the difference is only marginal. However, MMA has some reservations regarding the stability of this estimate over time and questions its usefulness in forecasting water consumption. This is further discussed in Section 2.3.1.

Figure 1-4 Average water consumption in the residential sector, kL



Source: SWC 2007 AIR and SIR submission to the Tribunal

Average consumption fell during the previous water restriction period (1994-1996) before recovering to pre-restriction levels. This is evident in Figure 1-4 between 1994 and 1996 when average consumption fell and the subsequent recovery between 1996 and 1998. Over the period between 1993 and 2003 average consumption remained relatively stable for most end-use segments over the long-term.

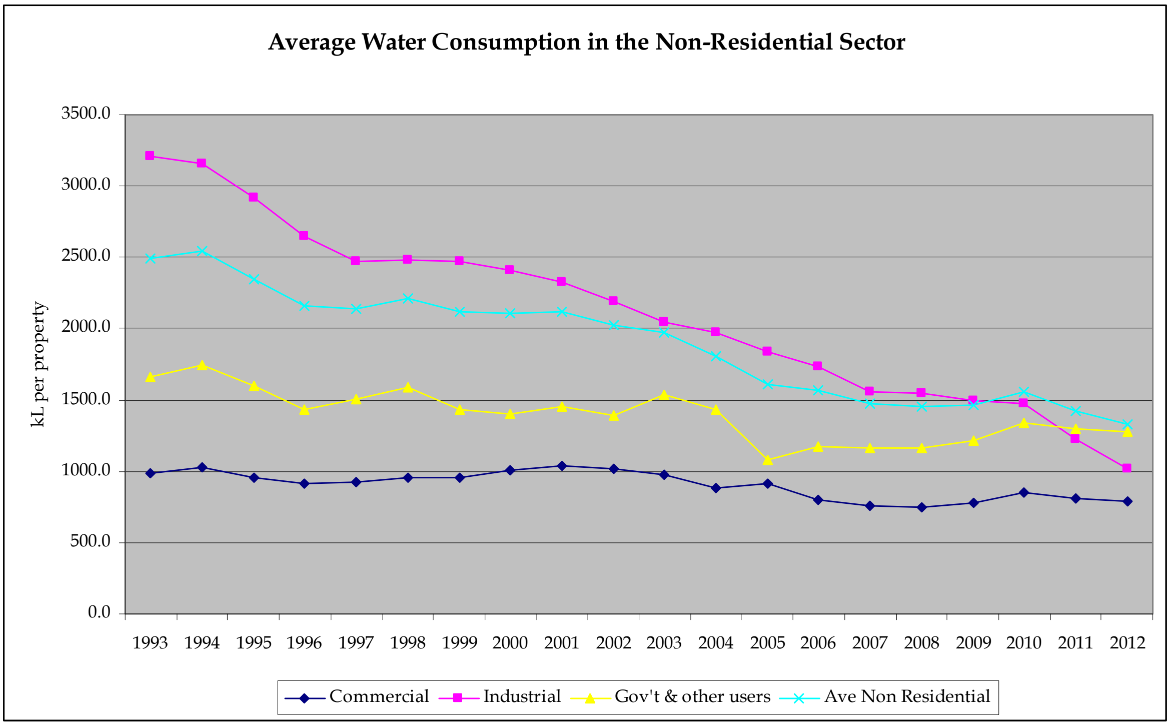
With the reintroduction of restrictions in late October 2002, average consumption again started to fall. SWC forecasts provide for a recovery in average consumption between 2008 and 2010 as water restriction levels are relaxed before continuing on a slow downward trend as technology changes towards greater water efficiencies lead to lower average consumption.

[2] MMA, *Review of Consumption Forecasts, NSW Metropolitan Water Agencies*, 21 December 2004, p17-19.

Average usage has fallen sharply for the industrial sectors, as shown in Figure 1-5, although the rate of this decline was modest between 1997 and 2000.

- Usage in the commercial sector has not exhibited as great a decline over the long-term, and there appears to have been a small increase in the average usage between the mid 1990 and early 2000s.
- Average consumption by government entities, institutions (hospitals, schools) and primary producers fell until the early 1990s, but remained stable between 1996 and 2004. A large drop occurred in 2005 before increasing slowing.
- On average, the non-residential sector shows a continuous decline since 1993 with SWC forecasting that this decline will continue in the forecast period albeit at a slower pace.

Figure 1-5 Average water consumption in the non-residential sectors, kL



Source: SWC 2007 AIR and SIR submission to the Tribunal

2 SWC FORECAST METHODOLOGY

2.1 Drivers of Consumption

A number of factors are important in determining the demand outlook for water. Based on a review of the literature, the key factors appear to be:

- Population growth. This is a key driver of overall demand growth, especially as domestic water usage is increasing in importance.
- Household formation patterns. In particular, in the Sydney region there has been a shift towards multi-unit dwellings and flats. The proportion of multi-unit dwellings has increased over the last ten years. In addition, the trend towards less people per household also increases water usage on a per capita basis, although the difference is likely to be small.
- Economic growth, which impacts on water usage at several levels. High economic growth will accelerate other trends, such as the move towards multi-unit dwellings and the purchase of more appliances.
- Price. Previous studies indicate that demand for water is only slightly responsive to changes in both the marginal price and the fixed usage charge. In a 2003 issues paper[3], the Tribunal formed the opinion that the price elasticity of water demand for the Sydney area was between -0.4 and 0 and recommended -0.13 as the most appropriate value for Sydney.
- Trends in appliance purchases and usage. There has been a move towards multiple toilets and showers in residences, which tends to increase water usage. The installation of automatic sprinkler systems is also likely to increase water usage. Countering this has been the trend towards more water efficient appliances such as dual-flush toilets and more recently front-loading washing machines.

Apart from these long-term factors, there are other factors that may result in short-term variations in demand. The most important variable is climate, particularly soil moisture and rainfall, which can have a significant impact on outdoor water usage. Temperature may also impact on water usage for air-conditioning. Tourist numbers will also impact on both short-term and long-term trends in water usage.

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[3] IPART 2003, *Investigation into Price Structures to Reduce the Demand for Water in the Sydney Basin: Issues Paper*, Independent Pricing and Regulatory Tribunal of New South Wales, December.

2.2 Method and Assumptions

SWC forecasts water usage on a bulk consumption basis, covering all customer segments and unaccounted for water supplies. It then splits the bulk consumption into sectoral consumption forecasts.

SWC's forecast begins with a baseline demand. The baseline covers demand in the absence of active demand side management programs including water conservation activities and restrictions. Then, the impact from various demand side management programs is deducted to arrive at the final forecast.

The following summarises the basic method as applied by SWC:

- First, a baseline bulk water demand forecast is developed. This baseline consumption is the potable water consumption in the absence of any water conservation initiatives like demand management, recycling or leak reduction. This baseline forecast was set at 426 LCD.

- The LCD estimate is multiplied by projections of population, based on the *NSW State & Regional Population Projections 2001-2051*. The population projections cover the relevant local government areas supplied by SWC. Not all customers in these regions are serviced by the company, so SWC adjusts the population projections to only account for those customers who are serviced by the SWC.

- The estimated savings in water consumption, due to the implementation of a range of demand management initiatives, are then deducted from the baseline forecasts to arrive at the final consumption forecasts. This is undertaken in two steps.

    - First, unrestricted bulk consumption is estimated by subtracting water savings from water conservation initiatives. These savings include savings from the long-term water saving rules that are expected to come into effect once drought restrictions are removed in July 2009. The impact of the water savings initiatives are estimated through the application of an end-use model.

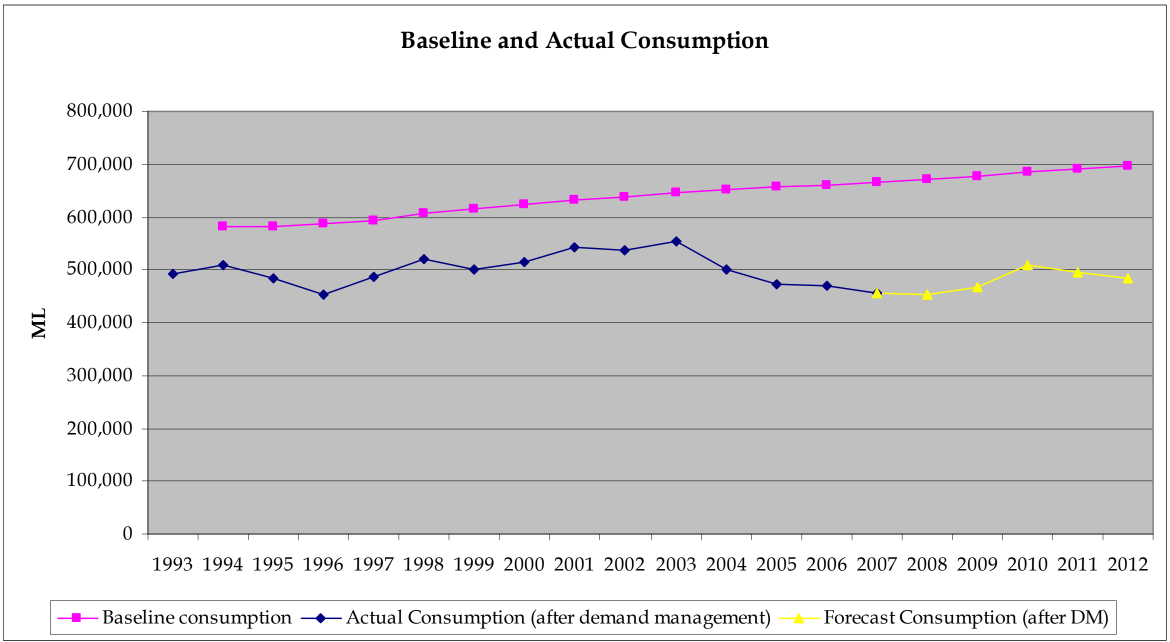
    - Second, restricted bulk consumption is estimated by subtracting the impact of drought restriction. SWC assumes that Level 2 restrictions will continue for the remainder of 2007/08 with Level 1 restrictions in place in 2008/09.

The forecasting method for baseline consumption is relatively simple. It relies on an historical average after correcting for weather. Estimates of water savings from demand side management involve the use of more sophisticated approaches, with forecasts supported by detailed end-use modelling. Regression modelling was used to estimate the impact of various stages of restrictions that have been in place since late 2002.

2.3 SWC Baseline and Actual Consumption Forecast

The forecast of baseline water demand provided by SWC is shown in Figure 2-1. Baseline water consumption is forecast to increase from 668.9 GL in 2008 to 693.4 GL in 2012. The average rate of growth over the forecast period is 0.9% per annum, which is slightly lower than the historical rate of growth since 1993 of 1.0% per annum. Final annual consumption, after deducting for water savings and restrictions, is projected to increase from 505.8 GL in 2008 to 558.7 GL in 2010 as restrictions are eased before falling to 532.4 GL in 2012[4].

Figure 2-1 Baseline and after demand management and water demand forecasts



Source: SWC 2007 AIR and SIR submission to the Tribunal

The growth rate is comparable with some of the key economic drivers underpinning water demand, as shown in Table 2-1. The real price increase is expected to augment further, but this is captured as a demand management measure. Price sensitivity is also less than one.

Table 2-1 Growth in water demand and growth in key drivers, 2007 to 2012

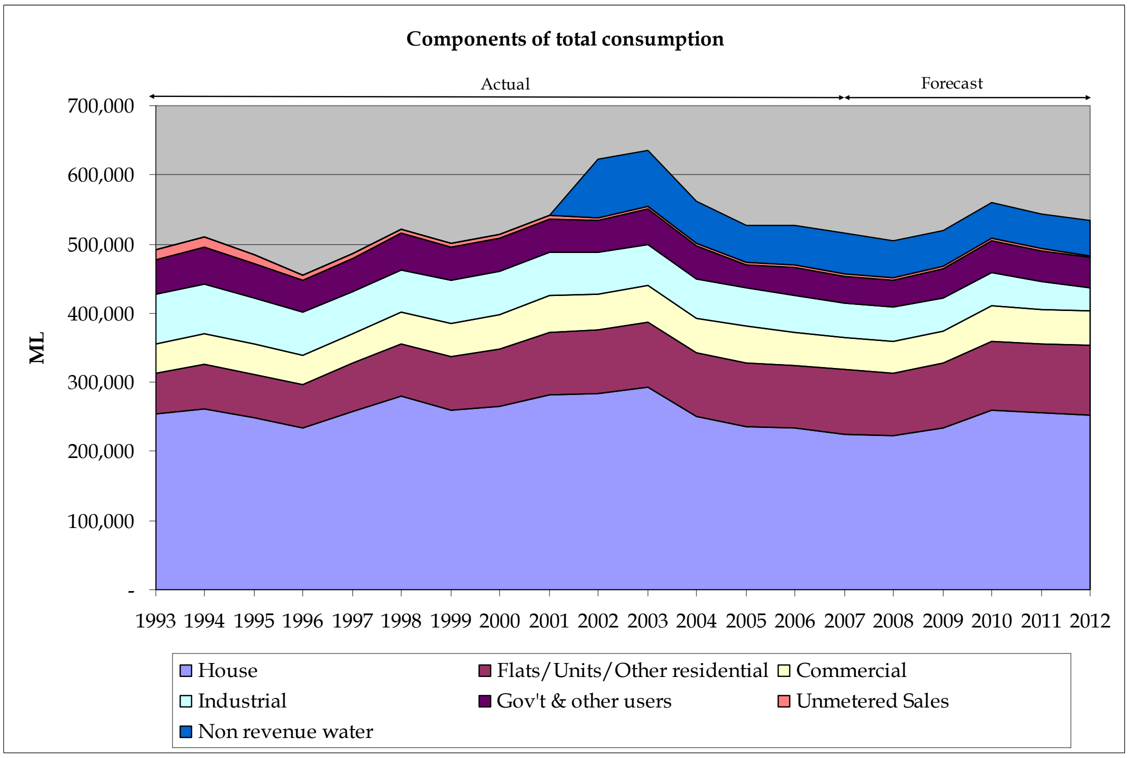
	Growth rate, % pa
Baseline demand	0.9
Population growth rate	0.9

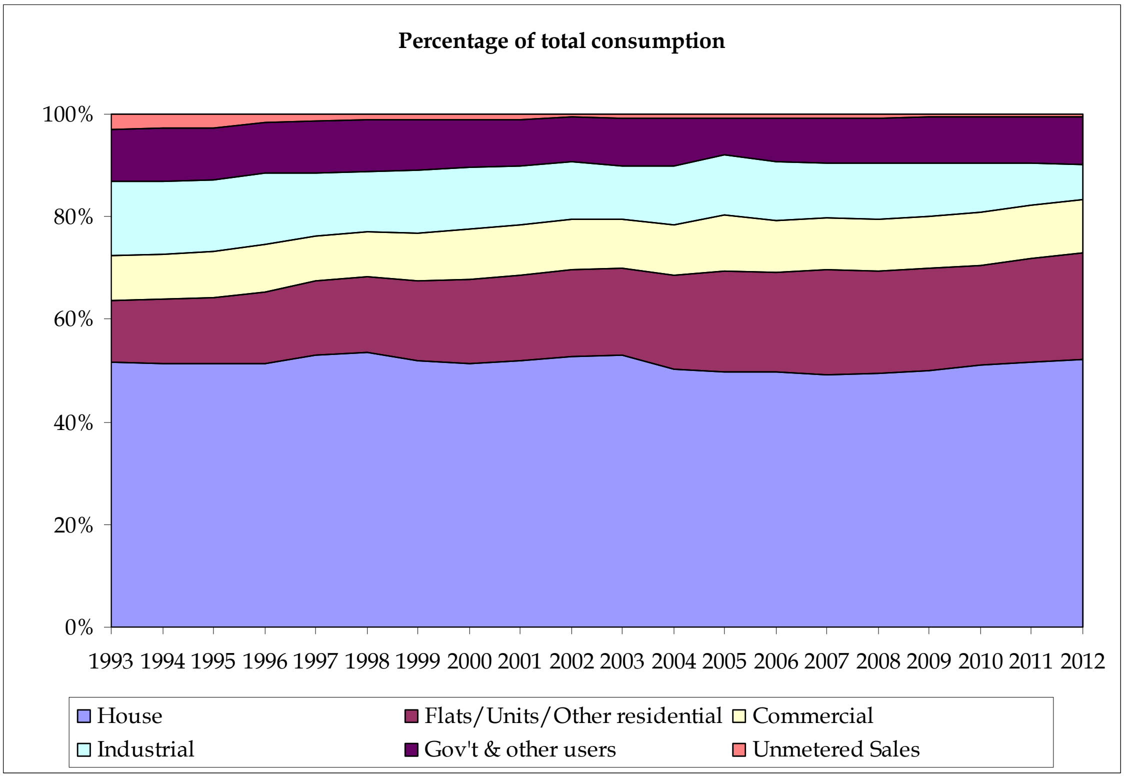
Source: SWC

Some trends can be discerned in the various segment demand components by examining forecasts of actual consumption after the impact of the demand side management initiates are deducted (see Figure 2-2).

