THE STATUS AND USE OF DRINKING WATER CONSERVATION AND SAVINGS DEVICES IN THE DOMESTIC AND COMMERCIAL ENVIRONMENTS IN SOUTH AFRICA

Report to the

Water Research Commission

by

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on behalf of

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Executive Summary

This report is the result of a project carried out to explore the status of water efficient devices in the domestic and commercial environments in South Africa. For the purposes of this study commercial environments were limited to public institutions such as schools, prisons and hospitals as well as shopping complexes and the hospitality industry. This report does not include information on the use of water efficient devices in industrial settings.

A water efficient device is one that serves the same function as its standard alternative, without any reduction in performance, while using less water. Traditionally the design considerations for toilets, showers, washing machines, basins, baths and taps have been functionality, aesthetics and cost. Not much attention was given to how much water these items used, because in many of the countries of manufacture water was always thought of as a cheap and abundant resource. However, the world's population has increased fourfold in the last century, and will at least double in the century to come. Along with this increase in population has been the emergence of megacities, sprawling densely populated conurbations with populations numbering in the tens of millions (e.g. Gauteng, with a population approaching 11 million and, at the present growth rate, set to reach 20 million by 2025). With these changes, the adequacy of water resources in many countries has become a matter of critical concern. According to the United Nations Environment Programme, one third of the world's population already lives in conditions of water stress, and this proportion can be expected to double within the next twenty five years. Water can no longer be used with abandon, but increasingly needs to be used appropriately, and efficiently.

A water supply authority, looking to conserve water and manage demand, needs a holistic plan with four main elements, which are in nature

- Structural
- Operational
- Economic and
- Socio-political.

The *socio-political* part of the campaign requires advertising in all forms of the media, as well as the revision of laws and regulations. Without these "push" factors the market will not by itself move buyers in the direction of water efficiency. Authorities use *economic* methods, comprising pricing changes and penalties, to ensure that marginal water use is given its real marginal value. In South Africa municipalities combine free basic supplies to the poor with stepped tariffs to ensure that those who choose to use above average amounts of water do pay for the privilege. *Operational* methods include the reduction of supply pressures (which in South Africa are often far higher than the 1 to 4 bar needed for domestic use) and the detection and repair of leaks. *Structural* methods include the fitting of on-site pressure reduction devices, the use of efficient irrigation systems, the use of recycling systems, and the use of water efficient devices.

There are many examples of water demand management and water conservation campaigns that have been implemented around the world. The city of Seattle in the United States, for example, has reduced its water consumption by 1% each year over the last 23 years despite a 23% increase in its population. In Southern Africa the city of Windhoek has managed to reduce average consumption from 320 litres per person per day to 220 litres per person per day over the last thirty years, in the process pioneering many of the demand management strategies that others are now emulating. In South Africa water conservation programmes carried out in the various municipalities supplied by Rand Water, the largest bulk water utility in Africa, have seen the annual growth rate in the water supply into that region reduce from 3.3% to 0% over the last three years, despite a concurrent 3.3% population growth rate. Cape Town, which has been through several years of water stress in the last seven years, has developed a holistic water conservation strategy, which includes the promulgation of the most comprehensive water conservation bylaws in South Africa.

In one sense it is against a municipality's interests to persuade its customers to use water efficiently and to penalise them financially for high water use, as water sales are a prime source of income for local government structures (in urban areas). However, if water is not used conservatively resulting in demand outstripping supply, then the municipality will end up having to pay for expensive infrastructure to augment its bulk water supply, which augmentation will cost in the billions of Rands for our larger cities. If a large water supply augmentation project can be delayed by five or ten years due to the introduction of good water conservation practice, the capital saving in present day terms will run into hundreds of millions of Rands.

The status and use of water efficient devices in South Africa – survey results

This study included four different surveys in order to gauge the status and use of water efficient devices in South Africa. Firstly, commercial and institutional settings such as hotels and hostels were investigated; secondly the suppliers of plumbing fittings were studied; thirdly the architectural profession was surveyed; and finally the knowledge and attitude of 1 428 home owners in 10 towns and cities in South Africa were tested.

Water Efficient Devices in commercial and institutional settings

In commercial and institutional settings, there is clear evidence that water efficient devices are becoming more common. From the City of Cape Town's programme to replace all the automatic flushing urinals in public buildings and install Hippo Bag displacement devices in all the old large capacity school toilet cisterns, to the sophisticated infrared operated taps and urinals that are becoming standard at airports, there is a move towards water saving and water efficiency. The larger hotel groups are signing onto environmental programmes, of which one component is sustainable water use, and there are encouraging examples where universities and other public buildings are being retrofitted with water saving cisterns, taps and showers.

Water Efficient Devices in the plumbing supply industry

The increasing market share of water efficient devices is apparent on the showroom floors of the major plumbing suppliers. This is almost in spite of the suppliers who, as a rule, do not push water efficiency (as one said, it is not their job to preach to their customers, who buy mainly on functionality, style and cost). The reason aerated taps, dual flush toilets, water efficient baths, basins and showers are increasingly been sold, is that these are becoming the standard in the countries of manufacture in Europe and the East. While South Africans are sometimes still wary of six litre flush toilets ("will they work?"), these, or even more efficient designs, are now the standard in parts of the USA, the UK and Europe.

Water Efficient Devices as regarded by the building profession

The building profession (architects, quantity surveyors and builders) is conservative by nature. No professional can afford comebacks from aggrieved customers who do not want to be used as guinea pigs for new inventions, and therefore there is a strong tendency to stick to the tried and tested. There is some evidence that architects are moving towards an awareness of sustainable water use. However, as one said in his response to the survey, they work to the building code, and if they are expected to change the way they work, then the building code should be changed.

Water Efficient Devices as understood by the general public

Of the 1 428 homeowners surveyed, 29% indicated that they had at least one water efficient device in the home. Typically only about 20% of the respondents in the average town believed they might possibly use too much water, but significantly more (40% to 50%) have considered reducing their water consumption. The factors which *prevent* people from installing water efficient devices include the following:

- they do not know of water efficient devices

- they do not own their own home (i.e. they are renting)
- they can't afford to make changes
- they do not see the need to make any changes
- they are too old to make any changes

Conversely the conditions which would persuade people to move to water efficient devices include the following:

- an increase in the price of water
- if rebates were offered for the installation of water efficient devices
- if there were water restrictions
- if they had a better understanding of water efficient devices, and
- if the use of hosepipes was banned.

South African municipal bylaws and Water Efficient Devices

A further part of this study was an investigation into the bylaws of South Africa's major towns and cities in so far as water demand management is concerned. It was found that while some (e.g. Cape Town and Ekurhuleni) give limits for cistern volumes and shower flows, outlaw automatic flushing urinals and are generally up to date regarding water conservation, others are silent or almost silent on the subject. In reality it is highly unlikely that municipal building inspectors have time to adequately police these provisions, especially when the neighbouring municipalities have bylaws which are not in line with theirs (e.g. Johannesburg and Ekurhuleni). Leadership at the national level is required to update the building code to comply with the more progressive water conservation bylaws. Once this is done, then architects, specifiers and builders nationally could all work to the same rules without having to know the details of the bylaws in every one of South Africa's 169 Water Supply Authority areas. If such a step could be taken, then the considerable sophistication and power of the existing building materials databases such as *Autospec* could relatively easily be harnessed to enable specifiers to find water efficient products (as defined by the codes), and for suppliers of those products to bring them to the attention of their potential customers.

The economics of fitting or retrofitting Water Efficient Devices

The economics of retrofitting water efficient devices to *existing* housing stock is very variable, depending on the device and the setting in question. It is relatively inexpensive and easy to swop out shower fittings (in much the same way Eskom has recently being going from house to house and swopping out energy efficient light bulbs for the older incandescent bulbs), and these will typically pay for themselves in water savings within a few years. The economics of changing out toilet cisterns and pans is rather less attractive, unless they are in a setting where they are used by more users than would be found in the average family home. For this reason large scale changes to the existing housing stock are unlikely, and therefore the penetration of water efficient devices into the South African domestic market is going to be slow and gradual, probably taking a few generations to become the norm.

Recommendations for increasing the status and use of water efficient devices

In order for South Africa to move more swiftly and effectively towards the entrenchment of water efficiency, the following actions are recommended:

- **Government must lead by example**

  Some of the worst offenders for high water usage are government buildings. The state landlord, the Department of Public Works, should embark on an audit of water usage and the presence of water efficient devices in all buildings under their care. This would have an impact firstly on the entire civil service, which employs over a million people[1], but secondly it would impact on the population at large, who would see the state leading by example. The state is also able to take a longer view on the economics of retrofitting water efficient devices than is the average citizen, having access to cheaper capital.

- **South Africa needs a labelling system for Water Efficient Devices**

  South Africa should emulate the water efficiency labelling systems practiced in other countries, of which the most advanced appears to be the Australian WELS label. This label is not just a general "green" label, but includes product specific information and a graded rating from 0 to 6 stars. If such labelling eventually becomes mandatory in South Africa, it will affect the whole supply chain from manufacture, to marketing, to purchasing. This will help not only the public, but also the building trade professionals, from plumbers, to builders, architects and quantity surveyors to become more knowledgeable about water efficiency.

- **South Africa needs a nationally sponsored public education campaign regarding Water Efficient Devices**

[1] The figure derived from the February 2006 Public Service Commission document entitled "An audit of affirmative action in the public service" is 996 734, but this excludes the departments of Defence and Safety and Security. It also excludes all municipal employees.

Apart from product specific labelling, the state needs to make a case for water saving with the public. This campaign should appeal both to the public's sense of civic duty ("it's the right thing to do"), while not underestimating their intelligence (answering questions like, "why don't we just build bigger dams?", and "If I am prepared to pay for what I use why can't I use as much as I want?").

- **Information on Water Efficient Devices must be easily obtainable**

The public and even the building industry is still relatively ill-informed about water efficient devices. Water conservation in the built environment should be taught at undergraduate level to architects, and at FET colleges to plumbers. Water saving tips should be regularly distributed with municipal accounts, and should be displayed in appropriate locations. A website with product information, educational material and links to other useful sites offers great potential as a tool to promote water efficiency, provided it can be maintained and updated. The existing online product databases used by the building industry (e.g. *Autospec* and *Specifile*) can relatively easily be made to respond to searches for information on water efficient products, but this can not be done until there is a nationally agreed standard for such devices.

- **Municipal bylaws must include provisions relating to water efficiency and water conservation, and ideally there should be convergence across municipalities**

Of South Africa's 283 municipalities[2], 169 are Water Services Authorities (WSAs), in other words, they have responsibility for the planning and regulation of all water supply in their area of jurisdiction. If the rate at which water is being used in their area is becoming unsustainable, then it is their responsibility to either increase the supply or decrease the demand. One measure at their disposal for decreasing demand is the promulgation of bylaws that promote water conservation. Some of South Africa's bigger municipalities have recently updated their water bylaws, and some of these, such as Ekurhuleni, Cape Town and Tshwane have included sections on water efficiency. It would help if there was more consensus between municipalities on water bylaws, particularly in the case of a large conurbation such as Gauteng which spans several municipal jurisdictions.

- **Building codes and bylaws must converge**

Bylaws relating to behavior such as the use of hosepipes for washing paved surfaces (at any time) or for washing cars or watering gardens in times of water restrictions can be enforced. However, bylaws relating to the types or showers, baths and toilets installed in houses are

[2] Made up of 6 Metropolitan Municipalities, 46 District Municipalities and 231 Local Municipalities.

really only enforceable for new housing stock, and even then it seems unlikely that municipalities have enough building inspectors to do this work adequately. It would be far simpler to inspect at the source, i.e. to control what products are sold by the plumbing suppliers. The supply cannot be controlled as long as there is wide variation in water bylaws, and, moreover, divergence between water bylaws and the building code. The first and most important step would be to add a section to the building code bringing it into line with modern water efficient good practice. If this was done, then the suppliers and specifiers would be able to follow without worrying that they are out of line with standard practice.

- **Retrofit programmes with rebates (where appropriate) should be encouraged**

In South Africa there are many millions of poor people who are not required to pay for their water supply. While the official policy guideline is that each family should get a lifeline amount of water of 6 kilolitres free, in some urban areas the reality is that no water is paid for. For people in these areas there is no incentive to conserve water. In such areas, it may pay a municipality to intervene with schemes to retrofit water efficient devices, even if the full cost were to be borne by the municipality.

- **Water supply pressures must be decreased**

Water supply pressures in South Africa are, in general, far above international norms. No more than four bars of pressure is needed for domestic water supply, and municipalities would save both themselves and their customers money if they took steps to regulate the pressure in their systems down to this level. Owners of buildings in high supply pressure zones would save themselves wear and tear on their plumbing fittings, and would save water, if they installed pressure reducing valves on their properties that brought their pressure down to under the four bar level.

- **Informative Billing**

Even educated consumers take little time to attempt to understand or analyse their utility bills, which typically combine water, electricity, refuse removal and sewage charges. For less literate consumers the bills are daunting, to say the least. With modern technology, it is however quite possible to include simple graphic information, like a graph showing how water consumption has varied month on month for the last twelve months. With such easy to read, visual information, consumers can be more easily alerted to leaks or wastage on their properties.

SUMMARY TABLE FOR RECOMMENDED WATER EFFICIENT MEASURES

The table on the next page has been drawn up after reviewing what is available in South Africa and standards elsewhere in the world. This is a draft table which would require discussion between plumbing industry stakeholders and government before ratification. If ratified, the table could form the basis for an amendment to SANS 0400, the *National Building Regulations*.

Item Description	Specification regarding water efficiency	Notes
Cistern and pan – single flush	No cistern and pan for a new building should require more than 9 litres to clear.	More efficient systems requiring 6 litres or less should be encouraged using a labelling system.
Cistern and pan – dual flush	No cistern and pan with a dual flush mechanism should require more than 6 litres to clear on the full flush setting	
Cistern and pan – Interruptible flush	Cisterns and pans with interruptible flush mechanisms are an acceptable alternative to low flush and dual flush options.	The pan should be able to clear with not more than nine litres.
Shower	Shower roses should not deliver more than 18 litres per second at 4 bars pressure.	Showers should be aerated to improve efficiency. More efficient showers delivering 10 litres or less should be encouraged using a labelling system.
Bath	Baths should not hold more than 250 litres to the *overflow* level.	More efficient bath designs should be encouraged using a labelling system.
Basin	Washroom – limit to 5 litres Bathroom – limit to 10 litres Kitchen – limit to 20 litres	More efficient basin and sink designs should be encouraged using a labelling system.
Urinal	Automatic flushing urinals should be illegal. Urinal flushing should be user activated (either manually or with sensors), and should use no more than 2 litres of water per flush.	
Tap – bath	Flows should not exceed 10 litres per minute for single taps and 18 litres per minute for mixer taps at 4 bars pressure.	
Tap – basin	Flows should not exceed 6 litres per minute for single taps and 10 litres per minute for mixer taps at 4 bars pressure. Taps over basins without plugs should not exceed 4 litres per minute flow.	Tap flows should be aerated
Tap – external	Flows should not exceed 20 litres per minute at 4 bars pressure.	Taps located in public places which are not used for irrigation should be self closing after a set time has passed or volume of water has been delivered, according to context.
Hosepipe	Use of hosepipes for washing paved surfaces should be illegal. Hosepipes should be fitted with shut-off valves at the user end.	
Irrigation system	Garden irrigation systems should be switched off using timers and/or soil moisture gauges.	
Pressure reduction	Domestic water pressure should be limited to 4 bars and hot and cold water pressures must be balanced.	
Waterless toilets	Information regarding well tested designs of waterless toilet should be made available and these should be allowed for within the building codes.	
Waterless urinals	Information regarding well tested designs of waterless urinal should be made available and these should be allowed for within the building codes.	
Water Efficient Dishwashers	More efficient models should be promoted through use of labelling.	
Water Efficient Washing Machines	More water efficient models should be encouraged through use of labelling.	
Greywater recycling systems	National standards for domestic greywater recycling systems should be developed and certified designs should be promoted.	

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List of abbreviations

ACSA	Airports Company of South Africa
ADD	Average Daily Demand
AFU	Automatic Flushing Urinal
BMP	Best Management Practices
CSIR	Council for Scientific and Industrial Research
CT	Cape Town
DWAF	Department of Water Affairs and Forestry
EMS	Environmental Management System
EPA	Environmental Protection Agency
FBoP	Federal Bureau of Prisons
FET	Further Education and Training
IDP	Integrated Development Plan
IOPSA	Institute of Plumbing of South Africa
ISO	International Organisation for Standardisation
JASWIC	Joint Acceptance Scheme for Water Installation Components
LEED	Leadership in Energy and Environmental Design
MELA	Mothers of East Los Angeles
NGO	Non Governmental Organisation
Pmb	Pietermaritzburg
RUE	Residential Unit Equivalent
SABS	South African Bureau of Standards
SANBI	South African National Biodiversity Institute
SANS	South African National Standards
TMNP	Table Mountain National Park
UCT	University of Cape Town
USAID	US Agency for International Development
WC	Water Conservation
WDM	Water Demand Management
WED	Water Efficient Device
WELS	Water Efficiency and Labelling Standards
WHO	World Health Organisation
WRC	Water Research Commission
WSA	Water Services Authority

1 AN INTRODUCTION TO WATER EFFICIENCY

South Africa's water resource scarcity is increasing mainly due to the demand from a growing economy and population, and the water supply backlog being addressed. South Africa's water supply is primarily dependent on surface water resources. Rainfall in South Africa is both unevenly distributed and highly variable. The demand for water has previously been met by the construction of dams and by inter-basin transfers of water to areas of high demand (Creemers et al., 2002). Meeting increasing water demands in this way is known as supply management, and is increasingly criticised because it is ultimately unsustainable. For the future sustainable use of our water resources there needs to be a shift towards water demand management. Implementing a demand management strategy would incorporate various ways of using water more efficiently (United Nations Economic and Social Commission for Western Asia, 2002).

There are a number of ways in which the demand for water can be reduced, and these are described below. This study will focus on those devices that improve water use efficiency. Such devices are referred to as *water efficient devices* throughout the report. Water efficient devices differ from water saving devices because while water saving devices may reduce water consumption they do not necessarily ensure that water is used productively, with minimum wastage (i.e. efficiently). Water saving devices and strategies may be necessary in times of water scarcity. Under such circumstances water consumption has to be reduced regardless of the effect this has on the consumer. For example, in a period of severe water shortage gardens may not be watered (a water saving strategy) and the aesthetic beauty of the garden is compromised. In contrast a water efficient strategy would be to hand water, to water only at times when evaporation is minimal, or to use soil moisture sensors and drip irrigation.

Water Saving Device
A device or component that *reduces* water consumption.

Water Efficient Device
A device or component that results in water being used more efficiently.

A range of options exist for both the consumer and supplier to reduce domestic and commercial water consumption and progress towards sustainable water use. It is important that strategies to improve water use efficiency be tailored to local conditions and include both the utility and the consumer (Solomon et al., 1998). According to Flack (1981) domestic and commercial water conservation methods can be divided using the following categories:

- Structural methods
- Operational methods
- Economic methods
- Socio-Political methods

Structural methods include metering, flow control devices and recycling systems. Plumbing fixtures and appliances that serve the same function as standard equipment but use less water (i.e. water efficient devices), would fall under this category. Home recycling systems are based on the segregation of wastewater flows in the home, usually into grey and black water components and involve reuse of the greywater.

Operational methods are normally under the control of the supplier and include leak detection and repair and reducing the pressure at which water is supplied (Maddaus, 1987). Pressure management was successfully used in the city of Mutare, Zimbabwe to reduce the water loss due to leakage. The City experiences high water losses due to an aged reticulation system, faulty metering of up to 25% and a water system that is operated under high pressures. It was concluded that operating the system at 50 metres in the area under pressure management, reduced the minimum nightly flow by 40% and thus reduced the amount of unaccounted water without affecting the service to the customer (Marunga et al*.,* 2005). Pressure management has been used successfully in leak reduction in South Africa in Cape Town, Emfuleni, Johannesburg and Durban, among others. The Khayelitsha Pressure Management Project resulted in a 40% saving in water (McKenzie et al., 2004)

Economic methods of reducing demand for water consist of pricing policy, incentives, penalties, and demand metering. Using block tariffs for water and informative billing contributed to the town of Hermanus in South Africa reducing its water consumption by 25% (van der Linde, 1997). Postel (1992) suggests that water pricing that reflects the true value of water can act as a strong incentive to reduce water consumption. The author sites studies from Australia, Canada, Israel and the United Status which indicate that a tariff increase of 10% results in a 3-7% reduction in household water use. Rate structures that reflect the value of water are powerful incentives for consumers to install water efficient devices and repair leaks (Solomon et al., 1998).

Economic methods need to be implemented with caution as they are often the least equitable. This is because low income users (who are least able to afford an increase in water tariffs) use water only for basic human needs (washing, cooking, drinking etc.). Even if the price increased they would be unable to reduce consumption (van Zyl et al., 2006a). In addition, rate increases should always be accompanied by an education program that helps customers reduce their water consumption (Solomon et al., 1998).

Socio-political methods comprise of public education programmes regarding conservation techniques (Grisham and Fleming, 1989), laws and regulations, and building code modifications.

World-wide domestic water use is reviewed in and the concept of cities being sustainable is discussed in Section 1.1 and Section 1.2. Australia has water resources challenges that are comparable to South Africa's and is more progressive in terms of water efficiency and is therefore a useful case study. Australian domestic water use is described in Section 1.2.3 along with the methods and innovations that have been implemented to reduce demand for water. Section 1.3 deals with the labelling of water efficient devices. This is a strategy which is being used in several countries to make people aware of the options available to them for saving water. In Section 1.4 South African water conservation legislation is described along with current domestic and commercial water use, with suggested water efficient devices for use in South Africa highlighted in Section 1.4.1. Trends in consumption are explained in 1.4.2 and previous work on recording and publicising water efficient devices is assessed in Section 1.4.3.

1.1. Sustainable cities

> *"For a sustainable urban future, society must move towards the goal of efficient and appropriate water use" (Dixon et al., 1999; p. 5).*

Previously, social and economic factors have prevented an efficient use of water in cities and also prevented the uptake of water efficient devices into the traditional urban water system. However, developments in technology and a discernable change in attitude towards water conservation internationally from industry, government and the public suggests that more efficient water use along with the adoption of systems that utilise greywater and rainwater could be realised in the foreseeable future (Dixon et al., 1999).

Global Water Statistics

About 80
The number of countries that had experienced serious water shortages by the mid 1990s. This makes up about 40 per cent of the world's population.

One-third
The proportion of the global population who live in countries with moderate-to-high water stress. Water stress occurs when water consumption exceeds 10 per cent of renewable freshwater resources.

Two-thirds
The proportion of the global population that is expected to be living in water stressed conditions in less than 25 years.

40%
The increase in global water use expected by 2020.

US$30 billion
The projected cost per year of bringing poor people universal access to water by 2015.

(Source: United Nations Environment Programme, GEO-Global Environment Outlook 3, Past, Present and Future Perspectives Accessed via http://www.cbc.ca/news/background/water/bynumbers.html)18 April 2006

Based on studies carried out in major cities such as Mexico City, Frankfurt, Madrid and Boston Viñuales Edo (1998) concluded that there are three important principles for sustainable water use in cities. These principles include:

- A change in technology should be combined with a change in habits by the consumer;
- All stakeholders who are part of the problem must be involved;
- Awareness in the educational sector must be raised; and an active publicity campaign must be directed towards the end-consumers (Viñuales Edo, 1998).

A Water Efficient Building

The C.K. Choi building in Vancouver, BC is a 3 story block designed to use less than 500 litres of water per day and recycle all wastewater. A comparable building using conventional fixtures would use 7 000 litres of water per day. The only water from the City of Vancouver mains that is used in the building is in the washroom and kitchen sinks. Sink taps have water efficient aerators. The building uses waterless composting toilets and waterless urinals. All landscaping needs are met with a combination of recycled greywater and collected rainwater. Greywater is treated by passing it through a recycling trench and wetland outside the building that is 30.5 meters long and 1 meter wide. Purified wastewater is then used for site irrigation and the excess amount is discharged to a storm sewer. Timed spray and drip irrigation systems are used to reduce water use for site irrigation. Native plants were chosen for landscaping to further minimize on site landscaping water needs. (Source: The Canadian Water and Wastewater Association: Water Efficiency Experiences Database (WEED) accessed via http://www.cwwa.ca/WEED/Index_e.asp on 18th April 2006.)

Such water conservation programmes should also incorporate other water saving options at a systems level, for example, dual water supply which is the use of a second system of water mains with lower water quality (Terpstra, 1999; van der Hoek et al., 1999) and the utilisation of rainwater (Villarreal and Dixon, 1999; Mikkelsen et al., 1999).

The tendency has been not to implement water conservation programs, but rather to meet the growing demand by developing new water systems. This is not indefinitely sustainable and therefore strategies that manage (rather than meet) the demand are necessary. The goal of a demand management strategy would be to reduce consumption through behaviour change (National Research Council, 1995).

The concept of a sustainable city requires a water saving ethos from both the residents of the city and from the institutions responsible for the abstraction, treatment, storage, transmission of water, the distribution of water to consumers and collection of wastewater.

1.1.1. Commercial initiatives

It is often easier and more effective to reduce water demand and monitor compliance within the commercial sector. This is because successful companies are more likely to have the resources to embark on capital expenditure programs than domestic households or municipal departments, and are easier to target for compliance.

There are a number of examples of commercial initiatives that have been successfully implemented around the world.

1.2. Domestic Water Use World-Wide

It has been estimated that to meet 2025 water needs, the world must develop 22% more primary water supplies. Worldwide investment in the water sector is US$80 billion p.a. today. An additional US$100 billion p.a. will be required to meet projected demands in 2025. An alternative is to reduce the demand for water and become more efficient in the use of current water resources.

The per capita residential use rates in North America are about 350 litres per person per day and in Europe about 200 litres per person per day. These are high compared to countries in sub-Saharan Africa, where average consumption is reported to be as low as 10 to 20 litres per person per day (Environment Canada, 2005). Specifically in Canada figures for 2001 show that the daily average daily freshwater domestic use per capita was 335 litres, of which 35% is for bathing, 25% for laundry and cleaning, 30% for toilet flushing, and 10% for cooking and drinking (Environment Canada, 2005). By way of comparison, the average daily water consumption in the area supplied by Durban (eThekwini Metro, population approx. 3.5 million) during the financial year 2003/2004 was 160 litres per capita.

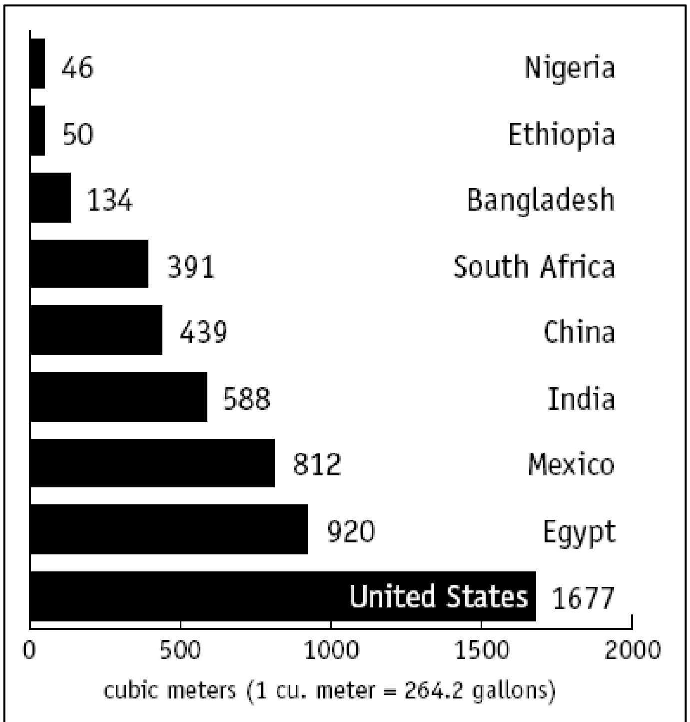


Figure 1.1 highlights the difference in annual per capita water use between the United States and various developing countries. Note this figure includes domestic, industrial and agricultural uses of water.

Figure 1.1: Annual per capita water use (domestic, industrial and agricultural use combined)
(After UNDP et al., 2000, 25-26)

1.2.1. Some international experience with water demand reduction

There is no single strategy to reduce wasteful domestic water use. As the various experiences below highlight, a combination of education, awareness, pricing and legislation are effective tools in a demand management strategy.

The Pacific Institute, a California water-research NGO, has calculated that average residential water use could be reduced by nearly 50% by 2020 by implementing a number of demand management strategies, including: fixing leaks; subsidising water-efficient technologies like low-flush toilets; increasing awareness through conservation campaigns; installing household water meters and increasing the price of water.

An important addition to household conservation strategies is for water service providers to reduce unnecessary water loss. Table 1.1 below highlights how ageing water delivery infrastructure in many cities accounts for significant water losses.

Table 1.1: Percentage of Water Loss through Distribution Systems

Country	Water loss
Africa	39%
Asia	42%
North America	15%
Latin America and the Caribbean	42%

(Source: After WHO and UNICEF, 2000)

Successful examples of how household level demand management strategies have reduced water consumption in cities around the world are summarised below.

Spain

In 1997 the city of Zaragosa in Spain undertook a water efficiency campaign with the aim of reducing water consumption in the city by 1 million kilolitres of domestic water consumption per year by its 700 000 inhabitants (equivalent to 3, 9 litres/person/day). The campaign was initiated due to water restrictions brought about by irregular and infrequent rainfall, misuse of water and a low cost of water to the consumer.

The water saving project sought to develop a water-saving ethos in the city through the efficient management of the water resources. In terms of sustainable cities the most important lesson described by Viñuales Edo (1998) was that there needed to be a sense of shared responsibility between the major shareholders, which included manufacturers, retailers, consumers, distributors and plumbers.

Amsterdam

In 2000 the city of Amsterdam commenced the building of a new housing estate which incorporated a dual water supply system to the houses on the estate. The dual water supply system provides drinking water from existing production plants, and household water for toilet flushing and washing from lower quality local surface water. There were no objections from institutions or from the public with regard to public health aspects, technical aspects and government legislation. It was thought that this dual system would result in cheaper drinking water and environmental benefits (van der Hoek et al., 1999).

United Kingdom

The Essex and Suffolk Water Agency implemented a self-audit scheme in 9 500 households in order to encourage households to reduce water consumption by retrofitting water efficient plumbing fixtures. Participating households that started using 'Save-a-Flush' displacement bags in toilets, hose guns, installed shower timers and repaired leaking taps by replacing worn washers saved on average 9, 91 litres of water per household per day. This resulted in a net saving of over 94 000 litres per day (Stedman, 2004).

A review of options for reducing domestic water demand in the UK indicated that by ensuring new housing stock is fitted with certain water efficient devices, water savings of up to 25% could be achieved, without altering water use habits (Sim et al., 2005). Table 1.2 below suggests that metering households and reducing the volume of a toilet cistern will have the most impact on reducing water demand.

The UK code for sustainable buildings recommends that all new houses should be built and fitted with appropriate water efficient devices. It is hoped that this will reduce the average daily per capita water consumption rate from 150 litres to 125 litres (Charted Institute for Water and Environmental Management, 2006).

Table 1.2: Technology options for reducing water consumption and their expected effect on new housing and existing housing stock in the UK

		Expected Uptake between 2001 and 2020		UK water reduction effect
Option	Current status	New homes	Old homes	
Metering	>20% households	All	Some – Most	**Major**
6 litre toilets	Current regulation	All	Few – some	**Major**
Low flush toilets	If current 6ℓ regulation further reduced	All	Few – some	Moderate
Toilet flush reduction (e.g. hippo)	Inexpensive and easy to install	Few	Some – most	Moderate
Water efficient clothes washing machines	90% households own one (have an 8 year life expectancy)	All	All – most	Moderate
Dishwashers	Low penetration	Few – some	Few – some	Small
Reduced flow showers	Future regulation uncertain, popularity of showering increases	Some	Few – some	Moderate
Water butts (outdoor use)	Future regulation	Few - some	Few – some	Small
Water efficient gardens	Possibly a feature in the future	Few – some	Few – some	Small
Rainwater collection (indoor use)	Relatively expensive & complicated	Very few - few	Very few	Very small
Grey water recycling	Relatively expensive & complicated	Very few	Very few	Very small

(Adapted from Sim et al., 2005).

Table 1.3: Household water use: standard versus water efficient

Water use component[1]	**Standard New Home**		**Water Efficient Home**		**Std vs. water efficient**
	Litres per use	Per capita consumption (ℓ/h/d) [2,3]	Litres per use	Per capita consumption (ℓ/h/d) [2,3]	Water use reduction (%)
Toilet	6	28	4	17	39
Shower	45	25	30	17	32
Bath	85	30	80	28	7
Taps (Internal)	-	12	-	10?	17?
Washing machine	60	13	40	9	31
Dishwasher	20	8	15	6	25
Garden	-	6	-	5?[5]	17
Sub-total[4] **(ℓ/person/day)**	-	122	-	92	**Overall 25% reduction**

[1] Component ownership levels are assumed constant for all types of new housing.
[2] Assumed average household occupancy of 2.5.
[3] Frequency of use assumptions developed from "A scenario approach to water demand forecasting" (Environment Agency 2001).
[4] Excludes all other non-specific uses that collectively may approximate to an additional 20l/h/d
[5] Rainwater collection or grey water recycling could halve toilet and garden water consumption resulting in 81 litre/person/day (Environment Agency 2003).
(Adapted from Sim et al., 2005).

Denmark

In addition to mains water, rainwater can be used for household purposes. For an area with a mean annual precipitation of 700 mm, if half that rain can be captured, then a roof area of 50 m^2 will enable a saving of 17.5 m^3 per year. This would result in 48 litres per day for the household to utilise. Mikkelsen et al. (1999) calculated the costs of implementing a household rainfall collection on a national scale in Denmark where there are concerns over heavy abstraction of groundwater. Their results showed that from a societal point of view there is neither an economic or environmental reason to promote rainfall collection on a large-scale in Denmark. However, due to the high density of population in and around Copenhagen an alternative to abstracting water from aquifers needed to be found and rainfall collection was one possible solution.

Sweden

On a localised scale in Sweden, Villarreal and Dixon (2005), found that important water saving efficiencies could be made if rainwater tanks were included as part of a dual water supply system. This is particularly pertinent in Sweden as local drinking water supply systems are susceptible to shortages and water quality deterioration, therefore, use of rainwater for non-drinking purposes e.g. toilet flushing and washing clothes, could help prevent future shortages.

Zambia

According to Handia et al. (2003) there appears to be potential for the adoption of rainwater harvesting in Zambia, particularly in the urban areas. In Lusaka currently only 80% of water needs are being supplied. The lack of safe drinking water could get worse due to lack of financial resources to augment the water supply system and from increased population in the city from rural to urban migration. Handia et al. (2003) found that there was a willingness to adopt household rainwater harvesting technologies as some residents in the communities surveyed had to walk up to 800 m to their water source.

Zimbabwe

According to Naphi et al. (2002) there appears to be a lack of a water conserving culture in Harare, Zimbabwe, which is a city that experiences water shortages. Table 1.4 gives estimates of domestic water use in Harare.

Table 1.4: Estimates of domestic water use in Harare

Usage	Residential density category		
	High (litres/person/day)	Medium (litres/person/day)	Low (litres/person/day)
Bath	25	90	90
Toilet	24	80	80
Laundry	5	16	26
Kitchen	5	11	26
Other (including gardening)	4	13	102
Total	63	210	315

(Source: after Naphi et al., 2002)

In high density areas where a shower or bucket is used instead of a bath water consumption is lower (Naphi et al., 2002). Likewise in higher density areas where there are either small or no gardens the water consumption is significantly lower.

1.2.2. Water efficiency in the United States

The greater Seattle area in the United States has seen the total bulk water delivered decrease by 1% each year over the last 20 years despite a 23 % increase in the population over the same period (Renton, 2002). The reduction in water usage in Seattle was partly due to a reduction in the amount of unaccounted for water, but a significant proportion was due to increased end-user efficiency.

Campbell et al. (1999) carried out a city wide survey in Phoenix, Arizona, USA and found that the installation of water efficient devices for all new and replacement plumbing fixtures saved the most water of any non-pricing method of conservation tried in the city.

In a study on public attitudes to water conservation Flack et al. (1987) found that those people in areas under water restriction were more willing to install water efficient devices than those in areas where there were no water restrictions. Campbell et al. (1999) reported that targeted retrofitting of water efficient plumbing fixtures had the next most potential for water saving in the city. With regard to retrofitting De Oreo et al. (2001) found that the most effective fixtures evaluated in a study in Seattle, USA, were toilets, washing machines, and tap aerators. The evaluation was based on measured savings. A secondary finding by Campbell et al. (1999) was that young adults (17-24 year olds) use the most water of any age group, implying that aspects of education programmes should be designed specifically for this age group.

In 2002 the Environmental Protection Agency (EPA) published 17 case studies of successful water conservation programs, eight of which are summarised in Table 1.5 below. For the purposes of this study the water savings have been highlighted, but it is worth noting that significant financial savings were also made as a result of net deferred capital expenditure. This was because many of the authorities were able to defer expensive capital expansion projects in both water production units and wastewater treatment plants.

Table 1.5: A Summary of Water Conservation Studies, United States of America

City	Approach	Water savings*
Ashland, Oregon	The 1991 water efficiency program included system leak detection and repair, conservation-based water rates, showerhead replacement program and toilet retrofits.	105 Mℓ of water per day saved (16% of winter usage).
Barrie, Ontario	Conservation plan focused on replacing inefficient shower heads and toilets.	Average savings 55 ℓ per person per day (5.5% saving).
Goleta, California	Established a water efficiency program emphasising plumbing retrofits including high-efficiency toilets and showerheads and increased rates.	30% reduction in water use.
Houston, Texas	Implemented a comprehensive conservation program comprising education, plumbing retrofits, audits, leak detection and repair, increasing-block rate structure.	Based on the success of the pilot program, project estimates are a 7.3% reduction in water demand by 2006.
Massachusetts Water Resources Authority	Conservation program began in 1986 and included leak detection and repair, plumbing retrofits, water management, education and meter improvements.	Average daily water demand reduced from 90 Mℓ/day (1987) to 68 Mℓ/day (1997).
New York City, New York	Conservation initiatives included education, metering, leak detection, water use regulation and a toilet replacement program.	Per capita water use reduced from 52 ℓ per day (1991) to 44.5 ℓ per day (1998).
Santa Monica, California	Water conservation program included water-use surveys, education, landscaping measures, toilet retrofits and an interest free loan program to assist with retrofits.	Water use reduced by 14%.
Tampa, Florida	Water conservation program includes high efficiency plumbing retrofits, an increasing block rate structure, irrigation restrictions, landscaping measures and public education.	The pilot retrofit program resulted in a 15% reduction in water use. The landscaping interventions reduced water consumption by 25%.

(Source: United States Environmental Protection Agency, 2002)

Common to all the case studies is the installation of water efficient devices (typically showerheads and toilets). However, the most successful interventions had a holistic approach to water conservation in which plumbing retrofitting with water efficient devices was only one component of the strategy.

1.2.2.1. Reducing water demand: a Californian example

Many cities and towns in the State of California have to import water from neighbouring catchments to meet domestic water demands. In the late 1980's and early 1990's many towns were also experiencing a prolonged period of drought. This resulted in research being conducted to explore California's current water demand, and potential options for demand management through improved water efficiency and conservation. Subsequently a number of water conservation strategies have been and are being implemented.

How much can be saved?

A report "Waste Not, Want Not" (Gleick et al., 2003) estimates that one third of California's current urban water use can be saved by using existing technologies. Not only do these technologies exist, but they are also cost-effective – 85% of water savings can be made at as cost well below what it would cost to exploit new water supplies.

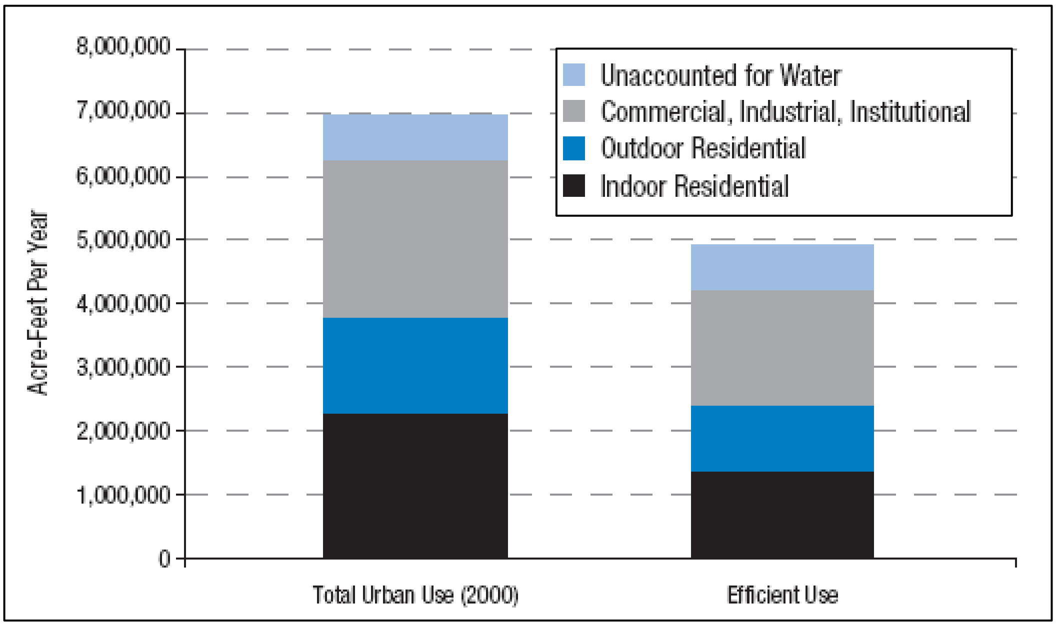


Figure 1.2: Summary of California Urban Water Use (2000) and the Potential for Cost-Effective Conservation Improvements (Source: Gleick et al., 2003).

Figure 1.2 above highlights how, by improving water efficiency utilising existing technologies, water consumption can be reduced by almost 30%. The efficient use of water would require a range of strategies to encourage greater efficiency amongst consumers (Gleick et al., 2003). A summary of the types of programs required are summarised below. These include legislative changes, the implementation of Best Practices at council level and a community based initiative.

Legislative changes

Assembly Bill 2515 (AB 2515)[3] is currently under review by the California Assembly. If the amendments are passed by Senate, the amended Bill would ensure that water efficient standards (similar to those developed for energy) are developed and implemented across the state.

The proposed water efficiency standards would: ensure all domestic washing machines are at least as water efficient as commercial machines; develop water efficient building and construction standards for new residential and non-residential buildings; and prepare design standards for water efficiency (Ruskin, 2006). The Bill also calls for further studies into the role that informational labels might play in helping consumers to select water efficient technologies and appliances (Hart, 2006).

The proposed amendments to Bill 2515 are supported by the California Urban Water Conservation Council, The Bay Institute, California Public Utilities Commission, East Bay Municipal Utility District, El Dorado Irrigation District, Environmental Defense, Mono Lake Committee, Planning and Conservation League, and the Sierra Club of California (Hart, 2006).

Best Practices

In 1991 fourteen Urban Water Agencies signed a Memorandum of Understanding agreeing to implement eleven best management practices (BMPs) if the strategies were locally cost-effective (Fiske and Associates, 2001). The original 11 BMPs drafted in 1991 and included in the MOU are as follows:

1. Rate structure and other economic incentives to encourage water conservation.
2. Efficiency standards for water using appliances and irrigation devices.
3. Replacement of existing water using appliances (except toilets, showerheads and washers which are already addressed by BMPs) and irrigation devices.
4. Retrofit of existing car washes.
5. Greywater reuse.
6. Distribution system pressure regulation.
7. Water supplier billing records broken down by customer class.
8. Swimming pool and spa conservation including covers to reduce evaporation.
9. Restrictions or prohibitions on devices that use evaporation to cool exterior spaces.

[3] An act to amend Section 25402 of the Public Resources Code, *and* to add Section 2714.5 to the Public Utilities Code, and to amend Section 10631 of the Water Code, relating to water conservation (Ruskin, 2006).

10. Point of use water heaters, recirculating hot water systems and hot water pipe insulation.
11. Efficiency standards for new industrial and commercial processes (Fiske and Associates, 2001)

Additionally, an extensive list of new candidate BMPs was drafted at the outset of the project. This list included:

(a) High-efficiency toilets
(b) Zero water consumption urinals
(c) Weather-based irrigation controllers
(d) Pre-rinse spray valves for the food service industry
(e) Ice making machines
(f) X-ray film processor recycling units
(g) Steam sterilizer retrofits (autoclaves)
(h) Commercial laundry systems with rinse water recycling
(i) Leak detection at a water system level
(j) Commercial dishwashers
(k) Boilerless steamers for the food service industry
(l) Plan review for new commercial, industrial, and institutional projects
(m) High-efficiency clothes washer technology improvements
(n) Monthly vs. bi-monthly customer billing
(o) Automated meter reading
(p) Metering and sub-metering

(Koeller et al., 2004).

Implementing strategies that increase the use of water efficient devices are highly effective in managing water demand, reducing waste water production and the economic costs associated with providing users with clean water and removing waste water. Hart (2006) suggests that by the widespread adoption of water efficient technologies, Californians would use 20% less water in 2030 than they did in 2000.

1.2.2.2. The Los Angeles toilet retrofit programme

In 1992 the water utility company in Los Angeles began a retrofitting program of water efficient toilets after the region had experienced six years of drought. The new toilets were 6 litre flush ones replacing cisterns of between 13 and 18 litres. As part of the program rebates were being offered to consumers by water utilities throughout southern California. If customers purchased and installed these low-flush toilets, they could receive rebates of US$100 or more from their utility.

However, the program was not working in lower income neighbourhoods as residents could not afford to wait for the utility to process the rebate cheque. This left thousands of residents out of the program. The water utility was approached by a local women's group called the Mothers of East Los Angeles (MELA) who wanted water efficiency in their communities. The groups began to work together and for every toilet that MELA could guarantee was replaced they would be paid US$25 per toilet. The guarantee consisted of the old toilet being removed and brought to MELA for recycling. The new toilets were provided free of charge by the water utility. MELA got to keep the US$25 per toilet, to pay community workers in the toilet program and to pay for scholarships, graffiti abatement, and other community needs. The MELA program was successful and by 1998 well over 50 000 toilets had been replaced, while at the same time employing 25 full-time and three part-time community residents in the MELA program (Dickinson, 2000).

1.2.2.3. Miami-Dade (South Florida) retrofit programme

High domestic water consumption habits and a growing population are rapidly propelling Miami-Dade County in South Florida to water crisis point which could see the doubling of water bills in a matter of time. In order to reduce household water consumption the county has embarked on a programme that targets individuals who are concerned about their water consumption.

The programme involves education, letting people know how much water they and their families are consuming, and then providing assistance with retrofitting older, more wasteful water fittings. The programme is currently replacing inefficient shower roses and taps with newer more efficient models for free. Households can exchange their current shower rose for a low flow shower rose for free (Andreu, 2007).

Figure 1.3: High efficiency shower rose offered as part of the Miami-Dade County water conservation programme

The shower roses use only about 8 litres of water per minute, a 50% drop in the amount of water used by most conventional shower roses. They are described as “fashionable white” have a “built-in massage, on/off valve and a swivel head for user comfort and convenience” (Andreu, 2007).