4 Some minor differences are present in the forecasts submitted by SWC in its 2007 AIR/SIR submission to the Tribunal and the forecasts in SWC's response to MMA's requests.

Figure 2-2 Forecast of consumption by customer segment





Source: SWC 2007 AIR and SIR submission to the Tribunal
Data for non revenue water only available from 2002

A review of the water consumption data submitted by SWC reveals that industrial demand is forecast to continue to fall as a result of water use efficiency improvements and increased usage of recycled water. Between 1993 and 2007, water demand in this segment fell by an average of 2.7% per annum. Demand is forecast to continue to fall by an average of 7.5% per annum over the forecast period.

Demand from the commercial and institutional sectors has been relatively stable over the period 1993 to 2007. Sales to the commercial sector increased by an average of 0.5% per annum while sales to government and institutions fell by 1.4% per annum on average. This would reflect the adoption of demand management initiatives in these sectors balanced by the continuing growth in the economy. Over the forecast period, as the economy continues to grow, water consumption in the commercial sector is expected to grow by 1.5% per annum while the government and institutional sector is expected increase its water use by 1.8% per annum.

The sector that has exhibited the fastest growth is flats and units. Between 1993 and 2007, water consumption in flats and units grew at 3.3% per annum as the rate at which flats and units were built increased. On the other hand, consumption in houses fell by 0.9% per annum on average over this same period due to the impact of water restrictions and other conservation measures. Over the forecast period, the consumption in the residential sector is expected to increase as water restrictions are eased and population growth continues. Houses are expected to consume 2.3% more per annum while flats and units by 1.5% more per annum.

2.3.1 MMA Analysis of SWC Bulk Baseline Forecast

SWC's forecasts rest on two sets of assumptions. Firstly, average daily consumption per capita, in the absence of demand management, remains constant at 426 LCD.

Secondly, existing and new demand management initiatives will be successful in leading to reductions in water usage from the baseline. The forecasts of the quantity of water saved by these programs depend on the assumptions used in estimating their impact. An analysis of the assumptions behind the demand management programs is provided in the next section.

Information provided in SWC's submission indicated that the estimate of 426 LCD was arrived at by an interdepartmental committee. The figure was derived to be used for planning purposes and to assess the impacts of various options for demand management and supply augmentation.

Support for the estimate is provided by a separate study undertaken by SWC.[5] In our 2004 review of SWC's demand forecast for the Tribunal, MMA reviewed this study and undertook some statistical analysis to assess the veracity of the assumptions. In that study, MMA replicated the SWC models and obtained identical results in terms of the adjusted R^2 statistic. However, the two models gave noticeably different results in terms of the trend coefficient, with SWC's model predicting an annual increase of 0.9 LCD and

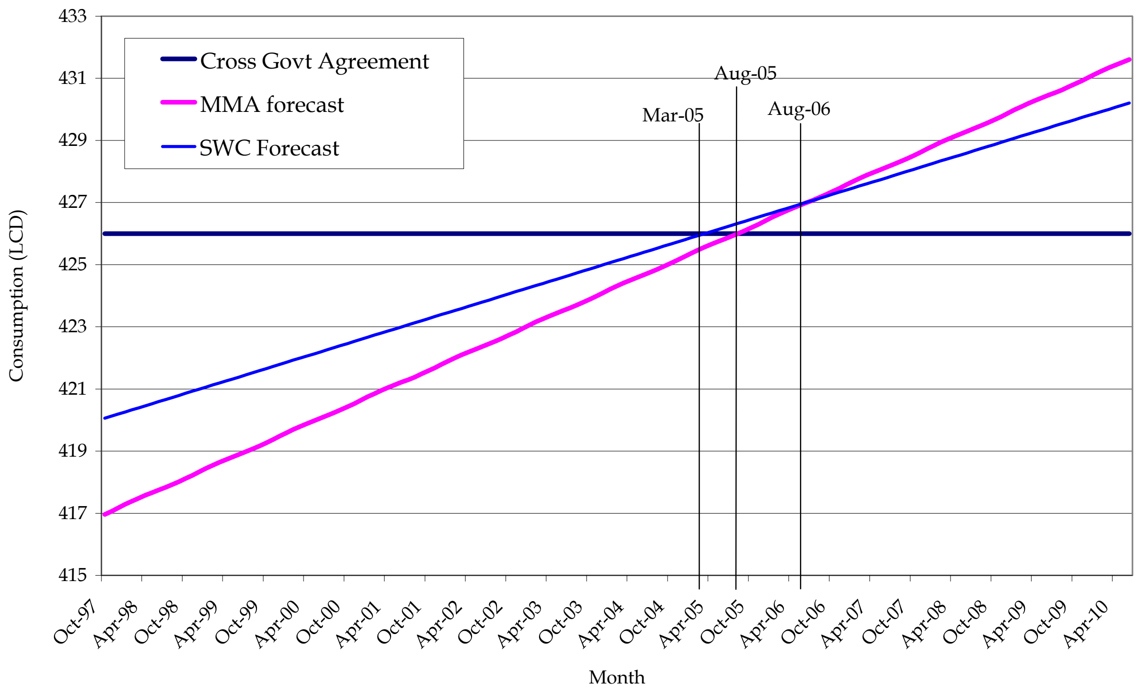
5 Sydney Water Corporation, 2004, *Recent Trends in Per Capita Demand*, a report prepared by the Strategic Directions Team, Sustainability Division, October.

MMA's model predicting an increase of 1.2 LCD. While MMA's model gave a more significant p-value for the trend coefficient, indicating that an increase of 1.2 LCD per annum may be more representative than SWC's 0.9 LCD per annum, the coefficient for the trend variable was not statistically significant at a 5% level.

The discrepant estimates of LCD had led to slightly different water consumption forecasts. The forecasts for LCD are shown in Figure 2-3. Although MMA's model predicted a greater rate of increase in LCD per annum, the lower value of the constant in the model actually resulted in the predicted LCD crossing the constant cross-government agreed value of 426 LCD at a slightly later date (approximately five months later, some time in August 2005). Beyond August 2006, MMA's model predicted higher rates of per capita consumption than SWC's model.

More importantly, based on SWC's own analysis, the estimate increases from 425 LCD in 2004 to 426 LCD in 2005 and then gradually rises to just over 430 LCD in 2010. The average over the forecast period is around 428 LCD. MMA's estimate of the average LCD is also slightly higher than the 426 LCD assumption used in SWC forecasts of water demand. However, the difference is not substantial, leading to an underestimation of demand of less than 1%.

Figure 2-3 Forecasts of LCD



As indicated in our 2004 study, in our view there were a number of limitations with this analysis that restricted its usefulness as a tool for demand forecasting.

These limitations include the fact that estimating monthly population growth is difficult, which leads to errors in the LCD calculated for each month.

Furthermore, the trends in the LCD mask a large number of other trends, such as reductions in industrial demand and leakage. The estimate of the trend variable is not robust and is likely to change over time as the interplay of underlying trends change. Making the assumption that the average per capita consumption remains constant at 426 LCD implies that water consumption pattern remains constant relative to the population. That is, for every increase of 1,000 in the population, water consumption grows at the same rate as population growth. However, the economy has been characterised by significant structural change with the growth of service industries offset by the decline of manufacturing. As a result of all these changes, water consumption is unlikely to remain constant relatively to population. It would be unusual to expect that an increase in water demand in one sector to be fully offset by a decrease in demand in another sector of the economy.

Also, we have experienced large decreases in industrial water demand over the last 20 years as industry moves to more water efficient means of production in response to water scarcity and pricing signals. In addition, the introduction of recycling has also distorted the balance as it has led to lower potable water consumption in industry.

The estimate of the trend in LCD is also highly sensitive to the specification of the weather variables. The specification used by SWC was based on analysis undertaken by a weather correction model. Previous analysis by MMA indicated that even slight changes to this specification resulted in different trend parameters.

To overcome these major issues, a methodology that does not depend on a fixed baseline estimate should be used. This could include the use of an econometric type multi-variate analysis that attempts to estimate how the per capita consumption changes over time in response to changes in income, level of restrictions and price taking into account appropriate weather conditions including temperature, rainfall and evaporation rates. This analysis should be conducted for each different segment of demand including:

- Bulk demand
- Residential demand
- Non-residential demand and
- Non-revenue water (if appropriate).

2.4 SWC Sectoral Baseline Forecast

Sectoral baseline consumption forecast for the residential sector are based on historical consumption data and forecasts of dwellings growth for the relevant property types. The forecast of baseline non-revenue water is based on historical estimates of non-revenue water, estimated savings from leak reduction programs to date and the growth in leakage in the absence of leak reduction activities.

The baseline non-residential consumption is forecast as the difference between the baseline bulk consumption forecast based on the constant per capita baseline consumption figure of 426 LCD and the sectoral forecasts for residential properties and non-revenue water.

2.4.1 Residential Baseline Forecast

Baseline consumption for the residential sectors is based on a baseline average consumption for each dwelling type. This is shown in Table 2-2.

Table 2-2 Annual Water Consumption of Residential Type

Type	Consumption
Single dwellings	290 kL/annum
Individually metered strata units	180 kL/annum
Common metered strata units and flats	166 kL/annum
Dual occupancies	210 kL/annum

The estimates are based on consumption by these dwelling types prior to the current drought restrictions. These savings were developed by SWC on the basis of the dwelling growth forecasts which were obtained from the Metropolitan Development Program (MDP) 2006-2016. The MDP forecasts were based on single dwelling and multi-dwellings only.

To produce consumption forecasts, SWC further splits multi-residential dwellings into forecasts for the 3 types of multi-residential dwellings based on the proportion of each of these types in total multi-residential dwellings for 2006. The SWC residential baseline forecast is shown in Table 2-3.

Table 2-3 Residential Baseline Consumption, GL

Baseline consumption	kL/annum	2007/08	2008/09	2009/10	2010/11	2011/12
Single dwellings	290	298.1	300.0	302.3	304.8	307.3
Common metered strata units	166	79.6	81.6	84.0	86.4	88.5
Individually metered strata units	180	16.8	17.2	17.7	18.1	18.6
Dual occupancies	210	6.0	6.1	6.3	6.5	6.6
Total Residential Baseline		400.4	404.9	410.3	415.8	421.0

2.4.2 Non-Revenue Water Baseline

The non-revenue water baseline forecast was based on the 2005/06 non-revenue water consumption. The estimated savings from leak reduction and other water conservation measures that affect the components of non-revenue water such as potable water savings at sewage treatment plants was added on to the 2005/06 non-revenue water consumption to arrive at a base consumption. In the absence of active leak reduction activities, SWC assumes that, water losses from leaks will grow by 1 ML/day/year. This growth rate is then applied to the baseline estimate of non-revenue water for 2005/06 to arrive at the baseline non-revenue water forecast. The baseline forecast for non-revenue water is shown in Table 2-4.

2.4.3 Non-Residential Baseline

The baseline for non-residential consumption is not calculated separately but rather as the difference between the baseline bulk demand forecast and the baseline demand forecast for the residential sectors and non-revenue water.

Baseline non-residential = Baseline bulk – (Baseline residential + Baseline non-revenue)

As a result, the sum of the baseline demands for the various sectors is by definition consistent with the baseline bulk demand forecast of 426 LCD. The baseline forecast for non-revenue water is shown in Table 2-4.

Table 2-4 Sectorial Baseline Consumption, GL

	2007/08	2008/09	2009/10	2010/11	2011/12
Total Baseline	**668,905**	**675,090**	**681,251**	**687,424**	**693,400**
Residential Baseline	400,389	404,945	410,286	415,848	420,990
Non-Revenue Water Baseline	80,730	81,095	81,460	81,825	82,190
Non-Residential Baseline	187,785	189,049	189,505	189,751	190,220

2.4.4 Comments on SWC Sectoral Baseline Forecasts

While the SWC methodology to estimate the sectorial baseline forecasts ensures that it is internally consistent and that the sector baseline forecasts do add up to the bulk baseline forecast, the use of the non-residential baseline forecast as the balancing sectoral baseline forecast is problematic.

While MMA understands the difficulty of directly forecasting the non-residential baseline given the vastly different characteristics of individual customers, the non-residential sector is an extremely important component of demand. In addition, for the Tribunal's purposes, the non-residential demand is a significant determinant of water prices.

Relegating this demand component to a balancing item is thus in our view not appropriate given its importance.

The baseline forecasting methodology depends on applying an assumed water loss rate growth of 1ML/day/year on an estimated non-metered volume to forecast the baseline non-revenue water. As non-revenue water is not directly metered, and the water loss rate growth of 1ML/day/year is an assumed rate of growth, this brings into question the reasonableness of the non-revenue baseline. As the non-residential base line is determined by subtracting the sum of the non-revenue baseline and residential baseline from the bulk baseline, the reasonableness of the non-residential baseline is questionable.

This methodology is also inconsistent with the manner in which actual consumption data is obtained. In obtaining actual consumption data, the majority of customers in the residential and non-residential sectors are metered. The consumption of the non-metered customers is usually well known and can be estimated to a fair degree of accuracy. To be consistent, the non-revenue water baseline should be used as the balancing item instead of the non-residential water baseline.

As indicated in Section 2.3.1, a regression analysis that attempts to estimate how the segment per capita consumption changes over time in response to changes in income, level of restrictions and price, taking into account appropriate weather conditions would be preferable. This would negate the need for using a baseline and thus avoid all the uncertainties that come with this methodology.

2.5 Impact of Restrictions

SWC carried out a statistical analysis of the impact of water restrictions on demand using monthly bulk consumption data up to June 2006. A model was developed that relates monthly (per capita) demand, in the absence of restrictions and water conservation programs, to weather conditions based on data from the most recent uninterrupted period of unrestricted demand, that is July 1997 to June 2002.

The demand data from the 1999/2000 financial year onwards was corrected for the estimated savings from water conservation programs implemented since that year. Using this model, an estimate of the unrestricted demand during the period from October 2003 to June 2006 was made before including the negative contribution of water restrictions and water conservation programs.

The estimated savings from demand management programs was then deducted from the unrestricted demand estimated. Where necessary, savings were adjusted to account for the fact that during periods of imposed restrictions some programs would not achieve their full savings. The difference between the demand estimated and the observed demand is assumed to be the reduction in demand due to restrictions.

Based on this analysis, SWC estimates that the annual percentage savings from restrictions are approximately:

- Level 1: 12%
- Level 2: 16%
- Level 3: 17%

2.5.1 MMA's Analysis of the Impact of Restrictions

Given the time limitations, MMA was unable to replicate SWC's analysis of the impact of restrictions. However, we did undertake an econometric analysis of the impact of restrictions based on data obtained from the Australian Bureau of Statistics, the Bureau of Metrology and SWC. The analysis was undertaken using quarterly data from July 1997 to June 2007 to be consistent with SWC's period of analysis. Ordinary least squares regression techniques were employed to determine the importance of relevant explanatory variables.

The explanatory variables used were:

- Seasonal Index (SI) – This variable takes seasonality into consideration. We estimated the seasonal index as the long-term ratio of the quarterly ML/day to the average ML/day for each quarter between the September 1997 quarter and June 2007 quarter. That is, for the September quarter SI is the average September quarter ML/day from September 1997 to 2006 divided by the average ML/day for all quarters over the full period.

  SI_{sep} = Ave(SepQtr97, SepQtr98,…,SepQtr2006)/Ave(AllQtr)

- Net Evaporation – The total quarterly evaporation less rainfall.

  Net evaporation = Quarterly evaporation - Rainfall

- Dummy variables were used for the different levels of restrictions:
  - Level 1 restrictions were assumed to have commenced in the June 2003 quarter about 6 months after voluntary restrictions were implemented in Sydney to allow for a time lag so that behaviour can adjust.
  - Level 2 restrictions commenced from the September 2004 quarter
  - Level 3 restrictions started from the September 2005 quarter.

The results of the analysis are shown in Table 2-5. This analysis should be treated as indicative given the lack of time in developing adequate formulations of the model.

Table 2-5 Impact of Water Restrictions

Variable	Impact	T statistic
Constant	182.5	1.602
Seasonal Index	234.31	1.982
Net Evaporation	0.3229	1.051
Level 1 restrictions	-53.175	-2.756
Level 2 restrictions	-82.594	-3.951

Level 3 restrictions	-92.875	-5.582

The resulting regression equation achieved an adjusted R^2 of 0.6897. The regression indicates that the imposition of water restrictions have a significant impact on water demand.

Under Level 1 restrictions, average per capita consumption fell by 53LCD. This is consistent with the SWC estimate.

Average consumption fell by 83 LCD under Level 2 restrictions and by 92 LCD under Level 3 restrictions.

The consumption fall as a result of Level 2 and Level 3 restrictions do appear to be excessive and is likely to reflect to presence of demand management programs that had been instituted independently of the restrictions. Thus we believe that the resulting coefficients for restrictions may have been contaminated by the presence of various demand management activities. Greater investigation should be given to this and may be undertaken as part of the next phase of this study. Given these indicative results from our analysis, SWC's estimates for savings as a result of restrictions appear to be reasonable.

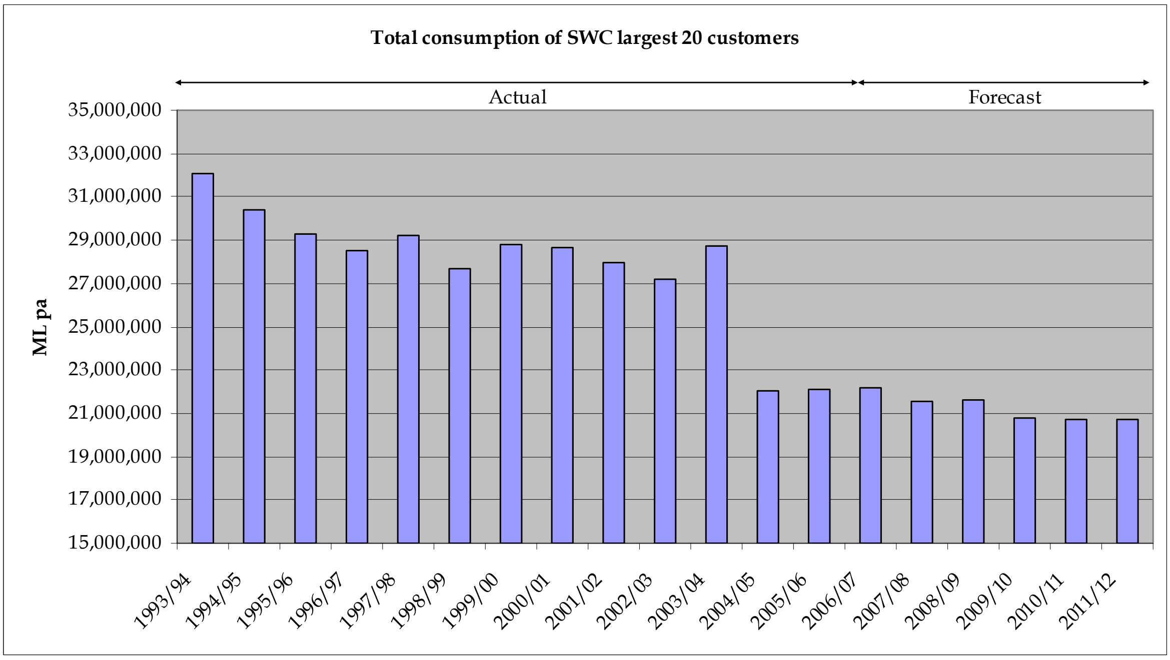
2.6 Large customers

SWC provided historical water consumption for its top 20 large customers. These customers represent a number of industries, ranging from mining and steel production to paper and food manufacturing.

These large customers mainly use water for:

- industrial processes
- dust suppression
- cooling towers.

Figure 2-4 Total Consumption of 20 Largest Customers



Source: SWC and MMA interviews with customers

Due to time constraints, MMA was able to interview only a small number of these customers. The interviews were conducted by telephone to identify expectations about their water consumption and conservation measures. Based on the information provided by customers, it appears that large industrial customers continue to employ water conservation measures to reduce potable water consumption by replacing it by recycled water or by implementing some of the water efficiency programs such as Every Drop Counts.

Water consumption for SWC's 20 largest customers has dropped from 28.7 GL in 2003/04 to 22.2 GL in 2006/07. It is estimated that total consumption will decrease from 22.2 GL in 2006/07 to approximately 20.7 GL in 2011/12, about a 1.3% reduction per annum mainly due to the implementation of water conservation programs and the use of recycled water. This can be seen in Figure 2-4.

3 DEMAND MANAGEMENT PROGRAMS

SWC has proposed a set of very wide-ranging Demand Management (DM) programs covering the period from 2004/05 to 2009/10. MMA has reviewed each of the more significant DM programs in some detail in order to comment on the reasonableness of DM savings proposed by SWC.

So that the Demand Management programs review is consistent with SWC's forecasting methodology, this section has adopted the following conventions:

- Only DM activities from 1998/99 are taken into account. This consumption analysis takes into account the impact of DM programs that commenced after 1 July 1998. Earlier programs have been included in the baseline assessment.

- Only half of the savings from programs which are expected to develop over the course of a year are allocated to that year. The remainder is allocated to the following year. Thus, if 1,000 homes are retrofitted over the course of the year 2008/09, each with an assumed saving of 20 kL, then during the year 2008/09 only half of the savings, i.e. 20,000/2=10,000 kL, is recognised. Conversely, where programs are fully in place from the start of a year, for example price increases assumed to take place on 1 July, it is assumed that the full impact of the program is achieved during the year.[6]

- Where double-counting is likely to be an issue, measures to eliminate or reduce this were examined. For example, although recycled water is being used in new homes, this is included under the BASIX program but not the recycled water program.

- MMA has generally assessed the programs as proposed by SWC. This raises the issue that the proposed program may not be undertaken or may be undertaken with different timing or parameters than those proposed. Thus, for example, MMA has assumed the rebates for rainwater tanks continue to be available as provided by SWC. If a different set of rebates are implemented, then the savings may need to be re-assessed.

- Significant uncertainty surrounds the likely impact of many of the programs proposed by SWC. Indeed, there are very few examples of programs where savings can be quantified with confidence. Where significant uncertainty exists, this is highlighted in the analysis.

- Materiality has been a consideration in the review. Where programs are very small, or the impact of alternative assumptions is relatively immaterial, MMA has generally not commented, or commented but not made alternative assumptions.

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6 In the subsequent tables, where water savings are shown for 2007, it reflects full year savings. The savings shown for 2007 forms the base year savings in our analysis.

- MMA has met with SWC personnel a number of times during this review. The meetings were for the purpose of explaining our information request and data requirements, clarifying SWC's position and allowing SWC to explain their modelling approach and assumptions. The savings for each DM program in this report are based on these discussions and the data provided to MMA by SWC.

3.1 WaterFix Programs

Two WaterFix programs have been implemented. The first program targets the general residential sector and commenced in 2000. The second WaterFix program targets Department of Housing tenants and is similar to the main WaterFix Program. This program commenced in November 2004.

The programs offers the installation of water efficient 3 star rated showerheads, tap flow regulators, toilet cistern flush arrestors and repair of minor leaks to residential households. In total, over 360,000 homes have participated in the main WaterFix program and about 70,000 homes in the Department of Housing program up to the end of the 2007 financial year. SWC is targeting another 60,000 homes in the general program to be completed by 2011/12 and another 5,000 homes in the Department of Housing program to be completed by 2008/09.

The Institute of Sustainable Futures (ISF) has estimated a saving of about 20.9 kL/HH/yr. This estimate was based on a review of the water consumption of participants before and after the installation of the retrofits relative to a control group. The review found that participating households had a savings of 20.9 kL per year and was consistent with the estimated savings from previous evaluations, which indicated savings of 20.1 kL/HH/yr. Accordingly, ISF concluded that the 20.9 kL/HH/yr has remained approximately constant over the life of the programs.[7]

SWC estimates the savings arising from the retrofit of over 360,000 houses to the end of 2007 to be about 7,500 ML/year under the general program and another 1,500 ML/year under the Department of Housing program from over 70,000 houses.

3.1.1 MMA assessment

After reviewing the material supplied by SWC, including the evaluation report from the ISF, MMA considers the savings of 20.9 kL/HH/yr to be a reasonable estimate for the average savings achieved per retrofit to date. The total savings and the break-up between components match reasonably well the findings in the Sarac et al study.[8]

MMA considers it reasonable to assume that the result of the targeted additional retrofits will continue to be 20.9 kL/HH/yr in line with current estimates.

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[7] Institute of Sustainable Futures, 2004, , *Every Drop Counts: residential retrofits, analysis of water savings. Report to SWC*, April.

[8] K Sarac, D Day, S White, ISF, *What are we saving anyway? The results of three water demand management programs in NSW*

The timing of the savings is of some relevance. As the retrofits are likely to take place at a steady rate throughout the year, water savings can be expect to only be achieved as the retrofits take place. This means that the likely impact in the first year is only half the annual amount. MMA's assessment of the annual savings is shown in Table 3-1.

Table 3-1 WaterFix Program, Annual Water Savings

	FY ending June		2007	2008	2009	2010	2011	2012
WaterFix Program	General		360,572	372,558	384,543	396,529	408,514	420,500
	DOH		70,140	75,000	75,000	75,000	75,000	75,000
	Total		430,712	447,558	459,543	471,529	483,514	495,500
Annual Savings	@ 20.9	kL/HH/yr						
	General	ML/yr	7,536	7,661	7,912	8,162	8,413	8,663
	DOH	ML/yr	1,466	1,517	1,568	1,568	1,568	1,568
	Total	**ML/yr**	**9,002**[9]	**9,178**	**9,479**	**9,730**	**9,980**	**10,231**

3.2 DIY Water Saving Kits

The DIY Water Saving Kits are an extension of the WaterFix program where instead of sending a plumber to the participating households, SWC provides a kit containing two flow regulators for showers, two flow regulating aerators for bathroom basin taps and one flow regulating aerator for kitchen taps. The household then installs these flow regulators themselves. In 2006/07, over 90,500 of such kits were distributed to SWC customers taking the total to around 127,600 kits distributed. SWC has targeted a total distribution of 195,600 kits by 2011/12. To achieve this target, SWC expects to distribute 50,000 kits in 2007/08 and 6,000 kits in the following 3 years.

It had been estimated based on reviewing the historical consumption data of households that received the DIY kit in the pilot group relative to the control group which did not receive the kit, that savings of 6.73kL/yr per distributed kit was achieved[10]. The savings of 6.73kL/yr thus takes into account the ratio of actual installation relative to distributed kits as it would be unlikely that all distributed kits would be installed.

SWC also applied a correction factor of 28% to the estimated quantity of water saved from DIY kits. This was to correct for the duplication with WaterFix to account for the fact that some DIY Kits were being distributed to WaterFix participants. This duplication was discovered when the databases of participants of both programs were examined and it was discovered that 28% of those who received the DIY kits had already participated in the WaterFix program. SWC thus discounted the savings from the DIY Kit program by 28% so that no additional savings would be achieved by participating in both programs – only savings from Waterfix program would count towards the saving forecast.

9 Level of full year savings forming the base year savings rate.
10 Internal SWC evaluation of the trial DIY programme indicated that savings fo 6.73kL per distributed kit was achieved.

3.2.1 MMA assessment

After reviewing the material supplied by SWC, MMA considers the savings of 6.73 kL/yr per distributed kit obtained from the pilot program appears to be a reasonable estimate for the average savings achieved per distributed kit. In MMA's previous review for the Tribunal[11], it was estimated that the installation of each tap aerator resulted in a saving of 3 kL per year. Given that each distributed kit contains two bathroom tap aerators plus one kitchen tap aerator and two shower flow regulators, the estimated 6.73 kL/yr saving appears consistent with the saving expected when the ratio of installation to distributed kit is taken into consideration.

We also accept that a discount for double dipping by participating in both the DIY and WaterFix program is appropriate given that the DIY kit is essentially a watered down version of the WaterFix that homeowners could undertake on their own. It is thus unlikely that a participant in the WaterFix program would be able to exploit any further savings from the DIY Kit. However, given that the 6.73kL/year savings takes into account those that have received the DIY kit but not installed it, discounting the full 28% of duplicated participants may be conservative.

Again, the timing of the savings has some relevance as the installations are likely to take place throughout the year. Accordingly, water savings from the DIY Kit can be expected to only be achieved as the retrofits take place. This means that the likely impact in the first year is only half the annual amount. MMA's assessment of the annual savings is shown in Table 3-2.

Table 3-2 DIY Water Saving Kits, Annual Water Savings

FY ending June		2007	2008	2009	2010	2011	2012
Distributed DIY Kit		127,600	177,600	183,600	189,600	195,600	195,600
Water saving @ 4.85 kL per distributed kit[12]							
Total annual savings	**ML/yr**	**309**[13]	**739**	**875**	**904**	**933**	**948**

3.3 Washing Machine Rebates

Rebates for 4A rated washing machines were trailed in a 2003 pilot that produced an annual savings of 18 kL per rebate from a total of 6,500 rebates. The current rebate program applies to 4 star/5A rated washing machines. By June 2007, 54,240 rebates have been given out. Another 50,000 rebates are targeted for 2007/08 and the program is forecast to end in June 2008.

Given the higher water efficiency rating of the current program compared to the pilot program, the expected annual water savings per rebate is estimated at 24.3 kL.

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11 MMA, *Review of Consumption Forecasts, NSW Metropolitan Water Agencies*, 21 December 2004

12 After taking into account the 28% discount for paarticipants who received the KIY kit who also participated in the WaterFix programme.

13 Level of full year savings forming the base year savings rate.

As with most such rebate schemes, the rebates given for high water efficiency washing machines can be expected to include those that would have purchased such machines in the absence of the rebates. To determine the savings, SWC has attempted to discount such free riders by allowing 4% of the rebates to be discounted from any savings achieved. Also discounted are those who would have purchased the higher efficiency machines due to the Federal Government's WELS[14] scheme in the absence of the rebate. This discount rises to 10% in 2006/07. For 2007/08, SWC has discounted a total of 30% of rebates to take into account these free riders who would have purchased the higher water efficient washing machines in the absence of a rebate mainly due to the impact of WELS.

3.3.1 MMA assessment

While the assumption that a savings of 24.3 kL/yr/rebate appear inconsistent with WELS estimated savings of 18 kL/year (see Section 3.16), this can be explained by the higher efficiency rating for this program compared to WELS. The rebate program provides rebates for AAAAA or 4 star washing machines while the WELS estimate was based on AAAA efficient washing machines. Assumptions on market penetration and savings were made and these assumption need to be tested with real data when it becomes available.