The programme was launched in August 2005 and 400 shower roses were exchanged at the launch event. Following the launch, residents could continue to exchange their old shower roses for the high efficiency roses at one of four centres. The programme to reduce wasteful water consumption includes tips on how to check for leaking toilets and information about other household fixtures that can easily be replaced with more water efficient devices that have limited payback periods for the homeowners. The county’s Water and Sewer website teaches residents how to read their water bill, assists them to calculate their water consumption, provides information on the free shower rose exchange programme and provides residents who have taken advantage of the high efficiency shower roses the opportunity to provide feedback in the form of an on-line survey.

Water Conservation Essay Contest

The South Florida Water Management District along with Miami-Dade County Water and Sewer sponsored an essay contest on water conservation. The contest, titled “***Do You Make Every Drop Count At Home?***” was aimed to bring water conservation awareness to all Miami-Dade County residents especially students and parents.

To enter, families had to submit an essay of 500 words or less expressing what their family was doing to conserve water, how much water they conserve and how water conservation is a family project. The Grand-Prize winning family received a gift card good for a weekend getaway to Walt Disney World, including tickets and hotel accommodation. (Source: http://www.sfwmd.gov/newsr/3_newsrel.html#md_contest)

In addition to the shower replacement programme, the county will introduce a US$130 rebate for residents that replace a pre-1996 large capacity toilet with a high-efficiency toilet. The program will be launched in April 2007. For more information about the various water conservation programmes implemented by Miami-Dade County visit http://www.miamidade.gov/wasd/home.asp

1.2.3. Efficient Water Use in Australia

Australia is the driest continent on earth yet the domestic consumption of water per household is amongst the highest. The average domestic water consumption in Australia is 350 litres per person per day (WELS, 2005). The components of domestic water use in Australia are shown in Table 1.6.

Table 1.6: Domestic water use in Australia

Domestic Water Use	% of Total Domestic Water Use
Garden	34
Toilet	20
Shower	20
Washing machine	12
Sink, dish washer, bath	14
TOTAL	100%

(Source: after WELS, 2005)

The population of Australia estimated in July 2005 is just over 20 million (CIA, 2005). The *Water Efficiency Labelling Standards Scheme* (WELS) aims to reduce the domestic consumption of water in Australia by 2021 by 87 200 mega litres per year (approximately 10 litres per person per day). A component of the scheme is supplying information on domestic water efficient devices for the following: showerheads, toilets, urinals, washing machines, dishwashers, taps and flow regulators.

Water efficient devices offer a lasting and potentially an inexpensive approach to water conservation (Hairston et al., 1995). To promote water efficient devices the National Government of Australia initiated the voluntary WELS in 1998. In October 2003 mandatory labelling was introduced for showerheads, washing machines, dishwashers and toilets (other products would still be covered on a voluntary basis). The water savings gained by using water efficient devices are described below based on figures by WELS (2005) and are summarised in Table 1.7.

Shower heads - A standard showerhead uses about 15 to 25 litres of water per minute but a water efficient showerhead can use as little as six or seven litres per minute. A regular showerhead uses at least 120 litres of water per eight-minute shower. A water efficient showerhead uses less than 72 litres - 40 percent less water. Assuming that the shower is used twice a day per day for four minutes per shower, the saving in a year would be 17.5 kilolitres. There is a proportional reduction in water heating costs after the installation of a water-efficient shower head.

Toilets - A minimum water efficiency standard will apply to all toilets sold in Australia. An old-style single flush toilet can use up to 12 litres of water in one flush but more water efficient dual flush toilets average less than four litres per flush. Using a water-efficient dual flush cistern could reduce operating costs over the long term by 65%. Replacing a traditional single flush toilet with a water efficient dual flush toilet typically saves up to 50 litres per person per day.

Urinals - About 60 000 new urinal stalls are installed in Australia each year. The average urinal uses about 2.2 litres per flush. The most efficient urinals reduce flush volumes to 1.5 litres per flush - a reduction of more than 30 percent. The potential water savings from using the most efficient urinals combined with smart controls could approach 40-50 percent.

Washing machines - A water efficient washing machine uses one-third of the water that is used by a standard machine. By using water efficient washing machines a national saving of 25 600 megalitres of water per year by 2016 could be achieved in Australia. That is an 8.8% reduction in the water consumption of the clothes washers that will be sold in Australia between 2003 and 2016.

Dishwashers - The most efficient dishwashers use half the water of average models. A reduction of about 6.5 percent is hoped for in the water consumption of the dishwashers that will be sold between 2003 and 2016.

Taps - Typical taps discharge 15 to 18 litres per minute but low-flow and aerating models may discharge as little as 2 litres per minute, depending on the intended application. Taps with an aerator or flow restrictor may reduce the flow to less than a third of that of standard taps.

Flow Regulators - A flow regulator is a device designed to produce a constant flow of water over a range of pressures. The regulators can be screwed to a tap outlet or installed in a tap supplying an outlet.

Table 1.7: Potential percentage of water saved by using water efficient devices

Water Devices	Relative % saving of water using water efficient version compared with standard version
Showerhead	40
Toilet	66
Urinals	30
Washing Machines	30
Dishwashers	50
Taps	60

In addition to the WELS labelling standards, there are two other voluntary initiatives that aim to educate the consumer about water efficiency, the Water Services Association of Australia labelling and the Smart Approved Water Mark. These are outlined in Table 1.8 below and discussed with other water labelling systems in the section below.

1.3. Labelling water efficient devices

Labelling devices is critical if water demand management depends on consumers choosing to buy water efficient devices instead of their standard counterparts.

Currently Australia and the United States of America have a dedicated water efficiency labelling system. The UK Home Office has been strongly supporting the introduction of a similar labelling scheme, and a number of other countries have an eco-label (Table 1.9 below) which incorporates water efficiency to various degrees. The various forms of labelling are reviewed in the sections below.

1.3.1. The Australian Labelling System

The Australian water labelling system is widely regarded as a "best practice". Two labels (managed by the National Government and The Water Services Authority) cover all domestic appliances while outdoor water saving products and services (the Smart Approved WaterMark) ensures comprehensive information is provided to consumers (see Table 1.8 below).

Even though information about water efficient technologies and their potential savings are readily available, the uptake of water efficient devices has been slow. This has impacted on the effect water efficient devices have had in reducing domestic water consumption. Some of the reasons cited for the slow up-take of water efficient devices in the residential sector in Australia include:

- Water pricing does not reflect the cost of water or of treating wastewater;
- Low public awareness of water and wastewater prices;
- Central metering of water use in multiple dwelling households provides little incentive for individual households to reduce their water consumption;
- Information on water efficiency is not well communicated to end users; and
- Residential property developers try to minimise capital costs (rather than operating costs).

(Minister for the Environment and Heritage, 2004)

Table 1.8: A Summary of Australian water efficiency labelling standards

Name	Background	Logo
WELS, National Government	Introduced as a voluntary label in 1998. Since 2003 mandatory for some appliances/plumbing fixtures.	
The National Water Conservation Rating and Labelling Scheme, Water Services Association of Australia	The National Water Conservation Rating and Labelling Scheme awards an A-rating to water efficient products that comply with all the relevant requirements of the Australian Standard AS6400.	
Smart Approved WaterMark scheme is managed by a steering committee.	Provides consumers with information regarding outdoor water saving products, services and water related organisations.	

1.3.2. WaterSense: The US water efficiency labelling system

The United States' Environmental Protection Agency (EPA) introduced the WaterSense label as a voluntary private-public partnership to certify products that are considered both water efficient and meet a certain performance level. The label differs from the Australian as there is no rating given depending on efficiency. Generally all products approved by WaterSense are at least 20% more efficient than similar products.

WaterSense labelled Bathroom sink taps that receive the WaterSense label may use no more than 6 litres/minute (older taps sometimes have flow rates as high as 11 to 26 litres/minute). The WaterSense label and performance criteria for high-efficiency toilets was introduced in 2007 and is only awarded to toilets that meet specific performance criteria and use less than 5 litres per flush (source: www.epa.gov).

Figure 1.4: WaterSense Label

(Source: www.epa.gov)

1.3.3. Support for product labelling in the UK

Currently the UK does not have a water efficiency labelling system. However the Select Committee on Science and Technology

> "recommend that the Government Press for a mandatory EU labelling scheme for all household water-using products" (Select Committee on Science and Technology, House of Commons, 2006).

Given the success of the EU energy labelling system, The Committee recommends a system similar to the WELS (Australian) labels as the committee did not think that the a voluntary system would be as effective in allowing consumers to make meaningful comparisons between competing products. For such a labelling system to be made mandatory in the UK it would need to be passed as such by the EU (Select Committee on Science and Technology, House of Commons, 2006).

1.3.4. Eco-Labelling

In addition to product labelling systems that deal specifically with water using devices and products, many countries have an Environmental Labelling System. Environmental Labelling programs are not only concerned with the water usage of the product, but are more comprehensive and look at energy efficiency and impact on the environment throughout the products life cycle. Some eco-labels are not restricted to certifying only goods, but have standards relating to water use for services as well. Labelling systems from different countries that include water efficient devices are highlighted in the table below.

Table 1.9: Summary of Eco-Labels that include criteria for water efficiency

Country	Icon	Products included
Australian Ecolabel Program		Companies listed providing the following services: Waterless car cleaning Low water steam car cleaning Waterless printing Domestic and commercial water saving products
For further information: http://www.aela.org.au		
Associacao Brasileira de Normas Tecnicas		
Fir further information: http://www.abnt.org.br/		
Environmental Choice[M] Program Canada		Standards given for washing machines and dishwashers.
For further information: http://www.environmentalchoice.com		
German Eco-label (The Blue Angel)		*Note: no toilets, shower roses, washing machines or dishwashers listed*
For further information: http://www.blauer-engel.de		
Finland, Sweden, Denmark and Norway use the Nordic Swan eco-label		97 Hotels and Youth Hostels 5 Laundries 1 Washing machine
For further information: http://www.svanen.nu/Eng/		
The Program for Development of Ecological Marking in Ukraine		
For further information: http://www.ecolabel.org.ua/		

Hong Kong's Green Label		Washing machines Dishwashers
For further information: http://www.greencouncil.org/eng/greenlabel/intro.asp		
Chinese Environmental Label		*Note: no toilets, shower roses, washing machines or dishwashers listed but water saving tips included on greenchoice website*
For further information: http://www.greencouncil.org/eng/greenlabel/china.asp or http://www.greenchoice.cn/index_eng.php?var1=content/mainpage/main.htm&		
Korea Eco-labelling Program		Water saving taps Water-saving showerheads and tap appendages Water-saving toilets Water-saving toilet components Water meters Urinals Washing machines Dishwashers
For further information: http://www.koeco.or.kr/eng/index.asp		

The labelling systems above all incorporate different products, but the underlying principles are the same: to provide environmental related information to consumers to help them make informed and more sustainable or efficient choices. The EU Eco-Label is discussed as one example in more detail below.

1.3.4.1. The European Union Eco-Label

The EU Eco-label can be awarded to both non-food products (devices) and services and water efficiency is only one of many reasons why the label might be awarded.

Figure 1.5: The Eco-Label

Products or services that have the Eco-label are ones that aim to reduce the environmental impact throughout the life-cycle of the product, from production, through to use by the consumer and disposal. Currently only washing machines and dishwashers are considered. A product marked with the label would have at least one of the following attributes:

- Reduced energy consumption
- Reduced water consumption
- Limited noise
- Designed to be easily disassembled and recycled
- Designed for environmental use such as prevention of excessive use of detergents
- User instructions for environmental use

The European Eco-label has an electronic catalogue, however there are currently no dishwashers or washing machines that meet the criteria (source: http://www.eco-label.com/default.htm).

The Eco-Label is unique because it also allows consumers to select environmentally friendly service providers. For example tourist faculties that are awarded the label would implement the following water saving measures:

- Towels and sheets would be changed only once or twice a week, unless otherwise requested (saving on water used in laundry services)
- All landscaped areas would only be watered outside of peak evaporation periods
- Showers and taps would be fitted with flow regulators
- Rainwater harvesting
- Regular checks for water leaks

(http://ec.europa.eu/environment/ecolabel/pdf/infokit/en_2006/holiday.pdf)

The Australians have found that labelling products as water efficient is insufficient on its own to promote domestic water efficiency. Nonetheless, many countries have acknowledged that eco-labelling/water efficiency labelling is an effective means of promoting environmental awareness amongst businesses and industry. If consumers can be made more aware of the economic and environmental benefits of using water efficient devices, then the labelling system will also become an incentive for manufacturers to produce products that are increasingly water efficient (Source: http://www.ens-newswire.com/ens/oct2005/2005-10-21-04.asp).

1.4. Domestic and Commercial Water Use in South Africa

In August 2004 the Department of Water Affairs and Forestry (DWAF) published the '*Water Conservation and Water Demand Management Strategy for the Water Services Sector*' to promote water use efficiency and effective management of water resources, which is a requirement contained within the National Water Act (Act 36 of 1998).

The August 2004 strategy defines Water Conservation as the minimisation of loss or waste, the care and protection of water resources and the efficient and effective use of water. The Act defines Water Demand Management as the adaptation and implementation of a strategy by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability. The objectives of the 'Water Conservation and Water Demand Management Strategy (WC/WDM) for the Water Services Sector' are shown in Table 1.10 below.

Table 1.10: **Objectives of the Water Conservation and Water Demand Management Strategy**

Objective Number	Objective
1	To facilitate the role of WC/WDM in achieving sustainable, efficient and affordable management of water resources and water services
2	To contribute to the protection of the environment, ecology and water resources
3	To create a culture of WC/WDM within all water management and water services institutions
4	To create a culture of WC/WDM for all consumers and users
5	To support water management and water services institutions to implement WC/WDM
6	To promote the allocation of adequate capacity and resources by water institutions for WC/WDM
7	To enable water management and water services institutions to adopt integrated planning
8	To promote international co-operation and participate with other Southern African countries, particularly basin-sharing countries, in developing joint WC/WDM strategies

(Source: after DWAF, 2004)

Some work has been done to estimate average breakdown of water use in urban areas based on information from Rand Water, eThekwini Water and Cape Town City Council (Table 1.11 below).

Table 1.11: National estimated water use in urban areas

Sector	% of Total Water Use
Commercial	10
Industrial	12
Municipal	2
Gardening	20
Household	30
Unaccounted for Water	26

(Source: after DWAF, 2004)

DWAF (2004) estimated that 'Unaccounted-for Water' in municipal supplies can be reduced from an average of 26% to an average of 11% by implementing the following procedures:

- adequate and technically correct operating and maintenance measures;
- pipe network replacement or rehabilitation;
- leak detection and repair;
- pressure management;
- repair of visible and reported leaks, and
- meter management programmes.

Similarly within households, it is estimated that water wastage due to leaks within the household can be as high 20% of household consumption. Therefore, repair of leaks by consumers is also important and this should be encouraged by the Water Services Providers. A further 40% reduction in water use could be achieved if existing plumbing fittings were replaced with water efficient devices. Water Service Providers can undertake the following activities to achieve retrofitting:

- retrofit water efficient devices in urban areas sponsored by the water institutions along with leak repair;
- communication and education campaigns;
- grant incentive schemes where water institutions will pay the consumer part of the retro-fit costs;
- regulations and by-laws;
- marketing and research of new technology; and
- school audits (DWAF, 2004).

A major component of domestic water consumption is gardening (see Table 1.11 above). However, a range of options are available for the householder to reduce consumption. DWAF

(2004) estimates that use of water for gardening could be reduced by between 6% and 30% if the following initiatives are utilised: use of water-wise plants, use of indigenous plants, mulching, efficient irrigation systems, irrigation scheduling, rainwater harvesting, and use of wastewater. Water Service Institutions can contribute to the efficient use of water in gardens by education campaigns, regulations, and research into new technologies and block tariff rates.

Demand for water by new consumers can be managed by selecting appropriate levels of service for different communities, efficient plumbing fittings, efficient reticulation design practices and pre-payment meters at the time of installation (DWAF, 2004).

1.4.1. Trends in Water Consumption in South Africa

There is currently no single consolidated database of information for water use available from Water Services Authorities (WSA) in South Africa. While it is recognised that water consumption varies according to stand size, household income and size, climate, pressure and water price, planning for water demand for water is based principally on stand size and has remained largely unchanged since the original guidelines were compiled for the Department of Community Development by the CSIR in 1983 (van Zyl et al., 2006a, 2000b).

These estimates (used to plan domestic water demand) vary largely and range from 5 litres per capita per day in developing areas[4] serviced by a well or standpipe further than 1km away to as much as 480 litres per capita per day in the more affluent areas[5] (van Zyl et al., 2006a).

In March 2006, a Water Research Commission (WRC) project to develop a national water consumption archive was completed. The methodology developed by the project team consolidates the data collected by Swift[6] on water consumption in such a way that it can be used to measure water consumption. Prior to the development of this archive, older data was discarded and therefore the potential to analyse water use over time was lost. The current archive overcomes this and a methodology has been developed to ensure sustained archiving of future water consumption data as it becomes available. The database will therefore become an

[4] Developing areas are considered to be those areas where the level of services to be installed may be subject to future upgrading to a higher level (van Zyl et al, 2006a).

[5] Developed areas are considered to be those areas where the services installed are already at their highest level and therefore will not require future upgrading (van Zyl et al., 2006a).

[6] Swift is a software product, developed by GLS consulting that consolidates demographic and water consumption information for a large number of users and has been implemented by many local authorities (van Zyl et al., 2006b).

important water demand management and water supply management tool in the future and is available for such use[7] (van Zyl et al., 2006b).

Currently the database contains water use data from 48 municipal treasury databases and contains over 2.7 million water meter records. Water use records for domestic, commercial, industrial and educational users are stored in a generic and easily accessible format that allows for estimated monthly consumption figures for more than two years (van Zyl et al., 2006b).

A significant percentage of South African households who receive municipal water use most of their water in their gardens (Figure 1.6 below). This should mean that containing water demand should be possible with minimal technical interventions and without compromising people's lifestyles or health.

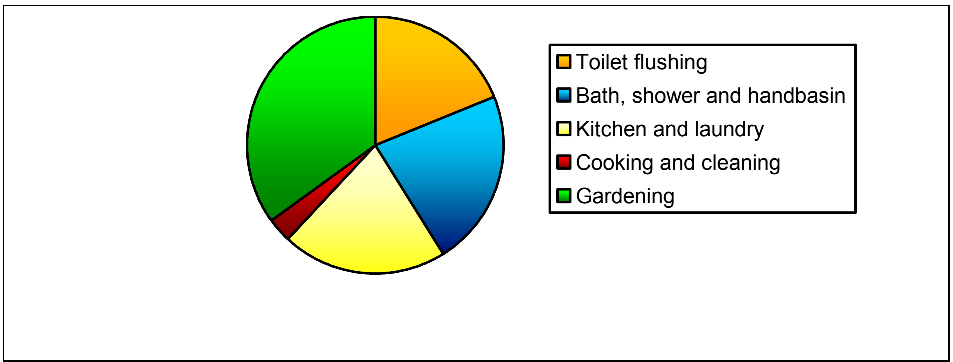


Figure 1.6: Domestic water consumption patterns

Note: Data based on a household containing 2 adults and 2 children from a middle to upper income group over a 24 hours period.
(Source: Biolytix Southern Africa)

Tracking trends in per capita consumption (rather than year on year water demand) will be more useful in assessing the success of the Department of Water Affairs and Forestry's (DWAF) Water Act.

1.4.1.1. Water Demand in Gauteng

The rate at which water demand is increasing in Gauteng is shown in Figure 1.7 below which highlights the growth trends in both total bulk water delivered by Rand Water and in the population within Rand Water's service region. The population growth is due to natural growth

[7] The importance of making the archive freely available to the research community was acknowledged by the project team. However, due to the sensitive nature of much the data contained in the records, and the fact that the municipalities gave permission for the Swift data to be used only for bona-fide research purposes (that excludes exploitation for commercial gain), permission is required in order to access the data (van Zyl et al., 2006b).

and migration into the region by work seekers, not just from South Africa but also from other African countries.

Rand Water is responsible for delivering bulk water to nearly 25% of South Africa's population. The total bulk water delivered by Rand Water increased by an average of over 3% per annum during the years 1998 to 2004. At that rate of increase the quantity delivered would double every 24 years. This rate of increase could not be met from currently available resources as this region already depends heavily on inter-basin transfer schemes from KwaZulu-Natal and Lesotho. For a region like the one that Rand Water supplies which relies on 'imported water' it is imperative that water is used efficiently.

During the period 2003 to 2007 most of the municipalities within the Rand Water supply area have improved their management systems, and as a result the growth in demand has stabilised. However, it should be noted that once all cost effective management improvements have been implemented, the growth in water demand will once again track population growth, unless changes can be made at the point of use.

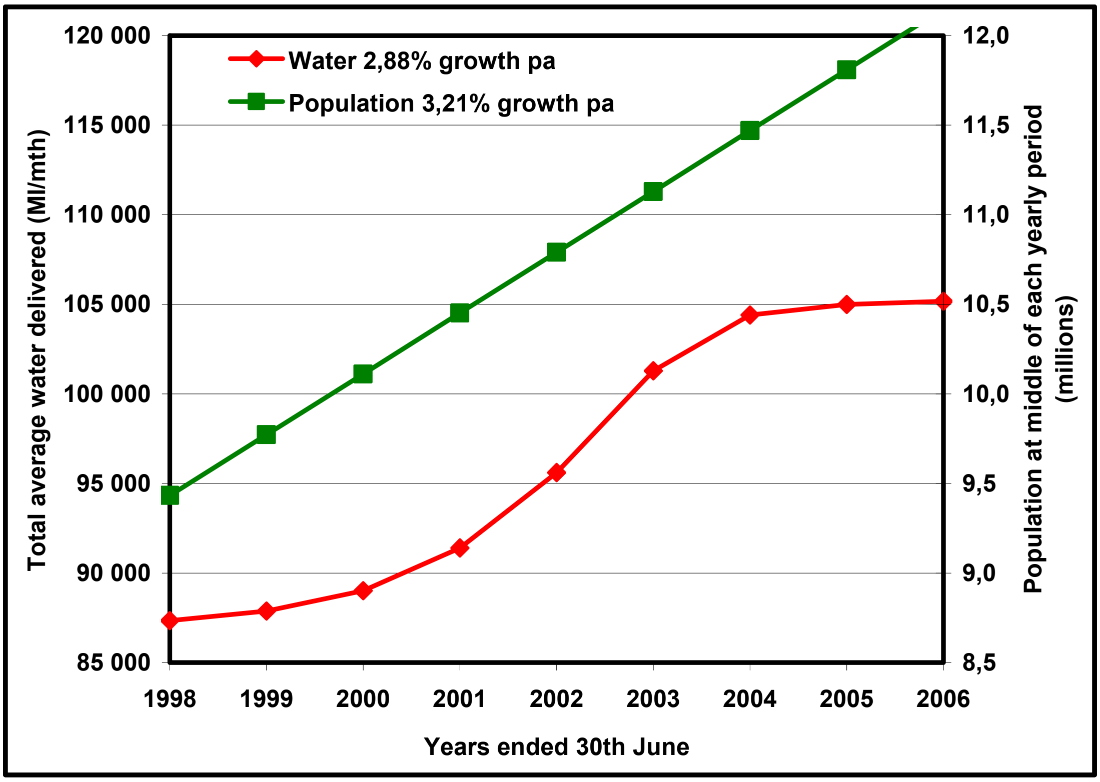


Figure 1.7: Trends in total bulk water delivered by Rand Water from 1998 to 2006

Figure 1.7 shows that Rand Water's bulk water supply increased at a rate roughly in line with population growth until 2004, after which demand stabilised. This was the result of a concerted improvement in the management of the water supply infrastructure at several of the municipalities (see Figure 1.8 below).

Figure 1.8 below shows the amount of water delivered per person[8] to Rand Water's customers. Tshwane, Johannesburg and Ekurhuleni account for the bulk of the population, and in these municipalities' water demand growth has been stabilised with the introduction of improved management practices. These are discussed in more detail in Section 4.2.3 of this report.

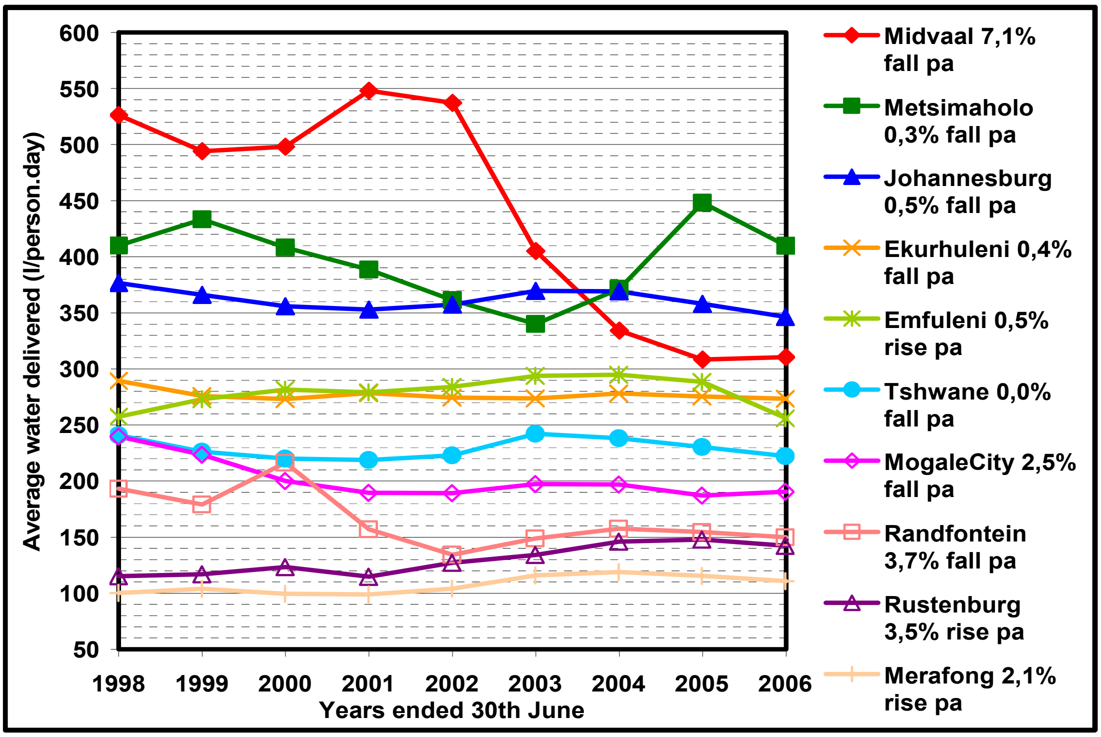


Figure 1.8: Water delivered per person to various Rand Water customers from 1998 to 2006

Figure 1.9 (below) shows the how Rand Water's four largest customers' consumption has grown between 1998-2006.

[8] In reporting population figures for the period 1 July 1997 to 30 June 2004, it is assumed that the trends observed over the 5 year period between the two census' dates are valid for the whole period being studied.

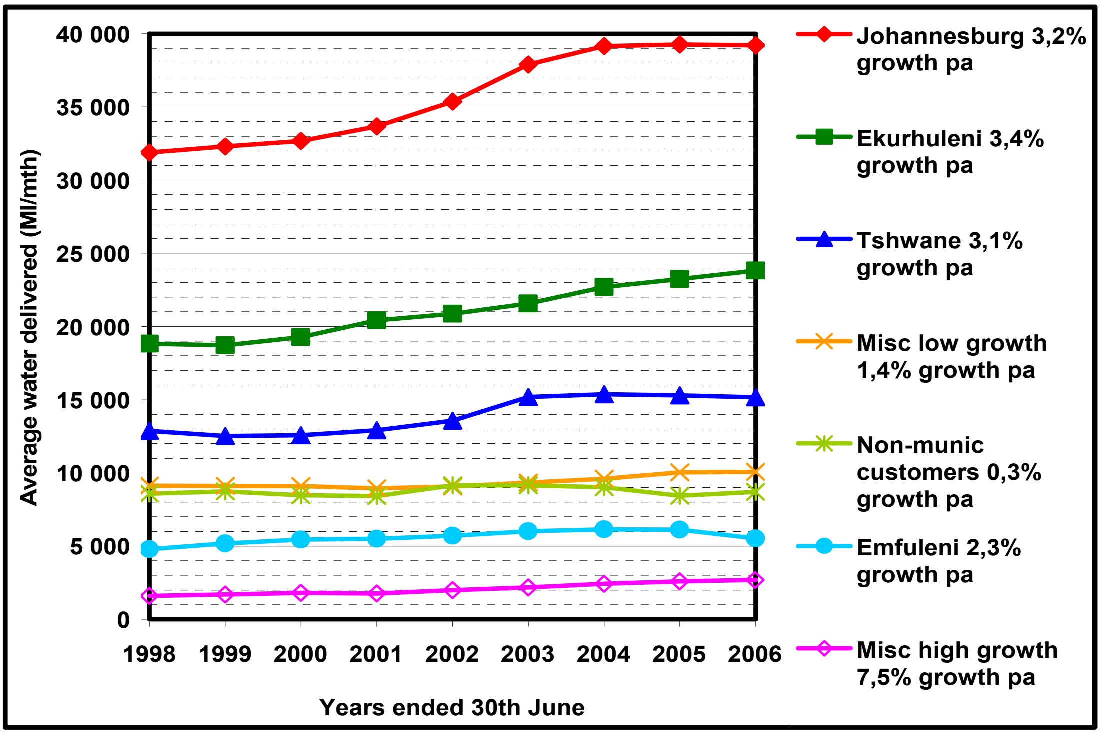


Figure 1.9: Bulk water delivered to various Rand Water customers or groups of customers 1998 to 2006

Increasing population served does not necessarily mean that water consumption needs to increase. In Greater Seattle, total bulk water delivery decreased by 1% on average over the past 20 years, despite a 23% increase in population for the same period (Renton, 2002). The Greater Seattle model highlights how water demand can be managed as populations or numbers of people served increases.

1.4.1.2. Domestic water consumption in Cape Town

Domestic water consumption in the City of Cape Town accounts for most of the city's water demand (see Figure 1.10 below).

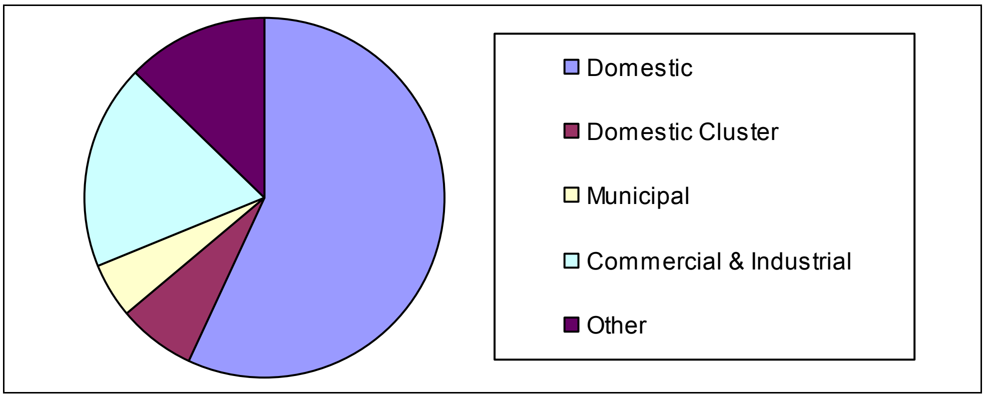


Figure 1.10: Distribution of Water Demand for Cape Town

(Source: City of Cape Town, 2006).

A study conducted by Community Engineering Services on Cape Town’s water consumption patterns in November 2005 found:

- Residential customers used 321 122 kℓ/day for the 12 month period from May 2004 to April 2005.
- Residential water use is significant in many administrative areas, accounting for 49% and 63% of total water use in Blaauwberg and Oostenberg respectively.
- Variations between residential areas exist with the greatest water demand stemming from Cape Town and the lowest from Helderberg.
- There were notable reductions in water use after the introduction of water restrictions (CES, 2005).

Other trends worth noting include the fact that people living in more affluent areas and on more expensive property stands consume more water than those living on lower valued stands. Residents on lower valued stands do not reduce water consumption as much as more affluent residents when water restrictions are introduced (CES, 2005). The ability of lower income households to reduce water consumption as much as more affluent residents should not be misinterpreted as lack of willingness to implement water savings. It is widely acknowledged that poorer households may already be using close to the minimum and therefore have less scope to make savings. Cape Town’s water demand management strategy is discussed in more depth in Chapter 4.

1.4.2. Examples of sustainable homes in South Africa

There are not many examples in South Africa of homes that can be considered truly sustainable considering that for outright sustainability a home must

> "exhibit all the sustainability features across the spectrum of social/institutional, financial/economic, technical and biophysical /ecological elements" (Mahomed, 2000).

Nonetheless, there are two local examples of housing projects where more efficient water usage has been included in the planning. These are described briefly below.

1.4.2.1. The All Africa Game Village

The Village consists of 1,799 homes and was constructed in Johannesburg in 1999, initially to house athletes for the 7th All African Games. The homes (which varied between two and three bedroom flats and stand alone homes cost on average R35 000 per unit (Napier et al., no date).

While there are many who suggest the construction of the village was done to showcase sustainable innovations that could be used in future low cost housing developments in South Africa (Mahomed, 2000), water and energy conservation was only considered relatively late in the project and only because the energy utilities (Eskom) and water provider (Rand Water) wished to be involved so as to pilot demand side management solutions (Napier et al., no date).

To improve water efficiency, water pressure was limited to 400 kPa and balanced between hot and cold. All taps were low flow taps and the showers had flow controllers. The showerheads were a cost effective efficient showerhead design delivering 12ℓ/min. The toilet was modified from the original single flush installation to a dual flush system with the half flush set at 3.5ℓ and the full flush at 9ℓ. The plastic taps and pipework were replaced with brass fittings to improve durability, limit leaks and vandalism. The additional cost of these items was R316 per unit (Rand Water, 2000).

A team of community liaison officers were trained and visited the households to inform them about the various water efficient devices, how to practice water efficient gardening and how using water efficiently could assist them in reducing their monthly service bills (Rand Water, 2000).

Water consumption at 170 of the housing units was monitored on three separate occasions over a period of a year (Figure 1.11 below).

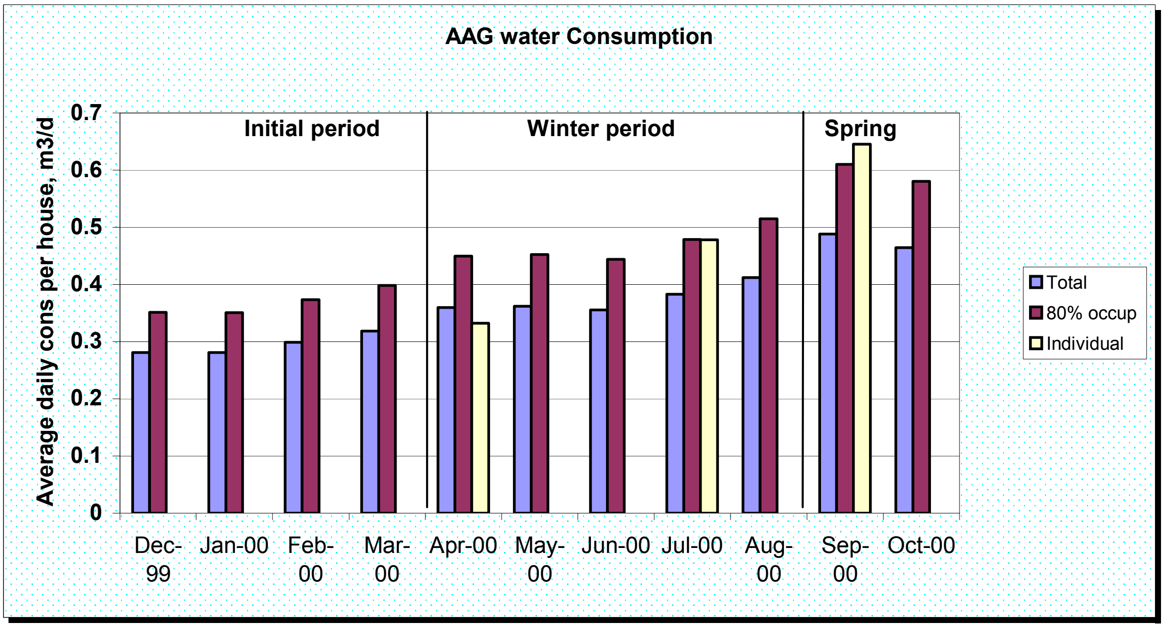


Figure 1.11: **Tsutsumani Village (All Africa Games Village) Water readings, Comparative monthly averages, m³/h/d**

(Source: Rand Water, 2000)

While the project team felt that the water savings had not fulfilled their expectations, the savings were still sufficient enough to support the fitting of similar water efficient products in other housing projects. On average, each unit saved 305ℓ per day, when compared to similar households elsewhere. This means that it would take less than a year for the water efficient fixtures to pay for themselves (Rand Water, 2000).

External evaluations of the project indicate that it is not the water efficient devices that fail to meet expectations, rather it is the human component. Napier at al, (no date) reports that although some education was done with the residents who moved into the housing development after the All Africa Games, it appears as though this was insufficient. Some of the residents did not understand the concept of dual flush, the preference for baths meant that many of the showers had been removed (negating the water savings realised by the low-flow shower heads). The authors also found that plumbers repairing the taps had removed many of the flow restrictors. Individual units did not have separate water (or electricity meters) which resulted in a flat rate being charged for services so there was no economic incentive for residents to use water efficiently.

1.4.2.2. Wiggins Fast Track Project, Durban

The Wiggins Fast Track project was implemented in Cato Manor (5 km west of the city centre) and was one of the first greenfields developments to be initiated in the area. The project ran from 1995 until 2000 in which just over 1 000 houses were built.

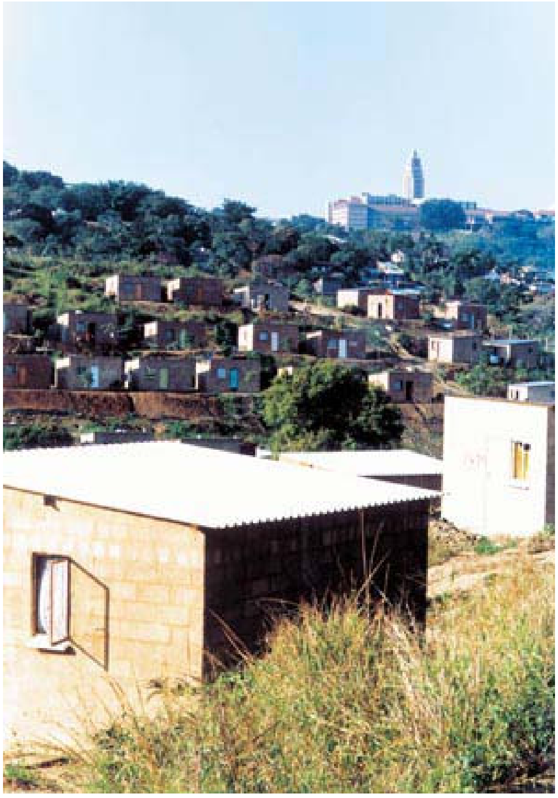
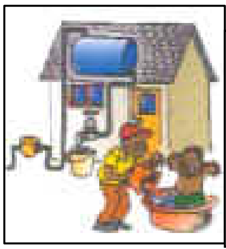


Figure 1.12: Phase 1 of the Cato Manor Housing Project adjoining an existing informal settlement (Source: CMDA Status Report, 2000)

eThekwini Water and Waste used the Wiggins project area as a pilot site to test a semi-pressure water system. The motivation behind implementing a semi-pressure system was to reduce water loss due to leakages and to assist households in managing their water consumption. The system also allowed for each household to receive the free basic allowance (6kℓ per month). Water pressure is reduced by the use of small diameter water pipes in the roads, restrictor valves installed at each plot's main connection and roof water tanks (best fitted in the roof structure but usually installed on top of the roof).

The project encountered some initial teething, site specific and attitudinal problems, most of which seem to have been addressed. Changes in the design (colour and lining) of the water tank have helped address complaints such as the water becoming too hot and algae growing within the tanks.

Most residents appeared to be happy with the water system and knowledgeable about water conservation. Internal plumbing fixtures (such as dual flush toilets and low flow showers) were not considered by the project design team (Napier et al., no date).



Domestic Roof Tank - Semi-pressure system
This service is available in low-cost housing settlements. A charge is made for the semi-pressure connection and the installation of the tank. Water consumption is levied in terms of the water tariffs. Source: http://www.durban.gov.za/eThekwini/Services/water_and_sanitation/services/potable_water?plone_skin=ethekwini_print

1.4.3. The Waterwise Campaign

In March 2007 the South African Department of Water Affairs announced the commencement of their new "Waterwise" campaign. The Waterwise Campaign, "an urgent appeal to all South Africans to conserve water", is planned to last three years.

The strategy is divided into three phases:

1. **Phase 1**: The first stage of the campaign is to be rolled out in 2007 and aims to make South Africans aware of just how precious water is, clearly showing the challenges facing the country.
2. **Phase 2:** The second stage of the campaign is to be rolled out in 2008 and occurs after the realities of South Africa's water situation have been made clear. This part of the campaign will call on specific stakeholders to improve the situation by showing achievable steps they can take.
3. **Phase 3:** The third stage is to be rolled out in 2009 and gives each and every South African greater awareness as well as providing guidelines on how water can be saved.

(Waterwise Campaign, DWAF, 2007).

The Campaign will make extensive use of television, print and radio over the three year period.

2 WHAT DOES THE MARKET OFFER?

2.1 What is a water efficient device?

The definition of what constitutes a water efficient device will always be somewhat relative and subjective. For example a 9 litre flush cistern is "efficient" relative to an older 13 litre flush cistern, but "inefficient" relative to a more modern 6 litre flush unit. Even more water efficient toilets require only 4.5 litres to flush. There are thus different standards to determine what can be considered water efficient and what products are devices.

Selections of suggested water efficient devices that are deemed appropriate for use in South Africa are described below with their flow rates, where appropriate, compared with standard components. The devices include water efficient taps, toilets, urinals, and shower heads along with gardening recommendations.

Taps – Like some shower heads, some spray taps have a pressure compensated flow-control device which means that the flow rate is essentially the same for all pressures in the range from 100 to 600 kPa. Tap flow rates are illustrated in Table 2.1. Appropriate options for use in South Africa would be spray and aerated taps particularly in the commercial environment such as service stations and airports where there is a large use of hand basins.

Table 2.1: Comparison of flow rates of taps

Description	Spray tap	Aerated tap	Conventional wash basin tap	15 mm sink tap
Water flow rate (litres/minute)	2.4	6	9	12

The UK water fittings regulations (DEFRA, 1999) specify that water delivered to basins or other similar receptacles not provided with a watertight and readily accessible plug or other device capable of closing the waste outlet shall have the water delivered to it exclusively at a rate not exceeding 3.6 litres per minute from a fitting designed or adapted for that purpose. Water efficient taps with a flow limiter and an aerator or spray insert would therefore be necessary to meet this stringent water requirement.

Toilets – There are a number of toilets that are appropriate for use in South Africa depending on the context. They range from low flush toilets to waterless ones. Studies have shown the installation of low flush toilets to be an effective way of conserving water, particularly in commercial environments and schools. The water saving in some cases paid for the cost of installing the toilet within a year (Pratt, 1979; Campbell et al., 1999). The following are a selection of these toilets:

- Low volume flush: 6 or 4.5 litres, instead of a 9, 11 or 13 litres.
- Dual volume flush: These come in a range from 11 or 6 litres, 6 or 3 litres and 4 or 2.5 litres
- Demand or multi-flush variable volume: The system only flushes as long as the handle is held down.
- Ultra low volume flush: variable flush max volume 3 litres.
- Retrofits: displacement devices, e.g. Hippo Bags (in large cisterns), early closure or demand flush mechanism. Waterless toilets with or without urine diversion, designed to dry or compost faeces in batches or continuously.
- Waterless or composing toilets that either uses a vacuum flush system or less then 0.5 litres.

Urinals (Non domestic buildings) – A urinal is a specialised toilet designed to be used only for urination, not defecation, and almost always by a standing male. Traditionally urinals comprised a stainless steel backdrop surface and bottom tray or gutter type drain. These urinals could be used by more than one person simultaneously. They either flushed continuously or had a timed flush that operated automatically at regular intervals. This type of urinal is very wasteful of water and has been banned in many cities in South Africa. As a first step the flushing should be turned off manually or with a timer when a facility in which such units are installed is not being used. Thereafter, as soon as practical, all continuous and automatically flushing urinals should at least be retrofitted with a push button flushing mechanism.

Waterless urinals – Although not common in South Africa, such units look like conventional modern urinals and either make use of a cartridge and drainpipe to drain away fluids (without the addition of water) or an Airflush® system.

Waterless urinals making use of a cartridge contain a pleasant smelling sealant liquid. The density of the sealant liquid is less than that of urine, and thus, when the urinal is used, the urine passes through the sealant liquid and into a normal drain pipe. Installation typically takes less time than for a flush urinal because there are no water connections. The cartridge or sealant liquid needs to be replaced three or four times per year.

Airflush® Waterless urinals make use of a long life DC fan to maintain a gentle flow of air down the urinal bowls. The Airflush® system eliminates individual traps and uses a single easily cleaned trap at the drain end.

Low-volume urinals – These units require the user to activate the flush by pushing a button, or are fitted with an infrared or ultrasound sensor activated flush control. Sensor activated flush controls reduce double flushing by users who are unfamiliar with low flush units.

Bathtubs

There are considerable differences in the water required for an "adequate" bath depending on the shape of the bathtub (see Table 2.2. below), with a large luxury bath requiring four or five times as much water as an efficient design.

The Archimedes allowance[9] given in Table 2.2 indicates the water that need not be drawn from the tap to attain the selected depth of 150 mm after the bather has got into the bath. For the water efficient bath, percentage wise this allowance becomes more significant. This is the reason for introducing it in Table 2.2 below, as it highlights the difference in water efficiency between different baths.

Table 2.2: Volume of water in baths filled to a depth of 150 mm

Manu-facturer [10]	Style	Nominal Size (cm)	Vol for 15 cm depth (ℓ)	Less 26l Archimedes allowance (ℓ)	% of norm
Duravit	2nd floor	210 x 90	238	212	663
		180 x 80	176	150	469
		170 x 75	154	128	400
		170 x 70	142	116	362
		160 x 70	133	107	334
Bette	Ocean	180 x 80	107	81	253
	Classic	180 x 80	73	47	146
	Bambino	157 x 70	62	36	113
	Classic	160 x 70	58	32	100
	Low-Line	170 x 70	58	32	100
	LaBette	130 x 70	58	32	100
	LaBette	120 x 70	53	27	84
	Low-Line	150 x 70	50	24	75
Libra	San	170 x 75	66	40	125
	Michelle	170 x 70	67	41	126
	Capri	150 x 70	55	29	91
Note: All volumes are approximate					

With respect to the baths, the squared off look bath is not water efficient and uses more than 4½ times as much water as the water efficient one. It is possible to have a bath with that squared off

[9] i.e. the calculation made to take into consideration the displacement of water by a person getting into the bathtub. This will vary according to the size of the bather, but 26 litres allows for an average size adult.