The discount for free riders is also appropriate. It is likely that in the future, with greater acceptance of the need to conserve water, more people will purchase the higher efficiency washing machines in the absence of any rebates. This will be especially so when the increased demand for such machines leads to lower prices and the price differential between high and low water efficient washing machines diminishes. It is thus likely that the proportion of free riders to this program would increase should this program be extended beyond 2008. SWC has not assumed that the program will be extended and has not included any additional savings post 2007/08.

3.4 Rainwater Tank Rebates

The NSW government currently provides three different rebates for rainwater tanks according to the sizes. Different rebates also apply depending on whether the tanks are connected to appliances indoor. The different rebates and expected annual water savings are shown in Table 3-3. These rebates for rainwater tank will continue to apply until 2011/12, but will exclude rebates to new homes to which BASIX applies.

14 Water Efficiency Labelling and Standards Scheme

Table 3-3 Rebates and Expected Annual Water Savings for Rainwater Tanks

Tank capacity	Outdoor connection only		With indoor connection		
		Annual Water Savings	Toilet only	Toilet and Washing machine	Annual Water Savings (kL)
	Rebate ($)	(kL)	Rebate ($)	Rebate ($)	
2,000 – 3,999 litres	150	35	650	1,150	46
4,000 – 6,999 litres	400	42	900	1,400	55
7,000 litres and above	500	45	1,000	1,500	60

In 2006/07, over 1,000 rebates were given each month for rainwater tanks. A total of over 36,800 rebates have been given since the program started in 2002. SWC expects that the number of rainwater tanks installed will continue to increase annually at a rate of 500 additional tanks per year. The number of tanks expected to be installed between 2008 and 2012 are shown in Table 3-4.

Table 3-4 Forecast Number of Rainwater Tank Rebates

Tank capacity and indoor connection	2008	2009	2010	2011	2012
2,000 – 3,999 litres	3,750	3,900	4,050	4,200	4,350
2,000 – 3,999 litres plus toilet	1,000	1,040	1,080	1,120	1,160
2,000 – 3,999 litres plus toilet & washing machine	625	650	675	700	725
4,000 – 6,999 litres	3,500	3,640	3,780	3,920	4,060
4,000 – 6,999 litres plus toilet	1,875	1,950	2,025	2,100	2,175
4,000 – 6,999 litres plus toilet & washing machine	875	910	945	980	1,015
7,000 litres and above	250	260	270	280	290
7,000 litres and above plus toilet	375	390	405	420	435
7,000 litres and above plus toilet & washing machine	250	260	270	280	290
Total rainwater tank rebates	**12,500**	**13,000**	**13,500**	**14,000**	**14,500**

SWC estimates that the rainwater tank rebates have saved 1,485 ML/year as at June 2007. Savings are forecast to reach 4,150 ML/year by 2012. These savings are calculated after subtracting 1,000 tanks from the number of rebates given as shown in Table 3-4. This is to avoid including the water saved from the 1,000 or so tanks that were normally installed prior to the introduction of the rebates as the water saved from the installation of these tanks had been already included in the baseline demand estimates.

3.4.1 MMA assessment

In 2006/07, the number of rebates paid reached 36,842[15]. This is an increase of about 12,400 rebates from the 24,449[16] rebates given by 30 June 2006. In 2005/06, just over 12,000 rebates were given. The increase in the number of rebates given could be due to the increase in the value of the rebates where indoor connections were installed. This increased from an additional rebate of $150 for internal connections in 2005/06 to $500 per indoor connection in 2006/07.

As no further increases in rebates are planned, the expected annual increase in tank installation may be optimistic. This may be especially so when the desalination plant is commissioned and restrictions relaxed leading to the dilution of the water conservation message. Unless the price of water increases to the extent that provides an additional boost to the economics of rainwater tanks from a user's perspective, it is unlikely that sales of rainwater tanks will continue to grow in the established homes market. Marsden Jacobs Associates in an April 2007 report[17] to the Nature Conservation Council of NSW, Australian Conservation Foundation and Environment Victoria found that rainwater tanks would cost more per kL than the cost of desalination in Sydney. In the absence of rebates, it is likely that rainwater tanks will only be installed by owners of existing houses that place an environmental value on rainwater tanks. It is also possible that those who intend to install rainwater tanks have already done so in the initial years of the rebates and that in the absence of increasing rebates, the number of rainwater tanks installed will start to decline.

SWC has only included one saving rate for indoor connections regardless of whether the participant has connected toilet or toilet and washing machine to the rainwater tank. This will tend to under-estimate the savings. Based on a 3 star rated washing machine using approximately 90L per wash, running 7 times a week, a household would use about 32.7kL per year. Including this estimate in the analysis, our forecast savings from rainwater tank rebates are shown in Table 3-5.

15 Sydney Water, *Water Conservation and Recycling Implementation Report*, 2006-2007
16 Sydney Water, *Water Conservation and Recycling Implementation Report*, 2005-2006
17 Marsden Jacobs Associatiates, *The economics of rainwater tanks and alternative water supply options*, 16 April 2007

Table 3-5 Forecast Savings from Rainwater Tank Rebates

Tank capacity and indoor connection	2007	2008	2009	2010	2011	2012
2,000 – 3,999 litres	337	397	521	649	783	922
2,000 – 3,999 litres plus toilet	118	139	182	228	274	323
2,000 – 3,999 litres plus toilet & washing machine	126	149	195	243	294	346
4,000 – 6,999 litres	377	445	583	727	877	1,033
4,000 – 6,999 litres plus toilet	265	312	409	510	615	725
4,000 – 6,999 litres plus toilet & washing machine	197	232	304	380	458	539
7,000 litres and above	29	34	45	56	67	79
7,000 litres and above plus toilet	58	68	89	111	134	158
7,000 litres and above plus toilet & washing machine	59	70	92	115	138	163
Yearly Savings	**1,567**[18]	**1,847**	**2,421**	**3,019**	**3,641**	**4,288**

3.5 Love Your Garden

The Love Your Garden Program is a behaviour change program that aims to encourage large water users reduce their water consumption in the garden. The program provides advice about the garden water needs and involves a qualified horticulturalist visiting a customer's home and evaluating the amount of water the garden needs. Smart water tools such as tap timers, rain gauges and tap tags are provided along with a detailed report. In a pilot program, 2,000 high water use properties were visited resulting in a recommended annual saving of 125 kL per property[19].

By June 2007, over 4,900 properties had participated in the program and it is targeted that 10,000 properties will be visited in the next three years and 6,000 in the two years following. Savings that are actually achieved from the program are estimated at 85% of the pilot program's recommended savings. This reflects the likelihood that not all the recommended savings will be acted upon.

3.5.1 MMA assessment

The main uncertainty in this program is the actual savings that may be achieved by individual participants. While the largest water users that are initially targeted may achieve significant savings, as the program progresses and smaller users are visited, the saving will progressively diminish. While 85% of the recommended savings may be appropriate for the initial participants, we expect that the recommended savings will get progressively smaller over time. In Table 3-6 we have shown the estimated saving when the percentage savings relative to the current recommended savings are reduce by 5% per year over time as the program continues to target relatively smaller customers. We have also discounted the savings from the first year of participation. This takes into account the

18 Level of full year savings forming the base year savings rate.

19 The pilot group used on average267kL of water outdoors. The recommended outdoor usage for these properties was 142kL, an estimated saving of 125kL per year.

timing within the year in which the customer is visited by the horticulturalist and receives the water saving advice.

Table 3-6 Estimated Annual Water Savings for the Love Your Garden Program

	2007	2008	2009	2010	2011	2012
No of participants	4,932	14,932	24,932	34,932	40,932	46,932
Estimated % of recommended savings	85%					
Recommended savings (kL/year/participant)	**Annual savings (ML)**					
125	524	524	524	524	524	524
119		505	1,009	1,009	1,009	1,009
113			479	959	959	959
107				455	911	911
102					260	519
Total savings	**524**[20]	**1,029**	**2,013**	**2,948**	**3,663**	**3,923**

3.6 Long-Term Water Saving Rules and Outdoor Education

Outdoor water use besides being one of the largest end uses of water is also more discretionary than indoor water use. There is thus greater potential in changed behaviour through education, marketing and other incentives. It is expected that when the desalination plant is commissioned, restrictions in Sydney will be replaced by permanent water saving rules that affect mainly outdoor use. This will include rules on the use of sprinklers and watering systems, and restrictions on the hosing of hard surfaces. These outdoor water conservation measures together with some pricing signals are expected to save 19 GL/year from 2009/10 onwards. This estimate is based on saving 3.2% of the 10 year average demand prior to the current restrictions of 600 GL/year. SWC estimated this savings by:

- Estimating the savings from specific restriction measures that were implemented during the current restrictions; and
- Converting these estimates to forecast savings from the proposed measures based on a qualitative assessment of the differences in the severity between the current restrictions and the proposed long-term water saving rules.

Level 1 restriction was estimated to have resulted in savings of 54.5GL/year. This estimate was based on the analysis using the End Use Model (EUM) outputs.

[20] Level of full year savings forming the base year savings rate.

Water use for car washing and hosing down in the absence of restrictions was estimated by the EUM to be 2.9 and 4.8 GL/annum, respectively. The EUM assumes that 50% of households wash their cars using a hose and this method uses 150 L/wash. The remaining 50% of households that use a bucket to wash their car consumes 100 L/wash. Accordingly, if all households that were using a hose convert to using a bucket, the water demand for car washing would be reduced by 20%.

The restriction on hosing down hard surfaces was assumed to reduce water demand for hosing hard surfaces by 90%. It was assumed that 75% of the hosing of hard surfaces was for the hosing of foot paths with the remaining for the hosing of building structures.

The remaining savings were all assumed to be due to the ban on using sprinklers and watering systems excluding drip irrigation. This implies that restrictions on the use of sprinklers and watering systems excluding drip irrigation would have resulted in a saving of 54.5 - (20%*2.9+90%*4.8) = 49.6 GL.

Under Level 2 restrictions, in addition to extra restrictions that to apply the hosing of lawns and gardens and the filling of pools, restrictions were imposed on the non-residential sector which saved 13.8 GL of water.

Under the long-term water saving rules, SWC assumes that:

- Restricting the times during which sprinklers and drip irrigation can be used to before 10am and after 4pm will result in savings of 25% of those from a complete ban on sprinklers only.
- Restricting the times during which sprinklers and drip irrigation can be used in the non-residential sector will result in savings of 25% of savings by non-residential customers during Level 2 of the current restrictions.
- Restrictions on hosing paths under the proposed permanent measures result in the same level of savings as under restrictions. However, no restrictions will apply to the hosing of building structures.
- Restricting the use of fire hoses to fire fighting purposes only will result in savings of 0.1 GL/annum as per calculations previously prepared for potential Level 4 restrictions.

The above assumptions resulted in forecast savings of 19.2 GL/year[21] or 3.2% if measured against a baseline demand of 600 GL.

3.6.1 MMA assessment

This program relies heavily on assumptions regarding the behaviour of water users under different set of rule governing water use. As a result we are of the opinion that the forecast savings are highly uncertain. While there is certainly scope to save significant

21 25%*49.6+25%*13.8+90%*75%*4.8+0.1=19.2GL

amounts of water through modifying external water usage we are of the opinion that significant uncertainty exists about:

- the extent to which long-term water saving rules apply over the forecast period and the decay effect of the current restrictions
- the extent of savings likely to be achieved from various programs targeting outdoor usage
- the extent to which savings "decay" – that is, the period over which users return to "normal" practice.

The assumption used by SWC for the demand forecasts is that the current level of mandatory restrictions will be relaxed on 1 July 2008, and lifted on 1 July 2009 but that a new level of long-term water saving rules will apply from 1 July 2009.

MMA is also not convinced that the hosing hard surfaces end-use is as high as shown in SWC's end-use model (about 3 kL/HH/year)[22]. However, the allowance of only 75% of this use for hosing of footpaths appears conservative as, in our opinion, almost all hosing would be for footpaths rather than building structures. Thus, this balances our concern over the high quantity used for the hosing of hard surfaces. With the relaxation of the current restrictions that prohibits all hosing of hard surfaces, MMA considers the reductions of 90% to the hosing of footpaths proposed by SWC to be reasonable.

While the savings attributed to reduction of hosing down due to long-term water saving rules is uncertain, MMA believes that the impact of water restrictions decays over time after they are removed, rather than taking effect immediately, especially after a fairly long period of restrictions as currently applying. We saw this impact in Melbourne over the period March 2005 and August 2006 when drought restrictions were lifted after 53 months of restrictions and replace with permanent water saving rules. MMA analysis conducted for the three Melbourne water retailers indicate that consumer behaviour did not change significantly and water consumption continued to be at levels consistent with that under restrictions. We thus believe that after a fairly lengthy period of time under restrictions, consumers learn to live with using less water. Any rebound to pre-restriction levels would not take place immediately. A decay rate where consumption behaviour adjusts over time should thus be factored into the forecast.

Changes to the SWC assumed 25% of savings from the ban of sprinklers and non-residential sector will also have a profound impact on the resulting savings as seen in Table 3-7.

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[22] SWC's data provides for 4.8GL of water use for hosing of hard surfaces in total. The nubder of residential customers in 2007 AIR is about 1.63 million. This means that about 3kL/HH/year is used for hosing hard surfaces.

Table 3-7 Sensitivity to changes in saving assumptions

	Non-residential sector	Sprinkler ban	Hosing footpath ban	Restriction on use of fire hose	Total saving
	GL				
Savings under restriction	13.8	49.6	3.2	0.0	**66.6**
Saving under LTWSR					
20%	2.8	9.9	3.2	0.1	**16.0**
25%	3.5	12.4	3.2	0.1	**19.2**
38%	4.1	14.9	3.2	0.1	**27.4**
50%	6.9	24.8	3.2	0.1	**35.0**

There is a strong potential that the saving under the long-term water saving rules may under estimate the savings achievable. Savings under the long-term water saving rules could thus be significantly greater than the 25% of savings assumed especially if a decay rate if factored into the analysis.

Although MMA is not convinced that the hosing hard surfaces end-use is as high as assumed by SWC overall MMA considers the reductions due to the long-term water saving rules and outdoor education proposed by SWC to be reasonable as the assumptions about the impact of the long-term water saving rules on the use of sprinklers are considered conservative. MMA, therefore, considers the SWC forecasts with regard to the net impact of mandatory restrictions in this area to be reasonable by the end of the period, but conservative in its timing. We expect that savings under the long-term water saving rules would be as shown in Table 3-8 after factoring in a decay rate at 50% in the first year and 38% in the second year before reaching the stable long-term saving rate of 25% in 2011/12.

Table 3-8 Savings under Long-Term Water Saving Rules

	2010	2011	2012
Saving under LTWSR (GL)	35.0	27.4	19.2

3.7 Business Water Efficiency Programs

Business programs are expected to contribute about 27 GL of savings out of a total saving of around 161 GL. To achieve this target, SWC has a number of initiatives including:

- Every Drop Counts Business Program
- Water Saving Action Plans
- Pilot Water Saving Fund, Water Savings Fund/Climate Change Fund administered by the Department of Environment and Climate Change.

The *Every Drop Counts* (EDC) Business Program is the main program targeting large water using businesses and government bodies. The program aims to assist large water using commercial enterprises in the manufacturing, commercial, hospitality, education, and health sectors, and government water users improve their water efficiency. In 2006/07, the program had 369 participants with savings totalling approximately 11GL/year. The program is designed to assist the participant company the financial, organisational and technical barriers to the implementation of water-efficiency projects. In 2006/07, the program carried out 56 water efficiency audits at customer sites and 6 reuse trials. Another 16 reuse trials are in progress. The program has identified potential water savings estimated at 57.5 ML/day, of which 30.2 ML/day (11 GL/year) have been implemented.

Building on the EDC program, a number of other programs have also been developed to enhance water savings among the largest water users in the business and government sectors. A total of 240 business and 40 Government sites using more than 50 ML/year, and all 44 councils in Sydney, Blue Mountains and the Illawarra are required to prepare Water Saving Action Plans. It is expected that these organisations will implement the plans to achieve average water savings of 20%.