[10] Note that Duravit and Bette bathtubs are aimed at the upper end of the market and are therefore only found in certain plumbing outlets. The Libra bathtubs are locally produced and are more representative of an average bathtub found on the showroom floor.

look that is just as water efficient as a moderately shaped conventional one by having the sides sloping in moderately from the top and at least one of the ends generously sloping in.

It is interesting to note from Table 2.2 above that a not excessively deep bath in an efficient bath design will only require between 29 and 47 litres, equivalent to approximately four minutes flow through a water efficient shower delivering approximately 10 litres per minute. Bathwater can moreover be shared by family members, which makes for greater water economy. It is therefore a misconception that showering is necessarily more water efficient than bathing.

Showerheads – Very few countries have regulations on shower flows, but interestingly the World Health Organisation (WHO) has drawn up a clear table to classify the water use efficiency of showers (WHO 2006).

Table 2.3: Classification of showers

Flow rate	Classification
6-8 litres per minute	Very good
8-12 litres per minute	Good
12-18 litres per minute	Reasonable
18-24 litres per minute	Fair
> 24 litres per minute	Poor and very wasteful

(After, WHO, 2006).

Low flow shower rose designs makes use of water aerators and/or pressure compensated flow-control devices. While regulations and bylaws (see Chapter 5) increasingly use 10 litres per minute as an upper limit for shower flows, an upmarket luxury shower design that uses, say, 18 litres per minute to achieve an effect that would have once required, say, 30 litres per minute, can also be said to be efficient in terms of its design parameters. Water efficient showers are discussed further in Section 2.2.8 below.

Washing machine – some domestic machines have an energy and water efficient cycle. Front loaders use less water than top loaders.

Dishwashing machine – dishwashing machines vary in terms of water consumption from 14 litres to 22 litres per load (on a normal wash cycle) (see Table 2.4 below).

Table 2.4: Review of dishwashing machines

Dishwashing machine	litres/ normal wash	Cost (Rands)
AEG 50700	15	4799
Asko D1976 SS	20	9000
Bosch SGS 4362	15	4199
Defy Dishmaid 3 button	19	2950
Indesit D64	22	4000
Siemens SK 25200	14	2399

(Source: after www.webfoundtry.co.za)

2.2 Availability of Water Efficient Devices in South Africa

To assess the availability of water efficient devices the project team used a number or resources to contact manufacturers of water efficient devices. These included:

- DWAF and JASWIC booklet entitled ‘A to Z of Water Saving Devices’.
- The CSIR web-site version of the ‘A to Z’ booklet
- An article in the *Plumbing Africa* magazine

2.2.1 DWAF and JASWIC booklet entitled ‘A to Z’ of Water Saving Devices

In 1995 as a component of a National Water Conservation Campaign, DWAF and JASWIC published a booklet entitled ‘A to Z of Water Saving Devices’. This booklet listed manufacturers of water efficient devices and contained a brief description of the water efficient device produced. The manufacturers listed were contacted using the information given in the booklet. However, due to the length of time since publication much of the contact information and indeed even company names had changed.

2.2.2 The CSIR web-site version of the ‘A to Z’ booklet

Manufacturers were also contacted from contact details given on the CSIR developed web-site version of the A-Z booklet called ‘A-Z of Best Practice in Water Installations in Commercial and Residential Buildings in South Africa’. Again some of the contact details proved out of date but most were contactable by phone or had a website. Nine manufacturers of water efficient devices were listed on the A-Z web site. The responses from manufacturers listed in the A-Z booklet and on the website are recorded in Appendices A and B.

2.2.3 Article in the IOPSA Plumbing Africa magazine

An article about this WRC project was published in the February 2006 *Plumbing Africa* magazine, which is the official journal of the Institute of Plumbing South Africa (IOPSA). The article invited manufacturers and suppliers to contact the project team and to supply information so their products could be included in the database. The response to this article was very limited. Table 2.5 is a list of manufacturers who currently produce water efficient devices in South Africa and responded to the project team by supplying information regarding their product range.

The manufacturers listed produce a range of water efficient devices that include:

- Low flush volume cisterns
- Dual flush toilets
- Leak free toilets
- Cistern volume reduction devices
- Toilet stops
- Waterless urinals
- Tap aerators
- Grey water reuse devices
- Devices to collect and store rain water
- Shower stops
- Hose burst safety device
- Flow reducers
- Infra red taps
- Water pressure reducing valves
- Water meters
- Shower and tap shut off valves
- Water efficient washing machines and dishwashers

Table 2.5: List of manufacturers and contact details

Manufacturers Name	Physical Address	Phone	Email
Addicom	Addicom (Pty) Ltd Reg no. 76/04450/07 PO Box 668 Germiston 1401	011 873 9410	info@addicom.net
Akuvuzi			bobcat@intekom.co.za
Churrasco	Churrasco c.c. P.O. Box 260268 Excom 2023	011 331-8417	rasco@netline.co.za
City Heat Geysers CC	PO Box 31170 Merebank 4059	031 461-3555	cityheat@iafrica.com
Cobra	Cobra Group Limited P.O. Box 1096 Krugersdorp 1740	011 951-5000 031701-4897	cobra@cobrataps.co.za
Dammetjies Horicultural Services	PO Box 12052 Centrahill Port Elizabeth 6006	041 366 1325	geoff@dammetjies.com
Development Solutions Africa	PO Box 15162 Westmead 3608	031 705 4230	dsadbn@mweb.co.za
Hansgrohe	PO Box 2912 Halfway House 1685	011 468-1152	sales@hansgrohe.co.za
Parker Manufacturing	Parker Manufacturing PO Box 43225 Industria 2042	011 474 1819	info@pennyware.net
Probrass (PTY) Ltd.	PO Box 43544 Industria 2042	011 473 1123	
RST	RST Western Cape PO Box 55011 Sunset Beach 7441	021 552-1658	info@rst.co.za
Sannitree	Sannitree International Westlake Business Park 13 Westlake Drive Westlake 7967 Cape Town	021 701-1266	sannitree@mweb.co.za
Vaal Sanitaryware	Head Office PO Box 49, Meyerton, 1960	016 360 6000	vaalsan@g5.co.za
Walker Crosweller	Walker Crosweller (Pty) Ltd P.O. Box 1018 Bromhof 2154	021 785-2976 072 821-4463	walcro@iafrica.com
Water Matters	Water Matters P.O. Box 681 Rondebosch 7701	021 674-1932 082 940-0964	drury@mweb.co.za
Water Rhapsody	Water Rhapsody 37 Forest Drive Pinelands 7405	021 531-9864	jeremy@water-rhapsody.co.za

2.2.4 Examples of water efficient toilets systems available in South Africa

2.2.4.1 Low volume flush toilet and dual flush toilets

A number of dual flush toilets available are manufactured with 6 and 9 litre flush options, such as the Vaal Sanitaryware china 'Loerie' (see Figure 2.1 below, left) which has a close coupled[11] 90° outlet open rim wash down pan and matching 6 litre push-button top dual flush cistern.

The Aquasave Slimline suite is designed to flush on 4.5 litres and is shown Figure 2.1 (right).

Figure 2.1: Products from the Vaal sanitaryware range: dual flush 6/9 litre (left), low volume flush 4.5 litres (right)

Figure 2.2: A locally supplied toilet with an imported dual flush mechanism

[11] A close coupled toilet system is one in which the cistern and the pan are part of one integrated unit and not two units separated by a pipe. See for example Figure 2.1 (left) for a close coupled system in comparison with Figure 2.1 (right).

In commercial settings, the amount of water flushed can be set using a valve. Using valves allows the flow volume of the toilet and urinal flushing to be set and adjusted on site to ensure the precise amount of water required can be set for the application. The Walcro valve from Walker Crossweller is shown in Figure 2.3 below.

Figure 2.3: Walcro toilet/urinal flushing valve

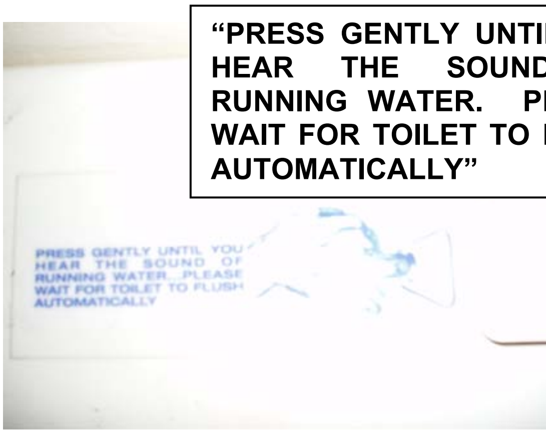
2.2.4.2 Leak free toilets: the Akuvuzi toilet cistern

Leaks from internal plumbing fixtures (no matter how efficient the water use device is) result in households wasting significant amounts of water. This is because many leaks go undetected for long periods of time. Leakages are usually a result of fixtures and pipe work not being maintained. The largest component of this leakage is usually the household's toilet cistern. The causes are:

- The cistern inlet float valve does not close after the cistern has filled, and/or
- The seal on the outlet flushing plunger valve leaks.

Water leakage is particularly problematic for poorer households trying to limit water use to within the free basic allowance.

The Akuvuzi cistern has been specially designed by Bobcat Water Solutions to overcome cistern leaks that use up customer's "free water". It works on the principle that the cistern remains empty at all times until water is needed to flush the toilet. After the toilet has been used, the user presses the operating button situated on top of the cistern. Only then does a pilot-operated diaphragm open the cistern's inlet valve to allow water into the cistern. Once the water has reached the preset volume, the flush mechanism is triggered. This automatically releases the water in the cistern to remove the wastes in the toilet bowl and closes the inlet valve at the same time to keep the cistern empty until the next user presses the operating button.



"PRESS GENTLY UNTIL YOU HEAR THE SOUND OF RUNNING WATER. PLEASE WAIT FOR TOILET TO FLUSH AUTOMATICALLY"

Figure 2.4: The Akuvuzi cistern, empty of water between flushes (left) and the instructions that appear on the top of the cistern (right)

Because the cistern is normally empty the seal on the outlet flushing plunger is practically redundant, and thus one of the two sources of a leaking toilet has been eliminated. It is still of however vitally important that the remaining source of toilet leaks, the inlet valve, operates 100% effectively, otherwise the cistern will not remain empty and will not be leak free despite being marketed as the "Akuvuzi leak free cistern".

There have been at least three Akuvuzi pilot studies conducted, two in Johannesburg and one in Mangaung Local Municipality. The first Johannesburg pilot was undertaken in 2004 and involved 150 toilets being installed by Jo'burg water. Some of the units failed within 6 months and as a result Johannesburg discontinued the pilot. A second pilot in Johannesburg of 30 toilets was undertaken by the inventor of the system in 2005 and when visited by this research team in 2007 all toilets were found to be still in good working order. There were no leaks and the owners were pleased with the units.

The Mangaung Local Municipality piloted Akuvuzi leak free toilets amongst 27 households in 2005. During the pilot there was constant monitoring of flows, consumer responses and acceptability. The study found that the Leak free toilet cistern was effective at reducing water loss due to leaking cisterns, with over 80% of the households recording a substantial drop in their monthly water consumption (GM Water and Sanitation, 2006). The report to the local municipality recommended that the toilets be tested in a larger scale.

The capacity of an Akuvuzi cistern is 11 litres but during installation the flush volume can be preset to any value between 6 and 11 litres. This is to make the unit suitable for use with any type of toilet bowl. However, presetting the flushing level, which sets the flush volume, has to be done by trial and error and the units cannot be tested without the lid on. This means one cannot check the water level at which flushing is taking place.

Figure 2.5: A typical Akuvuzi installation in Senaoane, Soweto, Johannesburg

2.2.5 Waterless urinals

Waterless urinals used to have the reputation of being high maintenance. In response manufacturers have produced designs that are less labour intensive to maintain. An example of this is the urinal produced by Sannitree, a cross section of which is shown in Figure 2.6. The urine flows into the inlet where it passes through a layer of a floating blue sealant liquid which forms a barrier that prevents the urine odour from escaping. The urine that is under the barrier of blue liquid overflows into the central tube and runs down to the sewer.

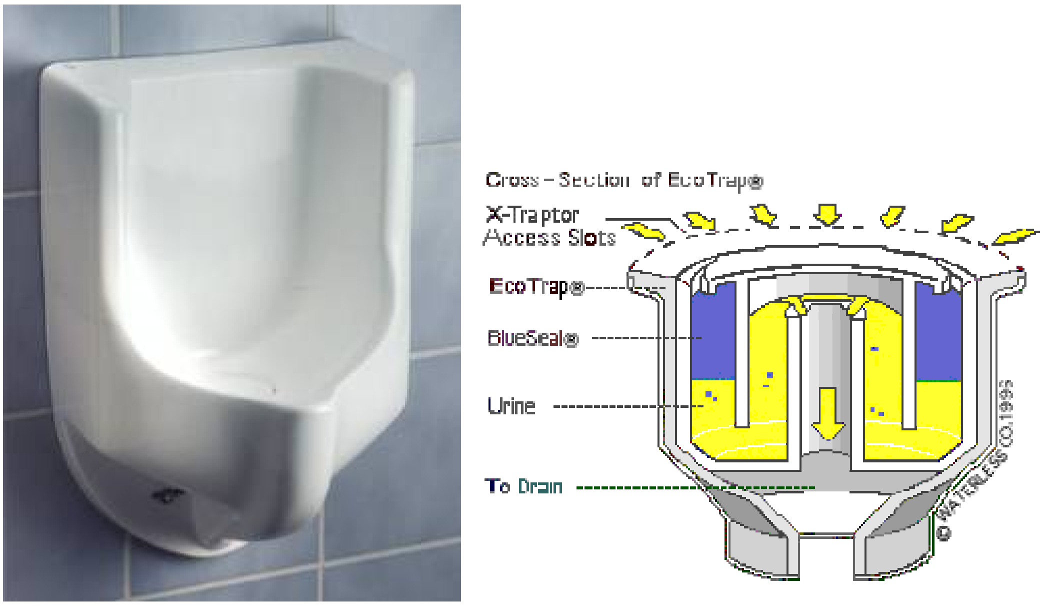


Figure 2.6: Sannitree waterless urinal (left), and its cross section, (right)
(Source: Sannitree, 2005)

Addicom first introduced waterless and odourless urinals into South Africa in 1983. Addicom's first waterless urinal product range were discontinued in 2000 and replaced by a model requiring less maintenance that no longer makes use of sealing liquid (which was reported to be causing blockages), (personal communication, Addicom, 2006).

In 2000 Addicom launched the EcoSmellstop system for waterless urinals. The ecostop drain which acts as a non-return valve for the urinal, which opens under the weight of a very small amount of liquid and then closes again (Addicom, 2005). It operates without any sealing liquid and also allows the passage of solids.

Figure 2.7: Addicom Waterless urinals – Johannesburg Taxi Rank

Addicom urinals have been installed on university campuses, at schools and in many public places such as taxi ranks. As the urinals require no water, they allow municipalities to provide urinals in areas that otherwise would be very costly to service. To date, 1 200 EcoSmellstop waterless urinals have been successfully installed.

A follow-up on the state of the waterless urinals installed in public places in Johannesburg in 2007, three years after they were initially introduced found that the urinals were working well

> "The installation of the EcoSmellstop system has brought considerable savings in water and maintenance, reduced vandalism and works very reliably" (extract from a letter of reference written by Mr.G Dunn, Depot Manager, City of Johannesburg, Facilities Management and Maintenance Unit, 6th February 2007).

2.2.6 Cistern volume reducing devices

A Hippo Bag (Figure 2.8 below) is a heavy duty plastic bag, which sits under the ball cock in a toilet cistern. The amount of water it displaces is dependent on the size of the cistern in which it is installed. It should be noted that Hippo Bags are suitable for installation in the larger 12 ℓ and 13 ℓ cisterns. There are two small holes in the bag which allow for the water to slowly come out after flushing and also allow for water to go back into the bag as the cistern is filling. The water saving per flush is in the region 2.5 to 3.5 litres.

Figure 2.8: The HIPPO bag being installed into a cistern (Wilson, 2004)

2.2.7 Toilet stops

By inserting a toilet stop into an existing toilet with a large cistern, water savings of up to 50% on toilet use can be realised (depending on pan design).

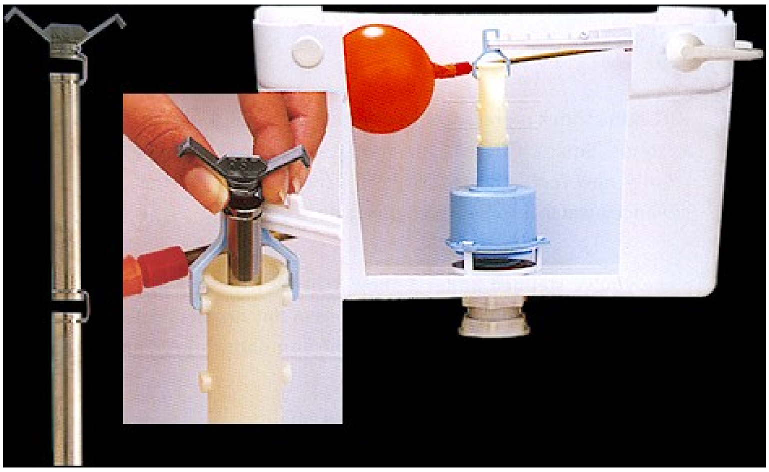


Figure 2.9: RST toilet stop

2.2.8 Water efficient showers

The designers of water efficient showers have to overcome consumer resistance in three areas:

- People like different types of shower sensations and they are concerned that it will be impossible to obtain the sensation they want “under a trickle”
- They worry that lime scale build-up will clog up the nozzles on low flow shower heads in hard water areas
- They like the shower to wet them all over without them having to move.

Water use is reduced in water efficient showers by *aeration*, so that the user is wet by a series of discrete droplets (like rain), rather than by continuous streams for water. For further efficiency shower stop valves allow users to switch the water flow on and off as required without altering the temperature.

Hans Grohe market a wide range of aerated ‘Raindance’ shower heads (Figure 2.10 below). These range from low flow to relatively high flow, but all use water efficiently relative to the type of shower they produce. The Raindance showers come in a range of sizes from standard to luxury (240 mm head diameter). The showers are aerated, and use a set of rubber nozzles which enable the easy removal of scale build-up.

The Novolence hand shower (Figure 2.11) is marketed as saving up to 50% water and energy compared with a standard hand shower[12]. The water is restricted and turned into tiny droplets in a turbulence chamber. These tiny droplets wet the skin more intensely than the standard large drops resulting in what the manufacturers describe as ‘increased showering comfort and a more pleasant feel to the skin’ (RST, 2005).

Figure 2.10: The Hans Grohe’s aerated “Raindance” shower head

Figure 2.11: The Novolence aerated hand shower marketed by RST

[12] This claim has been checked and confirmed by the research team. In the trial the RST shower delivered flows of between 4.5 and 10.7 litres per second over a pressure range where a standard non-aerated shower delivered flows between 7.5 and 20.9 litres per second.

2.2.9 Water efficient taps

Water efficient taps are fitted with tap aerators to increase the perceived volume of water, and to improve flow characteristics. Aerated taps are suitable for use in the kitchen and bathroom sinks in people's homes. Some, but not all, older taps can be fitted with aerators (without replacing the entire tap).

Figure 2.12: RST tap aerator

The South African manufactured Walcro ranges of taps from Walker Crossweller are examples of water efficient taps suitable for the commercial sector. Two taps from the range are shown in Figure 2.13.

Figure 2.13: Walcro taps: infrared tap (left) demand tap (right)

The electronic programming and sensor in the infrared tap ensures that water is only released when needed and automatically shuts off when the user has finished (Walker

Crossweller, 2005). In the case of the demand tap the user must depress the handle to get water and the tap shuts off as soon as the handle is released.

Although not designed specifically to save water, plastic taps and fittings are marketed as a water saver. Taps, fitting and pipes that are made of brass and which are located in public areas are sometime stolen and sold at scrap merchants. The theft and damage can cause major water loss as the resultant leak can take several days to be reported and fixed. The use of plastic taps, fittings and pipes instead can reduce water loss as they are not stolen.

2.2.10 Water Efficient Public Standpipes

South African companies have pioneered the development of manual and electronically operated water efficient public standpipes. Two examples of the former are the "Water Widget" standpipe marketed by Bobcat, illustrated in Figure 2.14 and the Thelamanzi illustrated in Figure 2.15 (www.dwaf.gov.za/tigds/profiles/organisations/Brochure04rev6.doc). For the Widget tap to operate, the user turns a handle as long as water is required. While the handle is turned, water is dispensed, and when the user stops turning the handle, water flow ceases. This system uses a solenoid valve and the turning of the handle creates the current that operates the valve.

Figure 2.14: The Widget water efficient public standpipe (manually operated)

Figure 2.15: The Thelamanzi water efficient public standpipe (manually operated)

The Thelamanzi tap is also manually operated, using a three way valve and hydraulics to operate the mechanism. There are also several makes of electronically controlled, battery powered prepayment and “freepayment” public standpipes on the market. All of these systems (manual or electronic) have been shown to make savings in water consumption of as much as 70%, without users necessarily being restricted in the number of times they draw water from the taps. The savings are achieved because taps cannot be left running by careless users. Their smooth working does, however, depend on correct installation, good maintenance and public respect for the system (see Figure 2.16, below). The Thelamanzi and the electronic standpipes can be linked to the use of pre-paid tokens, if the system requires payment for some or all of the water consumed. Operation of the Widget is not linked to any pre-paid token or payment mechanism – the system was developed in the context where water drawn from public standpipes does not need to be paid for.

Figure 2.16: Without public buy in, water efficient public standpipes are vulnerable to vandalism

2.2.11 Greywater Recycling Units

Greywater reuse simply refers to recycling or using certain streams of waste water for a second time. For example water from showers, baths, hand basins and possibly even washing machines or laundry buckets is used for other household functions such as flushing toilets or watering gardens. Greywater reuse saves potable water and reduces the quantity of wastewater produced. Table 2.6 below details the potential positive and negative impacts of greywater re-use.

Table 2.6: Potential positive and negative impacts of Greywater reuse

Potential Positive Impacts	Potential Negative Impacts
Regional level	**Regional level**
• reduce regional demand for fresh water	• over the long term, salination of soils and aquifers • aquifer contamination • surface water contamination
Municipal level	**Municipal level**
• reduce municipal demand for fresh water • high quality water can be reserved for where it is most needed • savings on water treatment • reduction in the urgency of sourcing new water supplies or building additional water storage and abstraction infrastructure	• reduction in the volume of sewage flows will result in a higher solid loading which may cause blockages
Local (household level)	**Local (household level)**
• Savings made on household water bills • Reduce the need for fertilizer • Some greywater might kill or weaken certain garden pests and reduce plant diseases	• Potential for pathogens in the water to cause ill-health amongst humans • Odour problems if water is stored for too long • Insect breeding if water is stored incorrectly • Quality of water might impact negatively on plants

(Source: after Murphy, 2006).

Murphy (2006) reports that there is no legislation that prohibits the use of grey water for yard irrigation, provided that its use does not contravene the Health Act No. 63 of 1977 and the National Water Act No. 36 of 1998. The main concerns outlined in these acts refer to nuisances that might be cause by the reuse of domestic water. These nuisances include:

- Fly or mosquito breeding
- Objectionable odours
- Surface ponding of water
- Entry of polluted water into a neighbouring property.

The promotion of greywater reuse is a contentious issue. The publication *Water Sewage and Effluent* introduced a debate on the suitability of greywater use for food production (Water Sewage and Effluent, 2006). Much of the debate centres around what constitutes "grey" water (water that can be safely reused) and when greywater becomes "black" water (water that needs to be disposed of).

In the debate, Professor Neil Armitage of the University of Cape Town suggested that greywater varies in quality from 'light grey' (lightly polluted), for example water from a shower, to 'medium grey' for example water from a washing machine, to 'dark grey' heavily polluted water from other household functions (such as kitchen sinks). There would be serious environmental and human health risks associated with using water other than that classified as 'light grey'. Even 'light grey' water needs to be stored and handled with care as all greywater contains pathogens and other disease causing bacteria.

Research is currently underway to determine the safety of greywater reuse. The WRC is funding the CSIR to conduct a fitness-for-use assessment of greywater, the University of Cape Town is surveying greywater quality with a view to providing management options, the University of KwaZulu-Natal is investigating the safe use of greywater for small-scale irrigation and eThekwini municipality has been involved in assessing the feasibility and acceptability of greywater irrigation systems (Rodda, 2006). Such research is critical if greywater reuse is to become recommended practice or the basis for domestic and market gardening projects.

Safe water reuse within an individual's home simply requires a little common sense (Dowling, 2005). Dowling recommends some basic rules such as using biodegradable laundry detergents which are low in phosphorus; avoiding using grey water on leafy green vegetables and refraining from reusing kitchen water. Enthusiasm for transferring water manually from baths and basins is likely to be difficult to sustain, and therefore the installation of a greywater recycling unit is advised.

While grey water recycling is yet to become widely popular in South Africa, internationally companies like Hans Grohe promote the use of domestic grey water recycling devices. Akwadoc is the South African agent responsible for distributing the Pontes[13] grey water recycling units (see Figure 2.17 below). Other commercially available units are available from Garden ResQ, Water Rhapsody and Biolytix. The available capacities range from as little as 700 litres per day, to as much as 10 000ℓ/day. Depending on size and what is included in the price (e.g. filters, pump and chamber, hose, sprinkler, switchgear etc.) the cost of these units typically varies from R1 000 to R45 000.

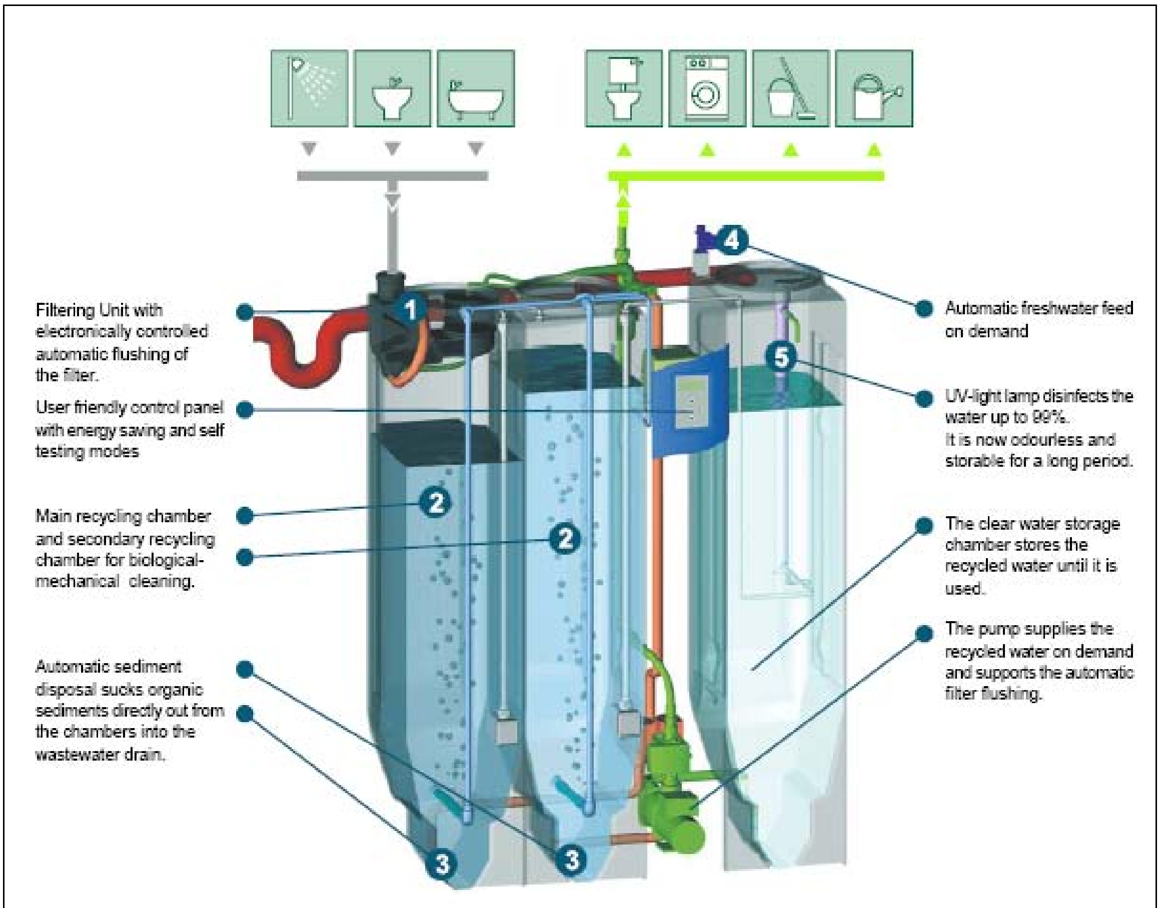


Figure 2.17: The Akwadoc water recycling system

13 Pontes is an independent subsidiary of Hans Grohe.

2.2.11.1 Outdoor and landscaping water efficient devices

This is an area where using water efficient technology on its own will not achieve the desired results, whilst good practice on its own can go a long way to achieving high water efficiencies. Good practice includes:

- The designing of gardens around indigenous plants, vegetables, and lawn grasses which are drought resistant and grow well without any additional watering.
- Protecting the soil by composting and mulching.
- Watering restricted to the morning and evening, as evaporation is highest between the hours of 10 am to 4 pm.
- Hand watering using a standard watering can. This is an efficient way of getting water to the roots, and is appropriate for use both in household gardens and community gardens (Walker, 1999). Hand watering with a watering can makes it easier to use rainwater collected off a roof, or grey water.

Water efficient devices for gardening include micro sprays, drip irrigation and soil moisture sensors. The most basic device is a fitting which is connected to the end of the hose pipe allowing the user to vary the spray intensity and to switch the hose off without going back to the point of connection (in some towns in South Africa the use of hosepipes not fitted with such a device is illegal).

2.2.12 Availability of water efficient devices in South Africa

The fact that many water efficient devices are appropriate for use in our homes and are even manufactured in South Africa does not necessarily mean they are well marketed or easy to obtain. For this reason an audit of retail and wholesale plumbing outlets was undertaken. The study included the following three components:

- A review of websites (Section 2.2.13 below)
- A questionnaire survey (Section 2.2.14 below)
- Visits by the project team to outlets in Pietermaritzburg and Durban (KwaZulu-Natal) and Gauteng (Section 2.2.15 below).

The aim of the audit was to assess which products were marketed (on the showroom floor and company websites) as water efficient, whether water efficient devices were easy to obtain and the cost of water efficient plumbing fixtures compared to standard products

2.2.13 Websites

As a starting point, sixteen different websites[14] of organisations selling sanitary and plumbing ware were accessed. Not surprisingly fashion statements about how to make your bathroom more elegant and stylish dominate the sites, with little mention of water saving or water efficient products anywhere. Where water or energy saving are mentioned, no specific water saving product ranges are named, and flush volumes or flow rates are rarely stated. Overall, the sites give the impression that selling water efficient devices is an insignificant part of suppliers business which is not worth promoting even for water demand management purposes.

Of the sixteen sites visited, three mentioned dual flush toilets and two mentioned aerated taps but again no specification was given in the sales text. Two sites, “Cobra Watertech” and “Plumblink”, have extensive catalogues where the specification for some products does give water usage figures and other interesting information but there are no pointers to water efficient devices. One has to search through these catalogues to find the water efficient items. Even then, there is no clear explanation as to how products work or clarity as to their purpose. For example: *Wash Basin Faucet – touch-free electronic control* and *Single Lever Basin Mixer - Temperature and flow control cartridge* are mentioned on the site, but without additional knowledge a consumer would not know that these products are more water efficient than similar standard products.

“On Tap”, a franchise chain, has no mention of water efficient devices anywhere in the descriptive sections of its website but does include some tips on saving water, which are mostly about behaviour. The only references to water efficient devices is to fit a displacement device (such as a hippo bag) in an existing toilet cistern and modifying automatic flushing urinals with user activated ones.

In response, one supplier indicated that their website does not provide information specifically on water efficient devices because

> “Websites are mainly designed to get customers into showrooms and to a lesser extent to help them to choose what to buy.”

Until consumer awareness and demand for water efficient devices increases, water efficiency will not be prominent in any marketing campaign (web-based or otherwise).

[14] The websites accessed were largely limited to the larger plumbing outlets, many of whom have branches or franchises in most of the larger towns and cities.

2.2.13.1 International Websites

Overseas websites were also searched to try and establish water efficient norms. Generally these sites were very similar to our local ones, being more dedicated to elegance criteria than any other facets of the sector. However, some of the "green sites" did provide additional information.

For example *The Green Building Store* website (http://www.greenbuildingstore.co.uk) provides detailed information about standard water using bathroom fittings and alternative, more water efficient products.

Figure 2.18 below shows the Monobloc tap (with brake to reduce flow rate to less than 5 litres per minute (LEFT), the waterless, airflush urinal (CENTRE) and the ultra-efficient 4.5 litre flush toilet (RIGHT).

Figure 2.18: Water efficient bathroom alternatives available from The Green Building Store: Monobloc tap (left), Waterless airflush urinal (centre) and Ultra-efficient 4.5 litre toilet (right)

Other sites of interest include:

- Victoriaplumb.com (http://www.victoriaplumb.com) provides potential customers with information about water (and energy) efficient products.
- Twford bathrooms (http://www.twfordbathrooms.com) a UK company provides information on a range of water efficient toilets.
- Bathroom and Kitchen Supplies (B&KS) (http://www.spec-net.com.au/company/bathkitch.htm) is an Australian supplier that actively markets the Evo water efficient toilet on their site and includes a link to download the Imperial Ware advanced water conservation brochure for 2007.
- UK Arrow Valves Limited (http://www.arrowvalves.co.uk) has products that help one to use water efficiently.
- UK Construction resources (http://www.constructionresources.com) specialises in water efficient products.
- Germany Bette (http://www.bette.de) specialise in steel/enamel baths in all shapes and sizes, including some more efficient ones.

2.2.14 Questionnaire Survey

A questionnaire survey was designed and sent out to retailers selling plumbing fixtures. The aim of the survey was to gain some insights into the plumbing sales environment and in particular acceptance and knowledge of water efficient devices. The questionnaire and accompanying letter can be found in Appendix H. Fifty-one questionnaires were distributed via e-mail and fax, but at the time of submitting the report, only seven completed surveys had been returned. One of the completed forms was from a supplier who does not have a showroom and a further two of the completed questionnaires were from companies specialising in water efficient devices that also do not have showrooms.

2.2.14.1 Limitations of the survey

Two of the suppliers phoned on receipt of the survey and raised some issues about potential discrepancies with the questions being asked. These suppliers expressed concern at having to rank some of the criteria because their customer base is so large, different customers' value criteria differently. For example *stylish and elegant* and *priced competitively* have different meanings and weightings for different customers. Similarly, with *easy to install*, this does not have the same connotations for a 'Do It Yourself' enthusiast as for a customer making use of a plumber.

2.2.14.2 Results

Respondents were provided with nine critical product criteria and asked to rank them in terms of importance <u>to the customers</u>. While the sample is small (only 7 respondents) it is interesting to note that the following ranking emerged:

Table 2.7: Ranking[15] of product criteria importance to customers

Product criteria	Ranking
Work effectively	1
Robust and durable	2
Use water efficiently*	3
Easy to maintain	3
Priced competitively	3
Supported by superb customer service	4
Easy to install	5
Elegant and stylish	6
Other: • Does not use any water • No scrap value resulting in minimum theft	7

* Note: 29% of the sample comprised of suppliers specialising in water efficient devices. Their customer base is therefore largely concerned with water efficiency and may not be a true reflection of the general public.

From Table 2.7 above, *use water efficiently* is ranked third. This is probably a true reflection of where water efficiency should be rated. Products must *work effectively* and *be robust and durable* before other considerations, as the selling of water efficient products that do not conform to these two criteria would hinder the advancement of water wise usage. As one of the respondents commented:

> "If a supplier ranks *products must use water efficiently* above these two criteria [*works effectively, robust and durable*] it is probably to please you because you are doing a project on water efficient devices, but is unlikely to be true."

It is interesting to note that water efficiency was not ranked uniformly amongst all the respondents. The two respondents from companies specialising in water efficient devices ranked water efficiency high, while two other suppliers ranked water efficiency as low as 7 and 8.

The inconsistency of criteria was not limited to water efficient devices. As can be seen in Figure 2.19 below, only one criterion, *robust and durable* received a reasonably consistent ranking.

[15] Ranking is based on 1 being the most important criterion and 9 being the least important. On occasions when the person completing the questionnaire allocated the same ranking to more than one criterion, the same rank was allocated to more than one criterion but otherwise the rank numbering system was left unaltered. For example: 1, 1, 3, 4, 5, 6, 7, 8, 9. Where no additional criteria were specified, *Other* was ranked 9.

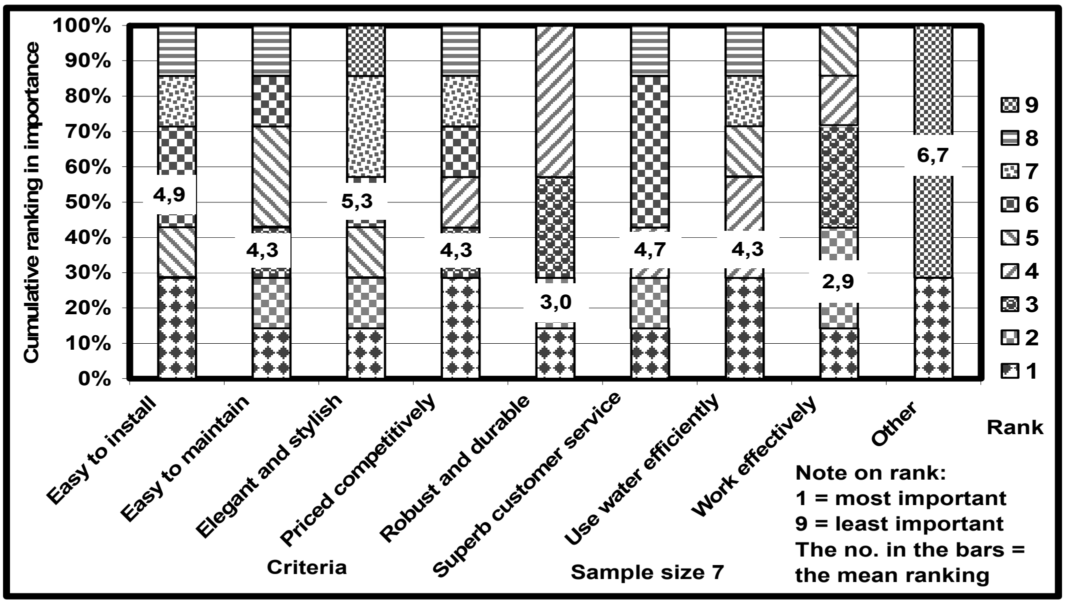


Figure 2.19: Critical criteria for customers as ranked by suppliers

The remaining sections of the questionnaire were poorly reported on and therefore the results are not analysed. However the following is worth noting:

- Labelling (water efficiency or water usage) by the manufacturers is not practiced.
- There is growing awareness about water efficiency amongst the public.
- Some customers express concern that water efficient products may not work as well as standard products.
- Saving energy is often seen as more important than saving water.
- Displays are important in determining what products get sold, and more could be done by the outlets to promote water efficient products in this regard.
- The most popular water efficient device is a toilet, with one respondent indicating that water efficient toilets make up just over 40% of the market share.
- Water efficient showerheads are the least popular, comprising a mere 13% of the market share.

Additional feedback from suppliers suggested that the most important attribute of any plumbing device is that

> "… works effectively in the way the customer wants it to in their environment".

2.2.15 Visits to plumbing outlets

Visits to plumbing outlets were undertaken in Pietermaritzburg and Pinetown (Durban) in KwaZulu-Natal and Gauteng. The aim of the visits was to establish what type of water efficient products are available for display and obtain some feedback from showroom staff about the various product ranges. Appendix I contains a more detailed record of some of these visits than could be summarised in this section.

2.2.15.1 An audit of plumbing outlets in Pietermaritzburg

Three plumbing outlets were visited in Pietermaritzburg, all with slightly different target markets. All three plumbing and bathroom outlets stock a variety of water efficient devices. The most common were aerated taps and dual flush toilets.

Dual Flush Toilets

Dual flush toilets are standard on the show room floor. In one outlet there were more dual flush toilets than standard toilets on display. Dual flush toilets are not any more expensive than standard products and increasingly architects specify top flush toilets (which are usually dual flush toilets) in their design. However, anecdotal evidence suggests that contract plumbers are more likely to fit front flush toilets (which are usually not dual flush). This was thought to be because the dual flush toilets initially introduced onto the market were more labour intensive to install and resulted in more comebacks for the plumbers.

Figure 2.20: Standard show room display, with dual flush toilet, mixer tap and standard size basin

Aerated taps

Almost all taps on the show room floor are aerated, excluding standing taps on bath tubs and some basins. However, the taps are not marketed as such and therefore most customers would not know they are fitting a device that uses water efficiently or be prodded to ask for other water saving or efficient devices.

Basins and bathtubs

A range of bathtubs were stocked at all three outlets. The standard 1.7 m by 700 mm was the most common, but all three showrooms also had at least one much larger, luxury bathtub on display.

Figure 2.21: Luxury bathtubs on display in Pietermaritzburg plumbing outlets

In two of the outlets, standard size basins made up the bulk of those on display, with fewer, lower volume basins. The lower volume basins are more exclusive, and targeting the upper end of the market.

Figure 2.22: Low volume basins on display in plumbing outlets

Shower roses

Most shower roses have adjustable heads which allow the user to adjust the rate of flow. Luxury lines such as Hans Grohe shower roses that provide "the ultimate shower experience" are adjustable over a wide flow range. One outlet had an old RST water efficient devices display board, but failed to order an RST showerhead for the researchers when asked to do so.

Water Efficient Devices

Showroom staff often looked confused by the term "water efficient" and preferred to refer to products as "water saving".

Products specifically marketed as water efficient were found to be difficult to obtain. Interestingly the plumbing outlets that stock plumbing fixtures imported from Europe were more likely to stock water efficient devices. This is because almost all product ranges produced for these countries are required to be water efficient (due to a combination of consumer demand and legislation in the countries of manufacture).

Cobra tap aerators were available in one size. However, these do not fit most of the older taps in a domestic kitchen or bathroom.

2.2.15.2 An audit of plumbing outlets in Pinetown (Durban)

Three plumbing outlets were visited in the Pinetown area of Durban. The findings from visiting the Pinetown showrooms were no different to the findings from the Pietermaritzburg survey, even though an effort was made to ensure that at least some of the outlets visited were not linked to the Pietermaritzburg outlets.

Showroom assistants indicated that style and price determined what people bought. Higher income customers decisions were based entirely on style and often had quite specific ideas about how they wanted their bathroom to look and feel while customers with a tighter budget are more likely to chose something that is moderately priced and recommended (for durability) by either a plumber of the showroom staff.

2.2.15.3 An audit of a Pretoria showroom (Gauteng)

Toilets

The plumbing outlet only had 6/3 or 7/4 litre dual flush cisterns on display. Nonetheless, the 9 and 11 litre cisterns still sell better. This is partly because the local sanitary ware manufacturing industry gave dual and low flush toilets a bad name when first introduced because the toilet bowls did not always clear adequately.

Figure 2.23: Dual 3/6 litre flush toilets on display at a major Pretoria outlet

Showerheads

The manager cautioned that the flow rates in most showerheads is not fixed and is dependent on pressure[16]. In addition, while flow rates for low flow “rain” showers tends to be lower than for a normal spray shower, people tend to stay longer under a rain shower. For this reason, showerheads designed to be more water efficient might not realise their theoretical water savings.

Taps

All taps marketed are aerated because they splash less and generally work better.

Basins and baths

The only bath on display was a 1.7 m by 700 mm wide curved bath designed for relaxation (without wasting water). If customers request different baths (longer or wider) they can be supplied, but they are not on display. The same holds for basins and kitchen sinks.

2.2.15.4 Midrand plumbing outlet, Gauteng

This particular plumbing outlet serves mainly architects responsible for a broad range of domestic and commercial developments. The architects tend to be conservative and water efficient products are rarely considered. Once again, the poor quality of initial water efficient products is to blame for their low uptake.

[16] A more detailed discussion on pressure management is contained within Appendix J.

Toilets

As with the Pretoria outlet, most toilets on display were dual flush, yet sales in toilets with the conventional 11 litre cistern still exceed the dual flush units. Interruptible flush toilets were introduced to the market to overcome the shortfalls of the earlier dual flush units, but these are very rarely asked for.

Showerheads

No water efficient shower heads are stocked or sold.

Taps

Nearly all taps sold are aerated (because most quality taps are made this way). For commercial buildings sensor taps are increasingly popular. This is because people do not want to touch taps in public places (rather than because they are more water efficient).

Baths and basins

Baths and basins tend to be smaller (and therefore use less water) than they were 10 years ago. However, the manager thought this was more likely to be because of current trends and smaller spaces, and not because of a decision by the buyer to save water.

2.2.15.5 An audit of a Benoni plumbing outlet

This particular plumbing outlet's customer base was predominately homeowners refurbishing their bathrooms or plumbers buying on their behalf.

Toilets

The showroom floor has predominately dual flush toilets with a full flush of 9 litres and a half flush of either 6 or 4.5 litres. However, if customers are only buying a new cistern the manager prefers to sell them a standard 11 litre cistern as the older bowls are not designed to work with the lower water volume.

Showerheads

The showerheads sold are all standard showerheads with a flow restrictor. The staff try and encourage the customers to leave the restrictor in and try the shower first. If they are unhappy after using the shower several times, then they would recommend removing the restrictor. About 10% of the customers insist that the restrictor is removed when they purchase it.

Taps

All mixer-taps sold are aerated but the manager did not think that this would save water. The main reason for the taps being aerated is performance, as the water flows better.

Baths and basins

Most customers opt for a standard size bath (1, 7 m by 700 mm) and basin. It is rare that customers ask for something smaller, and it is usually because of a space constraint (not because they would like to use less water).

2.2.15.6 An audit of a Bryanston plumbing outlet

The plumbing outlet visited is an upmarket franchise with six outlets and two trading partners in the more wealthy and taste conscious areas of South Africa. Their customer base is the architects for upmarket commercial and domestic developments. An essential element of all the products sold is water efficiency. The products they sell are mainly of European design with German technology.

> Aesthetics versus water efficiency
>
> "When I walked in, the manager was on the phone to an architect from some cluster housing development discussing what might be done about the toilets delivered to site because they were too tall to fit under the windows. The manager explained that if he really wanted something to fit under the window they would have to replace the 3/6 litre dual flush toilets with low profile 9 litre single flush units; 6 litre flush needed the extra head to work perfectly every time. She was at pains to explain that there was no problem about collecting all the toilets delivered to site and replacing them with the low profile units but was it right that the end users had to have a product that was less attractive visually and used 50 times more water than the dual flush used when the full flush was activated. Did he not want to go back to the drawing board and change the window design she asked, apparently to no avail!" (Manager, Gauteng plumbing supplier.)

Toilets

All toilets are 6/3 litre dual flush units. Only in special cases do they supply other flush volumes. The manager was of the opinion that it is the low flush volume of the full flush where the real water savings are realised, this is because very few people make use of the half flush.

Urinals

Urinals are only sold for commercial developments, and are nearly all waterless.

Showerheads

This is where luxury counts. The top of the range showerheads sold have a head size ranging from 100 to 210 mm. The shower is designed to deliver 3 litres of air with every 1 litre of water. The showers are adjustable to allow the user to select soft rain, heavy rain or lashing massage shower experience (Figure 2.24). These showers may not use less water than other showers, but they do use the water more efficiently.

Rain AIR / Whirl AIR

Water has many facets. It can caress and pamper us, massage and wake us up. With the new AIR spray mode, the choice is yours. With Rain AIR, the gently flowing water becomes even gentler, plump drops of air make the water seem even softer. Showering becomes a way of providing moisturising skin care. Whirl AIR is completely different. Here, the air accelerates the jets of water to an intense massage experience. Millions of new stimuli beat onto the body providing you with long-lasting energy.

Rain AIR

Air is drawn in all over the shower head and mixed with the inflowing water. This mixes 1 litre of water with around 3 litres of air! Consequently: the drops become larger, lighter and softer.

Whirl AIR

This also mixes water with air. The air is compressed in a very small space and the out-flowing massage jet accelerated. This results in a very powerful, intense massage – even at low water pressure.

Figure 2.24: Abstract on showerheads from the Hans Grohe website

Taps

Two types of water efficient taps are stocked. The first is energy and water efficient thermostatically controlled tap, which has a lever stop which reduces the water flow to less than half the flow when fully opened. The stop can be overridden by pressing a button at the back. Very few of these taps are sold. Architects generally prefer simpler aerated lever operated mixer taps, relying more on the visual appearance to make their final choice for different applications.

For commercial developments, architects prefer simple mixer taps over the sensor taps as sensor taps are more prone to vandalism and require more maintenance.

Basins and baths

Two bathtubs are stocked. The Duravit® ceramic bathtubs are just a little larger that standard bathtubs and a German range of Bette® steel-enamelled bathtubs, which are slightly shorted (1. 6 m long) than standard bath tubs.

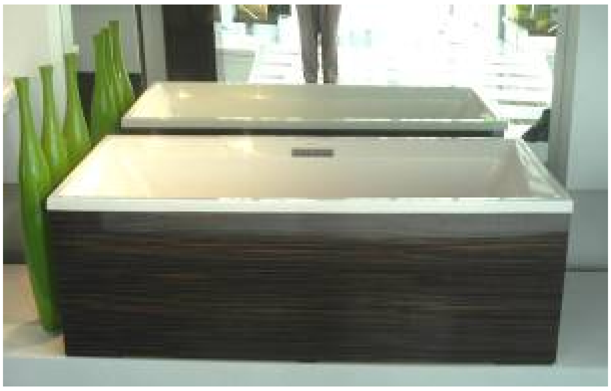


Figure 2.25: Typical Duravit® bathtub; simple, rectangular with clean lines

Many of the basins stocked are shallow basins, although sales in these have started to fall away, because clients complain that the basins are not as functional as traditional basins.

Figure 2.26: The shallow basins on show

(Note: This design has been found to be not as practical, and is now waning in popularity over the more traditional sink designs).

The range of basins is now larger, and most have modest volumes – a result of current trends.

Figure 2.27: Typical basins on display: all with modest volumes

In addition the manager of the outlet does inform architects about the Pontes grey water recycling systems distributed in South Africa by Akwadoc.

A fuller discussion of the visits to the Gauteng plumbing outlets is included in Appendix I.

In summary then, a range of water efficient devices are available in South Africa, and while their use is becoming more commonplace, it is not yet standard. The increasing appearance of these items in catalogues and showroom floors is driven by trends and legislation in the countries of manufacture (principally Europe) rather than South African demand. In this regard it is significant that the use of water efficient devices was most noticeable at the plumbing outlet in the most affluent area surveyed. The plumbing suppliers who phoned in after receiving the survey acknowledged that in many cases they could do better, and that displays were an important factor in determining what is sold, but they insisted that improving the sale of water efficient devices should not be left to them alone. Suppliers needed more support from manufacturers with respect to training and help with displays. They also complained that municipalities did little to promote good water management. Lastly, they stated that although the concept of reducing water usage through the use of water efficient devices (rather than through behavioural change) was attractive to both them and their customers, suppliers had to be a little cautious, as nearly all customers want to do their own choosing from a variety of products without being pushed or lectured to by sales staff. Good water management does, of course, encompass behavioural change as well as the universal use of water efficient products.

3 INSTITUTIONAL EXPERIENCE WITH WATER EFFICIENCY

This chapter reviews institutional experience with water use and water efficiency within South Africa, and where relevant, local water usage is benchmarked against international standards and best practices.

The chapter begins by reviewing water efficiency in prisons and hospitals. These essential public services are interesting as the installation of water efficient devices also needs to meet specific safety criteria. This is followed by an analysis of water usage at educational facilities (including schools and universities) transport hubs, shopping malls and the hospitality sector. To complete the overview, water use and efficiency at sports and recreational facilities and zoological gardens is examined.

3.1 Prisons

3.1.1 International benchmarks

A number of countries around the world have introduced benchmarks and desired standards for prisons in an effort to reduce the running costs of the institutions, fall into line with government policies on sustainable buildings and realise targets for environmental sustainability.

Interventions by the New Zealand Department of Corrections have reduced water consumption from 650 to 450 litres per prisoner per day. This has been achieved through the implementation of an Environmental Management System (guided by the ISO Standard 14001) which aims to reduce the operational impact of correctional facilities on the environment (Department of Corrections, 2005).

> HM Prison Wellingborough
>
> In 1999 began implementing a water management strategy as part of a broader initiative to minimise waste. The project targeted three main areas bathing, urinals and laundry facilities.
>
> Baths have been replaced with showers, the timers on the automated flushing urinals were adjusted to operate only when needed, laundry facilities were centralised. These measures have reduced monthly water consumption from 12 m^3 to 6 m^3 per prisoner place.
>
> These substantial savings have meant that although inmate numbers have increased from 180 to 518 water consumption is lower than it was previously. Payback periods for the urinal controllers are estimated to be about 4 months; the laundry and shower block renovations should be paid back in 3 and 4 years respectively.
>
> (Source: Water efficiency pages accessed via www.environment-agency.gov.uk)

The Home Office in the United Kingdom (responsible for state operated Correctional Services Facilities) undertook an assessment of water use in prisons and set targets for more efficient water use based on the state initiative "Watermark[17]" (Home Office, 2005). The "Best Practices" water goals have been set as 96 kilolitres per prisoner per annum (for all prisons) or 115 and 93 kilolitres for prisons with and without laundry facilities respectively (Kitchen et al., 2003). [Note: theses figures equate to 263, 315 and 255 litres/prisoner/day].

Interventions that save water at each prison might not be considered to be significant, the Benchmark data produced for the UK highlights that if all the prisons in the UK were to become more efficient, then across the 158 prison establishments there would be an estimated saving of 1 755 556 cubic meters of water save per annum (Kitchen et al., 2003), enough to supply the needs of a small town.

The State of Georgia, USA assesses water efficiency based on the Industrial, Commercial and Public/Institutional (ICI) water efficiency benchmarks. The state makes use of several sets of water use efficiency benchmarks including the UK Watermark Benchmarks for median water and for "best practice" to define water efficiency in prisons. Making use of the median water use benchmark for prisons with a laundry (143 kilolitres per prisoner per year) and the "best practice" benchmark (116 kilolitres per prisoner per year) they calculate that savings of up to 19% can be made by introducing small changes within prisons (www.georgiaplanning.com)

The United States' Federal Bureau of Prisons (FBoP) does not require water conservation strategies to be implemented in prisons beyond the requirements of the Environmental Policy Act of 1992. However, the Bureau is aiming to reduce water consumption in prisons by 30% through design specifications based on the LEED[18] (Leadership in Energy and Environmental Design) water efficiency standards (as published by the Whole Building Design Guide). Internal specifications would include low-flow shower fixtures, tap aerators, waterless urinals and water efficient appliances. Improving water efficiency outside would be achieved by using indigenous plants, harvesting rainwater and other innovative strategies for ensuring that potable water is not used for irrigation purposes (ENSAR Group, 2002). Table 3.1 below shows a comparison of international experience and benchmarks for water consumption in prisons.

[17] Additional information on the Watermark Study of Water Use and "Best Practice" Benchmarks at Public Facilities in the UK (2003) can be found at http://www.watermark.gov.uk

[18] Information of the LEED programme can be obtained from http://www.wbdg.org/tools/leed_atfp_rp.php?l=we

Table 3.1: Summary of international examples of water efficiency within prisons

	Litres/ prisoner/day	Interventions
New Zealand (Department of Corrections)	450	• Installed meters • Develop water use databases • Adopted water conservation measures • Used rainwater for irrigation
UK (Home Office)	263 (general) 315 (with laundry) 255 (without laundry)	• Water targets for each prison • Any increase in consumption over 2.5% has to be reported on by the governor
UK: HM Prison Wellingborough	200	• Baths replaced by showers • Automatic Flushing Urinals timers adjusted • Laundry facilities centralised
USA (Federal Bureau of prisons)	379	• Waterless urinals
USA (State of Georgia)	318-392	

3.1.2 South African prisons

Guidelines for water use per prisoner within South African prisons are found in the CSIR's Red Book guidelines (1994), which suggest an allowance of 150 litres per prisoner per day and the Department of Public Works, which indicates an average demand of 375 litres per prisoner per day. The water design standards (as specified for Civil Engineers) fall between these two benchmarks (Department of Public Works, 2004). Variations for water demand and design standards occur because of differences at each facility, including the relative numbers of inmates and staff, the type and quantity of staff accommodation provided, the sports facilities, laundry facilities, whether the prison is also a farm or not and the location of the prison. Appendix D provides a detailed breakdown of the average daily water demand figures and design specifications that consider these variations.

A number of South African prisons have implemented strategies to reduce water consumption. These strategies include education and creating awareness amongst prisoners and wardens, improved metering and technological interventions. Technological interventions to reduce water consumption have to be introduced with caution as care must be taken not to aggravate the prisoners or provide them inadvertently with a tool that can be used for escape or violence within the prison.

3.1.2.1 Westville Prison, KwaZulu-Natal

Westville Prison, one of South Africa's largest correctional institutions, houses about 12 000 inmates spread across 5 different prisons at any one time. All the prison functions are metered as one unit (except for the laundry which is metered separately due to billing from the municipality for effluent). There are no water efficient devices installed within the prison. All toilets are 9 litre Flushmaster systems and all urinals were removed (due to space constraints). Showerheads are described as standard.

Water use at Westville prison ranged from between 136,610 kilolitres per month and 215,250 kilolitres per month for four months in 2006 (see Table 3.2 below).

Table 3.2: Water consumption figures for Westville Prison (September to December 2006)

Month	Kilolitres
September	159 010
October	156 730
November	136 610
December	215 250

(Source: Department of Public Works and eThekwini Municipality)

This equates to an average water consumption of 0.419 kilolitres per person per day and a range between 0.343 and 0.540 kilolitres per person per day. This falls roughly within the design specifications as outlined in the Public Works document 342 which would allow just over 300 litres per prisoner per day[19].

3.1.2.2 Kokstad Prison

Kokstad prison was contentious when it was built because of concerns that the water, waste water and electricity supply systems in the town of Kokstad would be unable to cope with the additional demand from the prison.

The prison is fitted with Flushmaster toilets (currently operating at 7 litre per flush), and Flushmaster urinals (currently operating at 3.5 litres per flush) in the male sections and standard showerheads (thought to deliver around 7 litres per minute). The prison does not have a farm or any other operations that would significantly contribute to water consumption. There is a borehole on the property, but water is currently supplied from the municipality.

[19] The per prisoner water consumption appears high, but this figure would also include water consumption for staff accommodation.

In order to make comparisons with other prison facilities, the amount of water used per person[20] on site was calculated (Figure 3.1 below). Average water consumption over the 12 month period (September 2005 to August 2006) was roughly 400 litres per person per day, i.e. approximately the same as Westville, but a little high by international standards.

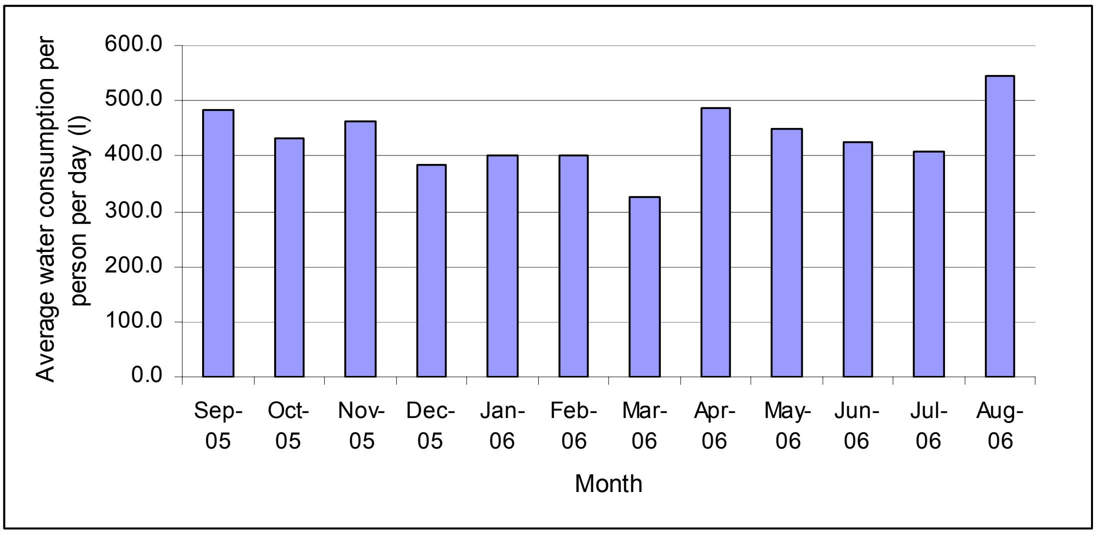


Figure 3.1 : Water consumption between September 2005 and August 2006 for Kokstad prison (medium security and maximum security) per person per day

(Source: Sisonke District Municipality)

3.1.2.3 Comparison of data with international prisons

The water consumption at the two South African prisons studied here is comparable to the water usage when compared with prisons around the world (Table 3.3 below), although it is on the higher side of the range.

However, the study found that there is a complete lack of water metering within the prisons which results in water leaks and illegal connections going unnoticed for significant periods of time. If water efficiency was actively pursued in South African prisons it is likely that water use could be reduced with no impact on the welfare of the inmates.

[20] Correctional services were unable to provide the exact number of people residing at the prison. Occupancy of 400 inmates in the Medium Security Unit and 300 inmates in the Maximum Security Unit was presumed. In addition is was assumed that the 80 single wardens quarters housed only one person each and a four person household was presumed for each of the 114 family units available on the premises for prison staff .

Table 3.3: Comparison of water use in South African prisons with international examples

	South African case studies		International Best Practice Examples		
Water Use	Westville	Kokstad	NZ	UK	USA
Litres per prisoner per day	419	400	450	256	300-380

3.2 Hospitals

Hospitals are another interesting area of study. State hospitals fall under the management of the Department of Public Works, and thus provide an indication of to what extent water conservation or water efficiency is a priority in this department. Hospitals are also known to be high water users. For example, Chris Hani Baragwanath Hospital is Johannesburg Water's largest single water user.

Data on water use was gathered from six urban hospitals (including 3 private medical facilities) and two rural hospitals located in Gauteng and KwaZulu-Natal. The primary purpose of the study was to ascertain the prevalence of water efficient fittings in hospitals. A secondary aim was to look more generally at the way in which water use was managed in the healthcare environment.

The selected hospitals were visited and a brief interview was held with the relevant hospital employees. If possible, a tour of the hospital was also conducted. The hospitals supplied monthly water consumption data for 2004 and 2005 based on municipal accounts (Table 3.4 below). Unfortunately the data was generally not sensitive enough to display obvious trends in water use and several situations reduced the usefulness of the data. For example, missed readings, averaged consumption, estimates and corrections and failed meters all occurred. The readings for the different hospitals were also not consistent in terms of which units and functions were included which complicates the comparing of results.

Table 3.4: Monthly water consumption of hospitals visited

Hospital	Monthly Consumption (kℓ)	No. of Beds	Occupancy %	Residents	Staff	Other	Use (litres)		
							Per patient per day	Per bed per day	Per capita per day
Chris Hani	101 501	2 888	78	970	5 071		1 501	1 172	402.6
Johannesburg	60 016	954	90	1 420	3 599		2,330	2 096	335.9
Private Hospital 1	4 043	260	60	0	555		864	518	187.1
Private Hospital 2	1 668	202	74	0	210		372	275	152.6
Private Hospital 3	3 927	230	75	0	505		427	569	190.7
Prince Mshyeni	48 152	1 080	80	500	2 000*		1 857	1 486	470.9
Mseleni	13 048	190		146	400	700°	-	2 289	256.9
Manguzi	1 890	251		162	460		-	251	344.5

* Staff numbers estimated from average for other hospitals.
°The Mseleni scheme also supplies approximately 700 people outside of the hospital grounds via yard connections. This has been discounted in the per bed and per capita figures
The "Red Book" guidelines for water consumption in hospitals are between 220 and 300 litres per bed per day (CSIR, 2003). Only Manguzi and the second Private Hospital fall within this range.

In the course of this exercise to determine water consumption it was found that the municipal accounts themselves were not always a particularly useful tool for water management. It seems to be necessary for the institution staff to take readings themselves for reliability. This was not done in most cases and demonstrates that water management conservation is not seen as a high priority.

3.2.1 The use of water efficient devices within hospitals

State health care facilities would have been constructed and fitted with standard plumbing fixtures as dictated by the specifications produced by the Department of Public Works. At the private facilities, the Technical Managers have more discretion, but are still guided by public health legislation and policy. In order to install water efficient devices they need to be able to justify the cost and therefore are only likely to consider them as part of a refurbishment process.

In the other hospitals the Technical Managers were either aware of them, but had no reason to replace the existing fittings, or they were not aware that the fittings existed. In general, the three private companies that were contacted had no policy related to the installation of water efficient fittings, either for or against.

The study found that there is low usage of water efficient fittings in hospitals. The reasons included a lack of awareness of water efficient fittings and a lack of confidence as to whether they would operate satisfactorily and justify the increased cost of procuring them. Technical managers seemed to have little awareness of the availability of water efficient devices or the cost of the fittings. There was also concern and uncertainty expressed about the effect on the *legionella* risk and other health related issues. Probably the most significant barrier to the widespread adoption of water efficient devices is that water use efficiency is not afforded a high priority in hospitals. Very little attention is paid to water management in the public sector. Some attention is paid to reducing costs by ensuring that the billing is correct, but not through reduction in use. Some effort is made in the private sector. Water consumption is monitored on a monthly basis. Water saving projects are done and implemented only if found to be cost effective.

3.2.2 Estimating potential savings

One aspect of this study is to estimate what potential savings are possible with the use of water efficient fittings. Unfortunately very little measured data is available with which to make the necessary calculations. Hence some assumptions are made.

Flush valves are used predominantly to flush the toilet pans in the hospitals and these can be suitably efficient if set and maintained properly. In cases where cisterns are used other criteria must also be met if low flush mechanisms are retrofitted. The pan must be of a design that will clear efficiently with a small flush volume. Conformance to the SANS 1733 specification is necessary in this instance. The hydraulics of the waste system must also be able to transport the solids with the reduced flow volume.

However, from a water use reduction perspective changing the shower roses remains a reasonable option. Johannesburg Hospital is used as an example as most of the required information was available.

There are shower roses in the wards and in the Nurses Residence, and the calculation is based on replacing all of them. The flow rate for a shower rose depends on the setting chosen by the user, the type of rose and operating pressure. Some roses will deliver up to 50 litres per minute if the reticulation can deliver that volume. A reasonable flow rate for a standard rose, however, is 25 litres per minute. For the purposes of the calculation it is assumed that all patients and resident staff will all take one shower per day. The water tariff quoted is from the Jo'burg Water 2005-2006 tariff list.

Table 3.5: Parameters used to calculate water savings using low flow shower roses

Item	Value
Number of shower roses	433
Number of people showering (per day)	2 280
Standard shower rose flow rate (ℓ/m)	25
Low flow shower rose flow rate (ℓ/m)	10
Cost of new shower rose	R220
Cost of replacement roses	R95 260
Water tariff (R/kℓ)	R6.70
Length of shower (minutes)	5
Number of showers per person (per day)	1

The calculated water and cost savings are presented in Table 3.6 below.

Table 3.6: Projected savings arising from low flow showerheads

Type of Shower rose	Shower volume (ℓ)	Volume per day (ℓ)	Cost per day	Saving (per day)		Pay back time (days)
				Rands	Volume (ℓ)	
Standard	125	285 000	R1 909			
Low flow	50	114 000	R764	R1 145	171 000	83
50% values				*R572.85*	*85 500*	*166*

In this scenario, changing shower roses gives a saving of 171 kℓ per day, or 62 Mℓ per year. The financial saving is R1 145 per day, or an annual cost reduction of R418 180. The sum spent on water by the hospital is approximately R5, 5 million, so the projected saving is 7.6% of the water bill. Even if the rate of showering is halved the savings are still reasonable. In addition to the water supply saving there will be an approximately equal saving in sewerage charges, as well as a saving in energy charges as less hot water will be used.

3.2.3 Comparison to a UK benchmark

The performance of three South African Hospitals was compared to a United Kingdom benchmark. The Benchmark value (Table 3.7 below) is the median of the sample, and the Best Practice is the value of the first quartile line. The values are expressed as a function of floor area, as this was found to give a better correlation coefficient in the sample set than patient or occupant numbers. Unfortunately, in the published report there was no indication of what functions were included when determining the floor area.

Table 3.7: UK benchmarks for water consumption at hospitals. All values are m^3/m^2 floor area/annum

Category	Benchmark	Best Practice
Large acute or teaching hospital	1.66	1.38
Small acute or long stay hospital without personal laundry facility	1.17	0.90
Small acute or long stay hospital with personal laundry facility	1.56	1.24
For hospitals with central laundry facilities, add 8.2 litres per laundry article processed per annum		

Table 3.8: Comparison of water consumption with UK benchmarks

Hospital	Category	Annual consumption (kℓ) (less laundry)	Area (m^2)	Low Value	High Value	UK Bench -mark
Chris Hani	Large acute or teaching hospital	1 203 324	222 496 212 981	5.22	5.75	1.66
Johannesburg	Large acute or teaching hospital	720 192	378 634 353 185	1.90	2.04	1.66
Private 3	Small acute or long stay hospital without personal laundry facility	13 716	5 188	2.64	-	1.17

There are some reservations about the comparability of the results, due to the use of floor area as the variable function. However, the large difference in the apparent efficiencies between the South African hospitals and the UK benchmark supports deeper investigation into the seemingly poor performance.

3.2.4 Recommendations

Within the healthcare environment there is limited awareness of water efficient devices. Readily available information on device types and performance measures would assist the specifiers, architects and the decision makers in the hospital or healthcare group, such as Regional Technical Managers, Procurement Managers and consulting architects to select water efficient devices. This could be supported by the development and publication of local case studies relating specifically to the health care sector.

In the context of hospitals the fittings considered as water efficient were taps fitted with aerators, shower roses with a controlled flow of 10 litres per minute, dual flush toilets, low flush toilets and metering taps. There are other technologies available that can also be considered as water efficient, such as pressure control, water and energy efficient domestic washing machines and industrial dish and laundry washers. In many instances these are would only be considered as part of a comprehensive renovation.

As it was anticipated that most of the establishments would not have these fittings, data was also gathered so that a water balance could be generated. This would enable an estimate to be made of the possible water savings if water efficient fittings were installed.

The full hospital case study report is included in Appendix C.

Cape Town Hospitals and Water Efficient Basin Taps

During 2003 a number of provincial hospitals in the Western Cape were renovated. Water efficient basin taps were specified by the architects. However, the contractors did not follow the specification and installed conventional spouts instead. There was no attempt on the part of the client or the architect to ensure that the specification was followed. This shows that not only must water efficient devices be specified, but there must also be the will to see that the specification is followed.

3.3 Universities

3.3.1 Stellenbosch

A pilot study was undertaken on a bank of four toilets at one of the ladies hostels at the University of Stellenbosch between 1997 and 1998. A water meter was fitted to the bank of toilets and read for a period of fourteen days. Following this, the existing standard symphonic flushing systems in 12 litre cisterns were replaced with Demand Flush Systems[21]. Water consumption was measured for another 14 days to determine the water savings. It is interesting to note that at the time the toilets were introduced, the main concern for the University was a toilet maintenance issue (rather than a water saving concern).

[21] The Demand Flush is a simple water efficient device that replaces the standard flushing mechanism in the toilet. The toilet flushes only for as long as the user holds the handle down. This enables the user to control the amount of water being used to flush the toilet (Mr D. Stone, Aqua Smart Water Management, 2007).

Table 3.9: Water savings made on a bank of 4 toilets over 14 days (Lydia Hostel, Stellenbosch University, 1997)

	Standard flush (ℓ)	Multi-flush (ℓ)	Water saved (ℓ)	% saved
Volume used	24 093	9 807	14 286	59.3%

(Source: Mr D. Stone, Aqua Smart Water Management, 2007)

The amount of water saved was just over a thousand litres per day or around 250 litres per toilet per day.

Demand flush systems are often criticised for creating maintenance problems because while a user might perceive the toilet bowl to have cleared, the amount of water used may not be sufficient to also clear the pipes. Remembering that the university's main concern was a maintenance issue, it was reported that there were less maintenance issues with the Multi-flush systems than the standard toilet systems.

Following the success of the pilot undertaken in the Lydia Hostel, 32 toilets at the Irene Hostel where retrofitted with Demand Flush mechanisms and monitored for a period of 12 months. Over this period the hostel reduced its water consumption by 4.2 million litres (a saving of 38%) see Figure 3.2 below.

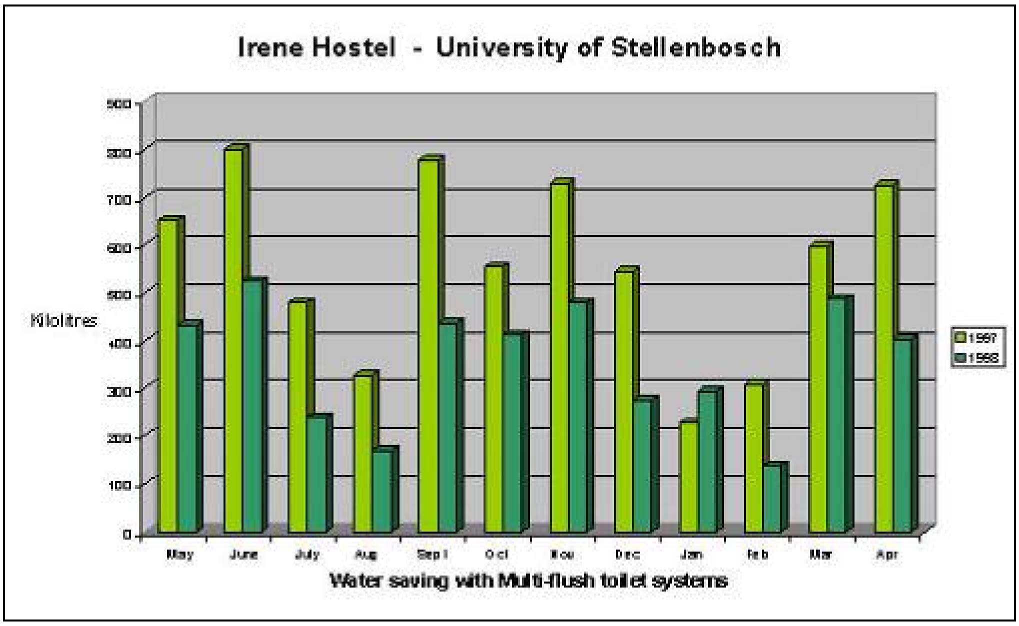


Figure 3.2: Water saving at Irene Hostel, University of Stellenbosch 1997 – 1998

(Source: Water Demand Management: The Household Water Audit Challenge Website).

The water savings made by the Multi-flush systems paid for the new flush mechanisms to be less than six months (Mr. D. Stone, 2007).

3.3.2 University of Cape Town

Six residences[22] at the University of Cape Town (UCT) installed Hippo Bags into the cisterns of all suitable toilets in May 2005. The Hippo Bags were given to the University by the City of Cape Town and are able to save between 2.5 and 3.5 litres per flush (Monday Paper, 2005).

In April 2006 the Veritas Residence was retrofitted with the Water Rhapsody Multi Flush toilet system[23], a demand type flush system. The main reason for targeting the Veritas residence was because of the bad quality of plumbing undertaken when the University converted the residence from a block of flats into student accommodation. Nonetheless, the installation of a demand flush toilet system has made a significant contribution to water saving in the residence (see Table 3.10 below).

Table 3.10: **Water savings made at Veritas Residence through the installation of Rhapsody Multi Flush (2005 - 2006)**

Month	Water (Bill in Rands)		Water consumption (kℓ/person/ month)		
	2005	2006	2005		2006
April	9 382	5 129	11.06		6.05
May	1 482	4 255	1.75		5.02
June	5 580	4 849	6.58		5.72
July	2 039	148	2.40		0.17
August	6 418	2 986	7.57		3.52
September	5 712	4 620	6.73		5.45
October	6 931	5 032	8.17		5.93
Total	R37 544	R27 019	Average	6.32	4.55

A number of automatic flushing urinals have been replaced around the campus with a Water Rhapsody multi flush system (pictured below) and the campus is also currently testing a waterless urinal. The University is satisfied with the waterless urinal and would like to begin a roll out process, retrofitting all the urinals on campus.

[22] The six residences are Rochester House, Groote Schuur Residence, Smuts, Fuller, Baxter Hall and Veritas.
[23] For more information on this system visit www.water_rhapsody.co.za

Figure 3.3: **An automatic flushing urinal retrofitted to be demand flush**

In order to ensure that the toilets were used correctly, an educational sticker was fixed to each unit.

Figure 3.4: Educational poster on opposite toilet wall (left) and sticker on Demand Flush toilet (right)

The executive director of Properties and Services indicated that the largest consumer of water on campus was irrigation. Measures have been taken to reduce the costs associated with irrigation including an attempt to harvest rainwater and recycle greywater. These measures have been abandoned because of odour problems emitting from the stored water.

The primary concern in terms of plumbing and the fitting of water using devices throughout the campus is operational and maintenance costs. Water (and the subsequent financial savings made as a result of fitting water efficient devices) does not appear to be a driving force behind the choice of plumbing fixtures on campus.

3.3.3 North-West University (formerly Potchefstroom)

North-West University (formerly Potchefstroom University) initially introduced water efficient shower roses in only two hostels. The RST showerheads were found to be water efficient, acceptable to the students and required less maintenance than standard shower roses. This has resulted in the university taking a decision to install the shower roses throughout the campus's six hostels. The university is also considering the installation of waterless urinals.

The university's maintenance department did measure the water savings during the pilot phase of the project and reportedly has figures to show the efficacy of the devices. Unfortunately this data could not be made available in time to be included in the report.

It is interesting to note that the motivation for the installation of the water efficient shower roses was in order to save electricity costs (associated with heating water) and not to reduce water consumption (Personal communication, maintenance department, Potchefstroom University).

3.3.4 The University of the Witwatersrand

The University of the Witwatersrand (Wits) introduced waterless urinals in 1997. The motivation for retrofitting the men's toilet facilities in some of the residences and the head office building was to save money (by reducing water consumption) and respond to the national request to save water and reduce water consumption[24].

After continuous complaints from users about odour problems, the suppliers upgraded the waterless and odourless urinals to the EcoSmellstop urinal in 2003. In addition the cleaning staff were also given demonstrations and received training on the correct cleaning procedure.

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[24] The installation of waterless urinals was the only plumbing retrofit made by the University as a response to the request to use water more efficiently. Other water efficient devices have not been considered (personal communication, the Maintenance Department, University of the Witwatersrand, 2006).

The situation in the more heavily used areas has not improved and the University still receives ongoing complaints about odour problems. Users are also reportedly concerned about the health implications if the urinals are not working properly. The University is now considering removing the waterless urinals and replacing them with traditional flush masters. This will be a costly undertaking for the University as the water pipe system for the original urinals has already been removed (personal communication, the Maintenance Department, University of the Witwatersrand, 2006).

3.4 Schools

Two schools are used as case study examples of schools that have implemented some form of water saving strategy. They are Hilton College in KwaZulu-Natal and President High School in the Western Cape.

Hilton College is an all boys, independent boarding high with approximately 500 boys housed in 7 different boarding houses. President High School is a day school in Parow.

3.4.1 Hilton College

Hilton College was approached by the manufacturers of waterless urinals to replace many of the existing automatic flushing urinals and push button urinals with waterless urinals. The waterless urinals were subsequently installed in several of the boarding houses.

However after two years, the waterless urinals were considered to be a failure because of odour problems. The schools maintenance department indicated that with assistance from the supplier, they tried to rectify the odour problem, but eventually decided to revert to flush urinals. The school is systematically reconnecting the water supply to the urinals and converting them back to push button urinals.

Figure 3.5: Waterless urinals converted to push button flush, Hilton College

3.4.2 President High School

The President High School in Parow (Western Cape) replaced the traditional toilet and urinal systems with Demand Flush systems and realised significant savings. The school measured accurately how much water they had saved after retro-fitting the water efficient devices, and found even after one year the financial savings were significant. They have reduced their average water consumption from 1200 kℓ per month to less than 300 kℓ per month, a water saving of around 75%. The school has also reported cost savings in the maintenance of their toilets and urinals (Personal Communication, Mr D. Stone)

3.5 Transport hubs

Two transport hubs were identified as areas where there is potentially a significant amount of water used; airports and service stations. It should be noted that for the purpose of this study water use was examined only as it was used directly by patrons and is therefore largely limited to water use in washroom facilities.

3.5.1 Airports

The Airports Company South Africa (ACSA) is the largest airports authority in Africa and operates South Africa's ten principal airports, including the three major international airports at:

- Johannesburg
- Cape Town and

- Durban.

The other seven are domestic airports of:

- Bloemfontein
- Port Elizabeth
- East London
- George
- Kimberly
- Upington and
- Pilanesberg

Together ACSA's 10 airports handle more than 200 000 aircraft landings and 23 million arriving and departing passengers annually (ACSA, 2005). ACSA was approached and asked to supply water consumption figures, number of passengers along with details of water efficient devices installed at the airports. Information from the three international airports has been promised but only water consumption figures from Cape Town airport has been received so far. The monthly water consumption for Cape Town airport (the average over 2005) is 16 877 kℓ, with the average number of passengers per month (average over 2005) is 561 558. From these figures, the average water consumption works out at 30 litres per passenger using the airport.

Johannesburg airport has infrared sensor operated taps and urinals. No water usage figures have been obtained.

3.5.2 Service Stations

Ten service stations in KwaZulu-Natal were visited and the restrooms were assessed for water efficient devices, and where available the manager was interviewed. The only water efficient devices found were demand flush urinals which were installed in four of the service stations.

The head offices for Engen and Shell South Africa were contacted and information regarding water efficient devices, environmental management systems and

Waterless Car Wash

Often associated with service stations is the presence of a carwash service. Water usage at a carwash can be reduced or non-potable water can be used or NO WATER can be used. Australia has an innovative NoWet waterless car cleaning system. For more information go to: http://www.nowetcarclean.com.au/

water consumption figures were requested. The findings are presented below.

3.5.2.1 Shell Service Stations

Almost all of the Shell services stations are franchised and therefore the head office has no authority to dictate the types of water use devices installed at the service stations.

In selecting the water fitting's durability the architect indicated that durability is considered to be the most important factor. The fact that there are only two toilets and at an average service station (not an Ultra City) the public washroom facilities would not be used that often, so water use is relatively low and as a result fitting water efficient devices was not seen as a priority. Service station owners would have discretion to retrofit but it is unlikely that this will be seen as worthwhile (from a financial perspective) because the low usage would not result in a quick return on investment (Personal Communication, Architect responsible for Shell service station design, 2006).

The Shell Ultra City stations are of greater interest. These are large stops that include a large number of toilets, a restaurant and sometimes even shops. There are 31 such service centres positioned along the major transport routes across the country. It is clear from using these facilities that the use of water efficient taps is gradually becoming common, but low flush or dual flush toilets are still rare.

3.6 Shopping malls and the hospitality sector

After several interviews with operation managers from shopping malls and hotels it was realised that unless there is a wider water conservation and energy efficient strategy in place within the operation then the use of water efficient devices is unlikely. There are a number of environmental management systems and guidelines available for commercial operations to implement. Two such systems are described; the ISO 14000 which is an internationally recognised environment standard system applicable to most commercial operations and the South African based Heritage Environmental Rating Program aimed specifically at the tourism industry in South Africa.

3.6.1 ISO 14000

The Organization de Standards International (ISO) sets standards for a wide range of products and management operations to ensure actions and processes are carried out in a correct and uniform manner. *ISO 14000* is a standards series for environmental management. The five areas that are addressed as part of the ISO 14000 are:

- Environmental Management Systems (ISO 14 001)
- Environmental Performance Evaluation
- Guidelines for Environmental Auditing (ISO 14 010)
- Life Cycle Assessment (ISO 14 040)
- Environmental Labelling

The three elements to an Environmental Management System (EMS) to be compliant with ISO 14000 standards are:

- A written program
- Education and training
- Knowledge of local and national environmental laws

Environmental performance is measured by quantifying the impact a business is having on the environment. This is determined by an inventory of current impacts and by identifying areas for improvement.

Best Practice: Water recycling at Truworths Head Office (Cape Town)

A sustainable water use system has been implemented at the head office and distribution centre for Truworths.
In 2005, WSP Facilities Management identified the car wash bay, plant watering systems and toilets as areas where recycled water could be used in the toilet flushing system, the car wash and plant sprinkler systems.
Measurement of the seepage water in the basement showed that 1 000 ℓ/h, the equivalent of 24 000 ℓ/day, and possibly more in the winter months was being pumped to waste. WSP found that, on average, the consumption of the building was 32 000 ℓ/day and that of the car wash was 6 000 ℓ/week. Most of the fresh water, some 80%, was being consumed by the toilet flushing system.
A combination of seepage water and recycled water was used to dramatically reduce the building's municipal water consumption.
(Source: Water Sewage & Effluent Bulletin, 2 May 2006. Bulletin #4)

An environmental audit is a routine evaluation of a company's environmental controls conducted by an independent third party. The ISO 14000 also has standards to help reduce the impacts products have at each stage of its life cycle i.e. during manufacturing, operation and disposal. The ISO 14000 system also encourages environmental labelling so that consumers are informed of the impact each product has on the environment.

It is beneficial for companies to implement ISO standards as it results in the reduction of operational costs, environmental impacts, it leads to more favourable insurance rates and helps develop a positive image of the company with consumers and shareholders (Kinsella, 1994).

3.6.2 Heritage Environmental Rating Programme

The Heritage Programme has been developed in the South African tourist industry and its aim is to reduce and limit the impact that tourism industry operations have on the environment. The introduction of Heritage follows research into seven international environmental initiatives and incorporates recognised ISO 14000 systems and other accepted audit and benchmark practices.

The Heritage Environmental Rating programme offers Silver, Gold and Platinum Classification to operators in regard to best practices in the management categories:

- Noise Management
- Energy Management
- Water Management
- Waste Management
- Air Quality Management
- Chemicals and Pesticides Management

(Heritage, 2006)

The Heritage Silver rating acknowledges the efforts and changes made by operators to their business practices. Heritage Gold recognises those businesses that observe higher than average standards of environmental awareness and Heritage Platinum represents those operators and businesses that practice exceptional environmental standards (SCC, 2002).

Once an establishment has reached the Heritage Platinum level, for an additional fee, it is eligible to qualify for accreditation by either the Green Globe organisation or the International Hotels Environmental Initiative (SCC, 2002).

The criteria for assessment and certification for the water impact management section of the rating programme includes effective steps being taken to reduce water utilisation and water usage monitoring being carried out. The water management criteria are more stringent as the operator progresses from silver through to platinum status.

Initial improvements can be made without any capital outlay by the hotel. These include:

- Reducing toilet flush volumes by adjusting the setting from 12 litres to 9 litres
- Measuring and recording water use
- Encouraging guests to use less water through signage e.g. suggesting showering instead of bathing

The environmental consultants suggest that on average 7% water saving is made from this first stage and with that money water efficient technologies such as dual flush toilets can be purchased, and this will reduce water saving even more.

There are currently 53 hotels in South Africa engaged in the Heritage Environment Programme of which 80% did not have any water saving measures in place before commencing with the programme (Dickinson, 2006).

3.6.3 Examples of Hotels which have successfully implemented best practices

Of the 53 hotels involved in the Heritage Environmental Programme several have been leaders in implementing best practices in water management, which has resulted in large savings in water usage, improved environmental conditions surrounding the hotel and reduced hotel operating costs. Some examples of best practices implemented are given below.

3.6.3.1 The Wild Coast Sun, Port Edward, Eastern Cape

The Wild Coast Sun has achieved Gold Class with the Heritage Environment Rating Programme. The hotel is situated within 750 hectares of natural bush between the Umtamvuna and Mzamba rivers, overlooking the Indian Ocean. Due to previous problems with the water treatment facilities at the resort, detrimental levels of wastewater were being returned to a closed lagoon system. This has now been stopped and all wastewater now meets internationally accepted levels of quality. The result has been a noticeable return of waterfowl and other birdlife to the lagoon. Wastewater from the hotel is used for irrigation of the hotel property and to a certain extent, the golf course as well. The irrigation system has been enhanced by the installation of timers which have reduced the overall water consumption of the resort.

3.6.3.2 The Michelangelo Hotel, Sandton, Johannesburg

The hotel has achieved Gold Class with the Heritage Environment Rating Programme and has implemented energy efficient practices along with improved water management. The hotel installed independent water meters and implemented water use monitoring and reporting which resulted in savings of more than R23 000 per month. The water pressure was adjusted in certain areas of the hotel which also resulted in water savings.

3.6.3.3 The Sandton Convention Centre, Sandton, Johannesburg

After discussions with the Heritage environment consultants the convention centre installed cut-off switches on the kitchen cyclowash extractor systems. The systems switch-off automatically after two hours to conserve water and energy, and if needed, the chef and staff simply restart the systems for a further period by engaging the switch. Previously the extractor systems had run continuously but with the introduction of cut-off switches the water use in the kitchens has been reduced by 75%. The convention centre also began monitoring the water use of the pumps and cooling systems more effectively with the result that the centre has been able to reduce overall water consumption by 30%. The centre has gold status with the Heritage Programme.

3.6.3.4 The Rosebank Hotel, Rosebank, Johannesburg

The hotel began monitoring and reporting on water use and discovered that water supplied to them was being used by adjacent properties. By stopping this practice the hotel has saved R20 000 a month. The hotel has gold status with the Heritage Programme (Heritage, 2006).

3.6.3.5 Bakubung Lodge, Pilanesberg, North West

The lodge has gold status with the Heritage Programme. Grey water, obtained from the water purification plant that is operated by the lodge, is used for irrigating the property. The waterhole that is situated at the front of the hotel is filled automatically in response to the requirements of the wildlife, and this helps to prevent run-off.

3.6.3.6 Ezulwini Sun, Ezulwini Valley, Swaziland

The hotel had a Heritage gold rating and with the introduction of regular monitoring and volume management has reduced overall water consumption in the resort. The hotel has made changes to the water treatment facility it operated. This has resulted in greater use of grey water from the sewage facilities for irrigation of the resort and golf course. The hotel is now less dependent on boreholes on the property. The wastewater quality from the resort has also improved, which has eliminated the health risk posed to local communities that live downstream of the resort's wastewater treatment plant.

3.6.3.7 Sun City Hotels, Pilanesberg, North West

The following hotels at the Sun City resort have achieved Heritage gold status:

- Cascades Hotel
- Sun City Cabanas
- Palace of the Lost City
- The Sun City Hotel

The resort has the following water efficient devices installed:

- Flow restrictors in showers, in 234 Cascades rooms
- Timed water taps in public areas
- Use of raw (rain) water and grey (treated) water for irrigation
- Moisture meters as part of our irrigation system
- Toilet flow restrictors

The latest project is the installation of meters to monitor water usage across the complex. This is a costly and extended project as approximately 70 primary, secondary and tertiary meters are being installed. The Environmental Officer for the resort, Isobel Swart, expects to have statistics available within the next 18 months, based on readings from this extensive metering network.

3.6.3.8 Southern Sun Hotels

The Southern Sun group of hotels is ranked in the top 50 in size worldwide and consists of over 80 hotels and includes the following brands in South Africa:

- Southern Sun Hotels
- Holiday Inn
- Garden Court, and
- Intercontinental Hotels.

In the Southern Sun Hotels 'Corporate Citizen and Sustainability Report 2002' several commitments were made towards monitoring resource use and implementing water resource conservation programmes.

The water consumption in each Southern Sun Hotel is measured regularly and is reported on a quarterly basis as part of the company's non-financial sustainability reporting. The figures for the financial year ending 31 March 2002 are used as the initial benchmarks of the company's performance. Figures obtained from the hotel group's baseline environmental audit in December 2000 show that the average consumption of water per room-night sold was 0.9 kℓ.

The objective regarding resource use stated for 2002-2004 in the Corporate Citizen and Sustainability Report 2002 was to 'focus its natural resource preservation efforts on reducing water and electricity usage in all properties. Investigations will focus on best practice in all hotels to identify the potential for improvement.'

To implement the above objective each hotel in the Southern Sun group was required to formulate a water conservation policy which is audited on a frequency of six months as part of a wider environmental management plan which includes the following six areas:

- Waste management
- Effluent and emissions
- Energy, water and resource conservation
- Product purchase and use

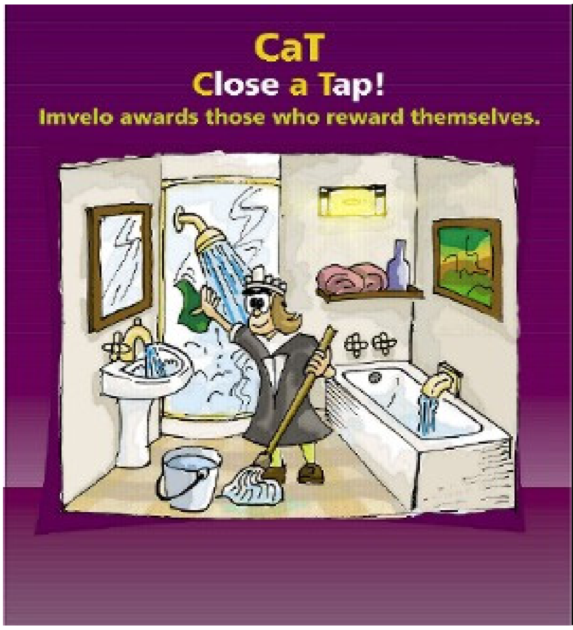
- Hazardous materials
- Socio-economic impact

In terms of water management this has meant that some of the hotels have fitted aerated taps and dual flush toilets and where the hotel has its own water treatment plant the greywater is reused where possible.

The group of hotels has a central development programme that retrofits aerated taps and dual flush toilets. Coupled with this is an education program for hotel staff on water use.