The EDC together with the Climate Change Fund (formerly Water Saving Fund) is expected to achieve incremental savings of 6 GL/year in 2007/08 and 5 GL/year between 2008/09 and 2011/12. These forecast targets are based on the program managers' expectation of individual participants' potential to achieve water savings.

Another initiative available to the government sector to save water is the pilot Water Saving Fund. This pilot fund provided funding to NSW Government agencies to implement water savings projects identified through the EDC program that were not commercially viable without supplementary funding. Grants were given for projects to achieve sustainable water savings of more than 20 kL a day. A total of 26 projects have been funded. 22 have been completed with water savings of 414 ML/year have been achieved. It is expected that all 26 projects (costing $2.3M) will be completed by the end of 2007, with associated savings of 726 ML/year. Based on this pilot project, the Water Savings Fund/Climate Change Fund was established in 2005 to deliver water savings across Sydney. Businesses, councils and NSW Government agencies were able to apply to the fund to support water saving initiatives. 99 projects have been allocated funding (of $48.8M) and are expected to save approximately 6 GL of water a year by 2010/11 for three round of funding allocation. This saving takes into account double counting with the EDC business program and a reduction of 20% due to potential cancellation of projects.

Another funding round is forecast for 2007/08. Funding up to $11.2M may be available for participants. Savings of 690ML/year is expected after 4 years.

In addition to these programs for larger businesses, a retrofit program was also available for smaller businesses. This program is similar in nature to the WaterFix program for the residential sector and involves the supply and fitting of showerheads and tap aerators.

SWC has estimated the savings of this program based on the number of small business customers in its area and segmented it into three categories of high, medium and low water consumers. It assumes that 10% of all small businesses will participate in the program, with savings of 30% of their water use in the amenities. The amount of expected water saved annually be each business type is shown in Table 3-9.

Table 3-9 Small Business Retrofit

Business Retrofit	High	Medium	Low
Ave Consumption (kL/day)	85	25	2.5
Number of properties	1,600	15,000	53,400
Amenity use %	10%	25%	30%
Savings	30%		
Take up rate	10%		
Annual savings (ML)	149	1,027	439

3.7.1 MMA assessment

The water saving potential of each participant in the EDC business program appears to have estimated individually based on the participants' characteristics. As the savings were provided by the program managers based on their understanding of the individual businesses' characteristics, the major uncertainty with the saving estimates of this program is that the businesses may not implement the savings identified especially if the businesses cost of water is a relatively small proportion of its production costs.

While continued funding of the Climate Change Fund program would result in a corresponding increase in water savings, it is also likely to be a potential for diminishing returns over time as the program matures. As the "low hanging fruit" are exploited, the returns on funding investment will inevitably decrease. This diminishing return can be seen in Table 3-10. These diminishing returns appears appropriate and in the absence of extended direct discussion with the program managers and the participants themselves regarding their individual water saving plans, MMA accepts the estimated savings produced by SWC.

Table 3-10 Savings under Water Saving/Climate Change Fund

	$m	ML/year	ML/$m
Pilot Water Saving Fund	2.3	726	315.7
First 3 funding rounds	48.8	6,000	123.0
Next Funding round	11.2	690	61.6

For the small business retrofit program, while the assumptions used by SWC appear to be reasonable, there are no basis provided for these assumptions. However, the take rate also appears to be fairly conservative at 10% and in our opinion, it may underestimate the participation of small businesses. This is because it would not cost the small business anything to participate in the program and would lead to lower cost in water use by its participation. There is however no strong reason to question the assumptions used by SWC and based on these figures, and SWC's expected annual take up profile, MMA's estimate of the water saving is shown in Table 3-11.

Table 3-11 Small Business Retrofit Savings

Water savings	2008	2009	2010	2011	2012
Take up profile		25%	35%	30%	10%
Savings (ML)		202	686	1,211	1,533

3.8 NSW Government Water Efficiency

In addition to the water efficiency programs that are available to businesses and government agencies, a separate program is targeted at NSW Government bodies. This program aims to reduce water consumption in NSW Government agencies by 15% by 2010/11. A total of 79 sites have been identified to be audited with the aim of identifying an average saving of 56 kL per day per site. The program savings assumes that 35% of savings identified will be implemented so that the end of the program in 2010, total savings of 565 ML/year may be achieved.

3.8.1 MMA assessment

SWC has not provided any real justification for its assumed subsidy level which is central to the whole calculation of water savings, apart from indicating that it is based on experience gained from projects assessed. Over time as the most efficient programs are undertaken and fewer material projects identified, it could generally be expected that the average subsidy required would increase as diminishing returns set in. In our view there is great uncertainty in the forecast for this program and this may be partially reflected in SWC's estimate that only 35% of identified savings is implemented.

3.9 Spray Valve Program

The Spray Valve program was identified from the EDC business program for the hospitality industry. The program fully funded by SWC involves replacing the existing pre-rinse spray valves that use around 11 litres a minute with low flow valves that use 6 litres a minute and have a more targeted spray pattern to improve efficiency. About 3,250 customers have been targeted (25% of the market). A pilot study in 2006/07 determined that pre-rinse usage accounted for about 2 kL/day per site and that replacement of the spray valve can reduce the pre-rinse usage by 35%. SWC expects to achieve savings of 822 ML/year can be achieved by 2011/12.

3.9.1 MMA assessment

The assumptions and targets for this program appear reasonable. While the pilot undertaken in 2006/07 only involves 12 spray valves and the results should be transferable across users as they are consistent with the flow rates. Based on these assumptions, MMA has estimated the savings from this program shown in Table 3-12. The estimated water savings are similar to those estimated by SWC.

Table 3-12 Spray Valves Rebate Water Savings

	2008	2009	2010	2011	2012
Water efficient spray valves	500	1750	3000	3250	3250
Average pre-rinse consumption	1.98	kL/day			
Savings	35%				
Estimated total savings (ML)	**63.2**	**284.6**	**600.7**	**790.5**	**822.1**

3.10 Every Drop Counts in Schools

The program targets water conservation in primary schools through a series of lessons involving students in a water audit and the development of a water saving plan. In 2006/07, 61 schools participated in the program, up from 54 in 2005/06. The aim of the program is to reduce water consumption in participating schools by 5% from the average 12.4 kL/day. Since the program started in 2004, a total of 217 schools have participated, saving an estimated total of 49 ML/year by the end of 2006/07. SWC is targeting the participating of 40 schools per year till the end of the program in 2011/12. This would result in a saving of 90 ML/year in 2011/12.

3.10.1 MMA assessment

MMA considers that the participation target of 40 schools per year as reasonable but conservative given that an average of over 50 schools per year have participated since the program inception in 2004. The 5% savings target also seems reasonable. Based on these assumptions, MMA expects that in 2007/08, a savings level of 54 ML will be achievable, increasing to 90 ML in 20011/12. This is shown in Table 3-13. These savings are consistent with SWC's estimates.

Table 3-13 Every Drop Counts in Schools

	2007	2008	2009	2010	2011	2012
Participating schools	217	257	297	337	377	417
Average consumption	4,526	kL/year				
Estimated savings (ML)		**53.6**	**62.7**	**71.7**	**80.8**	**89.8**

3.11 Rainwater Tanks in Schools

Another schools program is the provision of a rebate for the installation of rainwater tanks in schools. A rebate of up to $2,500 is offered towards the cost of purchasing and installing a rainwater tank and connecting it to toilets or a fixed irrigation system in conjunction with completing a water conservation education program with students. Of the schools that have participated in this program, 15.8% have connections made to the toilets while the remainder have connected to the outdoor irrigation system. Since its introduction 261 schools have participated in the rebate and program, saving an estimated 38 ML/year. Tanks connected to the toilets have saved on average 187.9 kL/year while those connected to the irrigation system saved an average of 138.6 kL/year. In its forecast SWC has targeted the participation of 40 schools per year in this rebate program and that savings from this program will reach 186 ML/year in 2011/12. The availability of the rebate is currently expected to cease in 2010/11.

In addition, the NSW government has committed to provide all NSW government schools a rainwater tank. In total 900 schools are expected to benefits from this grant spread over three years (300 per year). SWC assumes that under this program, all connections are outdoor only and savings of 125ML/year by 2010/11

3.11.1 MMA assessment

MMA considers that the participation target of 40 schools per year as appropriate given that the target is consistent with the Every Drop Counts program as the rebate is essentially only given for a school that participates or has participated in that program. While an average of over 100 schools per year have participated since the program inception in 2005, this is likely a reflection of the fact that the Every Drop Counts in schools program started earlier and that schools that participated in this program subsequently installed a rainwater tank when the rebate became available. Based on these assumptions, MMA expects that in 2007/08, a savings level of 54 ML will be achievable, increasing to 90 ML in 20011/12. This is shown in Table 3-14.

Table 3-14 Rainwater Tank Rebates in Schools

	2007	2008	2009	2010	2011	2012
Participating schools	261	301	341	381	421	421
NSW Government schools rainwater tank			300	600	900	900
Indoor connection (%)	15.8%					
Savings						
Outdoor connection	138.64	kL/year				
Indoor & Outdoor connection	187.9	kL/year				
Estimated Total Savings		**41.1**	**67.8**	**115.2**	**162.7**	**186.4**

3.12 Active Leak Detection and Repair

The Active Leak Detection Program acoustically scans for leaks in SWC's supply network. SWC's supply zones on an assessed on a priority basis where the greatest potential for leaks are scanned more often. Leaks found on water mains, connections to the mains, and on fittings such as hydrants and valves are repaired to minimise leakage.

In 2006/07, leak detection and repairs were completed in 82 supply zones. In total, over 18,000 km of SWC 21,000 km of mains were scanned. SWC expects to continue to inspect 18,000 km of pipes a year. To maximise leak reduction, inspection will be targeted at those areas where leaks had previously been found to be highest. SWC estimates savings of 21,900 ML/year will be achieved. This level of leakage reduction is required to fulfil its licence condition of saving 60 ML per day by 2008/09 from leakage reduction.

3.12.1 MMA assessment

The Active Leak Detection is the largest water saving program in SWC. In 2005/06, the program which also covered around 18,000 km saved over 18.5 GL. This increased to almost 21 GL in 2006/07 with about the same amount of pipes covered. In our previous report, MMA indicated that given the lack of historical data, there was uncertainty regarding the ability of SWC to achieve the targeted savings. However, SWC has achieved the level of water waving from this program in line with their targeted licence conditions over the last two years and MMA expects that SWC will be able to achieve the expected level of savings of between 21 GL and 22 GL per year over the regulatory period. There however still remains some uncertainty that this level of savings can be sustained over the long-term as the network ages.

3.13 Pressure Management

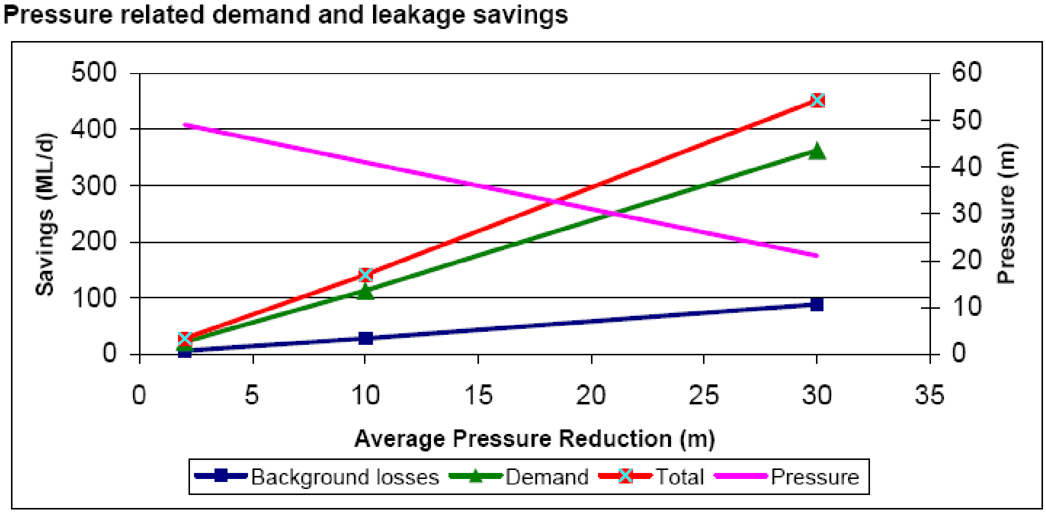
Reducing water pressure in areas where this is feasible, results in a reduction of both leakage and consumer demand. In areas of high water pressure, SWC has commenced the installation of pressure reducing valves to reducing pressure leading to reduced system leaks and main breaks. In total the program will install around 140 pressure reducing valves between 2005 and 2011. As at June 2007, 12 schemes had been established with three having had full pressure reduction. Savings of 59 ML/year has been estimated to have been achieved in 2006/07. This is in addition to the savings of 102ML/year achieved in 2005/06. A total savings of 161ML/year has so far been achieved.

In 2007/08, 23 additional schemes will be implemented with estimated savings of 4.2GL.

Modelling for these savings has been done by the SWC's Pressure Management Group based on accepted international experience that takes into consideration reduced leakages and reduce customer usage.

According to SWC, the impact of pressure reduction to the 40% or so of mainly residential areas suitable for implementation will be the same as reducing the pressure across the network as a whole from 51 m to 40 m, a reduction of about 20%. SWC has modelled savings from leakage and reduced consumer demand arising from the program using a software program developed in conjunction with the International Water Association and Water Loss Task Force. A graph provided by SWC showing the output from this model is provided in Figure 3-1.

Figure 3-1 Expected savings from reducing network pressure



Source: SWC, Sydney Water's Leakage Performance and Water Savings Improvement Program, page 16.

According to the model, the expected impact of average pressure reduction of 10 m is a reduction of about 20 ML/d in background losses (system leakages) and a further 130 ML/d in reduced demand. However, as this data is UK-based and modelled and has not been confirmed locally, SWC has, conservatively, assumed a saving of 50 ML/d, some 3% of the total annual system use. SWC has assumed that the impact is 50% due to leakage reduction and 50% to demand reduction.

3.13.1 MMA assessment

There is no doubt that pressure reduction will have an impact on both leakage and consumer demand. However, the quantity of the reduction is highly uncertain. For the consumer, reduced pressure will result in reduced flow rates. Consumer demand will be affected by a pressure reduction in several ways:

- demand for internal volumetric applications, such as toilets, baths, washing machines, dishwashers will be largely unaffected
- demand for internal "free fill" applications, such as showers, and some tap use will likely be reduced. For households with AAA fittings, the impact is likely to be negligible as these are already flow reduced
- demand for external use, largely garden and lawn watering but also car washing is expected to reduce
- leakage within the property will be reduced.

The extent of the reduction in all of these areas is uncertain and depends on the actual pressure reduction, stock of appliances and fittings and garden needs. Given the importance of garden and lawn watering, actual reductions here are very significant and basing assumptions on actual result experienced in broadly comparable communities is vital.

Theoretically, it can be demonstrated that for free-flow consumption purposes, the reduction in flow rates is proportional to the square root of the reduction in pressure. Thus a reduction in pressure by 20% will reduce free-flow rates by about 10%.[23] If external free-flow applications make up 25% of household usage then, without any compensation for reduced flow rates,[24] the impact of a 20% reduction in pressure will theoretically be about 2.5% of total residential use.

A study in the USA has found that this theoretical calculation does provides a good indicator for reduction in usage in irrigation (garden watering). The study found that the reduction in total bills from a pressure reduction of 17.6% in single residences (in which watering gardens made up approximately a third of water use) was about 1.9%, while there was no statistical difference when the pressure reduction was only 6%. For houses with large gardens the reduction found was about 4%.[25]

An Australian study conducted in 2002 examined the effect of reducing pressure from an average of 800 kPa to 350 kPa in several suburbs of Melbourne through individual household valves. As a result of complaints during the study, some households had their pressure increased to 500 kPa. Thus the actual pressure reduction was between 45% and 65%.

If free-flow applications including watering gardens make up 30% of household usage, the expected outcome would have been a reduction in usage by between 6% and 10%. Although the analysis was hindered by the impact of restrictions and variable results, the authors concluded that the outcome was a reduction of usage of between 3% and 4%.[26] The fact that this saving is significantly lower than expected is explained, in part, by the fact that many people apparently watered for longer than usual in order to compensate for the reduced water flow.

In a comment on MMA previous study on SWC's demand forecast, the Victorian Water Industry Association noted analysis done by Yarra Valley Water suggesting that pressure has an inconsequential effect on indoor use and that for small changes in pressure, say from 65 to 50 metres, the water savings are likely to be negligible.[27]

The impact of pressure management on commercial and institutional usage will be less than on the residential sector. This is due firstly to the fact that there is proportionally less outdoor usage than in the residential sector. We estimate that about 15% to 20% of non-

23 Note that the same relationship need not apply to leaks.

24 For example longer watering.

25 A Bamezai and D Lessick, 2003, Is system pressure reduction a valuable water conservation tool? Preliminary evidence from the Irvine Ranch Water District, 14 February 2003. Source: http://www.iwrd.com/conservation/PressureReduction.pdf

26 South East Water and Plumbing Industry Commission, 2004, Summary of the report on water pressure reduction project Appendix 1 in the Regulatory Impact Statement, Plumbing (water and energy savings) regulations 2004.

27 Victorian Water submission on the Regulatory Impact Statement Plumbing (water and energy savings) Regulations 2004, 14 May 2004.

residential usage is external. Much of the indoor usage, especially in the commercial sector, is understood to be related to toilet usage which will not be affected by water pressure. Secondly, many if not most, of the commercial and institutional premises would not be suitable for pressure reduction, for example in central business districts. If a large proportion of commercial/institutional premises are not affected at all, the saving could be of the order of only 0.6% of usage.

Industrial usage is expected to be largely unaffected.

The expected water savings also shows a significant increase from what is currently achieved (161ML/year from 12 schemes) to 4.2GL/year from 35 schemes in 2007/08, increasing to over 10GL by 2010/11. In our view these are ambition targets and given the highly uncertain nature of this saving estimate, we believe that the estimate of the quantity or water saved should be highly discounted. In our estimate, we have discounted this saving by 50%.

3.14 Leak/Break Response Times

SWC is also required by it Operating Licence to meet specified response times for water main breaks and leaks. SWC expects that this will reduce water loss from leaks and breaks by an estimated 2 ML/day or 730 ML/year. This estimate has been provided by the Leak Detection Team based on an estimate of the leakage rates and the saving due to the improved response times. The improvement in response time is based on SWC licence conditions which require that SWC respond to water main breaks and leaks in the trunk and reticulation components of SWC's system within a particular period. The periods set are:

- Priority 6 breaks/leaks: 70% of jobs within 2 hours
  90% of jobs within 3 hours
- Priority 5 breaks/leaks: 65% of jobs within 3 hours
  85% of jobs within 6 hours
- Priority 4 breaks/leaks: 50% of jobs by end of next working day
  100% of jobs within 5 days

The response time is measured from the time SWC receives notification of a break or leak to the time SWC stops the loss water. Based on these response times and leakage rates, SWC expects to save 730ML/year.

3.14.1 MMA assessment

MMA has reviewed SWC's performance against the criteria and found that SWC has improved its response times, while meeting the majority of its requirements. The only area where SWC has consistently failed to meet the requirements is in stopping all Priority 4 breaks and leaks within 5 days. In all other requirements, performance has exceeded the requirements. This is shown in Table 3-15. Given that in the majority of cases, SWC has met or exceeded the standard set, we accept that the estimates of water savings due to these standards are reasonable.

Table 3-15 SWC Leak/Break Response Time Performance

Priority	Performance Standard	Target	Performance				
			2003/04	2004/05	2005/06	2006/07	2007/08 YTD
6	<=2hrs	70%	69.0%	72.0%	72.3%	86.9%	80.0%
	<=3hrs	90%	83.0%	88.0%	84.3%	94.2%	90.0%
5	<=3hrs	65%	60.0%	55.0%	57.8%	71.0%	70.0%
	<=6hrs	85%	84.0%	78.0%	80.1%	92.6%	92.0%
4	Before next working day	50%	46.0%	55.0%	67.3%	79.6%	74.0%
	<=5 days	100%	81.0%	82.0%	90.9%	96.0%	96.0%

3.15 BASIX

The Building Sustainability Index (BASIX) program has been introduced by the NSW government to reduce the use of water and energy in new homes. BASIX makes it mandatory for development proposals for new dwellings and significant renovations where the estimated construction cost of the work is more than $50,000 and where development approval is required to meet the BASIX requirement. BASIX requires all new homes in NSW to use up to 40% less potable water and produce up to 40% fewer greenhouse gas emissions than the average home

According to BASIX, a typical development will meet the target for water conservation if it includes:

- showerheads of AAA rating or more
- tap fittings of AAA rating or more
- dual-flush toilets
- a rainwater tank or use of recycled water for outdoor water use and toilet flushing and/or laundry use.

SWC has calculated the savings from the implementation of BASIX as:

- the number of net new single or multi-unit homes in each year (from residential and demographic forecasts) based on estimates released by the Department of Planning adjusted for SWC's operating area
- additional 15% of net dwelling growth to take into account old houses being demolished and rebuilt

- the assumption that BASIX on new homes will reduce potable water usage by 40% in line with BASIX targets
- from a base of an average single residential dwelling using 298.3 kL/HH/year or of a unit using 171 kL/HH/year
- for alterations and additions SWC has assumed that there are 50,000 major renovations in NSW per year. This was based on the Victorian Building Commission who reported that the in Victoria the rate of renovations amount to 42,586 extensions/alterations in 2003. This number was adjusted for NSW based on the Victorian/NSW population ratio. Of the 50,000 major renovations, 62% are in the SWC area (based on the population in SWC's area relative to all of NSW). Of these:
    - 30% are to bathrooms only with a saving of 17.5 kL/HH/year (15 from showers, 2.5 from bathroom taps)
    - 20% are to kitchens only with a saving of 5 kL/HH/year (5 from kitchen taps)
    - 10% are to bathrooms and kitchens with a saving of 25 kL/HH/year
    - 5% are to laundries with a saving of 2.5 kL/HH/year from laundry taps,
    - leaks from bathrooms and kitchens are also assumed to be fixed at the rate of 5 kL/HH/year for all kitchen and bathroom renovations. Renovations from the laundry do not contribute to leak reduction.

  The estimated savings per appliance are based on the results of the ISF study on the retrofit program for SWC.

3.15.1 MMA assessment

MMA has reviewed the assumptions made by SWC relating to BASIX and has reviewed SWC's forecast based on details released by BASIX. While some differences are apparent between the information from BASIX and SWC the differences in the information may not necessarily be inconsistent. This relates to the usage level assumed. The BASIX benchmark indicates that potable water consumption benchmark is 90.34 kL/person/year. Based on the 2007 average number of people per dwelling in SWC's area of 2.68 persons per dwelling[28], the average usage on which BASIX savings are calculated is about 242.6 kL/HH/year. This includes both single dwellings as well as multi-unit dwellings and flats.

[28] SWC 2007 AIR and SIR submission to the Tribunal

BASIX also applies to major renovations. Water savings from this program needs to take into account savings from renovations as well as from new homes. Total savings estimate from the BASIX program is shown in Table 3-16.

Table 3-16 Forecast of BASIX program savings, ML pa

	2005	2006	2007	2008	2009	2010	2011	2012
New residential	3,383	2,885	3,049	25,707	25,674	26,895	23,891	23,840
Demolition & rebuild	507	433	457	3,856	3,851	4,034	3,584	3,576
Number of homes covered by BASIX	3,890	7,208	10,715	40,278	69,803	100,732	128,207	155,623
BASIX Consumption Benchmark	243	kL						
New homes Savings	40%							
Water Savings - new homes	ML			2,474	5,340	8,273	11,106	13,769
Number of Renovations		15,500	31,000	31,000	31,000	31,000	31,000	31,000
Bathrooms	30%	4,650	9,300	9,300	9,300	9,300	9,300	9,300
Kitchen	20%	3,100	6,200	6,200	6,200	6,200	6,200	6,200
Bathroom & Kitchen	10%	1,550	3,100	3,100	3,100	3,100	3,100	3,100
Laundry	5%	775	1,550	1,550	1,550	1,550	1,550	1,550
Savings from renovations								
Savings from renovations to								
Showers	1.5	kL/year						
Bath Taps	2.5	kL/year						
Kitchen Taps	5	kL/year						
Laundry Taps	2.5	kL/year						
Leaks	5	kL/year						
Bathrooms	ML	34	69	69	69	69	69	69
Kitchen	ML	33	66	66	66	66	66	66
Bathroom & Kitchen	ML	17	35	35	35	35	35	35
Laundry	ML	2	5	5	5	5	5	5
Annual Waster Savings - renovations	ML	87	175	175	175	175	175	175
Total Water Savings - renovations	ML	87	175	262	349	436	524	611
BASIX Water Savings	**ML**			**2,736**	**5,689**	**8,709**	**11,630**	**14,380**

SWC separately models single and multi-unit dwellings based on consumption of 298.3 kL/HH/year and 171kL/HH/year respectively. These savings are applied to the forecast number of separate houses and multi-unit dwellings. MMA's assessment of the expected impact of BASIX based on the above discussion compared against the combined SWC estimates (both adjusted for and unadjusted for the presences of recycled water is provided in Table 3-17. The difference between MMA's estimate and SWC's estimate before adjusting for recycled water is about 18% in 20011/12.

Table 3-17 Comparison of BASIX program savings, ML pa

FY ending June	2008	2009	2010	2011	2012
New houses	2,474	5,340	8,273	11,106	13,769
Alterations	262	349	436	524	611
Total MMA	2,736	5,689	8,709	11,630	14,380
Total SWC unadjusted for recycled water	1,929	4,135	6,803	9,575	12,183
Total SWC adjusted for recycled water savings	1,806	3,790	5,718	7,471	9,014

3.16 Water Efficiency Labelling and Standards Scheme

The Federal Government's Water Efficiency Labelling and Standards Scheme (WELS) require the water use rating and labelling of showerheads, washing machines, dishwashers, taps, urinals and toilets.

SWC has used its End Use Model in calculating the savings from the WELS program based on the sales and increasing penetration of water efficient appliances. In particular, SWC estimates that savings will come from AAA rate showerhead and AAAA or 3-star washing machines. SWC has estimated the number of washing machines and showerheads based on number of new homes and estimated replacement rate of existing washing machines. A washing machine life of 12 years has also been assumed.

SWC estimates that a water efficient washing machine will save 18kL per year from a normal one based on 2003 pilot washing machines rebate program. This is somewhat lower than the savings estimated from the washing machine rebate scheme (discussed in Section 3.3). To avoid double counting when the rebate scheme is operating, forecast sales of AAAA machines prior to 30 June 2008 are not considered in the forecast savings under WELS.

Similarly, SWC estimates that a AAA rated showerhead saves 16kL per year. This is based on the results of the ISF review[29] of SWC's WaterFix program. The penetration of AAA rated showerhead is based on the estimated number of new homes and an assumed replacement based on a 13 year life. It was also assumed that each house has approximately 1.5 showerheads.

3.16.1 MMA assessment

The average savings of 18kL per year per washing machine was based on the results of the pilot washing machine rebate program where rebates were provided for AAAA rated

[29] Institute of Sustainable Futures, 2004, , *Every Drop Counts: residential retrofits, analysis of water savings. Report to SWC,* April.

washing machines. This is lower than the 24.3kL/year savings assumed for the current washing machine rebate program which provides rebates for AAAAA or 4-star washing machines.

Savings from the sales of water efficient washing machines from 2006/07 and 2007/08 have been disregarded in SWC's forecast as the rebate scheme has been operating. This appears to be conservative estimate as the rebate only applies to the AAAAA or 4 star machines. There are likely to be sales of AAAA or 3 star machines due to the WELS scheme which did not attract the rebate which nevertheless would still have lead to some level of water savings. The numbers however are likely to be small and thus unlikely to impact significantly on the quantity of water consumed.

The overall sales forecast for washing machines appears to be reasonable. SWC appears to have assumed a penetration ratio of washing machines of approximately 85% of all homes. This is likely to be reasonable as there are usually a significant number of flats that do not own a washing machine, using instead commercial laundromats.

SWC forecast a penetration rate of 50% in 2008/09 and 90% in 2009/10 of such machines due to WELS after the expiry of the rebate. In our view this could be aggressive especially in 2009/10 in the absence of any sales or import restrictions unless the cost of water efficient machines fall to levels comparable with less water efficient machines. At present, the cost of water efficient machines remain more expansive than the less water efficient ones and it is likely that this differential will continue.

The SWC forecast of annual showerhead sales of between 147,000 and 160,000 over the forecast period appears to be reasonable. Based on previous studies, MMA agrees that the average life of a showerhead is around 13 years. Given that there are about 1.6m houses and units serviced in the SWC area this implies that annually about 125,000 to 132,000 of these homes would be replacing their showerheads. The SWC assumption of 147,000 sales in 2008 implies that each home has about 1.2 showerheads. This appears to be somewhat lower than the stated assumed rate of 1.45 showerheads. However, this discrepancy could be due to the fact that we do not have the age profile of the existing housing stock used by SWC but rather assumed that the age of houses are relatively uniform. Where the housing stock is instead relatively new, this could reduce the amount of replacement showerhead as newer homes would not be replacing their showerhead.

The estimated penetration rate with AAA showerheads of 30% in 2008 may be low as it does not appear to account for recent penetration rates recorded in the 2007 Australia Year Book[30] published by the Australian Bureau of Statistics (ABS) on 24 January 2007 which indicates that 44% of homes have low flow showerhead, up from 35% in 2001. Such an increase in penetration over six years would suggest that the 30% share of AAA rated showerheads would have been achieved throughout this decade. Given the recent publicity regarding the need to conserve water, we expect that the share of AAA

30 ABS Cat 1301.0 - Year Book Australia, 2007, 24 Jan 2007

showerhead sales would be closer to 50%. We would however agree that in the later part of this decade, we can expect showerhead sales to reach 90% of total showerhead sales.

There is again a timing issue. Given the likely spread of sales throughout the year, only half the savings from the purchase of washing machines in that year are likely to accrue within that time period. MMA's estimate of the savings from the WELS program is shown in Table 3-18.

Table 3-18 WELS program savings, ML pa

		2007	2008	2009	2010	2011	2012
Washing Machine sales		105,880	110,632	115,024	119,737	119,156	120,556
Penetration of 4 star washing machines		10%	30%	40%	50%	60%	70%
Savings per machine	18	kL/year					
Savings from annual sales	ML	191	597	828	1,078	1,287	1,519
Water savings from washing machines	ML			414	1,367	2,549	3,952
Showerhead sales		142,200	147,300	152,700	158,900	160,000	160,600
Penetration of AAA showerheads		10%	30%	50%	90%	90%	90%
Savings per AAA showerhead	16	kL/year					
Savings from annual sales	ML	228	707	1,222	2,288	2,304	2,313
Water savings from showerheads	ML		581	1,545	3,300	5,596	7,905
Total WELS savings	**ML**		**581**	**1,959**	**4,667**	**8,146**	**11,857**

3.17 Recycled Water

Recycled water is used to supply parks, golf courses, industrial and commercial businesses and homes. SWC has estimated the amount of potable water that the use of recycled water would save where it replaces an existing or future potable water demand. The use of recycled water that replaces other water sources including bore water or untreated water pumped directly from a river does not replace potable water and is thus not counted as water saved.