In the majority of Southern Sun hotels the laundry is outsourced and the partners are encouraged to be part of the water saving program. The Southern Sun resource saving program has been in place for 4 years and is ISO 14000 compliant. The majority of hotels met the initial target of reducing the water consumption by 5-10%, which in turn has seen a reduction in operating costs.

An example of this policy is at the Elangeni Hotel in Durban where the hotel has fitted aerated taps in all the rooms, pulsating shower heads and set the toilet flush to a minimum volume. The hotel has procedures in place where preventative maintenance is carried out and has a reporting system for leaks. The maintenance manager of the hotel, Mr. Leon van der Westhuyzen, says that the water efficient devices in the hotel do not require more maintenance than standard sanitary ware.



The Imvelo Awards

The Imvelo Awards are made annually to tourism ventures that are involved in sustainable practices. In 2002, Sun City won the Best Practice award for an Accommodation Establishment. Part of their environmental strategy includes recycling water (up to 2 million litres of water per day). Sabi Sabi was the winner in the category Best Water Conservation Programme. Each of the reserve's lodges has a wetland used to treat the wastewater generated by the lodge.

3.6.4 Shopping Malls

Ten shopping malls were visited in the Greater Durban and Pietermaritzburg area and a number of other malls were surveyed using e-mailed questionnaires and telephone calls. The water efficient devices identified in each of the malls are listed in Table 3.11.

There are no water efficient devices currently in either the Musgrave centre or the Berea centre. This can be partly attributed to the age of the buildings. However, major refits for both shopping malls are planned in the next 18 months and the operation manager of each mall is confident that water efficient devices will be installed. Eastgate shopping centre underwent a refurbishment in 2004 and installed aerated taps. The mall's next refurbishment would not be for another 8 to 10 years and therefore there are no plans to retrofit with any other water efficient devices in the near future.

The Pavilion in Westville was the only shopping mall visited that had water efficient devices other than demand flush urinals. According to the Operations Manager, Andrew Moller, censor flush urinals have been installed for five years and low flush cisterns for six years. The urinals flush when the user moves away from the urinal. When the devices were installed they made a noticeable reduction in water consumption (although no figures were available for analysis). The maintenance manager said that the censor flush urinals require minimal maintenance and that they are guaranteed for 10 years. The only problem is they have to keep a stock of censors as they are imported form Germany and take 6 weeks to arrive.

The Killarney Mall is currently testing a censor flush urinal. The test urinal is reported to be working well and the maintenance manager would like to install additional censor flush urinals in the future. The expense of the urinals was cited as the reason for the delay in the retrofit.

Menlyn Park, the largest shopping mall in South Africa currently has no water efficient devices installed and would only consider doing so if there was some incentive or proven financial benefit to doing so.

Table 3.11: Water efficient devices used in a selection of shopping malls

Name of mall	Area	Water efficient devices	Details of water efficient devices in the mall	Water efficiency in landscaped areas
Liberty Midlands Mall	PMB	√	Demand flush urinals	
Gateway	Umhlanga	√	Demand flush urinals	Grey water used for water features
Scottsville Mall	PMB	√	Demand flush urinals	
Musgrave Centre	Durban	None		No gardens
Berea Centre	Durban	None		No gardens
The Workshop	Durban	√	Demand flush urinals	
Northway Mall	PMB	None		
Pavilion	Westville	√	Low flush cisterns, censor flush urinals	Indigenous plants
Davenport Centre	Durban	√	Demand flush urinals	No gardens
Cascades	PMB	√	Demand flush urinals	
Eastgate	JHB	√	Aerated taps	Borehole water
Montecasino	JHB			
V&A Waterfront	Cape			
Killarney	JHB	√	Censor flush urinals, borehole water used for air-conditioning units	Gardens currently being developed
Woodlands Boulevard	Pretoria	√	Censor flush urinals, censor taps, dual flush toilets	Did not know
Menlyn Park	Pretoria	None		None

Other innovative management practices which help to reduce water consumption at various malls include:

- Routine and systematic leak testing (The Woodlands Boulevard)

- Borehole water used for air-conditioning (The Killarney Mall).

The water (and cost) savings are thought to be significant. The maintenance manager would like to be able to use the borehole water for flushing toilets, but is unsure about how to go about this.

From the summary table (Table 3.11 above) there appears to be no consistency in the types of water efficient devices installed at malls owned and managed by a specific property developer. Therefore Liberty Properties and Old Mutual were contacted to establish if there was a company policy about water efficient devices.

3.6.4.1 Liberty properties

The Head Office and project development team take into consideration water efficiency when designing new malls or refurbishments. However, there are no set minimum standards in terms of the types of fittings or other water saving strategies applied uniformly across Liberty Property developments. It also became apparent that some of the malls might not be aware that certain plumbing fittings are water efficient devices. At one particular mall the Head Office reported that more water efficient devices had been installed than indicated by the mall.

3.6.4.2 Old Mutual Properties

Old Mutual Properties have no standards regarding the installation of water efficient devices or other water management strategies. However, there is a concerted effort to make developments more utility friendly. Factors that influence the use of water efficient devices include:

- Availability of proven and tested products
- The capital cost, maintenance cost and the life cycle of the products
- The cost recovery period if water efficient devices are more expensive than standard products
- Public perception and user-friendliness

In terms of landscaping, there has been a move towards more indigenous planting, particularly in the Cape, but landscaped areas are important in terms of the theme of the development and this heavily influences plant choice. Short-term solutions to water shortages would be to use bark or other ground cover material to minimise water loss.

Existing water reticulation systems frequently mean that using grey water for air-conditioning cooling towers or landscaped areas is too costly. The cost recovery period associated with re-using grey water makes it difficult to justify the initial capital expense. At the Gateway centre, water from the air-conditioning unit is stored in tanks in the basement, treated and then re-used in the water features.

50% of water use in a mall is reported to be for the air-conditioning system. Large volumes of water can be saved by altering the operating times of the air-conditioning units (which reduces the evaporation from the cooling towers) and the number of cycles.

If water restrictions are imposed in an area, malls would typically:

- Change standard taps to aerated taps
- Place notices appealing to the public not to waste water
- Service the Flush masters to ensure they are set correctly
- Mulch gardens
- Alter/reduce air conditioning operating times.

3.7 Sports and Recreational facilities

3.7.1 Virgin Active Green Gyms

The Virgin Active Lifestyle and Fitness Centres have recently begun working with the Sustainability Institute of Stellenbosch and Biotol Industries to create “Green Gyms”. Table View in Cape Town is being used as pilot and technologies to reduce both water and energy consumption are being explored.

Swimming pools are the greatest user of water within the gyms and the gym is currently piloting the use of grey water from the swimming pool being used to flush the urinals and toilets. Aerated shower heads and taps as well as waterless urinals have been fitted. However, patrons have complained about the waterless urinals and these will be removed. Water consumption figures are being kept which will enable management to assess the significance of the savings and the successfulness of the pilot.

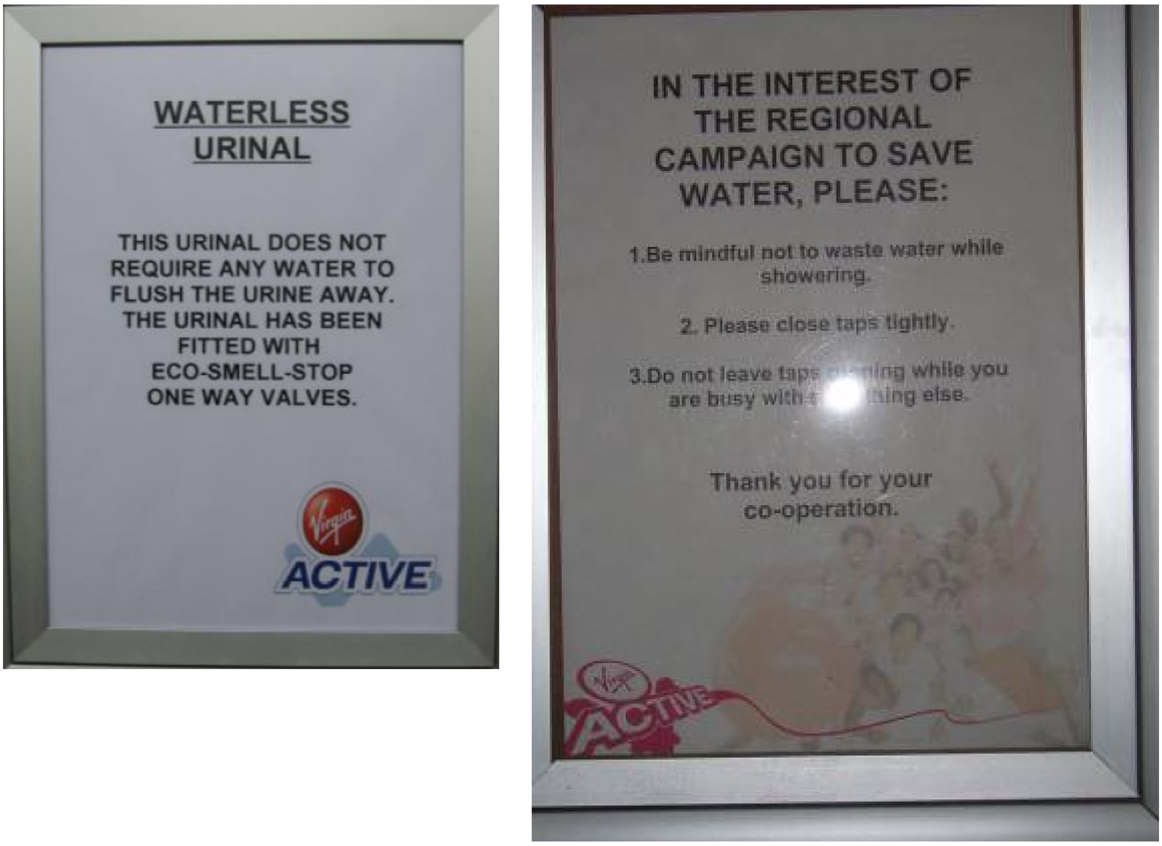


Figure 3.6: Posters on display in Virgin Active gyms in the Western Cape

3.7.2 The Royal Golf Course, Johannesburg

Johannesburg's oldest golf course started implementing a variety of environmental projects in order to achieve Audubon Certification. One of the requirements for certification is water conservation and water quality management. The Golf Course obtained its certification as an Audubon Co-operative Sanctuary Programme in 2006 (Audubon, 2007) and is the only South African Golf Course to have this accreditation.

The Audubon Co-operative Sanctuary Program (ACSP)
The USA based program aims to provide environmental information, guidance and support to golf courses world-wide. ACSP operates a certification process for golf courses meeting high environmental standards. The six categories include Water Quality Management and Water Conservation. See www.audubonintternational.org

Water conservation strategies include supplementing general irrigation of the greens with hand-watering when necessary. The remainder of the course is watered at night to reduce evaporation. Increased water flow onto the course (as a result of urbanisation) is now being stored and pumped to all areas of the course. Water retention ponds hold water for irrigation and act as hazards for the golfers (Knoll, 2004). The green keeper reported that irrigation of the golf course was increasingly done based on information obtained from the weather station and by visually looking at the course rather than by automated irrigating and pumping systems.

The clubhouse facilities do not include water efficient devices in either the changing rooms or kitchens.

3.7.3 The Pezula Golf course and the Sparrebosch Estate

Irrigation of the golf course had to be done in such a way as not to disturb the indigenous fynbos. A closed system was installed in which the drainage system recycles the irrigation seepage back to the irrigation dams. Most of the irrigation water is recycled sewage from Knysna, supplemented by borehole water and when necessary municipal water. The gardens are planted with indigenous plants selected from a list of locally occurring species (Avierionos, 2004).

3.8 Zoological Gardens

3.8.1 National Zoological Gardens of South Africa, Pretoria

The National Zoological Gardens of South Africa were founded in 1899 by Dr Gunning. The Zoo is on an 80 hectare plot and houses numerous mammals, fish, invertebrates, reptiles and amphibians and includes both an aquarium and reptile park. The Zoo receives approximately 600 000 visitors per year.

Following the success of a project to reduce energy consumption at the Zoo, the Pretoria Zoo signed a contract with a company to assist them in similarly reducing their water consumption.

Currently the use of water efficient devices is limited. However, as ablution facilities are upgraded, where water pressure permits, Flush master toilets are being fitted and water leak testing is conducted on a regular basis.

3.8.2 Zoological Gardens, Johannesburg

The Johannesburg Zoo was established in 1904 and historically has been owned and operated by the City of Johannesburg and registered as a Section 21 (Not for Profit) organisation. The Zoo encompasses an area of 54 hectares and is home to 2 070 animals of various species.

The Johannesburg Zoo is the first Zoo in Africa to join the HERITAGE Environmental Rating Programme, having received Silver Class status with the programme since 2004.

In order to operate a more environmentally responsible facility and reduce expenditure on water, the Zoo implemented a strategy to reduce water consumption. Savings are estimated to amount to R2.4 million per year.

The following water saving devices and strategies are being implemented at Johannesburg Zoo:

- Ablution facilities at the Zoo are fitted with low flush toilets and push button taps to save water.
- Leaking taps and drinking fountains have been repaired.
- In part assisted by the introduction of water meters on all public facilities to ensure efficient and correct billing from the council.
- Irrigation is done at night time and sprinklers are on a timed system.
- Water pipes are being replaced to reduce the amount of water lost to leaking pipes and the number of pipe bursts.
- Eradication or repairing of leaking moats associated with some of the older exhibitions.
- A comprehensive water recycling programme has been introduced to reduce the amount of potable water used for irrigation purposes .

Santa Barbara Zoo

75% of the Zoo's water is reclaimed water. Between 2001 and 2004 the amount of reclaimed water used by the zoo rose from 19 million to 23 million litres per year, mainly due to the introduction of additional water conservation practices that reduced potable water demand (Source http://www.bren.ucsb.edu).

The water recycling programme produces sufficient water to irrigate half of the landscaped areas, with the remained being irrigated from a borehole (Source: Endangered Wildlife Trust, 2005)

3.8.3 Tygerberg Zoo, Cape Town

The Tygerberg Zoo has reduced its municipal water consumption significantly, by sinking another borehole. Animal drinking troughs are fitted with automatic switch off valves to prevent them overflowing. The toilets flush only for as long as the handle is held down. Irrigation is done early in the morning and late in the evening to reduce evaporation.

3.8.4 Table Mountain Cableway

Table Mountain National Park (TMNP) is one of Cape Town's busiest tourist attractions, receiving on average 15 000 visitors per day. Most visitors choose to take the cableway to the top of the mountain where there are designated walk ways, restaurant the curio shop facilities.

In order to minimise the environmental footprint of the visitors, the toilet facilities are almost waterless and consist of Jet-o-matic[25] chemical recycling toilets and waterless urinals[26] , as shown in Figure 3.7. Taps in the hand basins are sensor operated to reduce water wastage. In addition there is educational material on the walls of the ablutions highlighting the need to conserve water and how some background on the low-water and waterless toilet facilities provided.

Figure 3.7: A typical container toilet (left) and waterless urinal (right) found at the tourist ablution facilities on Table Mountain

[25] The Jet-o-matic chemical recycling toilet operates in the same principal as systems on passenger aircraft, using chemicals to control odours. A mix of water and chemical liquid sit in the tank below the toilet pan. The flush water is drawn from this container through a filter (to exclude solids). The model uses compressed air power for the flush mechanism.
[26] The waterless urinals have a liquid seal.

However, ablution facilities provided for the staff working are not as water efficient. The toilet is a single flush toilet (see Figure 3.8 below).

Figure 3.8: Staff flush toilet facility, Table Mountain Cableway

It is useful to compare the water usage from the one staff flush toilet (used by staff) and the chemical toilets. Table 3.12 (below) records the average weekly water consumption recorded over the period May 2004 to March 2007. The weekly consumption per staff member is 925.5 litres compared with just 0.17 litres per visitor.

Table 3.12: Average weekly water consumption recorded for flush toilet and chemical toilet block

	Average weekly consumption		Used by
Flush toilet	1 851	Litres	2 staff
Consumption / staff	925.5	Litres	
Chemical recirculating toilets*	2 618	Litres	All visitors
Average Visitors per week	15 374	People	
Consumption / visitor	0.17	Litres	

* This consumption includes all the water used for the cleaning and the wash basins

In addition to the facilities at the top of Table Mountain, the TMNP is also responsible for the toilet facilities at Signal Hill and Silvermine. At both these locations Enviroloos[27] have been

[27] An Enviroloo is a modified pit latrine in which urine and faeces are separated. Each toilet is fitted with a ventilation pipe that aids in drying out the faecal matter and preventing bad odours.

installed, however they are not being well received by the public. This is not because of the toilets as such, but rather because of the poor maintenance. Staff employed at Signal Hill said they do not have water for cleaning the toilets. There is water in a small tank that supplies the hand basins and water is tankered in.

Figure 3.9: The Enviroloo ablution block at Silvermine

Figure 3.10: A poorly maintained Enviroloo at Signal Hill

3.8.5 South African National Biodiversity Institute (SANBI)

The South African National Biodiversity Institute (SANBI) has installed waterless urinals at the Kirstenbosch Botanical gardens and is happy with their performance to date.

4 MUNICIPAL EXPERIENCE WITH WATER EFFICIENCY AND WATER SAVING

There are four broad strategies to reduce water consumption amongst domestic users:

- Structural methods
- Operational methods
- Economic methods
- Socio-Political methods (Flack, 1981).

Implementing these methods of demand management in South Africa poses significant challenges for municipalities. Operational methods are hampered because of sometimes dilapidated municipal water mains and rusting steel pipes largely as a result of poor maintenance of water reticulation systems. Economic methods of reform are only marginally successful because of an entrenched culture that water should be free and a historical resistance to paying for services that became established during the apartheid years. (http://www.watergy.org/activities/countries/southafrica/southafrica.html).

This chapter begins with a detailed review of water saving measures in the City of Windhoek, Namibia, which is regarded as a successful example of good practice in this regard. It then moves on to South African case studies, namely Cape Town, Hermanus, Soweto and Emfuleni.

4.1 Namibia

Until Namibia's independence in 1990, Namibian water legislation was governed by The South African Water Act 54 of 1956. The Water Act undervalued the cost of water for most citizens, leading to the general perception that water is a cheap and abundant resource. Namibia's independence from South Africa provided the opportunity to review the current policies and to rewrite existing legislation, including the Namibian Water Act (Schachtschneider, 2001).

The manner in which water demand management systems have been drafted and implemented in Namibia is often cited as the "best practice" of water demand management for Southern Africa. A review of water regulations and demand management strategies implemented in Windhoek is detailed below as a case study.

Namibia is 824 116 km^2 in extent and is characterised by low rainfall (ranging between 15 and 700 mm per year) and limited freshwater resources (UN 2004). Of this limited rainfall, estimates suggest that 83% evaporates soon after it falls, 14% is lost through evapotranspiration, 2% can be captured and stored and only 1% recharges groundwater sources (Eales et al., no date).

Namibia's urban centres are situated far from its perennial rivers, which makes it largely dependent upon temporary rivers and ground water for urban consumption. Concerns have been raised that the current levels of groundwater use are not sustainable (LaRRI, 2004)

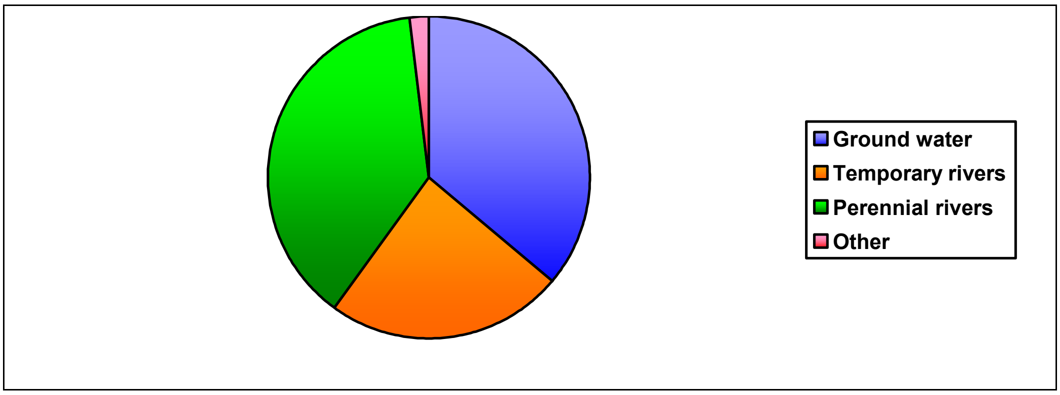
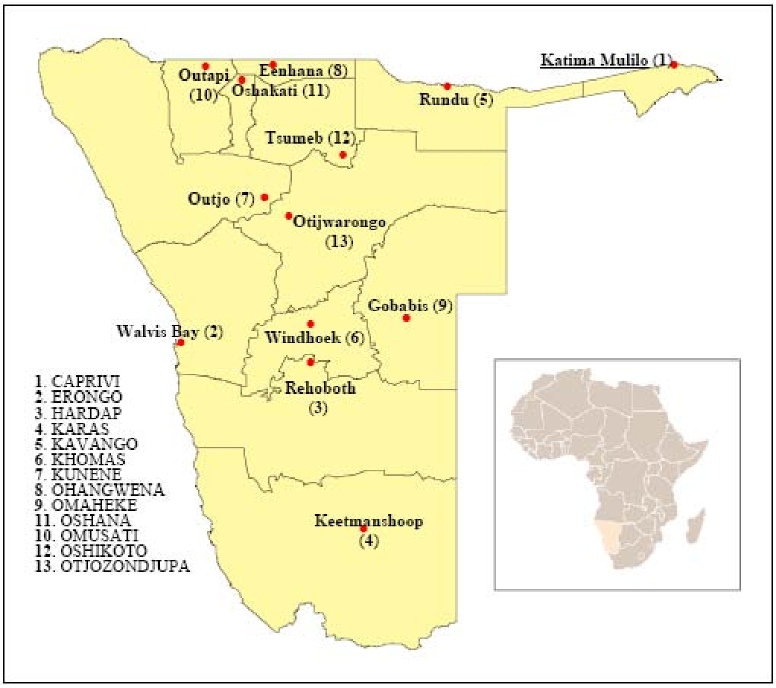


Figure 4.1: The contribution made by different water resources to Namibia's Water Supply (Source: After LaRRI, 2004).



Administratively, the country is divided into 13 regions, each managed by a Governor and a Regional Council. Windhoek is the capital of Namibia and is situated in the central highlands.

Figure 4.2: Namibia's Administrative Regions
(Source: UN, 2004)

4.1.1 Namibia's Water Policy

The South African Water Act 54 of 1956 was replaced by Model Water Regulations promulgated in 1996 and the Namibian Water Corporation Act 12 of 1997. This act led to the establishment of NamWater[28], and clearly provides for its powers, duties and functions. In 1998 the Namibian Government launched a review of the manner in which water was being managed. The outcome of the review process was the National Water Policy. This policy, adopted in 2000, will form the basis of a new Water Act more suitable to Namibia's particular circumstances.

The Policy developed in 2000 supports the implementation of Water Demand Management strategies, in that:

- Government will be the custodians of all water resources and will have the right to control all water use and disposal.
- Integrated supply and demand planning is required in both the short and long term.
- The Policy promotes sustainable water utilisation through appropriate pricing, promotion of water efficient technology, public information and awareness programs, information sharing and co-operation between parties, the promotion of wastewater reuse and active support of research and data gathering on water conservation.
- Consideration is given to the establishment of an environmental reserve.
- Catchment management is provided for.
- The establishment of Namibian water quality standards will be very important for wastewater reuse (Schachtschneider et al., 2002).

Until the formal adoption of a new Water Act, the NamWater Act of 1997 governs current water distribution and pricing. The 1997 Act specifies that NamWater bulk water supply must be operated on a full cost recovery basis (i.e. water is priced at its true cost to include operational and maintenance costs) and provide water at an affordable rate to the consumer. In order to

[28] Namibia Water Corporation (NamWater) was established as a wholly-owned government corporation following restructuring in the Ministry of Agriculture. NamWater took over the activities and services of the Department of Water Affairs (within the Ministry of Agriculture). The rationale behind its establishment was to save the government money. As Helge Habenicht, the CEO (who was brought in from Germany on a contract to manage NamWater) explains, the government had no idea of who it was subsidising and who it wasn't (interview: 30/09/99). It became apparent that it was losing money through subsidising the price of water for big business and municipalities, and this was by default rather than policy approach. Furthermore, while the Department of Water Affairs was responsible for billing for bulk water consumption, money was paid into and received by the Treasury, which meant that it became very difficult to know whether the cost of water was actually being recovered. For these reasons NamWater was established in 1997 with the task to manage the country's water resources, provide bulk water supply to customers, provide facilities and lease rights, and operate, manage and maintain the country's bulk water works.

Municipalities now have to pay NamWater directly for bulk water supply while the Ministry of Agriculture pays for the price of water for rural communities and currently recovers about 40% of these costs. The Ministry intends to move towards full cost-recovery and plans to have this policy fully implemented by 2010 (Interview with Helmut Angula, Minister of Agriculture, Water and Rural Development, 31.01.2002).

Shortly after NamWater was launched, the company announced that it would increase the price of bulk water by up to 20% annually for the coming 5 years. As a result, municipalities increased their tariffs to consumers accordingly resulting in large price increases for this commodity. (Source: Labour Resource and Research Institute, LaRRI, 2002) achieve full cost recovery, NamWater has implemented a volumetric tariff rate in which the capital costs associated with water service delivery are included in the tariff. Tariffs are reviewed annually and once approved by the Board of Directors and cabinet are published in the government gazette. This process of reviewing the water tariff on an annual basis is criticised by some sectors because it is non-participatory and not open to public scrutiny (LaRRI, 2004). Table 4.1 below highlights the tariff increase between 1995/6 and 1999/2000, with the cost of water increasing by N$1.27 or 106%.

Table 4.1: Weighted average of existing and full cost NamWater tariffs

	1995/6	**1996/7**	**1997/8**	**1998/9**	**1999/2000**
Tariff	N$1.20†	N$1.50	N$1.63	N$2.26	N$2.47
Full cost tariff*	N$2.36	N$2.36	N$2.96	N$2.41	N$2.65
% Cost recovery	51%	64%	55%	94%	93%

(Source: The Office of the President (no date) *Government Gazette, No. 1883, and NamWater Finance Division correspondence.*)

Definition of full cost has changed over the years. The Table uses the weighted average tariffs derived from the gazetted tariff schedule for 1997/8, 1996/7 and 1995/6. For 1998/99 and 1999/2000 tariffs have been quoted from the Finance Division at NamWater, with that for 1999/2000 being a 10% increase on N$2.41 for 1998/99.

† Note: N$1 = ZAR1.

Such increases in water tariffs are indicative of success in terms of full cost recovery. The government position on full cost recovery is positive, the official Ministry of Agriculture, Water and Forestry website states:

> "The near achievement of full cost recovery indicates that financial involvement of the government in the bulk water sector is being reduced, releasing valuable and scarce funds for other national concerns. The introduction of full cost recovery for bulk water supply will also have beneficial effects on the efficiency of water usage, financial sustainability of the water sector and environmental sustainability of Namibia's scarce water resources".

However, it is less clear whether the objective of providing water at an affordable cost to the consumer has also been achieved. Between 2003 and 2004 there was a 2.3% drop in water sales (coinciding with a further 12% rise in the cost of water provided by NamWater). Some detractors, however, question whether this is because of more efficient water use by consumers or consumers using less water because they can no longer afford to purchase water (The Namibian, 2004).

A LaRRI report in 2004 questioned whether increased tariffs were the most effective way to improve water efficiency. The report argues that high income households were likely to maintain their gardens and swimming pools and therefore high water use patterns. Similarly, because water bills represent only a small portion of most industries' running costs, tariffs on their own are an insufficient incentive to reduce wasteful water use. The report suggests that price is not a perfect incentive for water conservation because the manner in which water use responds to price is low or inconsistent. Low income users are often using as little water as possible, and therefore have little scope to reduce consumption if tariffs are increased.[29] On these grounds, the City of Windhoek challenged the proposed NamWater increase of 14% (N$3.67 to N$4.19 per 1000 litres) in 2003 as being too high (The Namibian Economist, 2003). Nonetheless, the increase was passed and the price of water rose yet again.

4.1.2 Windhoek

Windhoek is centrally located in the Khomas region and was originally established around hot water springs in 1840. Like many other cities, Windhoek has geographical disparities and inequalities with residents from different areas typically having different income levels, education, health status, access to housing and other urban services, including water (Magnusson, 2005).

The city is 700 km from the nearest perennial river and is dependent upon three surface reservoirs in ephemeral rivers, groundwater and reclaimed water to supply the city (van der Merwe). The bulk of the water is supplied by NamWater (70%) while 20% of potable water in the city is recycled or reclaimed (Magnusson, 2005). Reclaimed water is supplied by the Goreangab Water Reclamation Plant[30], which is one of the few water recycling units in the world to provide for direct potable water reuse. The plant was commissioned in 1968 and has been upgraded over the years. The overall contribution made by this recycled water to the city's resources has remained small but vital (Po et al., 2004).

[29] The counter argument is that realistic tariffs are intended to reduce water wastage rather than to reduce water use.

[30] The Goreangab Water Reclamation Plant is internationally renowned as the first Plant in the world to reclaim domestic sewage for drinking water purposes. The initial Goreangab Water Reclamation Plant was built by the City of Windhoek in 1967 to reclaim water directly from domestic sewage effluent as a supplement to Windhoek's very scarce raw water resources (source: http://www.windhoekcc.org.na/Default.aspx?page=117)

In 2002 the Goreangab recycling plant was upgraded to address the declining quality of the Goreangab Dam water, and extended to exploit the maximum reclaimable sources available to Windhoek (City of Windhoek)[31]. By 2004 dependence on the aquifer had increased to 25% of the city's demand and this was considered to be beyond sustainable levels of extraction (LaRRI, 2004).

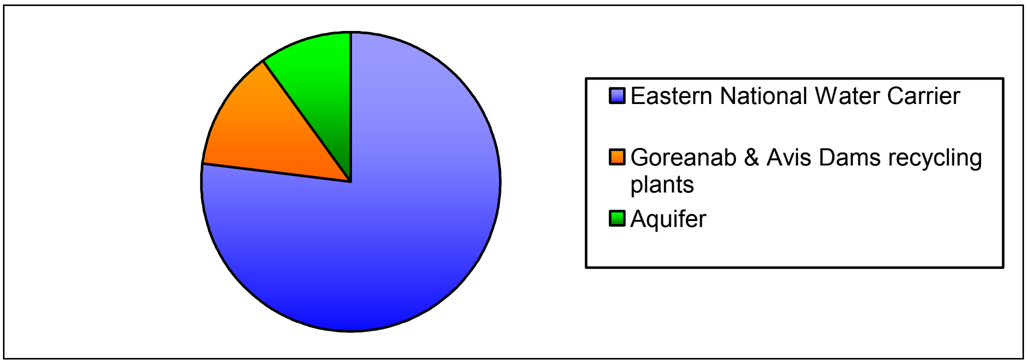


Figure 4.3: Resources used to meet Windhoek's water needs: 1998
(Source: After LaRRI, 2004).

The greatest demand for water comes from the domestic market, which accounts for 65% of the total water demand (Figure 4.4 below). Within the domestic sector, it is estimated that 97% of the residents of Windhoek have access to potable water (Magnusson, 2005).

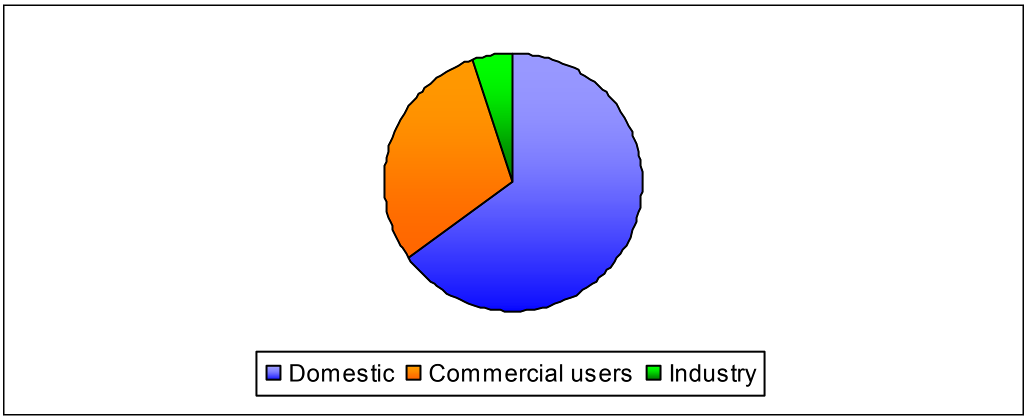


Figure 4.4: Water demand in Windhoek
(Source: Magnusson, 2005)

From the above figure it is clear that while water demand management should target all water users, the most significant reduction in wasted water use is likely to come from the domestic sector. Even though the city would position itself favourably to attract additional commercial

[31] Estimates of the contribution made by reclaimed water vary from about 13% (LaRRI, 2004) to 20% (Hazelton et al).

enterprises and industries, the domestic water market if left unmanaged has the potential to grow rapidly due to population growth, urbanisation and improved water services delivery.
Apart from the reclamation plant, Windhoek has implemented an aquifer recharge system, a dual pipe supply system and dry sewage in new developments around the city, all to assist with securing sufficient water for the city.

Aquifer recharge

One of the greatest consumers of water is evaporation, which can account for twice the amount used by consumers. Therefore, in years when rainfall exceeds the expected water demand, the "excess" water is used to artificially recharge the aquifer. In this way the city is able to "bank" water for drier years (Hayes, 2007).

Dual Pipe Supply

The dual pipe supply system provides separate water networks for potable water and semi-treated effluent. This allows potable water to be reserved for domestic consumption and semi-treated water to be used to irrigate sporting facilities and public open spaces (Hayes, 2007).

Dry sanitation

Windhoek, like many other cities is rapidly urbanising. In order to provide acceptable sanitation solutions to the rapidly expanding informal settlements, dry sanitation units are constructed. This significantly reduces the demand for domestic water (Hayes, 2007).

4.1.2.1 Windhoek's Water Policy

Water demand management and water conservation strategies have been implemented in the City of Windhoek since 1992. To begin with, an education campaign aimed at lowering water consumption was launched. The campaign was largely ineffective, with savings of only around 5% being made (see Figure 4.5 below). This resulted in the implementation of permanent rising block tariffs[32] in the second half of 1992. In 1994 an integrated Water Demand Management policy was approved and implemented by the City Council.

In December of 1996, an adapted version of the Model Water Regulations[33] was adopted by

[32] Block tariffs refer to a progressive rate structure where the price of water per m^3 increases in a stepwise fashion as the volume of water used is increased. The purpose of the block tariff structure is to use an economic incentive to improve water use efficiency, reduce luxury water demand, increase water awareness and improve cost recovery (Magnusson, 2005).

[33] In 1996 Ben van der Merwe at the request of the Ministry of Local Government and Housing, drafted Model Water Regulations. Following the promulgation of the regulations, each Local Authority had the option to modify the generic set to suit the specifics of their area before promulgating the regulations for themselves (Municipality of Windhoek, 1996).

Municipality of Windhoek. The Municipal strategy included various policies and a number of regulations to be implemented. These are summarised in Table 4.2 (policy implementation), Table 4.3 (water regulations), Table 4.4 (public participation and public awareness campaigns) and Table 4.5 (technical requirements).

Table 4.2: **Policy implementation in Windhoek**

Policy	Result of Implementation	Status as of August 2005*
Block tariff *See Water pricing below*	A permanent block tariff system, to reflect the real cost of water and to curb excessive water use, was implemented. This has proved successful in changing water use habits.	Well implemented
Maximum reuse of water	Semi-purified effluent per annum for irrigation has replaced potable water previously used for irrigation in Windhoek. Potable water can be reclaimed at the Goreangab Water Reclamation Plant. Grey water recycling occurs on private premises in Windhoek. A local brewery in Windhoek implemented a grey-water reuse unit is 1981.	Well implemented
Higher densities in all existing developed areas	Residential plot sizes in new development in Windhoek are reduced[34] and higher densities are allowed in existing urban areas.	Implemented in new township developments from 1994. Since 1990 two houses per plot has been allowed
Reduction of Municipal water use	Consumption of water on municipal gardens has been reduced by up to 50%.	Pursued from 1995 until 1997, nothing being done by August 2005
Wet industries	Guidelines are given to wet industries on a continuous basis for the efficient use of water and new wet industries planned for Windhoek will have to reuse water	Policy prohibits the development of all new wet industries

(Source after van der Merwe, 1998 and Magnusson, 2005 and * after van Rensburg, 2006)

[34] There is a distinct relationship between plot size and water use. Magnusson (2005) found that the larger the plot size and the wealthier the owner the correlated with water use. The higher levels of water use of due to extensive gardens, lawns and swimming pools.

Table 4.3: Implementation of water conservation regulations in Windhoek

<table>
<tr><th>Regulation</th><th>Implementation</th><th>Status as of August 2006*</th></tr>
<tr><td>Prevention of excessive water consumption on private properties</td><td>Windhoek has a Water Control Officer to enforce the regulation.</td><td rowspan="4">Initially controlled by the water control officer and meter readers from 1995. Since 1997 implemented very leniently.</td></tr>
<tr><td>Water efficient equipment</td><td>Metering taps must be used in hostels.
Taps outside non-residential buildings must be self-closing or lockable.
Automated flushing devices are prohibited.
Urinals may use no more than 2 litres per flush
Shower heads restricted to a maximum flow rate of 10 litres per minute.
Taps in public areas are to be fitted with a meter to ensure no more than 1 litre of water is discharged in each usage.
Showers in public spaces are to be fitted with a metering valve that limits each usage to 2.5 litres.
Toilet cisterns must be 6/3 litre dual flush units.</td></tr>
<tr><td>Gardens</td><td>Watering may not be done during high evaporation times, i.e. between the hours of 10:00 and 16:00.</td></tr>
<tr><td>Swimming pools[35]</td><td>Swimming pools must be covered when not in use.</td></tr>
<tr><td>Groundwater</td><td>Groundwater abstraction from private boreholes and groundwater levels are controlled.</td><td>Never implemented</td></tr>
</table>

(Source: after van der Merwe, 1998 and * after van Rensburg, 2006.)

Provision has been made for a fine to be levied on users who do not comply with the regulations outlined in the Water Supply Regulations. A spot fine of up to R300 can be levied by a traffic officer, water meter reader or a Water Control Officer.

The legislation implementation was backed by awareness campaigns that included public education on television, radio and in schools, a consumer advisory service, advice on water efficient gardening methods, and community empowerment, see Table 4.4 below (van der Merwe, 1998).

[35] The City of Windhoek's regulations require that swimming pool and spa covers are used to reduce water evaporation. Namibia has studied this problem and found that each pool in Windhoek loses about 40 cubic metres of water per year. Plastic covers are now required, and have reduced this loss by up to 95 percent (www.irn.org).

Table 4.4: **Summary of Public Participation and the Public Campaign**

Programme	Method of Implementation	Status as of August 2005*
Education programmes	All learners and students taught on water management. Radio, television and print media used for education and advertising campaign, saving water strategies distributed with accounts.	Implemented between 1995 and 1997 with a lower profile since then. Some schools based programmes still implemented.
Consumer advisory service	Provided information on all water related issues supplied to consumers.	Implemented between 1995 and 1997, now only as ad hoc service.
Advice on water efficient gardening	Advice on shrubs and garden watering techniques provided.	The advice component implemented successfully. The component to train gardeners was not successful.
Community empowerment (focussing on previously neglected areas)	Two strategies (training community based plumbers and gardeners), neither of which were had been implemented at time of publication.	Public campaign worked rather well, but training and further use of community based plumbers was not successful.

(Source: after van der Merwe, 1998 and *van Rensburg, 2006.)

Public information campaigns have continued intermittently, but seem to have limited value in increasing water efficiency. Magnusson (2005) found that a number of residents knew how to reduce their water consumption but did not want to, largely because higher income residents' attitude was that:

> "Yes we can lower our water consumption, but then it touches our quality of life",

and because

> "You can always lower your water use if you have to, but I don't think we do."
>
> "We don't waste water in this area, we use what we need."

Residents felt that if water readings were more accurate and linked to the education programmes, they would be more inclined to reduce water consumption.

Table 4.5: Technical Requirements and Methods of Implementation

Technical requirements	Method of Implementation	Status as of August 2006*
Lowering "unaccounted for water"	Leakage detection, repair programs, systematic pipe replacements and water audits are done on a continuous basis.	Programme has increased since 1997, with the launch of a large campaign in 2005.
Water efficient gardening	Municipal gardens are watered using proper irrigation systems and advice is given to private nurseries.	Only advocated from 1995 to 1997. Nurseries now try to drive it.
Rainwater harvesting	Rainwater collected from roofs on a small scale.	Little progress, thought to be because cost to consumers for storage units too high.

(Source: after van der Merwe, 1998 and * van Rensburg, 2006.)

4.1.2.2 Water Pricing in Windhoek

Water pricing changes in Windhoek have dominated the water demand management strategy. The policy is based on a rising block tariff system that aims for a full cost recovery while still maintaining (limited) services to lower income users.

In 1992 the manner in which water was billed was changed in an effort to control high and excessive water use. The increase in tariff was based on the assumption that water consumption was inflated because water was undervalued, and not sold at a full cost recovery price (van der Merwe, 1998).

Windhoek's water pricing policy, approved by the City Council in 1991 is based on the following principles:

- *Revenue efficiency:* municipalities should strive to recover all costs from the consumers; prices should be set in the public interest (i.e. full recovery of all capital, operational and maintenance costs) with no additional financial burden placed on the tax payer.
- *Equity and fairness:* tariffs must have a basis in cost and not be set arbitrarily.
- *Ease of understanding and implementation:* a balance needs to be made between tariff systems that incorporate principles of equity and fairness and ease of administration.
- *Economic efficiency:* neo-classical economic ideals do not lend themselves well to water supply. This is because care must be taken that the price of water does not mislead people to believe there is a water scarcity, nor must the cost of a minimum lifeline level of water be beyond the cost of very poor households.

- *Conservation:* water conservation can definitely be encouraged through appropriate tariff structures and the use of block tariffs is important in curbing excessive water use.
- *Assistance to lower income customers:* it is standard practice for utilities to provide a minimum level of water to all consumers to maintain a decent standard of living (van der Merwe, 1998).

By billing excessive water consumption at higher rates, lifeline supplies that have to be undervalued can be cross subsidised in such a way that there is still overall full cost recovery. This is usually done through the implementation of a rising block tariff. In 1991 Windhoek approved the following basis for tariff calculation:

Table 4.6: Rising block tariffs Windhoek

Block	Water per month	Cost calculated
Baseline block	6 m^3 per family per month	Bulk supply price + 10%
Block 1	7 m^3 – 15 m^3	Production and distribution costs (excludes capital costs)
Block 2	16 m^3 – 36 m^3	Full capital, operational and maintenance costs
Block 3	37 m^3 - 45 m^3	Full cost recovery + capital charges for infrastructure developments
Block 4	>45 m^3	Based on long term marginal cost to supply water to Windhoek

(Source: van der Merwe, 1998).

In order to accommodate this principle of full cost recovery, the price of water to Windhoek residents has risen on average 20% *per annum* since the introduction of the NamWater Act. In order to try and reduce the immediate impact on poorer households of the high cost of water, the Windhoek Municipality introduced a Tariff Stabilisation Fund.

In 2000, when NamWater hiked tariffs in Windhoek City from N$2.59 to N$3.11 it was contested by the City. Matthew Shikongo, the Mayor of Windhoek stated that

> "Past studies done on the affordability level of the poorest sector of our community have shown that water is already unaffordable to this sector." (LaRRI, 2004)

Yet in mid 2002, the City Council once again implemented an annual tariff increase and average water prices reportedly went up by a further 13% (LaRRI, 2004).

Table 4.7: Water consumption and payments by income group

	Water use	**Water payment (per month) in 2001**
Informal settlements	20-30 litres/capita/day	*No figures provided*
Low income households	70-80 litres/capita/day	N$150 – 700† *US$22 - 102*[36]
Middle to high income areas	130-260 litres/capita/day	N$200 – 1 000 *US$30 - 150*
Upper income areas	>400 litres/capita/day	N$2 000 – 3 000 *US$295 – 440*

(Source: after Magnusson, 2005).

† N$1 = ZAR1.

While current water prices have risen at a rate that exceeds inflation, there are no more-affordable water resource alternatives. The current supply of water is still the cheapest. For example if water were to be transported into Windhoek, it is estimated that the price would increase from N$4.11 per cubic meter to N$10 per cubic meter (LaRRI, 2004).

Table 4.8: **Water and the Windhoek budget (2003 – 2006)**

	2003	**2004**	**2005**	**2006**
Budget allocation to infrastructure development	N$15 million	N$25.4 million		N$26 million
NamWater tariff increase		12%	12%	11.5%
Windhoek tariff increase (basic charge)	None proposed (subject to NamWater not increasing tariffs)	12.5%	12%	10%
Windhoek tariff increase (consumption)	None proposed (subject to NamWater not increasing tariffs)	14%	10%	10%

(Source: Aloe City of Windhoek Issue 7, July 2006, Issue 7, July 2004, Issue 7, July 2003).

4.1.2.3 The effectiveness of the Water Policy and Water pricing

Per capita water consumption has been reduced in Namibia, although the role of water efficient devices in reducing inefficient water use is less certain. Average water consumption has been reduced from 360 litres/capita/day to 220 litres/capita/day (Figure 4.5 below) and as a result total potable water production in 2000 was 3.5% lower than in 1992 despite the city's population increasing by 5.5%. By 2004, water use in non-drought periods stabilised at between 155–120 litres/capita/day (Magnusson, 2005).

[36] US$ equivalent given for 2001 values.

Middle and higher income respondents to Magnusson's household interviews suggested that social pressure or environmental concern was most likely to influence them to use water more efficiently. Therefore for education programmes to be successful they need to go beyond merely providing basic user information to installing a conservation ethic amongst higher income user groups.

Pre-payment water systems were found to be an effective way of reducing water use amongst 75% of lower income households.

> "Now we use less water because we have to pay for the exact amount of water we use." (Magnusson, 2005, p 59)

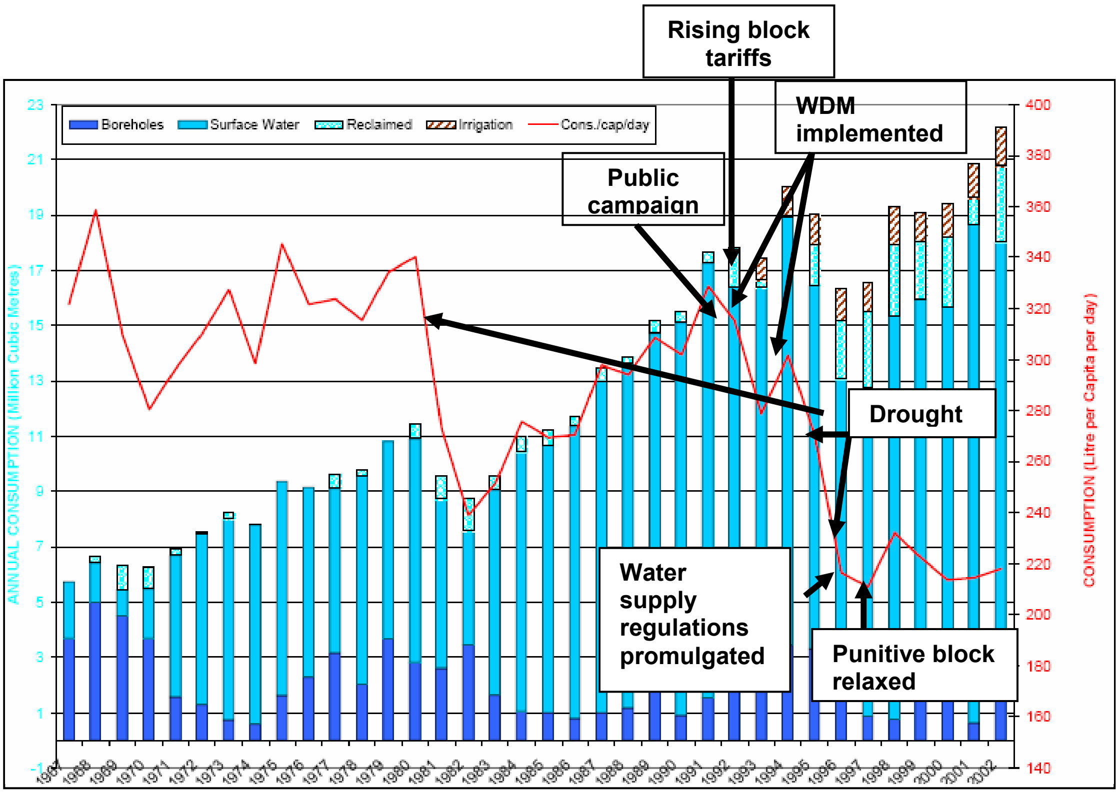


Figure 4.5: Windhoek water consumption per capita per day (red line) and interventions aimed at reducing water consumption, viewed against total per annum consumption for the city as a whole, 1967 to 2002.

Figure 4.5 highlights the effectiveness of a combination of water demand management strategies, including pricing, in reducing domestic water consumption. Magnusson's 2005 survey revealed five distinct groups of respondents in which differences in water usage could be related to ability to pay and access to water (Figure 4.6 below).

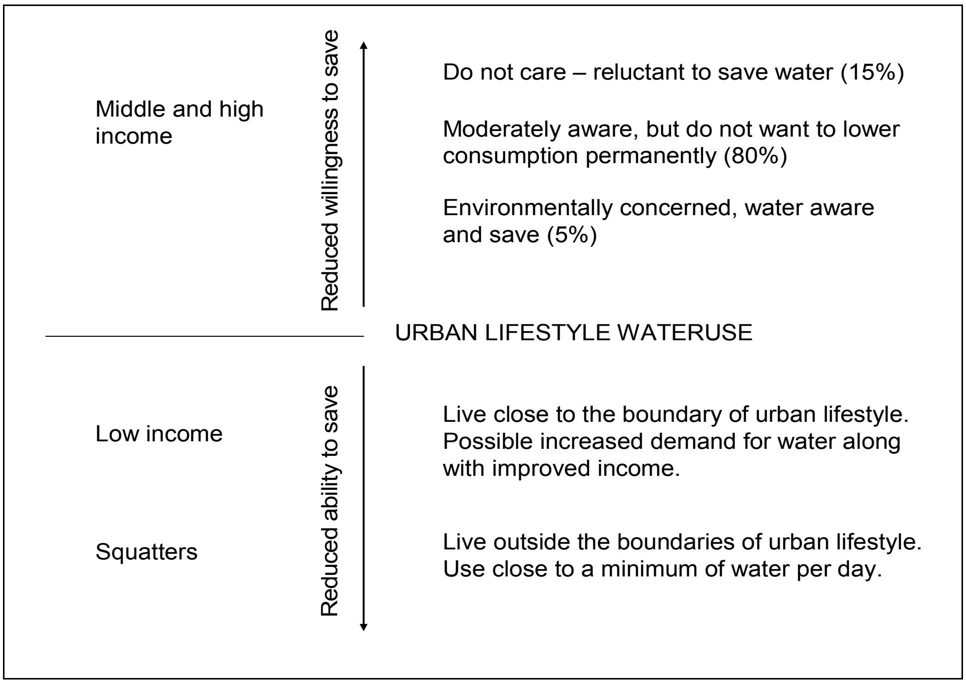


Figure 4.6: Summary of responses to saving water stratified by income group

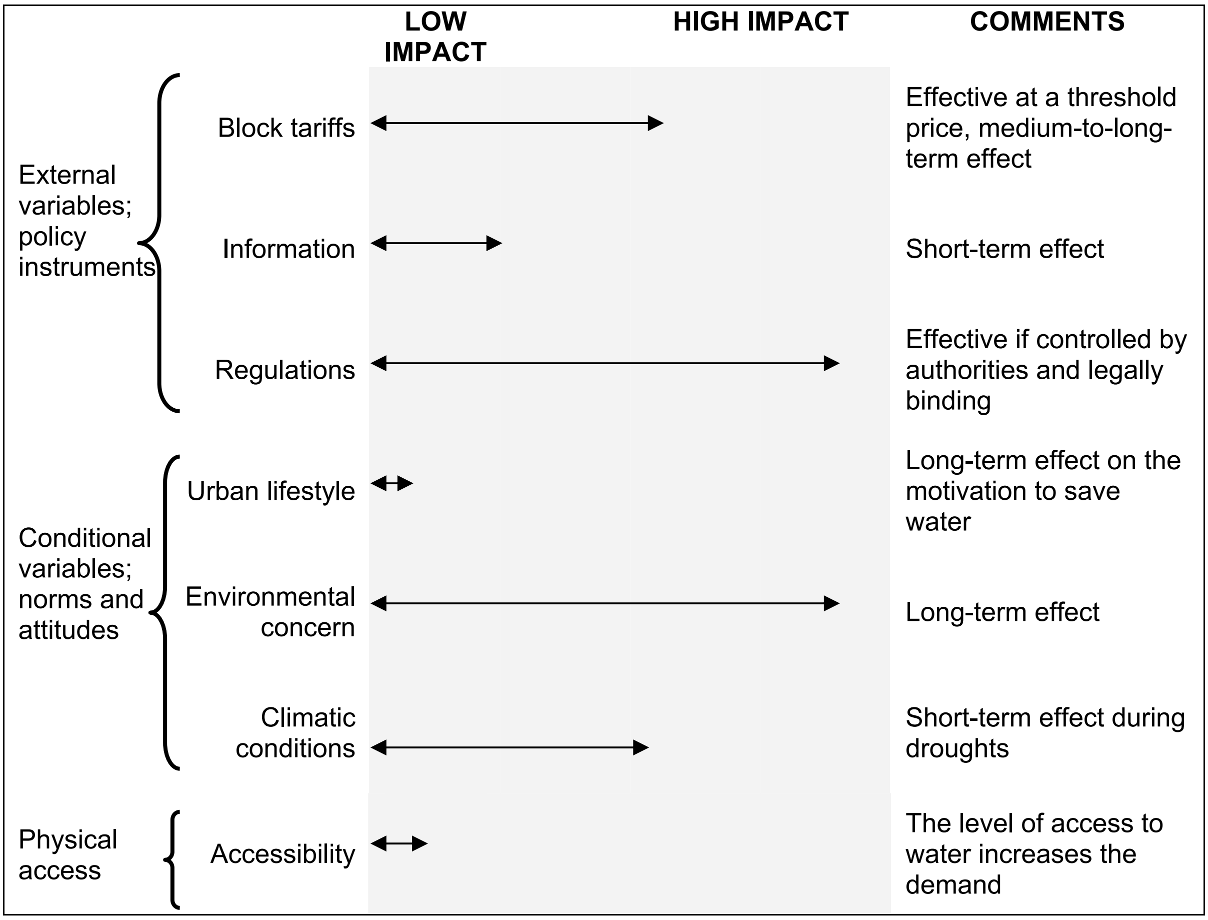


Figure 4.7: A summary of the role of policy instruments, norms, attitudes and accessibility to the motivation to save water and change water use behaviour in the domestic sector (Source: Magnusson, 2005).
Note: arrows indicate a spectrum of impact that differs between households

From the analysis provided by Magnusson (2005) it seems that although the water demand management policy included utilising water efficient devices to reduce domestic water consumption, in reality it was price-induced water reduction (as opposed to increased water efficiency) that has lowered per capita consumption.

For example, in Windhoek it was found that of the 30 highest water consumers, 17 were government departments. By transferring responsibility to these departments for their own water bills, some reductions have been made. However, as water bills for most industries and businesses are usually not a significant part of their operational cost, there is not much financial incentive to industrial consumers to conserve water. 75% of the businesses interviewed by Magnusson (2005) indicated that the then current rate structure on water did not influence their water usage.

All new industries to Windhoek are informed of the water scarcity and encouraged to install water efficient technologies, especially water recycling or reuse schemes. Since the implementation of this policy 50% of wet industries[37] had installed water efficient technologies (Magnusson, 2005) including systems that allowed for the re-use of industrial effluent on site (van der Merwe, 1998). For example Windhoek Lager (see box) use half as much water to brew a litre of beer as do most other breweries.

Windhoek Lager: Water efficient beer production

Namibian Breweries, mindful of the impact many industries have on scarce environmental resources. By being environmentally aware of their water usage and continuously seeking improvements in efficiency with the assistance of its strategic partners, a litre of Windhoek lager requires only 3 litres of water (compared with 5 and 8 litres at most other breweries).
To save water, the Pharduku process is used to capture steam/water from the wort boiling process and re-use it for cleaning purposes, while effluent water is recycled for cleaning purposes and irrigation on the Nambrew premises.
The greywater –reuse system was designed and built by the Brewery in 1981, before the new water tariff system was introduced and as such therefore there were no financial incentives to be water efficient.
(www.nambrew.com and van der Merwe 1998).

The hotel industry (defined as medium-wet to wet) is one of the biggest water consumers in Windhoek. Only 20% of hotels had installed any water efficient devices (including low flush toilets and aerated shower heads) in addition to informing guests about water scarcity. Common responses from hotel representatives include:

> "We cannot tell guests to save water when they are on holiday."

and

> "…it is difficult to save water within the hotel sector, because we have to balance water use with the level of service to the guests." (Magnusson, 2005).

[37] Business was divided into three groups wet, medium-wet and dry businesses. Wet businesses are considered those which are water intensive (Magnusson, 2005).

In addition, hotel grading systems which require rooms to have both a shower and a bath to receive 5 star status provide a disincentive to use water more efficiently (van der Merwe, 1998).

There is a general awareness amongst businesses of water scarcity, but this has not yet been matched by action to utilise water more efficiently. Businesses need to be educated in the technologies available to overcome the perception that a reduction in water use will result in an inferior product and that the technology required to reduce water wastage was expensive and offered only marginal benefits. Furthermore, Magnusson (2005) notes that if improved technologies are to be introduced the change needs to be driven by appropriate incentives (as opposed to being imposed on businesses).

4.2 Water demand management in South Africa

Increased water demand in South Africa has traditionally been met with an increased water supply, as opposed to any interventions aimed at reducing the demand. Historically proactive water demand management in South Africa has been limited to drought periods. When the available domestic water supply is reduced due to less than expected rainfall, municipalities implement a series of strategies (in accordance with local by-laws) to encourage domestic consumers to reduce their water consumption. The first step is often to appeal to the public and create awareness amongst users as to how to save water. If water shortages persist, water demand is managed by implementing different levels of water restrictions, changes in tariffs and penalties for non-compliance.

This is beginning to change, and the water demand management strategies of the City of Cape Town, Hermanus and two areas of Gauteng are reviewed below.

4.2.1 Water demand management in the City of Cape Town

Cape Town is a useful case study, because in addition to drought related water restrictions, the city began implementing a range of water demand management strategies in 2000/01.

The City of Cape Town introduced water demand management in order to manage escalating water demand, delay the implementation of expensive water augmentation projects and comply with the Integrated Development Plan (IDP) that aims to reduce water demand by 20% by the year 2010. The water demand management strategy is based on a three pronged approach:

- Water demand management options implemented by the City of Cape Town
- Water demand management options implemented by individuals

- Supply augmentation.

This approach has managed to reduce water demand significantly to below the targeted low water demand curve (of 2% per annum) as indicated in Figure 4.8 below. However, due to the expense of capital infrastructure programmes (designed to augment water supplies), the water demand management strategy has been intensified with a goal of a 1% growth rate in the demand curve. If this can be achieved and sustained, it will postpone water resource augmentation from 2013 to 2020.

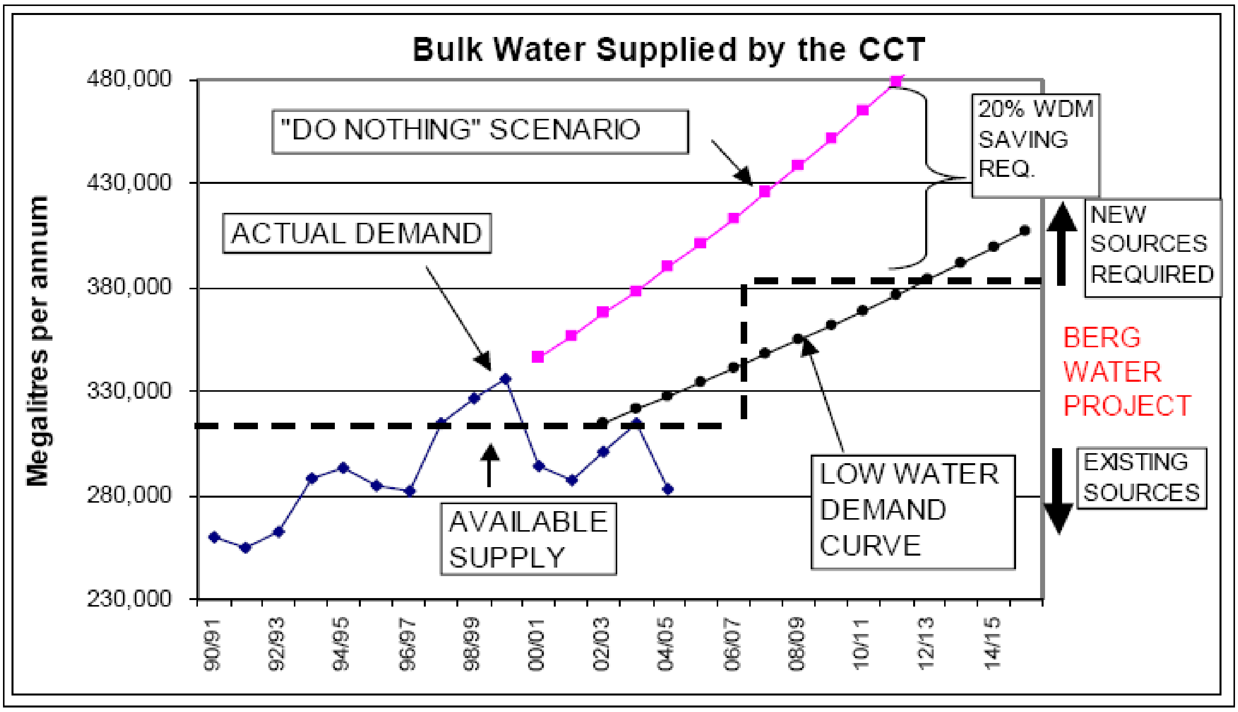


Figure 4.8: Water Conservation and Demand Management for Cape Town
(Source: City of Cape Town, 2006)

However, between 2003 and 2004 there was concern water demand was once again increasing at the unrestricted rate of between 3 and 4%. The increased demand and the drought in 2004/05 resulted in the Council approving a more comprehensive Water Demand Management Strategy (Ten Point Plan) to contain water demand below the low water demand projection (see Figure 4.8 above).

The ten-point strategic plan is to:
1. Reduce network and commercial losses (pressure management, repair leaks).
2. Reduce low-income household leaks through education and metering.

3. Leading by example to reduce council consumption through the installation of water efficient devices and reducing potable water consumption in all open space and nature areas.
4. Ensure equitable tariffs that act as an incentive to save water and help customers understand their water use through informative billing.
5. Control water wastage through by-laws and ensure that all new developments are water-wise.
6. Promote retrofitting and capacity-building programmes.
7. Communicate, educate and provide informative billing.
8. Promote alternative technologies and launch water-saving campaigns.
9. Conserve the City of Cape Town's water supply.
10. Create an enabling environment for long term effective water conservation and water demand management (City of Cape Town, 2006).

Table 4.9 below shows an analysis of the suitability of various water demand and water supply management options. Pressure management (as implemented by the city) is expected to be the most effective option, followed by the elimination of automatic flushing urinals, and then tariff restructuring. It is interesting to note that the introduction of water efficient devices (aside from water efficient urinals) and the promotion of grey water use fall in the bottom quarter of the table.

Table 4.9: Options considered for meeting additional water demand in Cape Town

OPTION	YIELD	FINAN-CIAL	SOCIO-ECON	ACCEPT-ABILITY	ENVIRON-MENT	OVERALL SCORE
Pressure management	64	84	62	95	93	83
Elimination of AFU	57	76	59	94	93	79
VoelVlei* Dam Augmentation	69	100	69	29	93	75
Tariffs, metering & credit control	87	83	54	83	51	74
Leakage repair	52	64	85	75	93	73
Lourens River Diversion	78	84	66	74	44	72
TMG Aquifer*	70	75	73	79	39	70
Eerste River Diversion	70	75	54	78	53	69
Cape Flats Aquifer	66	69	57	75	70	69
Treated wastewater for local urban & industrial use	41	75	31	68	97	67
Promotion of private boreholes	38	59	61	74	37	57
Desalination*	73	25	63	85	82	57
Introduction of WED	48	50	64	38	93	56
Promotion of greywater reuse	29	55	28	63	82	54
Treated wastewater for commercial irrigation farmers	48	72	10	26	82	51
Treated wastewater reclaimed to potable standard	71	17	71	38	97	47

* Options investigated in CMS Bulk Water Supply Study
AFU – Automatic Flushing Urinal. (Source: Dickens et al., 2004).

4.2.1.1 Stepping up water demand management in the face of water shortages

As far back as 1872 Cape Town has experienced frequent episodes of water shortage, resulting in the implementation of various water restrictions (Table 4.10 below).

Table 4.10: Historical review of drought years and restrictions imposed

Years	Restriction imposed
1872	Waterworks Committee reports supply not equal to demand. Temporary suspensions.
1881	Report in press referring to daily suspensions of water supply.
1902	Summer restrictions imposed.
1904 (- 1921)	Restrictions imposed due to insufficient summer supply. Supply frequently interrupted for up to 15 hours per day.
1949	Restrictions imposed on garden watering for 2 months preceding completion of Steenbras 840 mm diameter pipeline.
1956	Restrictions imposed preceding construction of Wemmershoek Dam.
1971-1973	Water restrictions imposed preceding completion of Voëlvlei Dam and a severe drought.
1993	Water restrictions imposed on garden watering for 2 months preceding the completion of Faure Water Treatment Plant.
2000	Water restrictions imposed for 10 months due to low winter rainfall.
2004	Restrictions imposed due to low rainfall in the winters of 2003 and 2004, dam levels dropped below 40%.

(Source: After City of Cape Town, 2006)

From the above table it is clear that early efforts to ensure sufficient water resources for the City of Cape Town focused predominately on water supply strategies (as opposed to water demand management strategies) with the introduction of new pipelines, new dams and new water treatment works. The exception being when water restrictions were imposed for limited time periods.

Water tariffs

Increased tariffs have proven to be effective in reducing water consumption. Tariffs, used in conjunction with water restrictions, education and awareness have resulted in savings as high as 31% (Figure 4.9) during the period October 2004 to January 2005.

Table 4.11: Water tariffs associated with water restrictions in Cape Town

Kilolitres (per month)	Water tariff: Level 1 Water restrictions	Water tariff: Level 2 Water restrictions
26 kℓ	R116 per month	R145.43 per month
30 kℓ	R150.43 per month	R192.90 per month

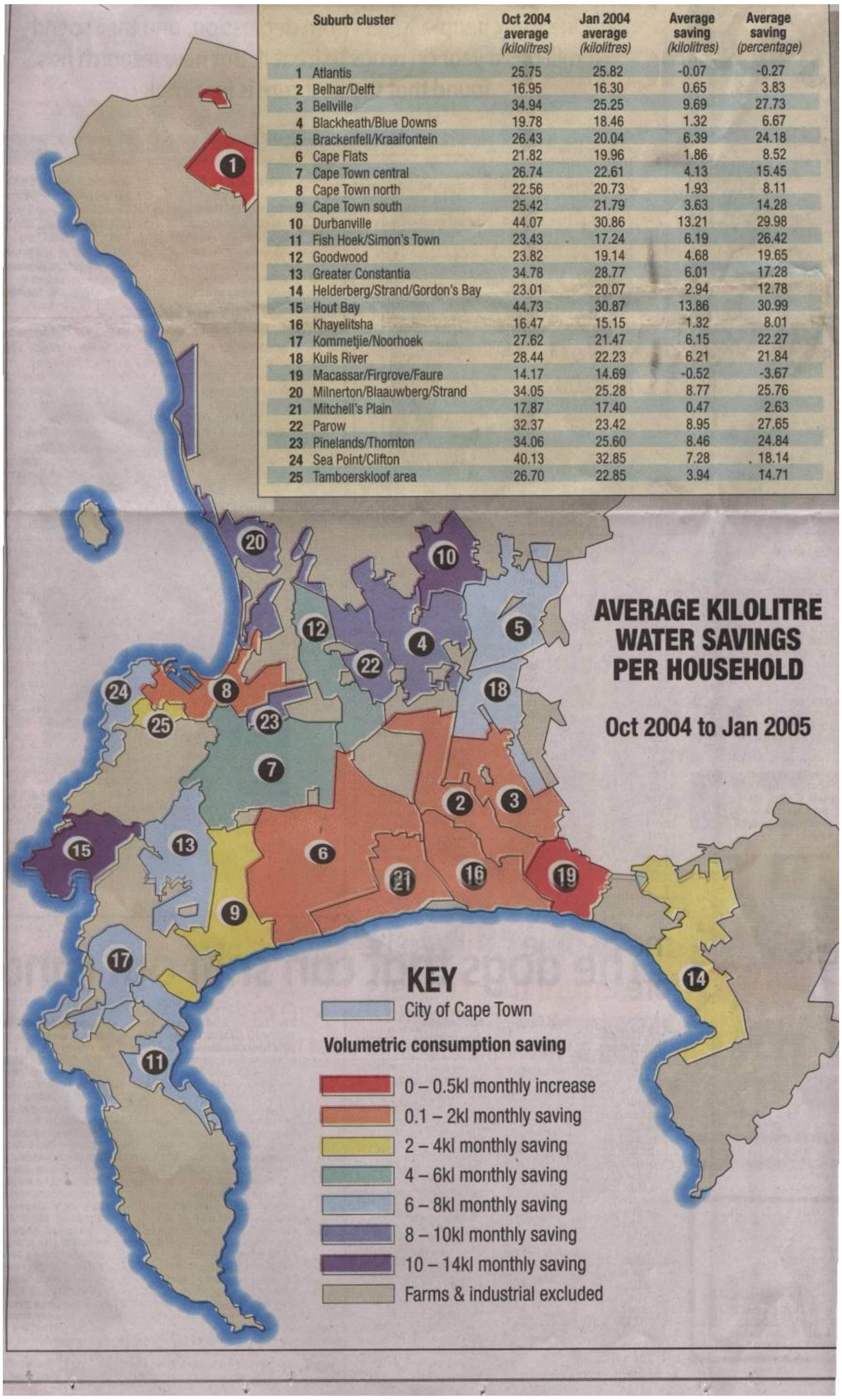
Notes: Rates are calculated for a 30 day month and are inclusive of VAT.
Level 1 tariffs are given for 2005 and Level 2 tariffs for 2004.
(Source: City of Cape Town, 2005)

Van Zyl et al. (2006a) cautions that water restrictions and revised tariffs do not usually result in continued water demand reductions. However, Cape Town's decreases in water consumption during the 2000 restrictions have been partially sustained.

Water restrictions

The water restrictions imposed in 2000 aimed to achieve a 10% saving in domestic water consumption actually resulted in a 15.5% saving that is reported to have been generally sustained. This indicates that consumers changed their water use habits permanently by reducing use and finding alternatives to potable water (for example by sinking a borehole), installing water efficient devices (including greywater recycling units) or paving areas to reduce the need to irrigate domestic gardens (City of Cape Town, 2004).

Figure 4.9 below maps the water savings achieved by various Cape Town suburbs during the most recent water restrictions imposed in 2004. The figure shows that Cape Town's higher income areas were able to reduce water use by the greatest amount. Hout Bay (a high income area) has had the greatest average water saving, close to 31%. Other significant savings have been made in Durbanville, Bellville and Parow (all middle to upper income areas). Households in poorer areas may already only be using minimal amounts of water, and water conservation targets that aim to reduce water use in these areas can be unrealistic. It is interesting to note that the average savings made by Hout Bay residents (13.86 kilolitres) is only slightly lower than the October 2004 average total use for lower income areas (14.17 kilolitres).



	Suburb cluster	Oct 2004 average (kilolitres)	Jan 2004 average (kilolitres)	Average saving (kilolitres)	Average saving (percentage)
1	Atlantis	25.75	25.82	-0.07	-0.27
2	Belhar/Delft	16.95	16.30	0.65	3.83
3	Bellville	34.94	25.25	9.69	27.73
4	Blackheath/Blue Downs	19.78	18.46	1.32	6.67
5	Brackenfell/Kraaifontein	26.43	20.04	6.39	24.18
6	Cape Flats	21.82	19.96	1.86	8.52
7	Cape Town central	26.74	22.61	4.13	15.45
8	Cape Town north	22.56	20.73	1.93	8.11
9	Cape Town south	25.42	21.79	3.63	14.28
10	Durbanville	44.07	30.86	13.21	29.98
11	Fish Hoek/Simon's Town	23.43	17.24	6.19	26.42
12	Goodwood	23.82	19.14	4.68	19.65
13	Greater Constantia	34.78	28.77	6.01	17.28
14	Helderberg/Strand/Gordon's Bay	23.01	20.07	2.94	12.78
15	Hout Bay	44.73	30.87	13.86	30.99
16	Khayelitsha	16.47	15.15	1.32	8.01
17	Kommetjie/Noorhoek	27.62	21.47	6.15	22.27
18	Kuils River	28.44	22.23	6.21	21.84
19	Macassar/Firgrove/Faure	14.17	14.69	-0.52	-3.67
20	Milnerton/Blaauwberg/Strand	34.05	25.28	8.77	25.76
21	Mitchell's Plain	17.87	17.40	0.47	2.63
22	Parow	32.37	23.42	8.95	27.65
23	Pinelands/Thornton	34.06	25.60	8.46	24.84
24	Sea Point/Clifton	40.13	32.85	7.28	18.14
25	Tamboerskloof area	26.70	22.85	3.94	14.71

Figure 4.9: Water usage and water use reduction in Cape Town (October 2004 – January 2005)

(Source: The Cape Argus, 2005)

Notes: Figures show water consumption levels for an average household (excluding flats and apartments and other residential units that do not have individual water meters. Based on similarities in household size, some areas have been clustered together.

A report detailing water consumption patterns in Cape Town reviewed water use pre- and post-water restrictions for the periods 1 September 2003 to 30th April 2004 and 1 September 2004 to 30 April 2005. The results indicated that the post-restriction water demand curve is lower for all stand sizes in all administration areas than for the pre-restriction period. During this period the average daily demand (ADD) for water reduced from 692 618 kℓ/day to 601 302 kℓ/day (a saving of 91 316 kℓ/day) (CES, 2005).

Table 4.12: Average daily demand (ADD) for water pre- and post- water restrictions, Cape Town

	ADD pre-water restrictions (kℓ/day)	ADD post-water restrictions (kℓ/day)	Saving (kℓ/day)
All water users	692 618	601 302	91 316 (13%)
Residential water users	384 575	325 126	59 449 (15.5%%)
Water reduction by STAND SIZE			
Stand size 1 m^2 to 499 m^2	203 953	193 534	10 418 (5%)
Stand size 500 m^2 to 999 m^2	115 853	87 035	28 818 (25%)
Water reduction by STAND VALUE			
Stand value between R0 and R200 000	242 799	205 647	37 152 (15%)

(Source: CES, 2005).

Figure 4.10 below plots the average daily demand (ADD) for the same group of customers as the above table, differentiating between indoor and outdoor water use. The graph highlights that while indoor water demand pre- and post- restrictions remains relatively constant, outdoor water demand is more flexible (CES, 2005).

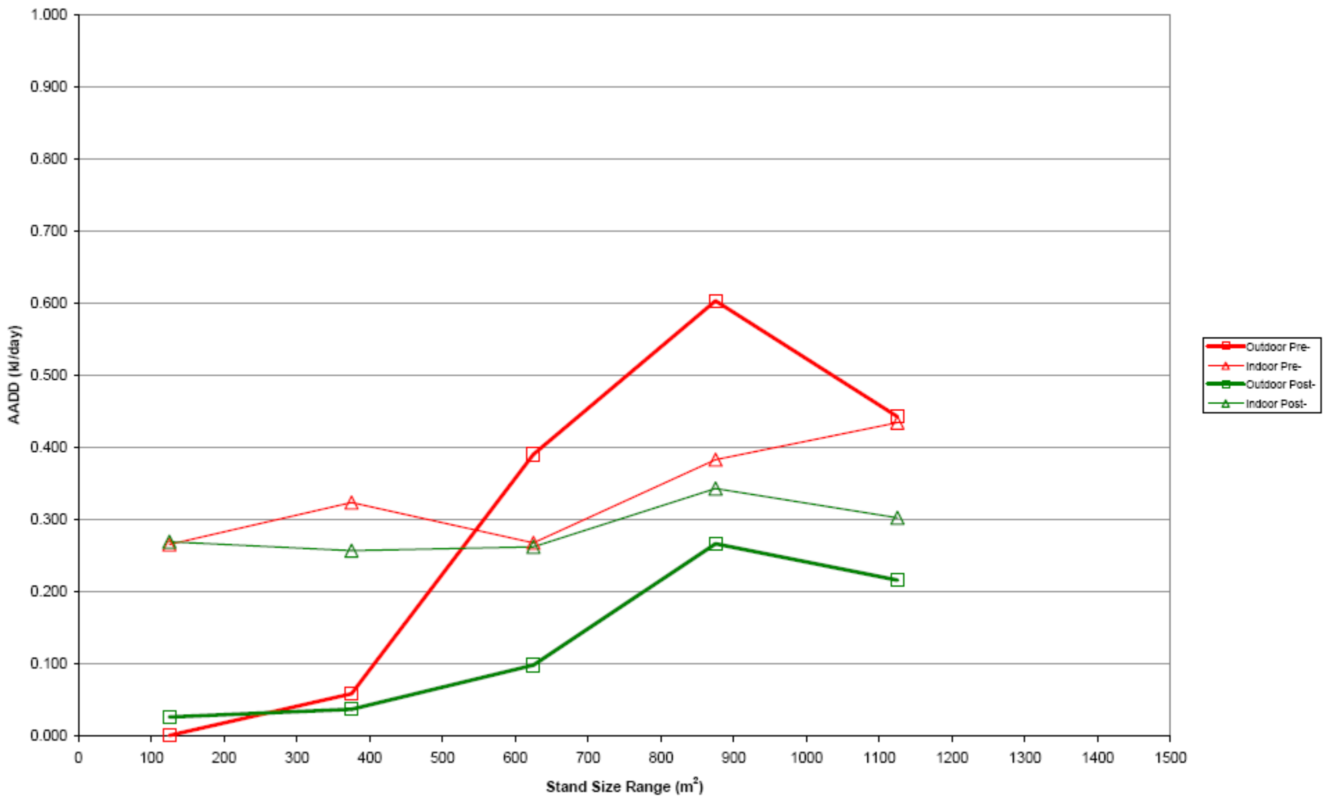


Figure 4.10: End-Use results per stand size - Indoor and outdoor components of demand
(Source: CES, 2005)

4.2.1.2 Modifying the current water demand management strategy to overcome emerging challenges

The City of Cape Town faces a host of challenges when trying to implement water demand management strategies, especially those that require cooperation from residents. Residents bypass water meters and pressure flow control devices causing leakages, damaging infrastructure and avoiding increased water tariffs and restrictions. To overcome this, the City of Cape Town has embarked on a number of strategies. Softer approaches include informative billing and education campaigns which are backed up by revised water tariffs and a revision of the water services bylaws. These measures are discussed below.

Improved metering and informative billing

The checking of water meters per district will be considered to strengthen the current system, spot losses and control water theft. The city intends including graphs on water bills so that each consumer can monitor his or her usage. Also under consideration is the introduction of pre-paid water meters across the board. Three pilot projects in different income groups will be undertaken to assess this programme in more detail.

Education

The city will embark on an education campaign, using advertisements, billboards and other media asking people to use water sparingly. It will also seek to develop a Water Charter.

Improving water efficiency

A number of strategies to improve water efficiency within the domestic sector have been considered and include:

- Encouraging users of large-volume cisterns, wasteful showerheads and non-aerated taps to switch over to water saving products. The city will consider subsidising the retrofit through higher tariffs and additional tariff steps.
- Residents will be encouraged to re-use water from baths and washing machines to water gardens. This would also be built-in as a regulation for new housing, if shown to be cost-effective in real terms.
- Swimming pool owners will be encouraged to use rain water from roofs to fill up their pools. This will be considered under a by-law, if found to be applicable.
- As in Durban, the city will consider supplying ground water tanks for poor households that provide a limited 200ℓ per day.

In addition, municipal interventions aimed at improving water efficiency such as servicing and repairing leaking water pipes that have corroded, exploring cost-effective options to re-use water from sewage works, registering all bore-holes to manage ground-water abstraction and the clearing of invasive alien plants in catchment areas to improve water run-off and prevent dams from silting up are being considered.

Revising the water tariff

The Council wants to change the current six-step domestic water tariff to a ten-step structure to discourage high water usage. The principle is that the more steps in the block-rate tariff, the greater the chance for equity (especially given the larger number of people in poorer households) and the more it encourages users to avoid paying the higher rates. It will draw on the experiences of the Hermanus Water Conservation Programme in which big properties like hotels are charged an equitable block-rate tariff.

Revision of water services bylaws

On 1 September 2006 the City of Cape Town gazetted new water services bylaws, which include the following schedule:

Schedule 2 Water Demand Management

1. *No person may without prior written authority from the Director: Water, water a garden, sports field, park, or other grassed area using potable water, between the hours of' 10:00 and 16:00.*
2. *Where a hosepipe is used to irrigate a garden, park, or sports field from a potable water source a| controlling device such as a sprayer shall be attached to the hose end.*
3. *No person may without prior written authority from the Director: Water hose down a hard-surfaced or paved area using water from a potable source.*
4. *A hosepipe used for washing vehicles, boats, and caravans must be fitted with an automatic self-closing device.*
5. *Automatic top up systems using a float valve fed from a potable water source to supply swimming pools and garden ponds are not allowed.*
6. *Commercial car wash industries must recycle a minimum of 50% of the water used in operations.*
7. *Wash-hand basins provided in public facilities must be fitted with demand type taps.*
8. *Showers provided at public facilities must be fitted with demand type valves.*
9. *Potable water may not be used to dampen building sand and other building material to prevent it from being blown away.*
10. *Stand pipe draw-off taps must be at a height of at least 450 mm, measured above ground level.*
11. *The maximum flow rate from any tap installed in a wash hand basin may not exceed 6 litres per minute.*
12. *The maximum flow rate from any showerhead may not exceed 10 litres per minute.*
13. *Water closet cisterns may not exceed 9,5 litres in capacity.*
14. *No automatic cistern or tipping tank may be used for flushing a urinal*
15. *Within two years after the promulgation of this by-law all automatic flushing cisterns fitted to urinals, must be replaced with either manually operated systems or non-manual apparatus which causes the flushing device to operate after each use of such urinal.*
16. *Terminal water fittings installed outside any buildings other than a residential dwelling must-*
    - *(a) incorporate a self-closing device, or*
    - *(b) have a removable handle for operating purposes, or*
    - *(c) be capable of being locked to prevent unauthorised use, or*
    - *(d) be of a demand type that limits the quantity of water discharged in each operation.*

With the promulgation of these bylaws Cape Town is probably the leading municipality in South Africa[38] as far as water conservation legislation is concerned.

The municipality have since been running workshops for government departments, industry and their own officials to inform them about the bylaws. The municipality will create a department responsible for the regulation of the revised bylaws. This department will be situated in the same section that deals with building plan approvals and will therefore be better able to ensure the compliance of new developments.

4.2.1.3 Education as a part of water demand management

As well as drafting legislation The City of Cape Town has conducted water saving initiatives. These include an EXPO, a Schools Water Awareness Project and exhibitions of water efficient devices.

Cape Town's Water Efficiency and Education Unit has a permanent exhibition of different types of water efficient devices but they do not endorse any products. They only have JASWIC or SABS approved products in the exhibition. The city does not believe it wise to advocate any particular system or technology because this would expose the city to accusations of having vested interests and would also allow for them to be perceived as responsible for problems.

A new exhibition area in a dedicated building is being developed. There are also plans to complete the schools Hippo Bag project. A leak fixing project is planned that will entail training of plumbers to fix leaks in indigent homes and council properties. An awareness campaign will focus on informal settlements and will include water saving.

The Schools Water Efficiency and Awareness Project was initiated in November 2002, and originated from a pilot project in Khayelitsha in 2001. The objectives of the project were to:

- Establish a supportive relationship with school caretakers & principals
- Establish a schools efficiency database from information collected
- Initiate savings from day one, by installing Hippo bags in all cisterns
- Initiate dialogue with Department of Education and the Department of Public Works to establish mechanisms to pay for retrofitting
- Prepare Action Plans for all schools to reach an acceptable water efficiency level

[38] Chapter 5 contains an analysis and comparison of the water services bylaws from various South African towns and cities as they relate to water efficiency.

During the project period 206 schools were visited, predominately in the south of the City and 6 213 Hippo bags were installed. The schools project aimed to develop a database of all the schools and to supply them all with Hippo bags. The caretaker of each school would do the Hippo installation. It is estimated that this only represents 50% of the work done during the programme. Although it was considered very successful (it was found that the savings to the school/Department of Education, after the fitting of the Hippo bags was almost 400% more than the cost of the project (Wilson, 2004)), the schools Hippo programme was not completed due to changes in priorities within the City. Currently it is the intention of the city to reactivate and complete the project.

The top priority in the past was to rid all schools and council buildings of automatic flush units. A total of 524 automatic flushing urinals were identified in these schools. Potential savings through the removal of the 524 automatic flushing urinals is considerable. Monitoring of water use in the Vanguard Primary School pilot project revealed that the water flow in these systems was 135 litres per hour. Extrapolating from this number, the total water used in 524 automatic flushing urinals would be 619 682 kℓ per annum. By replacing the automatic flushing urinals with a demand mechanism a 95% saving was achieved in Vanguard Primary School, and there is no reason why this saving could not be duplicated (Wilson, 2004). This saving alone would provide water (at an urban consumption rate of 150 ℓ/p/d) to over 11 000 people without any extra water having to be found.

The current priority is to do a complete audit of all the council owned and council run buildings, develop a plan for retrofitting and then implement the plan. Critics of this step by step approach believe the council could already start work on some high priority buildings while doing the audit of all buildings. In both the government and the private sector the user of a facility (who pays for the water used) is often not the owner. Building owners (Public Works and private landlords) are not keen to spend money on retrofitting with water efficient devices when the tenant covers the cost of water used. Conversely, tenants are not keen to spend money improving the landlord's building without compensation, and the result is a lack of initiative as far as water efficient devices are concerned.

The Water Services Directorate of the City of Cape Town in conjunction with the MTN ScienCentre organised a 'Water Saving EXPO' on water efficient devices and water wise gardening in February 2005. The stated objectives of the EXPO related to water saving were:

- To invite a wide spectrum of stakeholders in the field of water efficient devices to showcase their products to staff, management, politicians, residents and the business environment

- To introduce the use of these devices in households and industry in order to reduce water consumption and save water
- To create an opportunity to showcase innovation in the field of water
- To enhance and promote the Water Services Emergency number
- To promote water conservation through the water restrictions campaign
- To promote and raise awareness on Water Week 2005 and the schools competition
- To highlight the responsibility of society as a whole to contribute to saving water

4.2.1.4 Case Study: retrofits undertaken by Helderberg Municipality

The Helderberg Municipality (now part of the City of Cape Town) retrofitted some ablution facilities with Aqua Smart toilet and urinal systems. The water savings made in three buildings (The Strand Main Building, the Somerset West Library and the Strand Library) are outlined in the figures below.

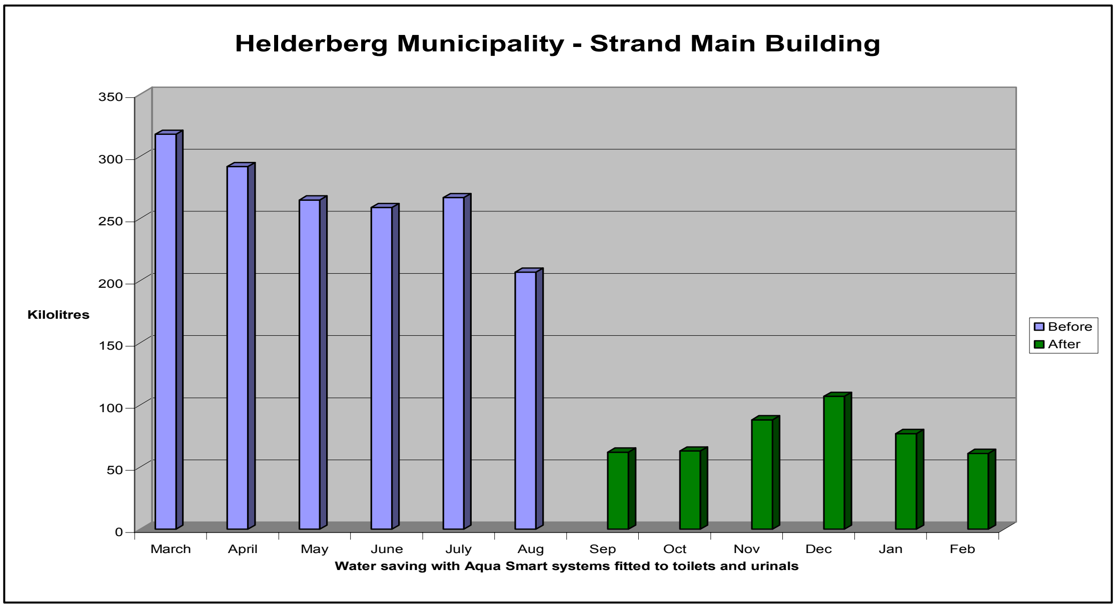


Figure 4.11: Water savings after retrofitting at the Strand Main Building

(Source: Mr. D. Stone, 2007)

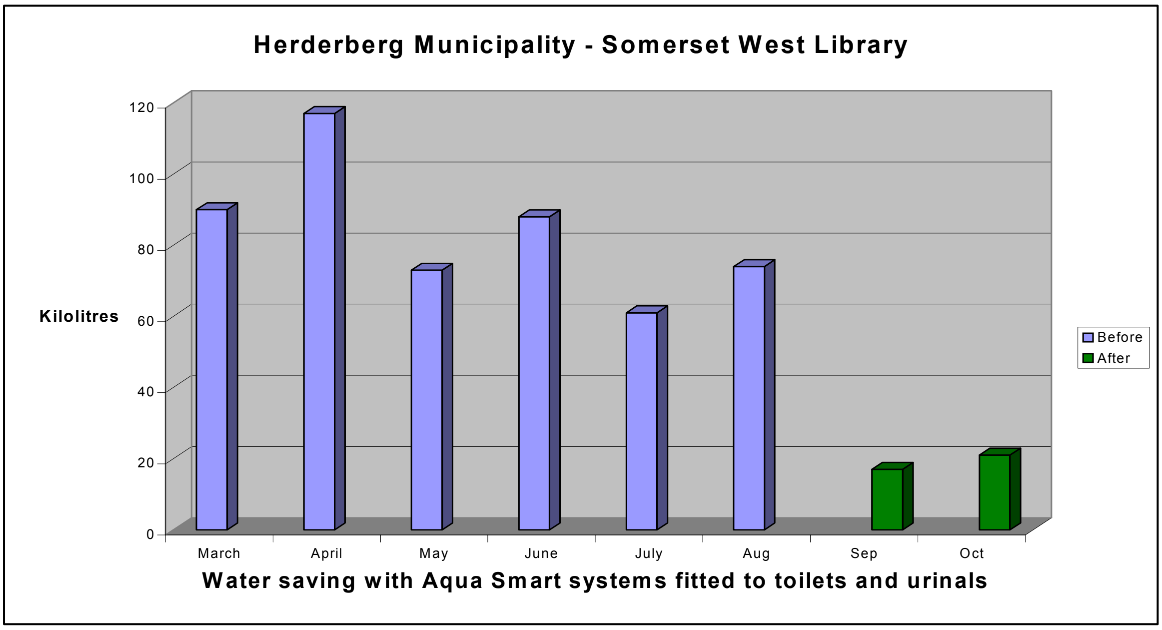


Figure 4.12: Water savings after retrofitting at the Somerset West Library (Source: Mr. D. Stone, Aqua Smart Water Management, 2007)

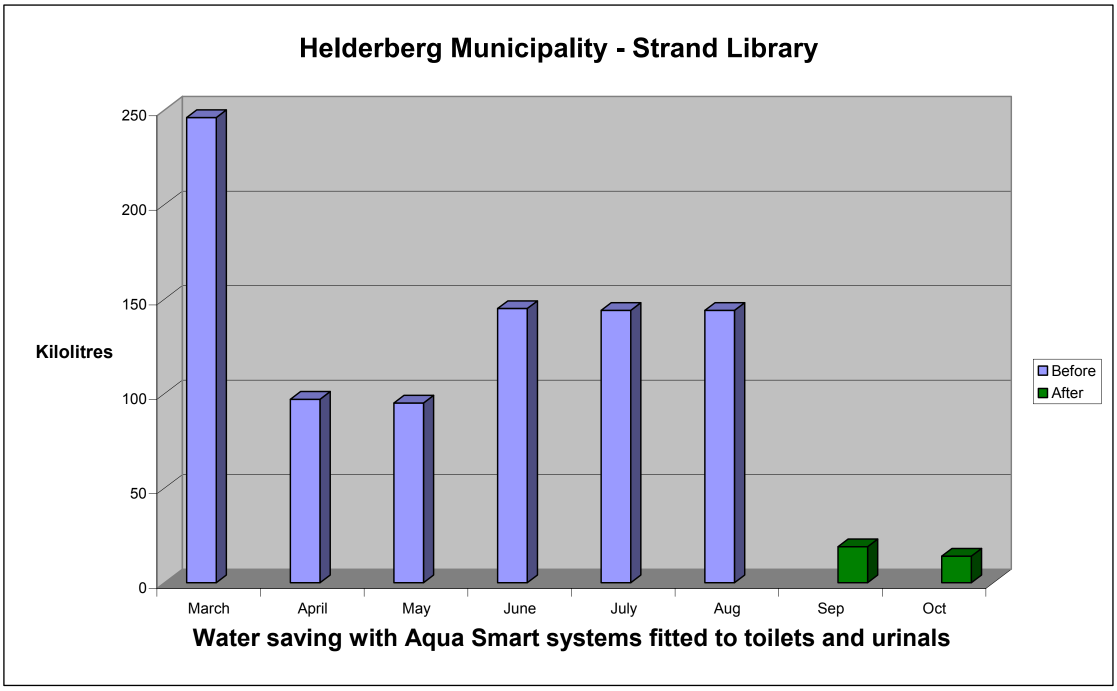


Figure 4.13: Water savings after retrofitting at the Strand Library
(Source: Mr. D. Stone, Aqua Smart Water Management, 2007)

As can be seen from the figures above, very significant water savings have been made. For example, in the Strand Main Building (Figure 4.11 above), the lowest water consumption in a month prior to the changes was 207 kilolitres (recorded in August). After the retrofit the highest water consumption was 107 kilolitres (recorded in December). The average water consumption prior to the retrofit was 268 kℓ per month. This dropped substantially to an average of 76 kilolitres per month after the retrofit. The table below outlines the savings in the three municipal buildings.