The major recycled water projects that have led to potable water savings include:

- Various sewage treatment plants that save over 2GL/year of potable water
- BlueScope Steel's Wollongong plant with savings of 7.3GL/year
- Orica's Botany plant with savings of about 1.3GL in 2007/08, rising to 5.5GL in 2011/12
- Rouse Hill residential estate[31] with total savings estimated at over 2.1GL/year

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31 Svings from residential estates are discounted to avoid double counting savings achieved under BASIX.

- Sydney Olympic Park Authority (SOPA) where recycled water is supplied for residential[31] and irrigation purposes and is estimated to save 0.85GL/year.

Various other schemes and extension to existing schemes have been planned for the supply of recycled water. By 2011/12, SWC forecast that these will include:

- Stage 2 and 3 to BlueScope Steel's Wollongong's plant which is expected to save an additional 4.2GL/year
- Quakers Hill where recycled water will supply industrial and residential[31] development saving over 1GL/year
- Hoxton Park where recycled water will supply industrial, irrigation and residential[31] development saving over 1.2GL/year
- Camellia industrial development saving 4.2GL/year
- Caltex Refinery at Kurnell saving 2.2GL/year
- Extensions to SOPA saving[31] an additional 300ML/year
- Extensions to Rouse Hill[31] saving an additional 433ML/year
- Other smaller irrigation, industrial and residential[31] developments altogether saving about 2.7GL/year.

For industrial usage of recycled water, SWC's estimates the savings for potable water based on the demand for recycled water. This saving is estimated after discounting the amount of recycled water that replaces non-potable water sourced from bores, rivers (where water is taken downstream from the dam) and other sources or where there is knowledge that the demand for recycled water is higher than that of potable water if recycled water is otherwise not available. These estimates are based on the project managers' knowledge and understanding of each recycled water project and assumes a direct replacement of potable water with recycled water.

For residential usage, SWC assumes that recycled water is used for outdoor purposes including car washing, hosing of hard surfaces and garden watering. All toilets are connected to recycled water and 40% of homes will connect recycled water to the washing machine. The resulting savings of potable water is estimated at 385L/dwelling/day based on SWC's end use model.

SWC then estimates the saving of potable water demand from recycled water alone by subtracting savings from BASIX which is estimated at 316L/dwelling per day.

SWC uses an assumed 465L/dwelling/day of recycled water demand to estimate the number of dwelling from the total residential recycled water demand they receive from the project managers.

Based on this number of dwellings, SWC estimates the total potable water save by recycling alone by multiplying the estimated number of dwellings receiving recycled water by the difference between the savings from recycled water less saving from BASIX thus:

(385-316)*365*dwellings = annual potable water saving from recycled water

3.17.1 MMA analysis

The SWC analysis for savings from recycled water is highly dependent on the estimates of recycled water demand provided by project managers. The estimate for recycled water demand does not easily allow the assumptions and methodology to be reviewed as the estimates are dependent on the project managers' understanding of the project, knowledge of the types of industry taking supply and experience of the likely outcome. As a result,, we remain uncertain as to the validity of the estimates and view the level of savings estimated to be highly uncertain. However, given the lack of detailed data and understanding of all the individual recycled water projects, we are unable to improve on the estimate provided by SWC.

In the residential sector, the savings due to recycled water is made more complex by the need to isolate the impact of BASIX. Recycled water is used for all outdoor purposes, toilets and 40% of washing machines. Since BASIX requires plumbing the rainwater tank or recycled water to dual flush toilets and/or the washing machine, it is appropriate to remove some BASIX savings from the savings from recycled water. The estimated 316L/dwelling/day saving from BASIX in homes that have recycled water is determined by the SWC's end use model. This is probably appropriate although it does seem fairly high given that total BASIX savings from houses estimated by SWC is 40% of 298.3kL per year or 327L/day. The difference in BASIX savings of about 11L/day must thus be due to the more water efficient showerhead and tap flow restrictors although it may be higher if the number of households that connect the washing machine to recycled water is greater than those who connect to the rainwater tank under BASIX. In any event, while the savings from BASIX of 316L/dwelling/day for recycled water connected houses seems high, any difference is unlikely to be significant.

Potable water savings are assumed to directly correspond to recycled water demand after removing the amount of recycled water that replaces non-potable water sourced from bores, rivers (where water is taken downstream from the dam) and other sources or where there is knowledge that the demand for recycled water is higher than that of potable water if recycled water is otherwise not available. It does not allow for the potential that users may behave differently because recycled water is being used instead of potable water or because the price of recycled water is lower than the price of potable water. This is especially so for outdoor use in the residential sector including washing the car and watering the garden more often. In the industrial and commercial sectors this could manifest itself in being less willing to change processes to reduce water consumption both due to lower cost of recycled water as well as less public pressure due to the use of recycled water. While it is difficult to quantify this tendency, MMA believes that the SWC estimate of saving from recycled water may be higher than actual due to the availability of recycled water. We would suggest that 90% of the savings estimated is real and the remainder is a reflection of the higher recycled water demand compared to potable water.

3.18 Pilot Programs

A number of pilot programs have been conducted by SWC targeting water savings in residential, business uses and leak reductions. These pilot programs have generally led to small reductions in water usage and include:

- Expanded Waterfix program was piloted and is expected to save 71ML/year by 2009/10.
- 550 properties were targeted to replace their single flush toilets with dual flush. This program was estimated to save 25kL/household/year, totalling about 14ML/year.
- Expanded EDC business program gave 50 business customers free flow-regulating and water efficient hardware for taps, shower flow regulators, cistern weights. Savings of up to 312ML are expected by 2011/12.
- A pilot leak reduction program for schools where leaks were repaired is estimated to have saved 280kL/day in the 20 schools that participated in the program, saving a total of 102ML/year.
- Expanded residential outdoor pilot program is estimated to save 22ML/year by 2009/10.

3.18.1 MMA analysis

In total, SWC estimates that water savings from the pilots would range from 166ML/year to 521ML/year over the forecast period. MMA does not propose to review these program as all the pilot programs are very small and any changes to their forecast savings will not have any material impact on the forecast water consumption.

4 PRELIMINARY RECOMMENDATION

4.1 Baselines

SWC had used the NSW Government's estimate of 426 LCD for its bulk water baseline demand. The figure was derived to be used for planning purposes and to assess the impacts of various options for demand management and supply augmentation. This estimate was determined based on actual consumption during the late 1990s when no drought restrictions applied. The estimate was obtained after correcting for weather conditions and was assumed to have remained stable over time.

The baseline consumption forecast for the residential sector was based on historical consumption data and projections of dwellings growth for the relevant property types.

The forecast of baseline non-revenue water was based on historical estimates of non-revenue water, estimated savings from leak reduction programs to date and the growth in leakage estimated at 1 ML/day/year in the SWC service area in the absence of leak reduction activities.

The baseline non-residential consumption was estimated as the difference between the baseline bulk consumption forecast based on the constant per capita baseline consumption figure of 426 LCD and the sectoral forecasts for residential properties and non-revenue water.

In our view, there were potentially a number of limitations with SWC's approach to the forecasting of baseline consumption that may restrict its usefulness as a tool for demand forecasting. These limitations include:

- Estimating monthly population growth is difficult, which leads to errors in the LCD calculated for each month.
- Trends in the LCD mask a large number of other trends, such as reductions in industrial demand and leakage.
- Estimate of the trend variable is not robust and is likely to change over time as the interplay of underlying trends change.
- Assuming that the average per capita consumption remains constant at 426 LCD means that water consumption patterns remain constant relative to the population.
    - However, the economy has been characterised by significant structural changes with the growth of service industries offset by the decline of manufacturing,
    - but we have experienced large decreases in industrial water demand over the last 20 years as industry moves to more water efficient means of production in response to water scarcity and pricing signals, and

  - o the introduction of recycling water has also distorted the balance as it has led to lower potable water consumption in industry.

  It would be unusual to expect that an increase in water demand in one sector to be fully offset by a decrease in demand in another sector of the economy.

- The estimate of the trend in LCD is also highly sensitive to the specification of weather variables. The specification used by SWC was based on analysis undertaken by a weather correction model. Previous analysis by MMA indicated that even slight changes to this specification resulted in different trend parameters.

To overcome these major issues, a methodology that does not depend on a fixed baseline estimate was recommended including the use of an econometric type multi-variate regression analysis that attempts to estimate how the per capita consumption changes over time in response to changes in income, level of restrictions and price. It should also take into account weather conditions by including temperature, rainfall and evaporation rates. By appropriately segmenting the demand data, estimates for the residential and non-residential sectors may be made with non-revenue water as the balancing item between the bulk demand and sectoral demands. Alternatively, the bulk demand may simply be the sum of the sectorial demands. This would overcome the conceptual inconsistency between how the data is collected and SWC's methodology which makes use of the non-residential baseline demand as the balancing item.

4.2 Restrictions

MMA undertook an indicative assessment of the impact of restrictions and was of the opinion that SWC's methodology did provide a reasonable assessment of its impact. Our review indicated that restrictions did have a significant impact on water consumption. Also we found that our assessment of water restrictions arrived at a similar impact of Level 1 restriction as SWC's.

The initial results obtained for Levels 2 and 3 however were contaminated by the presence of demand management programs and thus were only be seen as indicative at this stage of the analysis. It did however indicate that higher levels of restrictions reduced water consumption more than Level 1. The challenge in undertaking an econometric multi-variate analysis was to adequately specify the savings from demand management measures to isolate the impact of different levels of restrictions. To adequately estimate the impact of restrictions, it is likely that the following steps will have to be implemented:

- Determine the level of demand for each sector including
  - o Bulk demand
  - o Residential demand
  - o Non-residential demand; and
  - o Non-revenue water (if appropriate)

- Determine the historical impact of demand management programs on consumption and add this back into the actual water demand for each sector of demand.
- Set up an econometric model to predict the per capita demand using explanatory variables such as:
    - Income levels
    - Net evaporation rates
    - Prices
    - Dummy variables for different levels of restrictions.

4.3 Demand Management Programs

MMA conducted a detailed assessment of the impact of the various demand management programs initiated by various NSW government departments and SWC. In our view, most of the assumptions used by SWC in assessing the impact were reasonable and the methodologies used to estimate water savings were appropriate. In certain areas however, there were minor differences in opinion mainly regarding the speed at which certain measures would be taken up and in some cases the uncertainty over the ability to determine participant behaviour. However, in our opinion, significant uncertainties still existed in determining a number of these estimates especially for some of the largest programs including:

- Long-term water saving rules which is expected to save over 19 GL by 2011/12
- Recycled water estimated to save over 30 GL by 2011/12
- Active leak detection saving about 22 GL pa over the regulatory period.

To adequately forecast water consumption using an econometric multi-variate model, it was necessary to:

- assess the impact of the demand management programs since their inception;
- include these estimates as explanatory variables or perhaps more appropriately, adjust the historical data by the amount of water savings from these programs;
- determine the impact of different levels of restrictions based on a properly specified econometric model; and
- use model to estimate future consumption before the impact of Demand Management.

Subtracting the future impact of Demand Management Programs to these estimates can then be made to forecast consumption for each sector of demand.

4.4 Preliminary Forecast of Water Consumption

Our initial review of the water savings under various demand management and restriction regimes indicates that SWC's forecast appears to be reasonable.

Where appropriate, MMA took a different view of the level of savings and included these into the recommended forecast. This is shown in Table 4-1. Table 4-1 also shows the difference between SWC's forecast and MMA's review of SWC's forecast. The forecasts provided by SWC do not exhibit any significant step changes from recent consumption history. In the previous three years, actual total water consumption averaged around 522 GL with 515 GL consumed in 2006/07. The 2007/08 forecast provided by SWC is within 2% of the average consumption from the last 3 years. Given the other uncertainties inherent in these forecasts, the differences between SWC's forecast and MMA's assessment were in our view insignificant.

Table 4-1 Forecast of Consumption, ML pa

		2008	2009	2010	2011	2012
	Bulk Baseline	673,877	678,243	684,486	690,743	698,575
Less	Restrictions	97,564	74,083			
	LTWSR			35,040	27,432	19,190
DM Programs	WaterFix including DOH WaterFix	9,178	9,479	9,730	9,980	10,231
	DIY	739	875	904	933	948
	Washing Machine Rebate	1,597	2,022	2,022	2,022	2,022
	Rainwater Tank Rebate	1,847	2,421	3,019	3,641	4,288
	Love Your Garden	1,029	2,013	2,948	3,663	3,923
	Business Programs	13,386	17,026	21,247	24,652	26,846
	Small Business Retrofit		202	686	1,211	1,533
	Spray Valves Rebate	63	285	601	790	822
	Every Drop Counts in Schools	54	63	72	81	90
	Rainwater Tanks in Schools	41	68	115	163	186
	NSW Government Water Efficiency	94	283	471	565	565
	Recycled Water Savings	11,999	13,950	17,174	24,757	31,281
	WELS	581	1,959	4,667	8,146	11,857
	BASIX adjusted for recycled water saving	2,736	5,689	9,593	11,854	14,066
	Pilot water saving programs	166	339	473	505	521
	Active Leak Detection	21,171	21,901	21,901	21,901	21,901
	Pressure Management	1,122	2,813	3,986	4,956	5,276
	Improved Leak/Break Response times	730	730	730	730	730
Forecast water consumption (ML)		**509,781**	**522,043**	**549,107**	**542,761**	**542,299**
SWC forecast (ML)		**505,085**	**519,371**	**560,039**	**544,082**	**534,465**
Difference (ML)		**4,696**	**2,672**	**-10,932**	**-1,321**	**7,834**
Difference (%)		**0.9%**	**0.5%**	**-2.0%**	**-0.2%**	**1.4%**

4.5 Preliminary Recommendation

The methodology used by SWC depends heavily on the reasonableness of the baseline. This in turn depended on the stability of the per capita water consumption over time.

MMA had a number of concerns regarding the validity of the 426 LCD.

- As this standard was formulated base on a relatively short period in the late 1990s, MMA was not confident that the assumptions are still valid.
- The non-residential baseline was used as a balancing item to ensure consistency with the bulk baseline determined by multiplying 426 LCD by population. We were uncertain that this was appropriate as the non-residential sector is a major consumer and is a significant contributor to SWC's revenue.

We were of the opinion that a methodology that directly forecasts non-residential water consumption is preferable.

5 INDEPENDENT FORECAST

Subsequent to our recommendations in our initial review, the Tribunal commissioned MMA to undertake an independent forecast based on the methodology provided in Sections 4.2 and 4.3.

5.1 Data

The following data and their sources were made available and used for this study:

- Daily bulk water releases between July 1987 and June 2007 (source: Sydney Water Corporation)
- Monthly impact of demand management programmes from March 1999 to Jun 2007 (source: Sydney Water Corporation)
- Quarterly Estimated Resident Population, NSW between June 1981 and June 2007 (source: ABS)
- Annual Population served by SWC (source: Sydney Water Corporation)
- Daily Climate Data for Sydney Airport between July 1987 and June 2007 (source: Australian Government Bureau of Meteorology)
- Duration of Level 1, 2 and 3 restrictions (source: Sydney Water Corporation)
- Level of pricing blocks since 1990 (source: Sydney Water Corporation)

5.2 Methodology

Prior to the formulation of the regression model, some manipulation of the raw data was required. This included:

- The historical quarterly population served by SWC was estimated based on ABS Quarterly Estimated Resident Population, NSW multiplied by the annual percentage of NSW population serve by SWC.
- The base LCD was estimated by adding the estimated historical quarterly impact of demand management to the bulk water release data provided by SWC and dividing by the estimated quarterly population of the area served by SWC.
- A seasonal index was calculated by dividing the average quarterly per capita consumption by the average annual consumption between January 1993 and June 2007.