Table 4.13: Water savings made after retrofits – Helderberg Municipal Buildings

	Lowest water reading prior to retrofit (kℓ)	**Highest** water reading after retrofit (kℓ)	Average water consumption per month before retrofit (kℓ)	Average water consumption per month after retrofit (kℓ)
Strand Main Building	207	107	268	76
Somerset West Library	61	21	84	19*
Strand Library	95	19	145	16.5*

* Note: readings taken over a very limited time period may skew results
(Source: Mr. D. Stone, Aqua Smart Water Management, 2007)

4.2.2 Hermanus, Western Cape

The Greater Hermanus area is the 25 kilometre stretch of Coastline between the Bot River Lagoon and the Klein River estuary. 50% of total water consumption is for in-house domestic use and a further 26% for gardening. The permanent population of the town is about 20 000, but increases threefold during peak seasons. This is particularly problematic because the area receives winter rainfall and the peak holiday season is in summer (Turton, 1999).

Hermanus' water is supplied by the De Bos Dam, and when constructed in the late 1970's this was designed to meet the needs of the Greater Hermanus area until 2010. However, a property boom in the 1990's resulted in the water demand growing faster than expected, beyond the supply capacity. Supply side measures including raising the dam wall, exploiting groundwater supplies and desalination were explored, but none were found to be viable options. The Department of Water Affairs in conjunction with the local authority therefore implemented the Greater Hermanus Water Conservation Programme (Turton, 1999).

The Greater Hermanus Water Conservation Programme (Figure 4.14) was initiated in 1997 as a water demand management plan with 12 focal points[39], the most important of which were:

- Rising block tariffs

[39] The 12 focal points are: (1) Assurance of Supply Tariff, (2) Block Rate Tariff, (3) Hermanus Working for Water Project, (4) School Water Audits, (5) Water Loss Management, (6) Retrofit Programme, (7) Water-Wise Gardening, (8) Water-Wise Food Production, (9) Security Meter, (10) National Water Regulations, (11) Communication and (12) Informative Billing (Turton, 1999).

- Informative billing (Figure 4.15 below)
- Education and awareness (Figure 4.14 and Figure 4.16 below)
- Invasive alien vegetation clearing in the catchment
- Encouraging the use of well points and boreholes for garden irrigation – all groundwater users are registered with the municipality

Figure 4.14: Water consumption awareness sign at the entrance of Hermanus

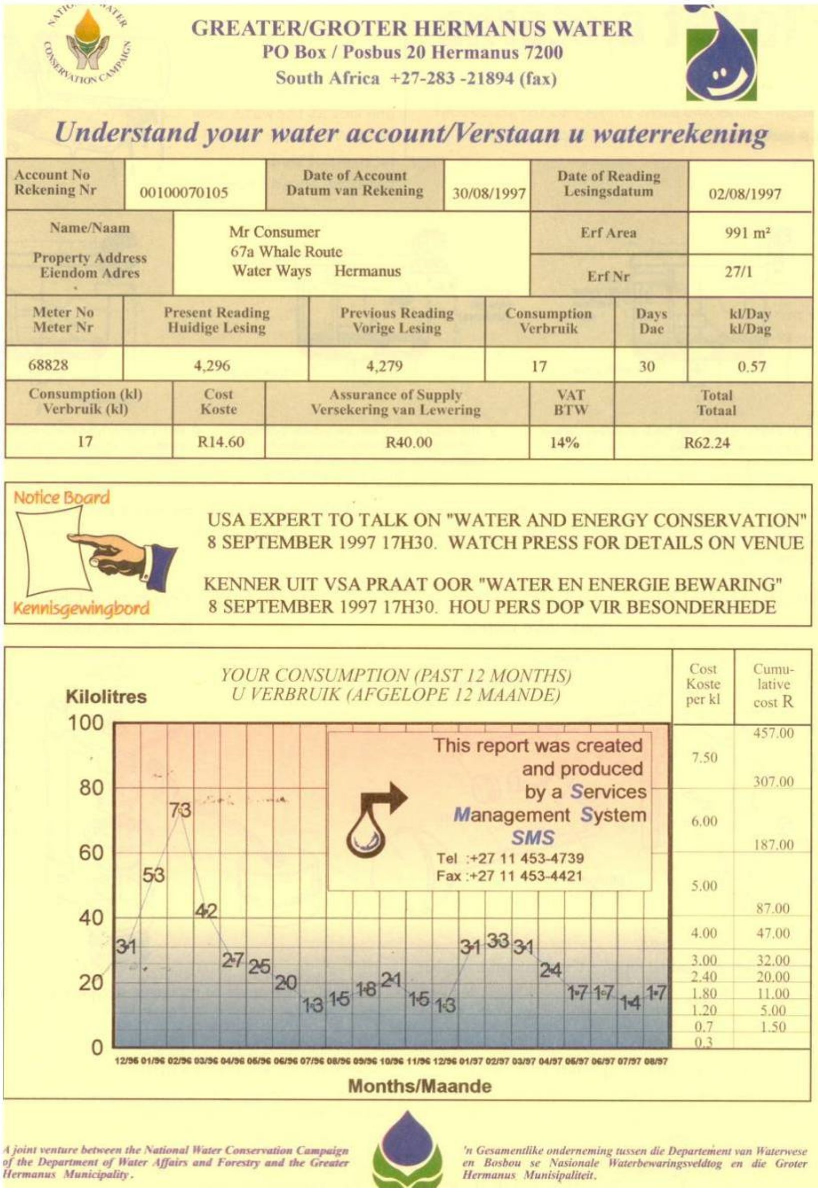
The Block-Rate Tariff

The principle behind the rising block tariff system is that the more water you use, the more you pay per unit. The 11 point escalating tariff provided the municipality with the means to provide a lifeline tariff to lower income users and charge excessive and wasteful use at a higher rate (Turton, 1999). The rising block tariff system was based upon an estimate of reasonable water use per residential unit and this was defined as a single residential unit. Where a user needed more water (for example for a guesthouse) they were allocated more than one residential unit equivalent (RUE). To take the example of a guesthouse, they would be allocated three RUE (for example). This would mean they paid 3x the fixed cost, were allocated 3x6 kl = 18 kl a month free and each tariff block volume was multiplied by three.

Education and Awareness

The awareness programme was focused on getting the users to understand the problem and providing them with information that they could use to reduce their consumption. Bea Whittaker, of Hermanus Municipality, believes the programme was a success because they were honest and open about what they were doing and this was critical in getting the users buy in. The relationship of trust between the users and the municipality was critical to the success. The awareness included information about Hermanus' water supply, water wise gardening, tips on how to water gardens most effectively, groundwater information as well as information on water efficient devices and maintenance of domestic water infrastructure.

The Schools Water Audits were designed so as to create a new water ethic amongst the children. The school children monitored the schools water meter over a period of a time and then investigated ways their school could reduce water consumption. This element of the programme hoped to have a long term influence over water consumption patterns (Turton, 1999).



GREATER/GROTER HERMANUS WATER
PO Box / Posbus 20 Hermanus 7200
South Africa +27-283 -21894 (fax)

Understand your water account/Verstaan u waterrekening

Account No Rekening Nr	00100070105	Date of Account Datum van Rekening	30/08/1997	Date of Reading Lesingsdatum	02/08/1997
Name/Naam Property Address Eiendom Adres	Mr Consumer 67a Whale Route Water Ways Hermanus			Erf Area	991 m²
				Erf Nr	27/1

Meter No Meter Nr	Present Reading Huidige Lesing	Previous Reading Vorige Lesing	Consumption Verbruik	Days Dae	kl/Day kl/Dag
68828	4,296	4,279	17	30	0.57

Consumption (kl) Verbruik (kl)	Cost Koste	Assurance of Supply Versekering van Lewering	VAT BTW	Total Totaal
17	R14.60	R40.00	14%	R62.24

Notice Board / Kennisgewingbord

USA EXPERT TO TALK ON "WATER AND ENERGY CONSERVATION"
8 SEPTEMBER 1997 17H30. WATCH PRESS FOR DETAILS ON VENUE

KENNER UIT VSA PRAAT OOR "WATER EN ENERGIE BEWARING"
8 SEPTEMBER 1997 17H30. HOU PERS DOP VIR BESONDERHEDE

A joint venture between the National Water Conservation Campaign of the Department of Water Affairs and Forestry and the Greater Hermanus Municipality.

'n Gesamentlike onderneming tussen die Departement van Waterwese en Bosbou se Nasionale Waterbewaringsveldtog en die Groter Hermanus Munisipaliteit.

Figure 4.15: An example of a water bill in Hermanus which includes a graph of water consumption by the householder

Retrofit Programme

The Water Demand Management Strategy originally included an extensive domestic retrofit programme that was to be implemented at no direct cost to the consumer and if the home owner consented. The installations proposed were dual flush toilets, low-flow showerheads and tap aerators (Turton, 1999). The degree to which this element of the Water Demand Management Strategy was implemented appears to have been limited. There are currently no plans to broaden the water management strategy to include water efficient devices. People who contact the municipality regarding water efficient devices are referred to local plumbers. This is due the to the municipal treasury believing that after three years there was no additional income from this and terminating the project funding. The only remnant of the water efficient device project is that letters approving housing plans include the sentence:

> "It is recommended that all new developments in Greater Hermanus consider the installation of water efficient devices"

Dual flush cisterns were installed in a township in Hermanus, but there was a high level of failure of the units.

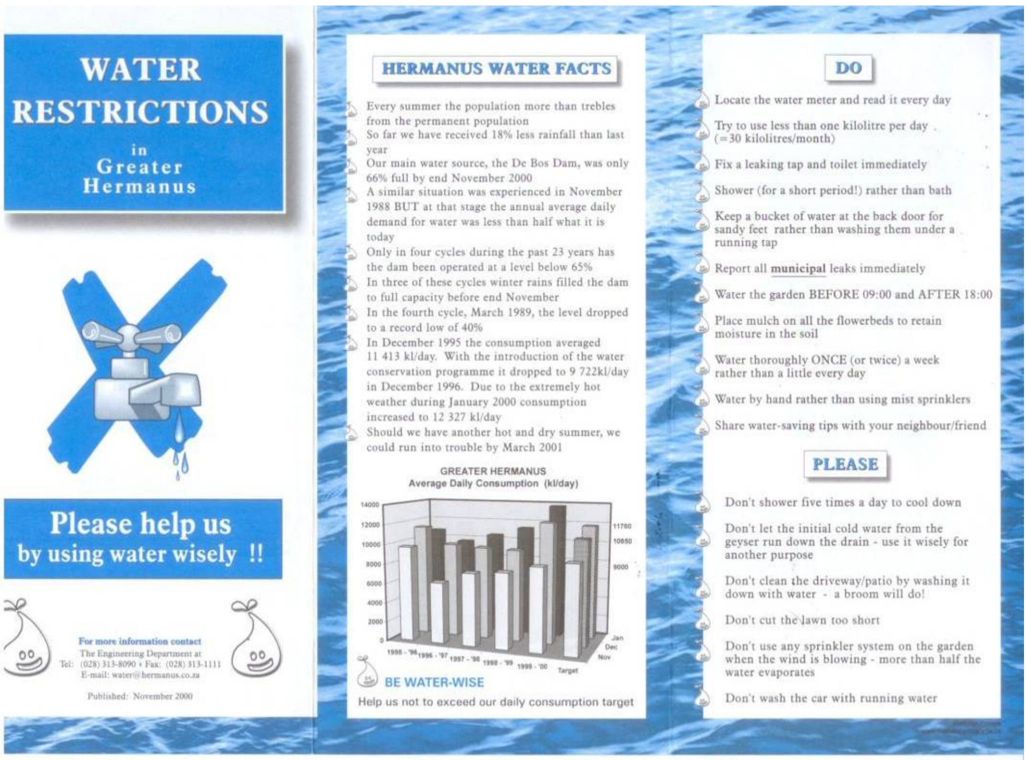


Figure 4.16: An example of a pamphlet that formed part of the Greater Hermanus Water Conservation Programme

Working for Water Project

Under the auspices of a National poverty alleviation strategy a “Working for Water” Team was employed to clear alien invasive vegetation from around the De Bos Dam. By removing alien plant species, the run-off into the De Bos Dam was enhanced and the yield of the dam would be improved (Turton, 1999).

The Hermanus Water Conservation Programme was discontinued several years ago as it was no longer considered a municipal priority.

4.2.3 Water demand management in Gauteng

4.2.3.1 Soweto

The supply of water to Soweto is characterised by high waste. Water supplied to the region averages around 70 kℓ per property per month, which is particularly high for relatively small properties. There are several reasons for the high levels of unaccounted for water in the area and these include:

- The ‘deemed consumption’ billing method for water services
- A lack of maintenance of private plumbing fixtures
- The poor condition of the water network (Rabe et al., 2005).

In 2004 Jo’burg Water commenced *Operation Gcin’amanzi* (“Save Water”), a programme to reduce water loss and wastage initially in Soweto. Through Operation Gcin’amanzi it was hoped that the community would benefit from:

- Improved water service delivery and customer interface
- Rehabilitated municipal infrastructure
- Rehabilitated private plumbing fixtures
- Temporary and permanent employment for unskilled and semi-skilled labour in Soweto
- Empowering the customer to take ownership of their water consumption
- Net reduction in the cost of water to the end user
- Dispensing Free Basic Water to all residential properties, and
- Reduced municipal service arrears based on acceptance of the prepayment metering system.

These objectives would be met through the installation of water meters and the fixing of all water leaks (termed the retrofit programme).

Electronic pre-paid meters

The prepayment metering system dispenses 6 000 litres of Free Basic Water to each property every month plus further water according to the credit on the meter of the property. The results achieved in the prototype area of Phiri included the average water supply dropping from levels of about 70 kℓ per residential property per month before the project an average of 25 kℓ per property per month. The full project is now underway, with a budget of close to R700 million, and expected water savings of R200 million per year (Singh, 2006). The pre-payment meters effectively transfer responsibility for water usage to the customer.

The retrofit programme

The retrofit programme involved fixing all on-site leaks, including pipe work and leaking plumbing fixtures. The project ensured that the retrofit products would be similar to the existing fixtures in the home. The exception was for the toilet cistern, all new cisterns had to have a maximum capacity of 9 litres.

Operation G'cin amanzi has achieved its results through improving the reliability of the service, through fixing leaks on domestic properties, through fixing leaks in municipal mains and in replacing mains, and through the implementation of a prepayment billing system (coupled with the 6 kℓ free water).

Detractors of the programme raise the following criticisms:

- Will homeowners be prepared to fix their leaking toilets and taps when next they start leaking, or will they expect the municipality to do it for them? Specialists in the field feel that a leak repair and retrofit programme can not be seen as a once off intervention.
- The 6 kℓ is insufficient for the indigent, given that they have waterborne sanitation.
- The 6 kℓ is not equitable, being standard for families small and large.

From a financial perspective, the project can be considered successful. However, there are still questions regarding the moral grounds and implications for health for households who are unable to curb water usage to within the free basic allowance or purchase additional water.

The financial success of the project has resulted in similar projects being implemented by the eThekwini and Cape Town Municipalities.

4.2.3.2 Emfuleni

Sebokeng and Evaton are two residential areas in the Emfuleni Local Municipality; they are served by Metsi-a-Lekoa, the water and sanitation business unit of Emfuleni municipality. These areas have a combined population of 420 000.

Historically many household plumbing fixtures in Sebokeng and Evaton have failed due to high pressures in the water network. This causes leakage and the leaks can remain for substantial periods of time before they are repaired. The overall effect is high levels of water wastage as measured in terms of Minimum Night Flow. The Minimum Night Flow was high in the area at 70% of the average peak daily demand flow rate. WATERGY Alliance[40] notes the Minimum Night Flow for Sebokeng and Evaton was the highest of the cities in the 12 countries the Alliance had worked with. It has been established that the bulk of the leakage in Sebokeng and Evaton is occurring within homes, based on night time sewer flows of 2500 m^3/h. With pressure management this figure was reduced to 1500 m^3/hr (Rabe, 2006).

In the project run by WATERGY in conjunction with the municipality the high operating pressures in the water system were reduced, preventing further damage to fixtures and reducing the amount of water wasted due to leaks. Further pressure reduction was implemented at night time when full operating pressures are unnecessary due to low demand. Pressure management in the Sebokeng and Evaton was relatively easily achieved as the municipal water is supplied from a single point (Rabe, 2005).

In the case of Emfuleni intervention there has not yet been any particular emphasis on water efficient devices.

Rand Water Retrofit Programmes

In addition to the Jo'burg Water "Gcin' amanzi Project", Rand Water has also implemented the following retrofit programmes:

- Soweto – water demand reduced by 500 00kℓ/month
- Kagiso: 6 000 houses – water demand reduced by 280 000kℓ/month
- Odi: retrofit 16 000 dual flush toilets & leak repair – 2.9kℓ/stand/month saved
- Sebokeng – water demand reduced 23kℓ/stand/month to 14.5kℓ/stand/month
- Thembisa-East: 14 500 stands (not possible quantify savings)
- Thembisa-West: 5 000 stands (not possible to quantify savings)
- Thokoza: 2 500 stands - 2 kℓ/stand/month saved (Jacobs, 2004).

Note: retrofits often only part of a larger programme therefore not all savings can be attributed to retrofits.

[40] The WATERGY Alliance is committed to improving water and energy efficiency worldwide. The Alliance has worked with over 40 municipalities in nine countries around the world since 1997, helping cities supply clean water and treat wastewater more efficiently, saving energy, water and money. For more information about WATERGY visit http://www.watergy.net

4.2.4 Water demand management in eThekwini

Dickens et al. (2004) reports how eThekwini was able to reduce water consumption to 1995 levels through the implementation a range of water demand management strategies. The programme focused on:

- Repairing water leaks
- Disconnecting some of the 90 000 illegal water connections
- Improving water fault reporting
- Implementing a pressure management system
- Installing prepaid meters
- Conducting community education campaigns
- Installing water efficient fittings
- Providing households with a free basic water allowance combined with a graded level of service provision for different socio-economic groups.

Water demand in eThekwini appears to be levelling out (Figure 4.17 below) with some of the earlier increases in demand a result of an increased number of residents receiving services. Therefore figures are likely to indicate a reduction in per capita water usage.

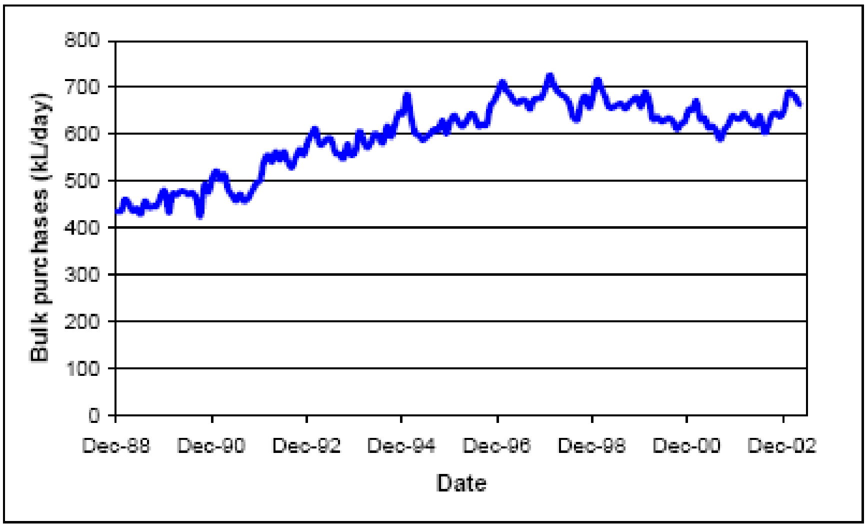


Figure 4.17: Water demand in Durban (eThekwini) between 1988 and 2003 (Source: Bailey, 2003)

Water demand in eThekwini is sensitive to changes in price. Unlike in the other cities studied, the lower income users in Durban are more likely to adjust water consumption patterns downward as tariff increase than either middle or higher income groups (Figure 4.18 below).

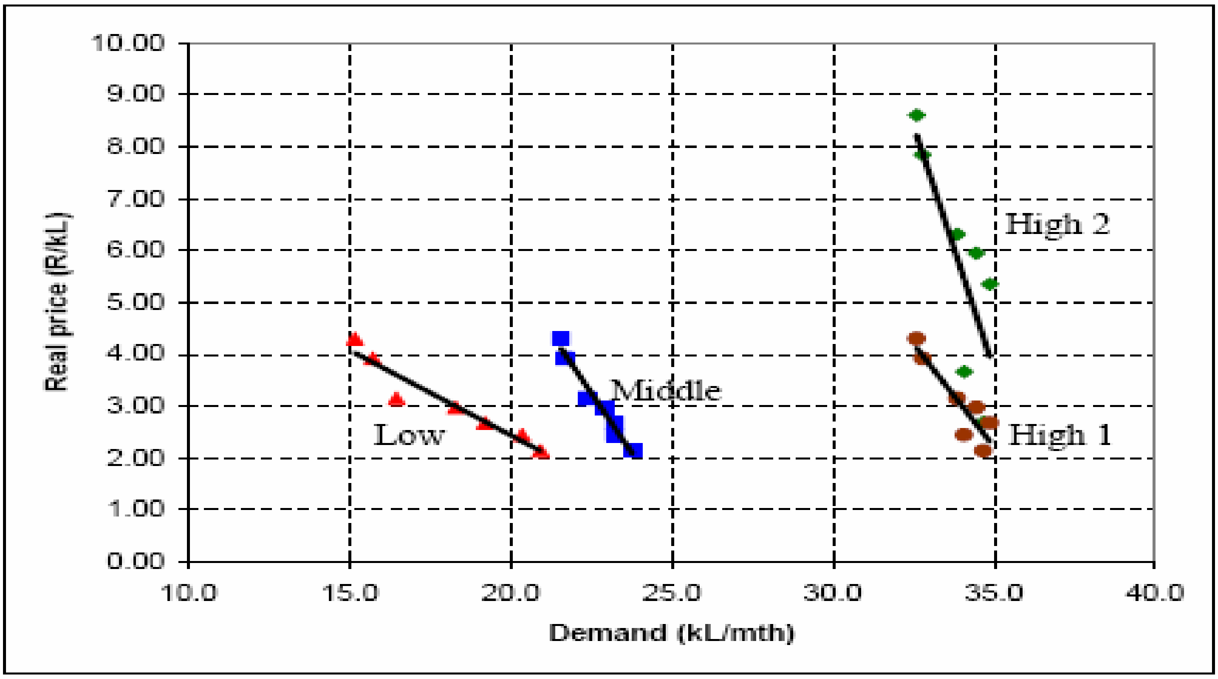


Figure 4.18: Relationship between average monthly demand and real marginal price (base 2000) for low[41], middle and high income groups in Durban

(Source: Bailey, 2003)

Bailey (2003) also found that increasing temperature was associated with increasing water demand, a relationship that was more positive for the lower income water user group than the other two groups. A similar relationship was found between rainfall and water demand, i.e. increasing rainfall was correlated with increasing demand for water. The author of the report comments that while this was unexpected, the relationship may be partly due to the correlation between temperature and rainfall.

[41] In the absence of micro-level household income data, low, middle and high income groups were determined by looking at the property valuation role.

5 A REVIEW OF MUNICIPAL BYLAWS RELATING TO WATER EFFICIENCY

5.1 Introduction

The review of international experience (see Chapter 1) indicates that the building profession, plumbers and plumbing trade manufacturers are unlikely to seriously engage with the issue of water efficiency in the domestic and commercial settings unless they are encouraged to do so by legislation (it is after all not them who will be paying for the water). The Water Services Act (No 108 of 1997) places the responsibility for the management of water provision to consumers at local government level. It is thus at this level that bylaws have to be promulgated to mandate a move to water efficiency.

Unfortunately it is not as simple as one might think to review what municipal bylaws around South Africa have to say on this topic. The research team has been unable to locate any one centralised record, online or on paper, which contains all the current municipal bylaws of South Africa [should such a record be created it would no doubt assist all those concerned with or interested in local government matters in South Africa]. Accordingly bylaws have been collected through legal libraries and from the municipalities themselves. Bylaws from the following municipalities have been assembled: Cape Town, eThekwini (Durban), Msunduzi (Pietermaritzburg), Tshwane (Pretoria), Ekurhuleni (East Rand), Overstrand (Hermanus), Buffalo City (East London), uMhlatuze (Richards Bay), Mbombela (Nelspruit), Johannesburg, Bloemfontein, Sol Plaatje (Kimberley), Emfuleni (Vanderbijlpark), Polokwane (Pietersburg) and Nelson Mandela (Port Elizabeth). The bylaws range from very new (Cape Town, September 2006) to very old (Hermanus, 1953, revised in 1986).

This chapter contains an overview and analysis of what those fourteen sets of bylaws have to say about water conservation and water efficient devices specifically. The team was unsuccessful in obtaining copies of bylaws from the following municipalities, despite a concerted effort: Bisho, East London and Umtata. Nevertheless, with the 14 cities and towns that are represented, the bylaws governing 52% of those in South Africa with in-house or in yard piped water will have been covered (see Table 5.1 below). To cover the other 48% of South Africa's population which has piped water will require a study of the bylaws of another 155 Water Services Authorities, which would be beyond the scope of this study. Moreover, it seems that the smaller the local government body, the less likely it is to have updated its bylaws.

Table 5.1: Numbers of people supplied with water at "above RDP service level" (i.e. in house water supply) according to the DWAF Free Basic Water website

Town/City Name	Number of people served
Bloemfontein	492 612
Buffalo City (East London)	454 719
Cape Town	2 915 860
Ekurhuleni (East Rand)	2 510 987
Emfuleni (Vanderbijlpark)	686 182
eThekwini (Durban)	2 588 299
Johannesburg	3 300 636
Mbombela (Nelspruit)	317 484
Nelson Mandela (Port Elizabeth)	854 377
Overstrand (Hermanus)	62 099
Polokwane (Pietersburg)	316 729
Sol Plaatje (Kimberley)	182 957
Tshwane (Pretoria)	1 819 035
uMhlatuze (Richard's Bay)	174 110
uMsunduzi (Pietermaritzburg)	415 081
Total	**18 275 518**
Total in South Africa served with water at "above RDP service level" (i.e. in house or yard supply)	**31 813 840**
% of these in the towns and cities listed above	**57%**

(Source: www.dwaf.gov.za, accessed 30 April 2007)

5.2 Bylaws reviewed

The Model Water Services Bylaws issued by the Minister of Water Affairs and Forestry in terms of the Water Services Act 108 of 1997 have been analyzed, as well as the bylaws of the following municipalities relating to potable water supply (gazette dates, where available) appear next to each municipality's name):

- Bloemfontein 25 April 1975
- Cape Town 1 September 2006
- Buffalo City (East London) 23 April 1982
- Ekurhuleni (East Rand) 6 March 2002
- Emfuleni (Vanderbijlpark) 21 May 2004
- eThekwini (Durban) (gazette date not confirmed)
- Johannesburg 21 May 2004

- Mbombela (Nelspruit) 5 March 2004
- Nelson Mandela (Port Elizabeth) after 1990
- Overstrand (Hermanus) 19 June 1953
- Polokwane (Pietersburg) draft
- Sol Plaatjie (Nelspruit) 5 March 2006
- Tshwane (Pretoria) 5 November 2003
- uMhlatuze (Richard's Bay) 2005 (final draft)
- uMsunduzi (Pietermaritzburg) 17 March 2005

5.3 Model Water Services Bylaws

The Model Water Services Bylaws are recommendations intended to assist municipal authorities in the formulation of their own bylaws dealing with the supply of potable water and incidental matters. Much of the content of these Model Bylaws has been incorporated by most of these municipalities. The Model Bylaw provisions pertaining to the conservation of water and prevention of water wastage contain the following main provisions:

- Municipal consent for the installation of new pipes and fittings.
- Standards pertaining to the quality and installation of pipes and fittings.
- Powers of municipal authority to prevent wasteful use of water or to impose restrictions on the use of water in the event of water shortage, drought or flood.
- Prohibitions on the waste of water by consumers.
- Requirement of an annual water audit required by water users who consume more than 3650 kilolitres per annum.

In addition to the above main aspects, the following provisions are also relevant:-

- Water demand management (water saving measures).
- Offences and associated penalty clauses.

The summarised provisions below constitute a combination of all the municipalities' measures taken together, thus providing an overview of the kinds of water conservation measures currently in force. Tables comparing the various municipalities' provisions are included in Appendix E.

5.4 Key Water Conservation Measures Identified

The following important provisions emerge from an analysis of the bylaws of the abovementioned municipalities:

5.4.1 Standards for Quality and Installation of Pipes and Fittings

Standards for quality of and installation of pipes and fittings have the potential to prevent wastage of water. With the exception of Overstrand municipality, whose bylaws do not appear to have been substantially overhauled since their promulgation in 1953, the bylaws examined all reflect similar provisions to the Model Water Services Bylaws, and in the main these provide that where pipes and fittings are installed in a context other than repair work:

- Written municipal approval to the owner of the premises is required (in some municipalities this requirement is limited to non-dwelling units).
- Pipes and fittings must be SABS approved items, listed in a schedule.
- Installations must comply with prescribed standards and procedures.
- Installation work must be conducted by a qualified and approved plumber.

5.4.2 Water Use Restriction

The municipal authority is empowered, at its discretion, under special circumstances, or in case of emergency, flood, drought, or water shortage, to:

- Prohibit or restrict use of water during specified hours, on specified days, or for any specified purpose.
- Impose a special tariff for water consumed in excess of a set amount, and a general surcharge in respect of consumption.
- Order a consumer to install meters to measure and devices to restrict the flow of water.
- Restrict the use of a water-consuming appliance, or the connection of such an appliance to the water supply.
- Require a consumer to install a measuring device, or device restricting the flow of water, at the consumer's expense.

5.4.3 Prevention of Inefficient or Wasteful Water Use

The following key provisions emerged:

- Prohibition on wasteful discharge of water, leaking or defective components, persisting overflow, or persisting 'wasteful use'.
- Power of municipality to cut off water supply to any premises in order to prevent wastage.
- Power of municipality's authorised representative to enter premises to do necessary emergency work at owner's expense.

- Prohibition on persons to allow water wastage to occur.
- Obligation upon owner to replace pipes or fittings which cause or are likely to cause wastage of water, and power of municipality to take such steps at owner's cost, should owner fail to comply with a notice to do so.
- Prohibition on the use of inefficient water installations.
- Duty imposed on public to report water wastage.
- Requirement that consumer ensure that any equipment or plant connected to a water installation uses water in an efficient manner. This should cover industrial plants. The lack of a definition of 'efficient manner' is noted.

Limits on shower flows

Limits on shower flows are becoming more common. Tshwane, Ekurhuleni, Cape Town, uMhlatuze, and Emfuleni all specify a maximum shower flow of 10 litres/min. The other bylaws do not specify the maximum shower flows.

Automatic flushing urinals

Old style automatic flushing urinals are illegal in Tshwane, Ekurhuleni, Cape Town, uMhlatuze, and Nelson Mandela. The other by laws do not have this clause.

Limits to Cistern Capacity

Limits to cistern capacity are becoming more common, with the following being specified:

- Cape Town	9.5 litres
- eThekwini	9.5 litres
- Nelson Mandela	between 9.5 and 8.5 litres
- Ekurhuleni	6 litres
- uMhlatuze	6 litres
- Emfuleni and Tshwane	9.0 litres (with dual flush/interruptible flush if more than 4.5 litres)

The other bylaws are silent on this subject.

5.4.4 Water Saving Measures: Potable Water

An extract from Cape Town’s new water services bylaws is reproduced on page 131 of this report. For a detailed comparative analysis between the fourteen municipalities’ bylaws, see the four tables in Appendix E.

The following requirements were identified:

- No watering of gardens, sports fields, parks or other grassed areas, between 10:00 and 16:00, without prior written authority.
- Where a hosepipe is used for the above purpose, a controlling device such as a sprayer to be attached to the hose end.
- No hosing down of hard-surfaced or tarred areas without prior written authority
- Hosepipe used for washing vehicles, boats, caravans must be fitted with an automatic self-closing device.
- Potable water may not be used to dampen building sand and other building material to prevent it from being blown away.
- Prohibition on automatic top-up systems using a float valve to supply swimming pools and garden ponds.
- Commercial car wash industries must recycle 50% - 70% of the water used.
- Wash hand basins in public facilities must be fitted with demand type (metering) taps.
- Maximum flow rate from any tap installed in wash hand basin may not exceed 6 litres per minute.
- Hand basins in batteries of three or more must be fitted with metering tap which limits discharge to 1 litre per usage.
- Showers at public facilities must be fitted with demand valves.
- A shower with more than 200 kPa pressure at the shower control valve and where the water pressures are balanced between the hot and cold water supply to the shower control valve, may not have a shower head with a maximum flow rate of more than 10 litres per minute.
- Showers in batteries of two or more must be fitted with metering device that limits discharge to 2.5 litres per usage.
- Water closet cisterns may not exceed 9.5 litres in capacity, or have a smaller capacity than 8.5 litres.
- A single flush device installed in a cistern serving in a water closet pan shall not be capable of discharging more than 6 litres of water in one complete flush.
- In a dual flush unit, the full flush level may not discharge more than 6 litres of water in a complete flush, and the low flush level in a dual unit may not discharge more than 3 litres of water in a complete flush
- Any cistern not for public use and having a capacity of over 4.5 litres must have a device allowing interruptible or multiple flushes.
- A non-manually operated flushing device shall be so designed that if it malfunctions no flush will take place.

- No automatic cistern or tipping tank may be used for flushing a urinal.
- Automatic flushing cisterns fitted to urinals must be replaced within 2 years of promulgation of the bylaw, with either manually operated systems, or non-manual apparatus which causes the flushing device to operate after each use.
- The overflow pipe from a water closet cistern shall be carried through an outside wall of the building so that discharge of water is readily visible from outside the building.
- A terminal water fitting other than a valve float serving a cistern or storage tank, shall be installed in such a position and in such a manner that the discharge of water from it is visible.
- Terminal water fittings installed outside buildings other than residential dwelling must incorporate a self-closing device, have a removable handle for operating purposes, be capable of being locked to prevent unauthorised use, and be of a demand type that limits the quantity of water discharged in each operation.
- Stand pipe draw-off taps must be at height of at least 450 mm measured above ground level.
- No person may allow water used as a heat-exchange medium in any equipment or plant and supplied from a water installation, to run continuously to waste except in order to maintain a prescribed level of total dissolved solids in a recirculating plant.
- A pipe conveying hot water directly from a fixed water heater or from the point of take-off from a hot water circulating system, to a terminal water fitting shall not contain a volume of more than 4 litres.
- The electrical heating element of a fixed water heater having a capacity of more than 500 litres shall be removable without loss of water from such heater.
- FIRE FIGHTING INSTALLATIONS: Prohibition of water usage from unmetered fire fighting installations, and provision for levying charges for unauthorised use.
- WATER AUDIT: Major water users, defined as those using more than 3 650 kilolitres per annum, must undertake an annual water audit. [NOTE: Tshwane bylaws provide that an audit may be required of any customer and is not limited to users of water over an amount of 3 650 kℓ/pa]. Such an audit must contain the following detail:
    1. amount of water used
    2. amount paid for water
    3. number of people living on premises
    4. number of people permanently working on premises
    5. comparison of above factors with those reported in each of the previous 3 years
    6. seasonal variation in demand (monthly consumption figures)
    7. details of water pollution monitoring methods
    8. details of current initiatives to manage demand for water
    9. details of plans to manage water demand

10. comparison of above factors with those reported in each of previous 3 years
11. estimate of consumption by various components in use

5.4.5 Offences

All the above bylaws contain specific penalty clauses as well as a general penalty clause for any non-compliance or violation of the provisions contained in the bylaws. The accompaniment of a penalty clause in the form of an appropriate maximum fine is obviously essential to create a deterrent effect. It is noted that the maximum fine for contravening any water bylaw provisions varies tremendously, from as little as R50, to R20 000. It is clear that a greater uniformity is necessary across municipal boundaries, to reflect a consistent approach to penalizing offenders.

5.5 Building Codes

It is significantly less expensive to include water efficient devices at the time of the initial house construction than it is to retrofit them into properties at a later stage. Revised building codes in terms of water efficiency need to be considered across the range of housing stock, and these should not exclude lower income housing developments. Even where the new housing stock is heavily subsidised by government and building materials and fixtures tend to be restricted by capital outlay water efficient technologies that are appropriately priced do exist (particularly low flush, leak free and dual flush toilets). Fitting water efficient devices in low cost housing developments would not only ensure housing is more environmentally sustainable, it would also assist home owners to contain household water bills.

An Interdepartmental Task Team set up to assist the National Department of Housing develop policies and strategies aimed at promoting environmentally sound housing has drafted the “National Norms and Standards in Respect of Permanent Residential Structures”. The document explores innovative and progressive options for improving the water and thermal performance of residential dwellings. Under water consumption, the policy document states:

> “The design of the water supply and the specification of devices such as taps, showers and toilets must be in accordance with the aims of the National Water Conservation Campaign.”

This includes

> “…appropriate devices such as: water-conserving taps, low flow rate shower-heads, [and] dual flush toilets”. (Scholand et al., 1999).

6 WATER EFFICIENT DEVICES IN SOUTH AFRICA: A SURVEY OF DOMESTIC USER KNOWLEDGE AND ATTITUDES

6.1 Introduction

A survey was carried out to evaluate the level of use and awareness of water efficient devices by domestic consumers in ten cities across five provinces. The questionnaire asked households about the use of water efficient devices and water conservation or saving practices in their homes and gardens. The questionnaire included three questions asking consumers to consider their current water consumption patterns and what would motivate them to consider reducing it (through the installation of water efficient devices or modified behaviour).

A pilot study of domestic water consumers from Pietermaritzburg and the surrounding areas was conducted between December 2005 and January 2006 using a quasi-random sampling method from the local area phone book. Following the pilot survey, the questionnaire and sampling method was modified. The final questionnaire is shown in Appendix F. The sampling method was modified to ensure that the sample was representative of different economic groups within the cities (based loosely on the profile of the residential area) and the size of the city.

Prospective participants were interviewed over the telephone with the aid of the questionnaire. Due to the size of the sample, a number of research assistants were employed to conduct the survey in the various areas. Each interviewer was provided with notes about water efficient devices to ensure a common understanding and knowledge. Interviews were carried out over the period of April 2006 to March 2007.

For each successful survey to be carried out, approximately three homes had to be contacted, i.e. the response rate was about 33% across most cities.

Figure 6.1: Map of cities surveyed

Table 6.1: Domestic user sample sizes

City	Sample Size[42]
Durban, KwaZulu-Natal	240
Pietermaritzburg, KwaZulu-Natal	94
Cape Town, Western Cape	250
Hermanus, Western Cape	50
Johannesburg, Gauteng	272
Pretoria, Gauteng	145
Polokwane	141
Port Elizabeth, Eastern Cape	149
Garies, Northern Cape	40
Springbok, Northern Cape	47
Total	**1 428**

[42] Sample size reflects the numbers of respondents after certain questionnaires were discarded. Questionnaires were removed from the sample because respondents either did not have municipal water connection or the connection was limited to a communal or garden standpipe.

6.2 Limitations of the domestic survey

Due to the large number of people surveyed, the geographical distribution of the survey and the need for explanations to be provided in several languages there were 12 different interviewers. While each interviewer was given the same instructions and background information there is likely to be some difference in the way the interview was approached, the recording of information and understanding of water efficient devices.

The survey might undercount the number of water efficient devices households have. This is because not all respondents would necessarily know how many litres of the water the cistern used for each flush or the type of shower fittings their homes have. For example many low cost housing projects have fitted 6 litre cisterns as standard (to prevent high water bills amongst low income households). The relatively small percentage of respondents who reported they had low volume flush toilets might in fact be an undercount.

As with much consumer awareness research, respondents are inclined to answer questions relating to their willingness to use or pay for various devices in a positive way if they think they are likely to get something for free. Many respondents will also tend to provide you with the "right" answers to questions, as one interviewer summed up in a debriefing session:

> "They [the respondents] immediately give me the answers they think I want to hear without really thinking about it. You can call this politeness or lies, whichever you choose…"

On the other hand, some respondents seemed wary that if they indicated they would like to install one or more of the water efficient devices, that someone (Jo'burg water), would come and install the plumbing fixture and then the resident would be forced to pay for it. The interviewer explains:

> "When they heard me asking questions about special new water efficient fittings they were hoping that Johannesburg Water was going to come and fit them for free. Once they understood that they will not get new fitting for free some were afraid that someone will come and fit the fittings and the force them to pay for them. This made them nervous about showing interest and asking questions."

6.2.1.1 Note on Water Efficient Washing Machines

After analysing two data sets it was decided to exclude water efficient washing machines from the analysis. This was because there was no way of verifying whether a machine was in fact water efficient. This was an oversight in the interview, and the interviewers should have been instructed to ask further questions if people answered that a top loading machine was water efficient if the machine was older than 15 years. In addition, some machines require users to select the water saving option (i.e. they are not automatically water efficient).

6.3 Results from the Domestic Survey

Results are presented to indicate the level of uptake of water efficient devices across South Africa, followed by an analysis of why households do or do not have water efficient devices within their homes and gardens. While it is acknowledged that there are relatively few water efficient devices for use outdoors, the significant amount of potable water consumed in gardens means it is important to consider attitudes and perceptions to outdoor water use.

6.3.1 Uptake of water efficient devices

Uptake of water efficient devices across South Africa can generally be described as low. Only 29% of the respondents indicated that they had fitted one or more water efficient device. Of the 10 cities sampled, Pretoria has the highest uptake of water efficient devices with 64% of homesteads fitted with at least one such device.

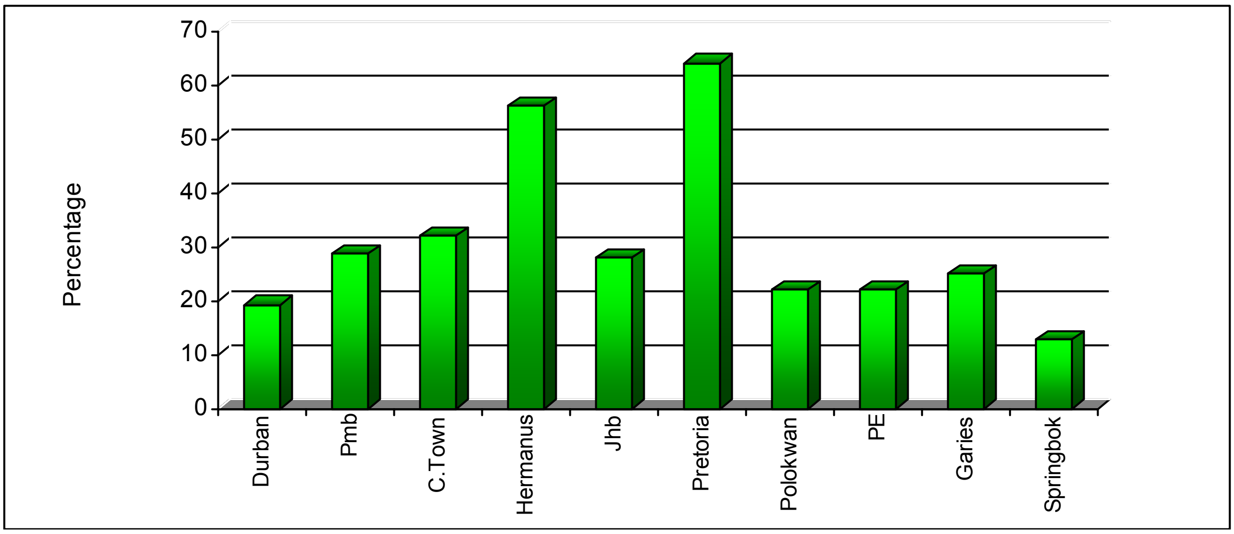


Figure 6.2: Percentage of households making use of at least one water efficient device[43] within their homes (sample sizes vary for each city)

[43] Households were asked whether they had any of the following devices installed: low volume flush toilet, dual flush toilet, low flow shower, aerated tap, cistern displacement device (e.g. a Hippo Bag or a brick) or any other device.

Pretoria residents were also more likely to have more than one water efficient device fitted; just over half of all households had installed more than a single device.

The most common water efficient device fitted in South African homes was reported to be a cistern displacement device (Figure 6.3 below). Low volume flush toilets were also popular.

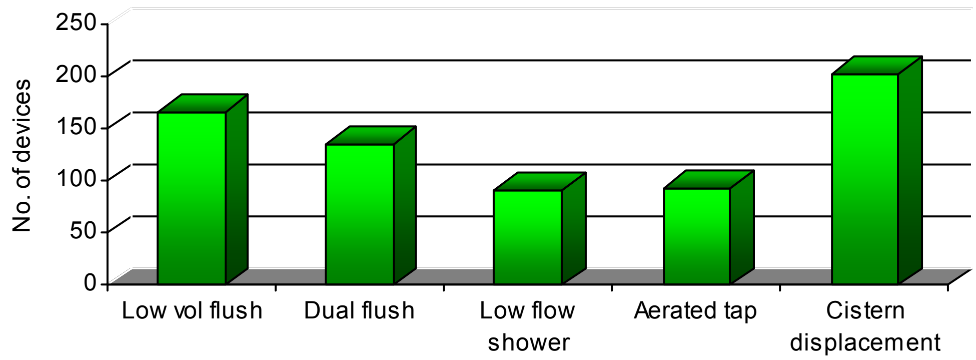


Figure 6.3: Number and type of water efficient devices fitted in survey respondents' homes

As a large percentage of potable water is still used for gardening, it is interesting to investigate the extent to which households are aware of outside water consumption and making an effort to reduce it. Many studies have shown that stand size is directly correlated to water consumption; the larger the stand sizes the more water the household uses. Unless households install a greywater recycling unit, reducing water consumption in the garden relies on adapting gardening practices and therefore does not make use of water efficient devices as such. Figure 6.4 below highlights the extent to which South African homeowners practice water-wise gardening[44].

[44] Water-wise gardening techniques would include mulching around plants, planting indigenous plants, watering early in the morning or late evening, re-using household water to water plants, water with a can/bucket.