SHAZAM, an econometric software platform developed by Northwest Econometrics Ltd, University of British Columbia was used to analyse the data. The initial basic demand equation adopted takes the following functional form:

$$LCD_t = \beta_0 SI_t + \beta_1 Evap_t - \beta_2 Rain_t + \beta_3 Temp_t - \beta_4 \Pr ice_t - \beta_5 L1_t - \beta_6 L2_t - \beta_7 L3_t + C$$

Where:

$LCD_t =$	Dependent Variable - Litres per Capita per Day
$SI =$	Seasonal index for each quarter
$Evap =$	Net evaporation rate (evaporation rate – rainfall) over a quarter
$Rain =$	Number of rain days (rainfall >1mm) over a quarter
$Temp =$	Number of day per quarter where temperature exceed 30°C
$\Pr ice =$	Average marginal price of water
$L1 =$	Dummy variable encompassing period where Levels 1 – 3 restrictions apply
$L2 =$	Dummy variable encompassing period where Levels 2 – 3 restrictions apply
$L3 =$	Dummy variable encompassing period where Level 3 restrictions apply
$\beta_k =$	Co-efficient of independent variable
$t =$	Time period expressed as quarters

Similar approaches for the functional form were adopted in developing the regression equations for the residential and non-residential sectors using annual data.

5.3 Regression Results

In Table 5-1, the results for the demand of bulk water are reported for the period January 1993 to June 2007. The results for initial equation indicate that the net evaporation rate and the number of days of semi-extreme heat are the key drivers of consumers' behaviour with respect to lawn and garden watering. These weather variables appear to adequately explain the seasonal variations such that the seasonal index was not a significant variable by itself. The number of days of rainfall above 1mm also was not significant. The impact of Level 3 restrictions was not significant and in any event appears to detract from the impact of Level 2 restrictions. The model was specified such that the effect of restrictions is cumulative. The equations were corrected for auto regression resulting in improved Durbin-Watson statistics.

The final regression for bulk water demand produced the following equation with an adjusted R^2 of 0.8.

LCD = 440.01 + 0.062149*Evap – 1.347*Temp – 36.58*Price – 34.139*L1 – 27.125*L2

A similar regression formulation was undertaken for the residential sector water demand. In this case however, SWC has been unable to supply monthly or quarterly demand data in time for the analysis to be done. As a consequence, annual data was used instead. The results of the regression analysis are shown in Table 5-2.

Table 5-1 Bulk Water Consumption Regression Results

Variable	Initial Equation	Final Equation
Constant	400.77 (7.925)	440.01 (18.42)
Seasonal Index (SI)	52.129 (1.217)	
Net Evaporation	0.050991 (2.779)	0.062149 (4.088)
Number of Day with Rainfall above 1mm	-0.56339 (-1.281)	
Number of days above 30°C	2.2217 (3.83)	-1.347 (-2.127)
Price of Water	-35.166 (-1.425)	-36.58 (-1.525)
Level 1 Restrictions in place	-35.166 (-4.744)	-34.139 (-4.561)
Level 2 Restrictions in place	-27.34 (-1.972)	-27.125 (-2.29)
Level 3 Restrictions in place	0.47777 (0.03358)	
Adjusted R-Squared	**0.7988**	**0.7996**
DW statistic	1.9177	1.9067

t-statistics in parenthesis

Table 5-2 Residential Sector Consumption Regression Results

Variable	Initial	Next	Final Equation
Constant	181.51 (4.38)	232.65 (6.319)	234.28 (37.52)
Net Evaporation	0.035459 (2.304)	0.019498 (2.652)	0.017653 (2.452)
Number of Day with Rainfall above 1mm	0.095482 (0.3817)		
Number of days above 30°C	0.048319 (0.2249)		
Price of Water	28.2 (2.184)		
Level 1 Restrictions in place	-26.186 (-5.018)	-30.222 (-6.261)	-32.271 (-9.366)
Level 2 Restrictions in place	-22.412 (-10.79)	-3.5784 (-0.6875)	
Level 3 Restrictions in place	3.962 (0.5176)		
Adjusted R-Squared	**0.8488**	**0.8452**	**0.8525**
DW statistic	2.3867	1.818	1.845

t-statistics in parenthesis

The regression analysis above indicates that Net Evaporation rates are a significant explanatory variable. Other climatic variables are not significant. The presences of Level 3 restrictions is also insignificant and again the regression analysis indicates that the impact of Level 3 restrictions detract from Level 2 restrictions. Consequently, these variables were discarded. Surprisingly, while the co-efficient for Price was significant, it had the wrong sign! Accepting this co-efficient means that for every $1 increase in the price of water, the residential sector consumed 28 LCD more. This clearly is not reasonable and is likely to be a reflection of the price variable picking up a spurious correlation. It may also be a reflection of the fact that there are only 15 data points available for this analysis due to the lack of quarterly or monthly data from SWC.

A second regression run was undertaken of residential demand. Level 2 restrictions did not return a statistically significant co-efficient. This variable was thus rejected resulting with the following final regression model with an adjusted R^2 of 0.85:

$LCD = 234.28 + 0.017653*Evap – 32.271*L1$

The resulting regression equation indicates that per capita residential consumption has declined significantly even after taking into account the impact of restrictions and demand management programs. This indicates that there has been significant behavioural change that has occurred since SWC first estimated their base consumption. This is likely to have occurred as a result of the publicity of the need to save water and the change in public consciousness due to the impact of the long drought.

The non-residential sector analysis encountered the same data difficulties as the residential sector analysis. SWC was unable to provide monthly or quarterly data in sufficient time for a full analysis to be done and annual data had to be used instead. The results of the regression analysis are shown in Table 5-3.

Table 5-3 Non-Residential Sector Consumption Regression Results

Variable	Initial Equation	Final Equation
Constant	122.83 (5.596)	113.79 (31.92)
Net Evaporation	-0.0013087 (-0.1837)	
Number of Day with Rainfall above 1mm	-0.053347 (-0.4313)	
Number of days above 30°C	0.067784 (0.5829)	
Price of Water	-4.8487 (-0.3818)	
Level 1 Restrictions in place	-8.8459 (-2.428)	-8.5687 (-3.159)
Level 2 Restrictions in place	-4.3436 (-0.7346)	-6.6591 (-1.811)
Level 3 Restrictions in place	-1.2902 (-0.2571)	
Adjusted R-Squared	**0.7801**	0.85687
DW statistic	0.8953	1.1814

t-statistics in parenthesis

The initial regression analysis indicates that none of the climatic variables had any significance in explaining non-residential water demand. This is perhaps not entirely surprising as commercial and industrial water usage is largely independent of the weather. The use of water for irrigation in SWC's area is also likely to be relatively small. The price of water as an explanatory variable is also not significant. The presence of restrictions however does prove to be significant. While Level 3 restrictions do not add any explanatory substance to the regression equation, when it is removed, the coefficient for Level 2 restrictions does become significant. The following is the final regression model for the non-residential sector with an adjusted R^2 of 0.86:

LCD = 113.79 – 8.5687*L1 – 6.6591*L2

Again, some reservations are held for the robustness of this estimate given the lack of monthly or quarterly data available during its analysis.

5.4 Demand Forecast

5.4.1 Bulk Demand

The base demand for bulk water was calculated based on the results of the regression analysis. The values of the forecast variables applied to the regression coefficients are based on data supplied by SWC and the Australian Bureau of Metrology. These include:

- Estimate of the population served by SWC
- Average net evaporation rates per quarter between January 1993 and June 2007

- Average number of days per quarter when temperature exceeded 30°C between January 1993 and June 2007
- Expected water price increase of 18% in 2009, 20% in 2010 and 3% for 2011 and 2012 as proposed by SWC in their pricing submission
- Level 2 restrictions ending by July 2008 and Level 1 restrictions ending by July 2009.

The regression results produced the expected per capita bulk consumption per day under the various restriction regimes. The estimated daily per capita bulk consumption was multiplied by the expected population served by SWC to produce the bulk base demand. This bulk base demand is an indication of the climate corrected demand based on average weather conditions in the absence of any demand management measures but includes the impact of restrictions that are expected to apply in 2008 and 2009. As restrictions are progressively relaxed, it can also be expected that water consumption behaviour are unlikely to change immediately. This had been factored into the forecast by allowing the effect of any relaxation of restrictions to decay at a 50% rate over 6 months (September and December quarters).

From the base demand, savings from the demand management programmes were subtracted. The savings from demand management programmes discussed in our earlier Preliminary Report were adjusted to take into account the lower assumed baseline per capita consumption. This adjustment was made because base per capita consumption is lower than that assumed during the work undertaken for the Preliminary Report. With lower per capita consumption, it is likely that the opportunities for savings under the demand management programmes would be reduced. As a result, savings from the demand management programmes were lower than that reported in the Preliminary Report.

The resulting bulk demand is shown in Table 5-4.

Table 5-4 Bulk Water Demand

	Coefficient	2008	2009	2010	2011	2012
Net Evaporation	6.21E-02	**Forecast Variables**				
September quarter		118.69	118.69	118.69	118.69	118.69
December quarter		449.27	449.27	449.27	449.27	449.27
March quarter		313.40	313.40	313.40	313.40	313.40
June quarter		2.03	2.03	2.03	2.03	2.03
Temp days	1.9531					
September quarter		1.29	1.29	1.29	1.29	1.29
December quarter		10.64	10.64	10.64	10.64	10.64
March quarter		12.47	12.47	12.47	12.47	12.47
June quarter		0.73	0.73	0.73	0.73	0.73
Price	-36.58	1.3635	1.6089	1.9306	1.9886	2.0482
L1 restrictions	-34.139	1	1	0	0	0
L2 restrictions	-27.125	1	0	0	0	0

Constant	440.01	1	1	1	1	1
Base LCD Forecast		Demand Forecast, ML				
September quarter		338.76	356.91	379.27	377.16	374.97
December quarter		377.58	395.73	418.10	415.98	413.79
March quarter		372.70	390.84	413.21	411.09	408.91
June quarter		330.43	348.58	370.95	368.83	366.64
Annual LCD Forecast		354.88	368.41	389.71	393.23	391.10
Population		4,322,054	4,361,975	4,402,122	4,442,361	4,480,459
Bulk Base Forecast		561,381	588,158	627,897	639,359	641,343
DM Programmes Savings		64,987	78,479	93,120	111,277	125,839
Bulk Water Forecast		**496,395**	**509,679**	**534,777**	**528,081**	**515,504**

5.4.2 Residential Demand

The residential demand estimate is similarly based on using regression results to estimate the residential sector base per capita water consumption. As the regression analysis was conducted using annual data, the quarterly forecast variable for net evaporation was not used but annual average daily net evaporation rate was used instead. The regression analysis also found that different levels of restrictions had no significant difference in their impact on consumption. As a result, combined restrictions were assumed to apply till June 2009.

The resulting estimated daily per capita residential demand was then multiplied by the estimated population to determine the estimated base residential demand. This produced a climate corrected demand under restrictions prior to the application of demand management measures.

Savings from demand management programmes targeted at the residential sector were then subtracted from the base annual demand after adjustments were made to the saving expected due to the lower base demand.

The resulting forecast residential demand is shown in Table 5-5.

Table 5-5 Residential Water Demand

		2008	**2009**	**2010**	**2011**	**2012**
	Coefficient	**Forecast Variables**				
Net Evaporation	1.77E-02	874.26	874.26	874.26	874.26	874.26
Restrictions	-32.271	1	1	0	0	0
Constant	234.28	1	1	1	1	1
		Demand Forecast, ML				
Annual Base LCD Residential Forecast		217.44	217.44	249.71	249.71	249.71
Population		4,322,054	4,361,975	4,402,122	4,442,361	4,480,459
Base Forecast		343,966	346,194	401,233	404,901	409,492
DM Programmes Savings		19,539	26,371	69,437	69,173	68,853
Residential Forecast		**324,427**	**319,823**	**331,796**	**335,727**	**340,639**

The resulting regression equation indicates that per capita residential consumption has declined significantly from the level assumed by SWC even after taking into account the impact of restrictions and demand management programs. This indicates that there has been significant behavioural change that has occurred since SWC first estimated their base consumption. This is likely to have occurred as a result of the publicity of the need to save water and the change in public consciousness due to the impact of the long drought.

5.4.3 Non-Residential Demand

Again the estimation of the non-residential demand was based on the non-residential demand regression results to estimate the base per capita consumption from the non-residential sector. As weather conditions were not shown to affect non-residential demand significantly, no weather variables were included in the forecasting equation. Different restriction levels were however shown to be significant. The estimated non-residential per capita demand was then multiplied by the estimated SWC population to determine the estimated base non-residential demand.

Table 5-6 Non-Residential Water Demand

		2008	2009	2010	2011	2012
	Coefficient	**Forecast Variables**				
L1 Restrictions	-8.5687	1	1	0	0	0
L2 Restrictions	-6.6591	1	0	0	0	0
Constant	113.79	1	1	1	1	1
		Demand Forecast, ML				
Annual Base Non-residential LCD Forecast		98.56	105.22	113.79	113.79	113.79
Population		4,322,054	4,361,975	4,402,122	4,442,361	4,480,459
Base Forecast		155,913	167,525	182,835	184,506	186,598
Savings DM Programmes		23,705	29,441	37,042	48,112	57,232
Non-Residential Forecast		**132,207**	**138,084**	**145,793**	**136,394**	**129,366**

Savings from demand management programmes targeted at the non-residential sector were then subtracted from the base annual demand to produce the forecast non-residential demand shown in Table 5-6.

The MMA forecast of non-residential water consumption is higher than SWC's forecast. This could reflect the more recent higher economic growth of the Sydney economy resulting in higher water consumption despite the measures taken by businesses to reduce consumption. However, as with the residential water consumption forecast, some caution should be applied to the sectorial consumption forecast as only annual data was used in the regression analysis due to the lack of data available at the time of the analysis.

5.5 Conclusion

The resulting demand forecasts for each of the sectors are shown in Table 5-7. Also shown is the comparison with SWC's forecast and the difference. MMA's forecast of non-revenue water is simply the difference between bulk water consumption and the sum of residential and non-residential consumption

Table 5-7 Forecast of Consumption, ML pa

	2009	2010	2011	2012
MMA Forecast				
Bulk Water Forecast	508,072	533,061	526,334	515,504
Residential Water Forecast	319,823	331,796	335,727	340,639
Non-residential Water Forecast	138,084	145,793	136,394	129,366
Non-Revenue Water Forecast	50,165	55,472	54,213	45,499
SWC Forecast				
Bulk Water Forecast	519,371	560,039	544,082	534,465
Residential Water Forecast	327,010	358,996	355,144	352,907
Non-residential Water Forecast	131,489	140,515	130,994	124,603
Non-Revenue Water Forecast	60,872	60,528	57,944	56,955
Difference				
Bulk Water Forecast	-11,299	-26,978	-17,748	-18,961
Residential Water Forecast	-7,187	-27,199	-19,417	-12,268
Non-residential Water Forecast	6,595	5,278	5,400	4,763
Non-Revenue Water Forecast	-10,707	-5,056	-3,731	-11,456

The comparison shows that MMA's independent forecast for bulk water and residential water consumption is lower then SWC's forecast. This is largely the result of the lower base per capita consumption used in MMA's forecast resulting from a different baseline. While SWC's baseline forecast was derived from the period during the late 1990s when no restrictions applied, MMA's base was derived from 1993 through to 2007 with the impact of demand management and restrictions isolated. It thus includes more recent data and would have captured the effect of the more recent behavioural change from consumers. The change in water consumption behaviour could be the result of the success of public education regarding the need to conserve water and the long drought.

The higher MMA forecast of non-residential water consumption is likely a reflection of recent high growth of the Sydney economy despite the measures taken by businesses to reduce consumption. As SWC's methodology in forecasting non-residential water is based on the residual after subtracting residential and non-revenue water from its baseline bulk water forecast, the SWC non-residential forecast reflects the consumption pattern during the late 1990s which is likely to have changed since. However, as with the residential water consumption forecast, some caution should be applied to the non-residential forecast as only annual data was used in the regression analysis due to the lack of data available at the time of the analysis.

MMA's non-revenue water forecast is the residual after subtracting residential and non-residential water consumption from bulk water consumption forecast. It is lower than SWC's forecast and reflects the lower per capita consumption. With lower bulk water consumption, it can be expected that losses, metering errors and other sources of non-revenue water will also be lower.