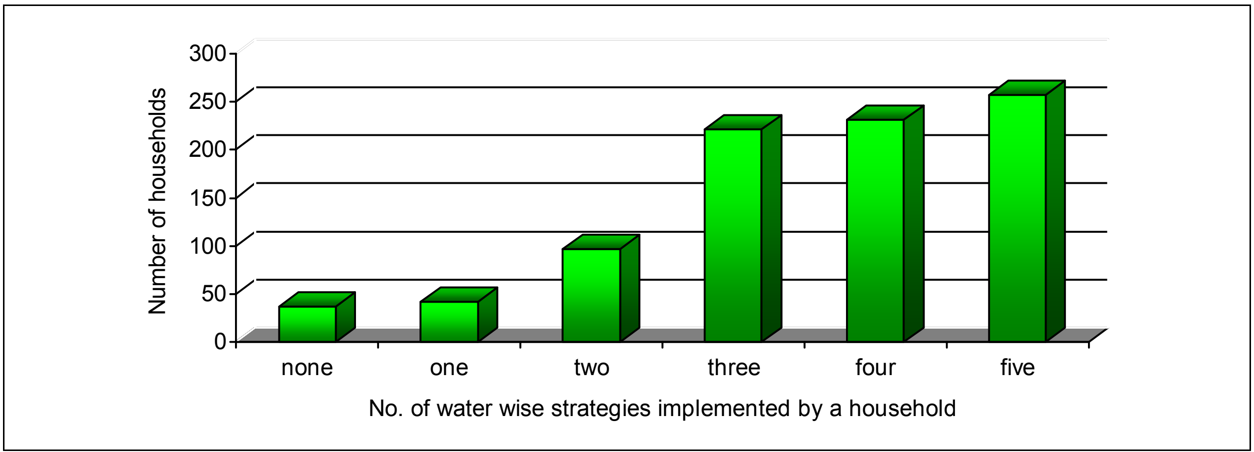


Figure 6.4: The number of water-wise gardening strategies implemented per household (for households with gardens[45])

Most gardeners (96%) practice at least one water wise gardening technique. Pretoria, Hermanus and Garies are more aware of water conservation than the other cities, with more than 50% of households with gardens practicing four or more water wise strategies simultaneously. Durban has the lowest percentage of water-wise gardening households, with only 9% of gardeners implementing water saving strategies.

6.3.2 Reasons for the low uptake of water efficient devices

It is unlikely that respondents would consider installing water efficient devices in their homes unless they a) thought their water consumption was excessive or b) had considered trying to reduce water consumption for economic, environmental or legal requirements (such as water restrictions). Therefore, the questionnaire began with three obvious questions:

1) Do you think your household uses too much water?
2) Have you considered reducing your water consumption?
3) Why?

Most of the respondents surveyed did not think their households used too much water (see Figure 6.5 below). In some areas, for example Garies, this is likely to be a true reflection of water use practices. Respondents from water scarce areas, such as Garies and Springbok, were more aware of the need to use water sparingly and efficiently.

> "Water is scarce and expensive." (Springbok resident)

> "We use as little as possible." (Garies resident)

[45] 885 households reported having gardens in the survey.

We use rainwater for drinking and household use." (Garies resident)

In many other areas, respondents seemed to take water for granted, were largely unaware of water efficient devices or strategies, or even how much water they consumed.

"I simply pay the water bill, I have never thought of reducing consumption." (Durban respondent)

"I don't see any need to reduce my water consumption. I am still OK with payments. I've heard of the devices but do not intend to install them because there is no provision for the cost and I am still OK with my fittings." (Johannesburg resident)

"Why do I have to save water if I am paying for it?" (Pretoria resident)

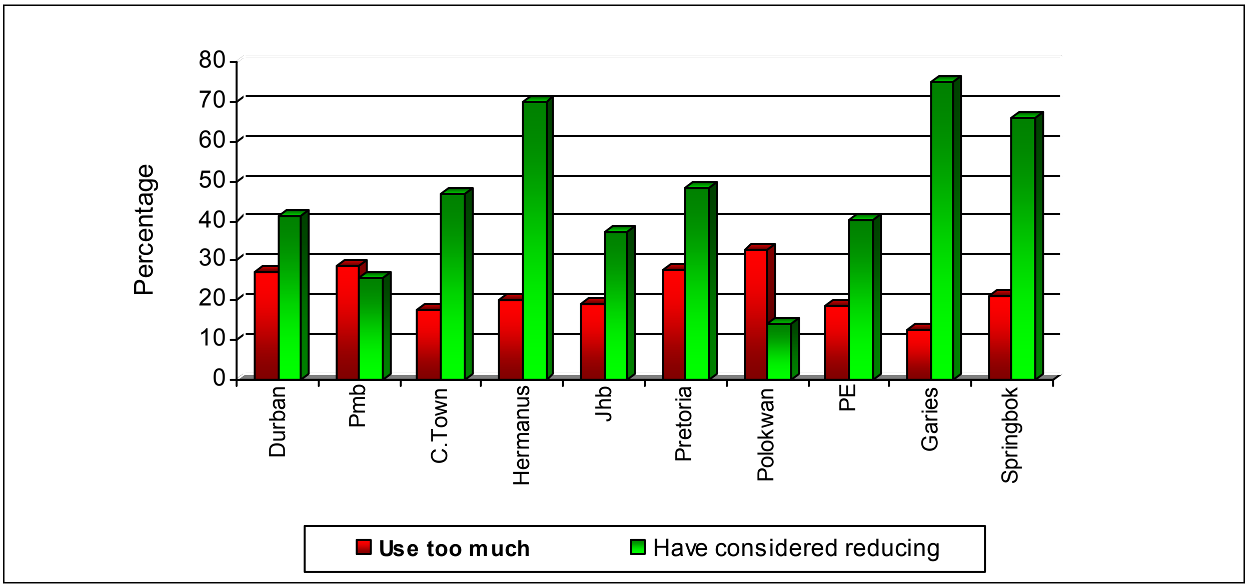


Figure 6.5: Percentage of households who thought they used too much water and percentage of households that have considered reducing water consumption (sample sizes vary for each city)

Many more households indicated that they have considered reducing their water consumption than thought they consumed too much water. There were definite trends in terms of the responses by areas and income groups. In many lower income areas respondents had considered reducing water in order to contain high water bills. In more arid parts of the country and areas with recent water restrictions, respondents indicated the scarcity of water and restrictions were primary reasons for considering reducing their water consumption. Therefore, the low uptake of water efficient devices is not attributable to lack of a desire to save water.

Households provided a number of reasons why they had not installed water efficient devices in their homes (see Figure 6.6 below). The main reason was ignorance – most respondents had never heard of water efficient or water saving devices.

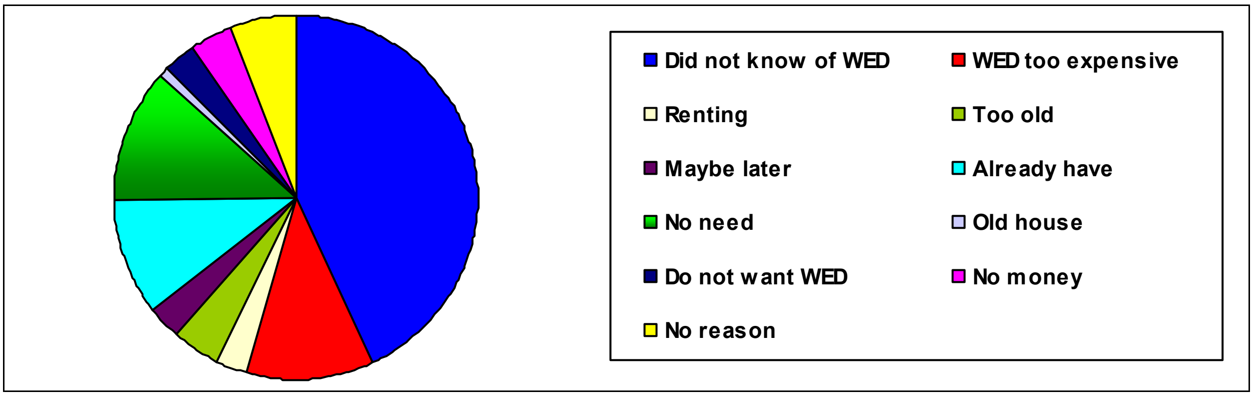


Figure 6.6: Reasons why households reported not installing water efficient devices

The lack of general knowledge about the existence of water efficient devices or their benefit for home owners was highlighted by some of the respondents who indicated that their use of water efficient devices would certainly be higher if

> "… the stores marketed and displayed water efficient devices" (Johannesburg resident)

> "If there is access to information about these devices in the community or maybe if it is advertised in radio, newspapers, television etc." (Pietermaritzburg respondent)

> "She is interested in the water efficient devices but however is not prepared to install them because she is not aware of them. The water efficient devices must be well advertised on television, newspapers, internet and radio to motivate her to install the devices in the near future. It is the first time hearing about water saving devices and is shocked that they exist." (Pietermaritzburg respondent)

> "I would like to install water efficient devices, but only if there is a demonstration of the devices. I would prefer to see it working first, before installing." (Polokwane resident).

When water is not metered (and therefore not paid for), when water meters don't work, when meters are perceived as not working or when families do not receive water bills any of these factors act as a disincentive to save water, for example

> "Don't think it [water efficient devices] is necessary because we stay in a block of flats" (Port Elizabeth respondent)

> "The meter reader does not read the meters, they just estimate and the water bills come up very high." (Pietermaritzburg resident)

Working water meters seem to have acted as an effective incentive to residents in Johannesburg to reduce water consumption and contain water usage with the free basic allowance:

> "We are already saving water because we are using water meter system."

> "I collect rain water because I am using prepaid meter."

> "It is not been long that we have been using the meter, it shows us how much we are using."

Once residents have made the decision to reduce water consumption, they are more likely to be open to technologies that help them achieve this. Whether for financial or ecological reasons, developing an understanding of the need to conserve water is a necessary first step in improving the uptake of water efficient devices.

A number of respondents indicated that they had already installed some of the devices and would be interested in installing others. Lack of information about other devices and the cost of installing them were often cited as prohibiting factors.

> "I already have some [water efficient devices] and would install the rest if money was available." (Polokwane resident)

> "I do not know about the others [water efficient devices]". (Polokwane resident)

These results seem to indicate that there is scope for improving the uptake of water efficient devices across South Africa.

6.3.3 Potential for increasing uptake of water efficient devices

Respondents were asked for each device they did not have fitted whether they would like to install one. Amongst many of the respondents (particularly respondents from low income areas) there was a tendency to say "yes" to every device. This was regardless of whether they had any knowledge about the device or whether it would be logical to install two different devices that reduce water consumption for the same activity[46]. Therefore results need to be interpreted considering this bias.

Potentially the most popular device to install would be a dual flush toilet. Cistern displacement devices were the most well known device, but one of the less popular amongst respondents (Table 6.2 below).

Table 6.2: Number of respondents indicating they would like to install water efficient devices in their homes

Water efficient device	**No. of respondents who would like to install the device**	**Percentage of respondents who do not have the device and would like to install one**
Low volume flush toilet	359	28.5
Dual flush toilet	420	32.3
Low flow shower	406[47]	30.4
Aerated tap	370[48]	27.7
Cistern displacement device	377	30.8

There were interesting differences between cities. Respondents from Hermanus and Pretoria were more likely to know about the various water efficient devices than residents in other cities. Considering that Pretoria already has the highest uptake of water efficient devices, the greatest acceptance of water efficient devices is likely to be in Garies, Springbok and Hermanus.

Although uptake of water efficient devices is low, there is a high level of user satisfaction with the products. Most respondents indicated that based on their experience, they would recommend water efficient devices to others (Figure 6.7 below).

[46] Many of the respondents indicated they would like to install both a low volume flush toilet and a dual flush toilet (and some even included a cistern displacement device as well). In terms of water saving one or the other would be sufficient.
[47] Note: only 294 of the respondents had ever heard of a low flow showerhead, yet 406 respondents indicated they would like to install one.
[48] Note: only 235 of the respondents had ever heard of an aerated tap, yet 370 respondents indicated they would like to install one.

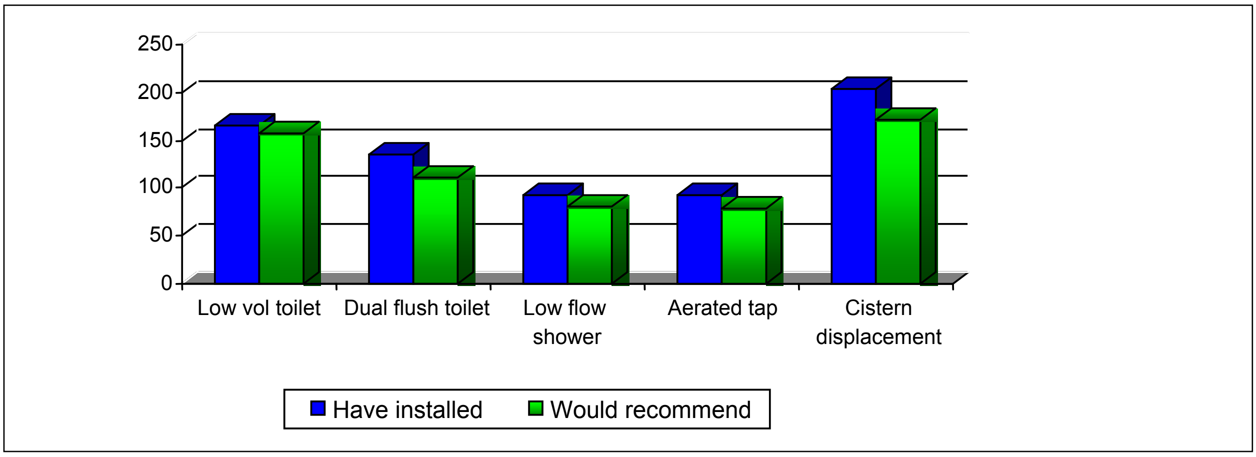


Figure 6.7: A comparison of the number of water efficient devices installed and whether user would recommend the device to others

Very few of the respondents were prepared to comment on their willingness to pay for water efficient devices, and a recurring theme amongst the participants was the perception that the cost of water efficient devices would be too expensive and/or unaffordable.

The survey seems to indicate that without municipal intervention, the uptake of water efficient devices will remain low. Municipal intervention can be in the form of education, incentives to adopt water efficient technologies, penalties for wasting (inefficient water usage) or a combination of all three.

Figure 6.8 below highlights which strategies respondents thought would be the most motivating to them to reduce water consumption and act as incentives for increasing the uptake of water efficient devices.

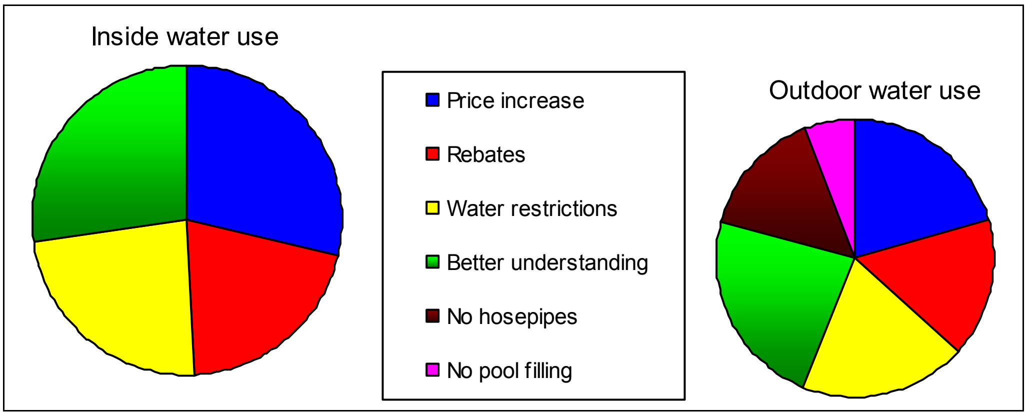


Figure 6.8: Factors that would encourage respondents to fit water efficient devices in their homes save water in their gardens

From Figure 6.8 above it appears as though the biggest incentive to encourage households to fit water efficient devices to their homes and save water in the garden would be *a better understanding of how to save water.* An increase in the price of water would be effective in encouraging home owners to fit water efficient devices inside their homes, but less effective in reducing outside water consumption. Water restrictions which have been traditionally used in the past were not viewed by the respondents as being particularly good incentives.

The question also asked if respondents thought any other incentives could be introduced to save water. While the number of respondents suggesting alternatives is insignificant (and therefore not included in Figure 6.8 above), suggestions included:

- A visible gauge that would help create awareness about the amount of water being used for various activities.
- Leak detection and management (by both homeowners and the municipality)
- Penalties for wasting water
- Improved marketing and advertising of the devices
- If water efficient devices were available free of charge
- If water efficient devices were affordable
- Compulsory/mandatory use of water efficient devices
- Drought conditions.

One respondent indicated that increased water prices, rebate schemes and other interventions would only be successful if people display

> "… a willingness to save water" (Port Elizabeth respondent).

The questions regarding incentives for outdoor water use reduction gave rise to some interesting feedback from respondents. Respondents indicated that if watering their gardens became very expensive or labour intensive they would simple pave most of the area. Other respondents indicated that they would more seriously consider sinking a borehole or harvesting rainwater to ensure they could maintain their gardens. Some pool owners worried that if their pools were left to run low that would have longer term repercussions:

> "…can't prohibit people filling their pools, pools might crack and waste even more water" (Johannesburg respondent)

From early on in the survey it became apparent that the lack of general awareness about water efficient or water saving devices was a definite barrier to improving their uptake. Other factors are summarised in the boxes below.

Summary Box:
Barriers to water efficient device usage

- Awareness of devices
- Affordability
- Income
- Home ownership
- Perception of own water use
- Standard installations (especially in low-cost housing)
- Satisfaction with current products

Summary Box:
Incentives to water efficient device usage

- Access to devices
- Environmental awareness
- Water restrictions & education
- Planned refurbishment
- Owning own home
- Water authorities setting a good example

6.3.4 Rainwater harvesting and grey water recycling

Rainwater harvesting is a practical way of augmenting municipal water supplies and along with grey water recycling helps to reduce potable water consumption within a household. It is therefore useful to consider rainwater harvesting and greywater recycling in conjunction with water efficient devices.

Greywater recycling

Only nine respondents indicated that they recycled water and only one used a recycling system. Eight of the households which reported recycling water were from lower income areas and was almost exclusively the reuse of laundry water in the garden:

> "… after washing [clothes] we reuse the water to water the garden." (Pretoria respondent)

Rainwater harvesting

A total of 347 households (24%) of the sample reported harvesting rainwater. Rainwater harvesting is extremely popular in more arid areas and areas that have historically been short of water, such as Garies and Springbok (Figure 6.9 below).

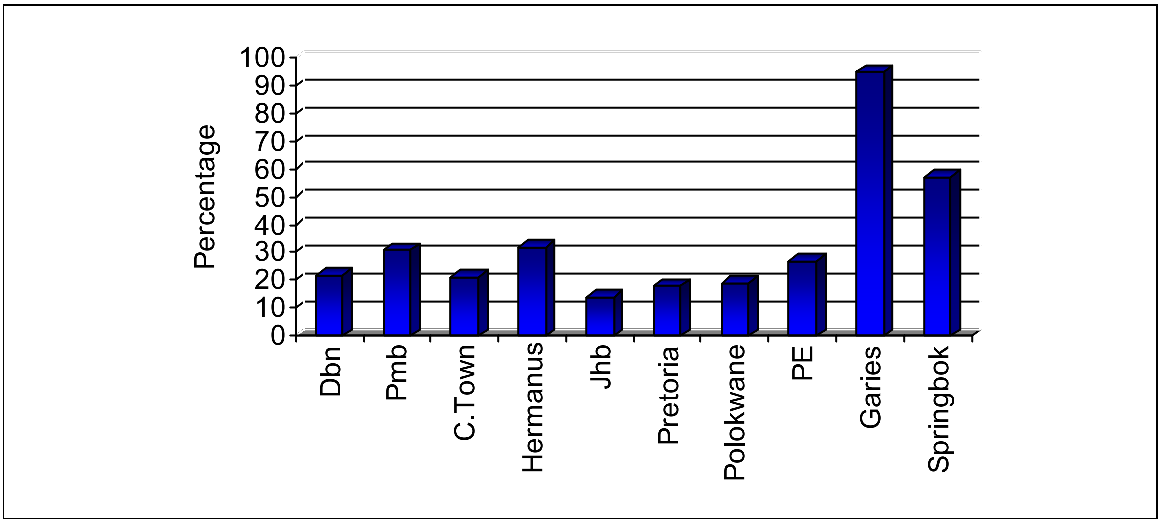


Figure 6.9: Percentage of respondents harvesting rainwater (sample sizes vary for each city)

The use of rainwater varies across the country. In dry areas, like Garies and Springbok, respondents reported collecting rainwater for essential household activities, including domestic consumption. In other cities, rainwater is used predominately for watering gardens and plants and car washing. A few respondents from lower income areas reported using water for essential domestic chores.

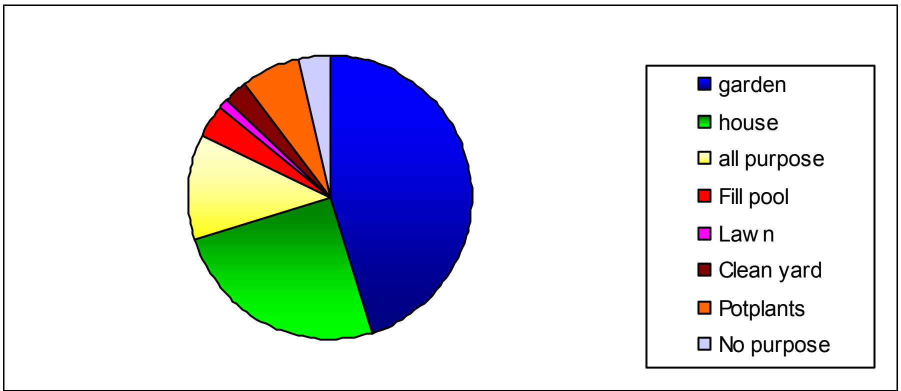


Figure 6.10: Uses of harvested rainwater in cities across South Africa

The potential for rainwater harvesting is overlooked by a number of South African households. Rainwater harvesting can be as simple as directing your roof down pipes into your swimming pool or into flower beds. In areas such as Garies, the older homes were constructed with rainwater tanks under the verandas. More modern systems usually consist of the guttering from the roof being directed into a storage tank that has some sort of a filter to prevent leaves and other debris getting into the tank.

6.3.5 Summary of findings

In summary then, the survey suggests that many South African residents (from all income groups) would be open to the concept of water efficient devices. However, information and marketing of these products needs to be far more aggressive. It seems unlikely that this will come from within the industry and therefore outside (municipal or government) intervention is needed if the use of these devices within the domestic sector is to make a significant impact on potable water demand in the future.

7 ARCHITECTS AND WATER EFFICIENCY: A SURVEY OF ATTITUDES AND PRACTICES

The previous chapter explored domestic user knowledge and attitudes towards water efficient devices in an attempt to gain some insight into the usage of water efficient devices across South Africa. This chapter explores the results from a survey undertaken amongst architects across the country. The aim of the survey was to establish how professionals feel about water efficient devices and the extent to which they promote their use.

7.1 Methodology

A questionnaire previously used by the CSIR in a study undertaken in 2002 amongst architects was used as a basis for a new survey. The new questionnaire consisted of nine questions dealing with plumbing fixture preferences, experience with water efficient devices and sources of information about water efficient plumbing fixtures. The questionnaire is included as Appendix G.

It was initially thought that the questionnaire would be sent to both quantity surveyors and architects, but it was established early on in the process that quantity surveyors have limited input into the selection of plumbing fixtures and devices. They were subsequently excluded from the survey.

The South African Institute of Architects database[49] was used to obtain additional contact details for architects around the country. A total of 152 e-mails were successfully[50] sent. Response rates were very low. Follow-up phone calls resulted in leaving messages, limited responses and “not interested” responses.

In the end a total of 19 questionnaires were returned, including five questionnaires from architects that indicated that the questionnaire was not relevant to them i.e. they were not responsible for selecting plumbing fixtures.

[49] The database was accessed via the internet: http://www.saia.org.za
[50] A total of 175 e-mails were sent, but 23 of the e-mails failed to deliver.

7.1.1 Limitations of the study

The very low response rate (12.5%) and the fact that the final sample was only 14, makes it difficult to say conclusively that this is the how the industry as a whole views water efficiency.

7.2 Results

The results are presented to reflect three key aspects that relate to the use of water efficient devices in local building projects. These are:

1. The criteria used by architects for selecting plumbing fixtures (Section 7.2.1).
2. Whether architects consider water efficiency in design and what water efficient devices they are most likely to make use of (Section 7.2.2)
3. Sources of information about water efficient devices (Section 7.2.2.1)

An analysis of the results follows and comparisons are made with findings from the 2002 CSIR study and the survey of plumbing outlets contained in Chapter Two of this report.

7.2.1 Criterion for selecting plumbing fixtures

Cost and *durability* are the most frequently cited criteria for selecting plumbing fixtures. If the criteria for selecting plumbing fixtures are ranked, *durability* and *efficiency* become the most important criterion followed by *aesthetics/style* and *cost* (see Table 7.1 below).

7.2.2 Considering water efficiency in design

64% of the respondents indicated that they did consider water efficiency in their designs generally. Three respondents indicated that they consider water efficiency regardless of whether they were designing a low cost, middle income or upmarket development. A further two architects who do not design for low-cost housing developments would consider water efficiency in both middle income and upmarket developments.

Table 7.1: Ranking of criteria for selecting plumbing devices

Criteria	**Score[51]**	**Ranking**
Durability	12	1
Efficiency	**12**	**1**
Aesthetics/style	9	3
Cost	9	3
Availability	8	5
Reliability	5	6
Back-up/maintenance	4	**7**
Ecological impacts/site sensitivity	4	7
Solar heating	3	9
Performance	2	10
Clients preference/motivation	2	10
Grey water retrieval	1	12
Brand	1	12

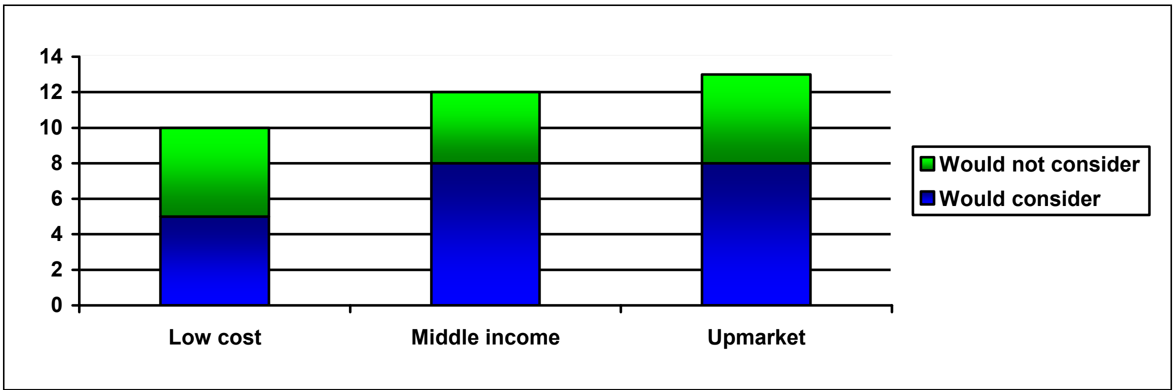


Figure 7.1: The number of respondents who indicated that they would consider water efficient devices in low cost, middle income or upmarket developments

It is unlikely that clients play a major role in influencing the architect to select a water efficient device as only two architects indicated that clients usually ask for such devices.

[51] Respondents were asked what they considered to be the three most important criteria to use in the selection of water components. A point allocation of 3 was allocated to the first criteria, 2 to the second and 1 to the final criteria. The points were then added to give a final score.

7.2.2.1 The use of water efficient devices

Aerated taps and dual flush toilets are the most commonly used water efficient devices, with 93% of the respondents indicating they had made use of such a device (Figure 7.2 below). Low volume flush toilets and rainwater tanks are also popular amongst architects. These are also the three water efficient devices most likely to be used by the architects in the future.

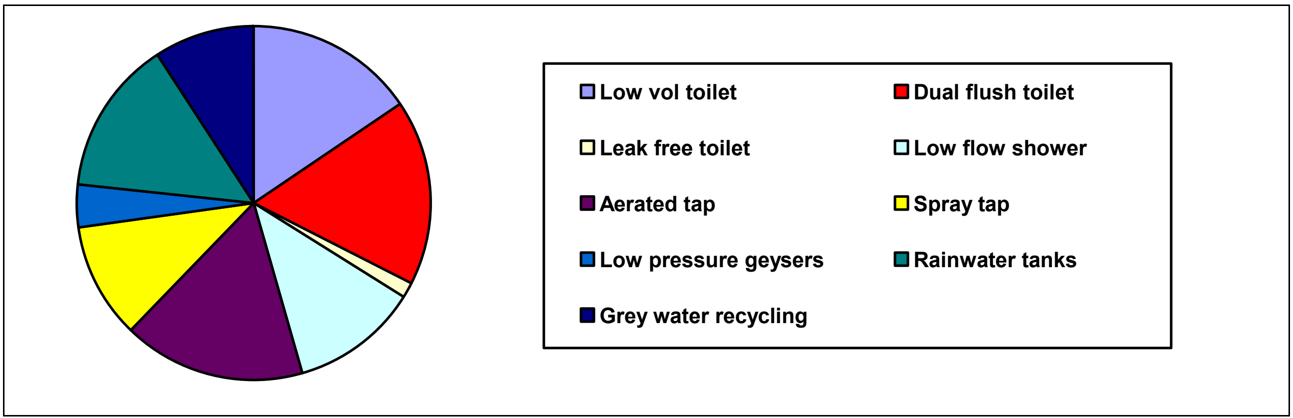


Figure 7.2: Water efficient devices that architects have used in developments

The low usage of leak free toilets can be attributed to the fact that most (64%) of the respondents had never heard of this product.

Products that were widely available in the market place and acceptable to clients were most likely to be selected by the architects. Several architects highlighted that for water efficient devices to be acceptable to the client they must not require the users to alter their behaviour and must “sell themselves”.

7.2.3 Information sources

There is no one definitive source of information on water efficient devices. Most architects surveyed rely on a combination of trade literature, design specification tools and retail and manufacturer reps. One respondent was of the opinion that there was no good local source of information and using international literature and websites was more useful.

7.3 Analysis

Even though water efficiency is considered a critical component for selecting a plumbing fixture (see Table 7.1 above), the use of the devices in projects remains low. As clients rarely request water efficient devices, the increased use of such devices will rely on the architects incorporating them into their designs on a more regular basis.

Most architects surveyed thought that as a profession, architects do not take enough responsibility for ensuring water efficiency within people's homes (Figure 7.3). However, some of the respondents were quick to point out that more a proactive approach needs to be taken by the government through improved legislation and incentives:

> "In my opinion these aspects are usually very low in priority for clients as there seems to be too little institutional incentive for people to take sustainability seriously… I do feel that we need better legislation about how we impact on and abuse our natural resources. Local authorities need more teeth to encourage, maybe enforce minimum requirements…"
>
> "We operate within the building regulations. If you want change, change the regulations".

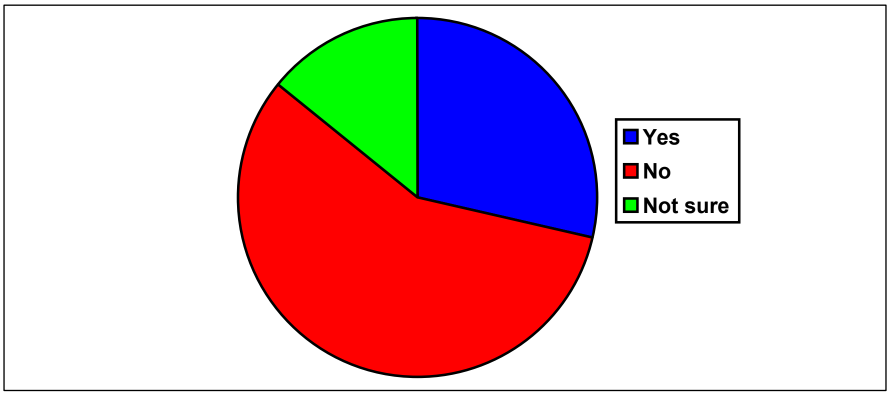


Figure 7.3: Respondents who thought their profession took enough responsibility for ensuring people's homes are water efficient

7.3.1 A comparison of the architects responses with plumbing supply stores

In Chapter 2 of this report, plumbing supply outlets were asked to rank what they thought customers prioritised in terms of plumbing fixtures. It is interesting to compare their perception of important criteria with that of the architects.

As can be seen from the Table 7.2 below, there are not significant differences. It is also interesting to note that while 'elegant and stylish' is perceived as important by architects, it is ranked far lower by plumbing outlets and yet plumbing outlets marketing (especially their websites) focuses on this attribute.

Table 7.2: A comparison[52] of product criteria ranking (based on perceived importance to customers) between plumbing outlets and architects

Product criteria	Ranking by pluming outlets	Ranking by architects
Work effectively†	1	6 (reliability) 10 (performance)
Robust and durable	2	1
Use water efficiently	3	1
Easy to maintain	3	7
Priced competitively*	3	3
Supported by superb customer service	4	
Easy to install	5	7
Elegant and stylish	6	3
Other: • Does not use any water • No scrap value resulting in minimum theft	7	

† Works effectively and reliability/performance were equated across the two studies.
* Priced competitively and Cost were equated across the two studies

7.3.2 A comparison with the CSIR study

The CSIR study undertaken in 2002 asked respondents to nominate whether for each plumbing fixture selected one of twelve criteria was *critically* important, *considered only* or *not considered.* The criteria were:

- Aesthetics
- Availability
- Confidence in manufacturer
- Corrosion resistant
- Cost
- Country of manufacture
- Cut and paste from previous projects
- Ease of maintenance
- Familiarity with product
- Manufacturers technical specifications
- Resistance to vandalism
- Water consumption/efficiency

[52] It should be noted that the plumbing outlets were given eight criteria (and the option to include "others") to rank in order, whereas the architects had no list from which to work.

The study found that the most important criteria in terms of selecting plumbing fixtures was *aesthetics* and *confidence in the manufacturer*, both of which were considered critically important by around 80% of the respondents. *Availability*, *cost* and *ease of maintenance* were also considered critically important by over 50% of the respondents. *Water consumption/efficiency* was considered to be critically important by only 20% of the respondents (CSIR, 2002).

It is interesting to note that priorities seem to be changing amongst professionals. Based on the comparison between this survey and the 2002 survey, water efficiency is increasing in importance in their decision making. *Cost* and *aesthetics* remain important considerations, but *confidence in the manufacturer* (equated with *brand* in this survey) has lost prominence.

8 THE ECONOMICS OF WATER EFFICIENT DEVICES

8.1 The Payback Period

The formula relating the cost of an investment to the return on that investment and the applicable interest rate is

$$A = P \left[\frac{i\,(1+i)^{n}}{(1+i)^{n} - 1} \right] \qquad \text{Equation 8.1}$$

where

- P is the cost of the investment
- A is the income derived from the investment at the end of each of
- n periods of time, and
- i is the applicable rate of interest.

This formula is also used for calculating the repayments to be made over n periods on a loan of value P at the interest rate *i*.

In the case of water efficient devices, it is unlikely that the organisation or person considering the investment will be doing so in order to make money, i.e. as a business decision per se. The consideration will be "How long will it take for the savings in water to pay for the cost of the water saving measures taken". In other words, the key consideration is the *pay back* period.

The formula above can be solved for *n,* the payback period, and rewritten as follows:

$$n = \frac{\log \left[\dfrac{A}{A - i.P} \right]}{\log(1+i)} \qquad \text{Equation 8.2}$$

The income derived from the investment (A) is equivalent to the value of the water saved, which will be the volume of water saved times the marginal cost of water applicable to that saving (i.e. where the user is paying for water on a stepped tariff, the marginal cost will be the value of the highest step applicable to the user's monthly water account).

Figures 8.1 and 8.2 below show a set of curves derived for monthly savings of R10, R20, R30, R50, R70, R100, R200, R300, R500, R700, R1 000, R2 000, R3 000, R5 000, R7 000 and R10 000. The smaller amounts would apply to a domestic setting, while the higher amounts would apply to a commercial setting such as a hotel. The graphs are plotted on a logarithmic scale, as the relationships between the investment value, the savings generated and the payback period are logarithmic (see Equation 8.2 above).

On Figures 8.1 and 8.2 a horizontal line has been drawn at 40 months on the Y axis. Those purchasing water efficient devices may wish to see them pay for themselves in 40 months or less, so this is drawn as an indication of the boundary between an attractive and a not so attractive investment. [This is used for illustration purposes. Each person or organisation will have their own resistance level beyond which they will not feel happy to make an investment. However, in the case of water efficient devices, there are factors that count against an investor taking a long view – e.g. will the device work? Will the device last? Will I still own the house or building in 3 or 5 years time?].

Figure 8.1 shows the payback periods applicable based on an applicable real interest rate of 5%, while Figure 8.2 shows the payback periods applicable based on a real interest rate of 15%. The 5% rate would be appropriate if the investor was using cash for which they had no other use. The latter, 15%, would be appropriate if the investor was using borrowed money, or money that would otherwise have been invested at a high rate of return.

8.2 Some worked examples of payback period

Over short payback periods of 10 months or less the differences between the curves in Figures 8.1 and 8.2 are not that noticeable, due to the compressing effect of the logarithmic scale.

It is easier to see the effect of interest rate on a specific worked example. Figures 8.3 and 8.4 show the calculations and results for three scenarios, each involving the calculation of the time required for the savings generated from the installation of a water efficient device costing R2000 (say, a dual flush toilet) to pay for the device. The calculation is repeated for 6, 8 and 12 users respectively, and it is assumed that each user would be using the device four times per day, saving 5 litres each time. The figures show that in order for such a retrofit to be attractive (defined here as having a payback in less than four years) at a 15% interest rate, a large number of users (12 in this case) would be needed. At an interest rate of 5% the investment is fair with only 8 users.

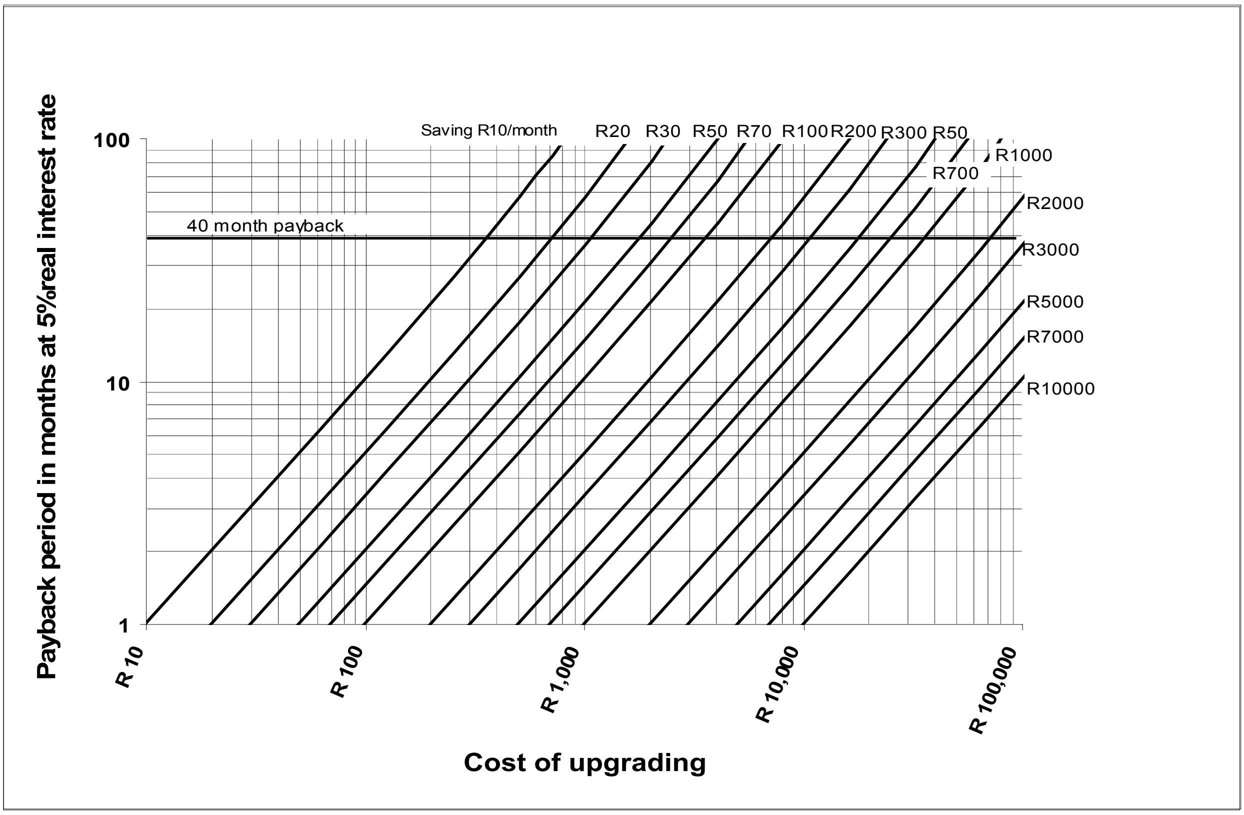


Figure 8.1: Payback period for investments at various rates of savings generated, at 5% interest

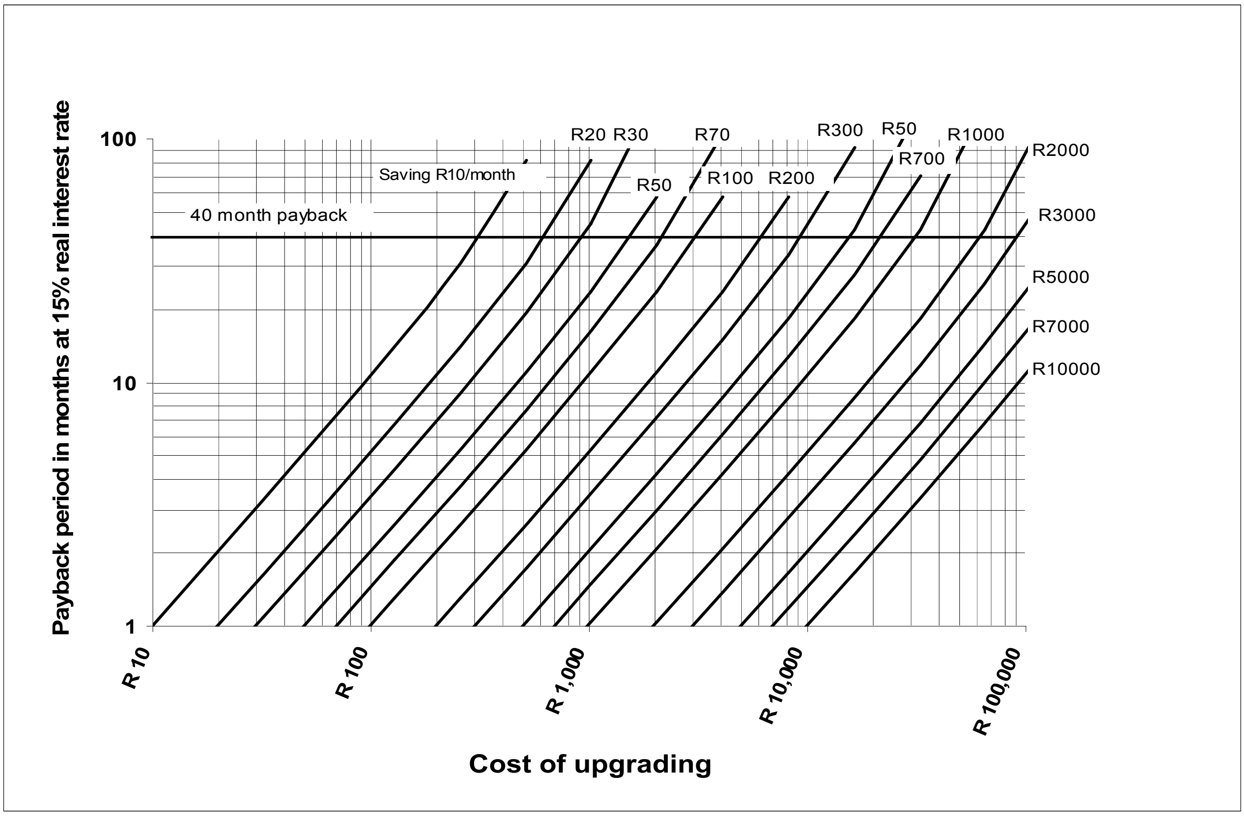


Figure 8.2: Payback period for investments at various rates of savings generated, at 15% interest

IS IT WORTH INVESTING IN WATER EFFICIENT DEVICES TO SAVE WATER?

Example 1. A marginal investment

If the marginal price of water is	R8.00			
and the device is used by	6	users		
who each use the device	4	times per day		
and each time they use it	5	litres is saved, compared with the device it is replacing		
then the **volume** of water saved per month is				
	3 650	litres		
and the **value** of water saved per month is				
	R29.20			
If the purchase and installation of the device costs			R2 000	
and the real interest rate is			5.0%	per annum, compounded monthly
then the **payback period** is			81	months
		or	**6.7**	**years**

Example 2. A fair investment

If the marginal price of water is	R8.00			
and the device is used by	8	users		
who each use the device	4	times per day		
and each time they use it	5	litres is saved, compared with the device it is replacing		
then the **volume** of water saved per month is				
	4 867	litres		
and the **value** of water saved per month is				
	R38.93			
If the purchase and installation of the device costs			R2 000	
and the real interest rate is			5.0%	per annum, compounded monthly
then the **payback period** is			58	months
		or	**4.8**	**years**

Example 3. An attractive investment

If the marginal price of water is	R8.00			
and the device is used by	12	users		
who each use the device	4	times per day		
and each time they use it	5	litres is saved, compared with the device it is replacing		
then the **volume** of water saved per month is				
	7 300	litres		
and the **value** of water saved per month is				
	R58.40			
If the purchase and installation of the device costs			R2 000	
and the real interest rate is			5.0%	per annum, compounded monthly
then the **payback period** is			37	months
		or	**3.1**	**years**

Figure 8.3: Worked example for R2 000 retrofit at 5% interest.

IS IT WORTH INVESTING IN WATER EFFICIENT DEVICES TO SAVE WATER (2)?

Example 1. A poor investment

If the marginal price of water is	R8.00			
and the device is used by	6	users		
who each use the device	4	times per day		
and each time they use it	5	litres is saved, compared with the device it is replacing		
then the **volume** of water saved per month is				
	3 650	litres		
and the **value** of water saved per month is				
	R29.20			
If the purchase and installation of the device costs			R2 000	
and the real interest rate is			15.0%	per annum, compounded monthly
then the **payback period** is			156	months
		or	**13.0**	**years**

Example 2. A marginal investment

If the marginal price of water is	R8.00			
and the device is used by	8	users		
who each use the device	4	times per day		
and each time they use it	5	litres is saved, compared with the device it is replacing		
then the **volume** of water saved per month is				
	4 867	litres		
and the **value** of water saved per month is				
	R38.93			
If the purchase and installation of the device costs			R2 000	
and the real interest rate is			15.0%	per annum, compounded monthly
then the **payback period** is			83	months
		or	**6.9**	**years**

Example 3. An attractive investment

If the marginal price of water is	R8.00			
and the device is used by	12	users		
who each use the device	4	times per day		
and each time they use it	5	litres is saved, compared with the device it is replacing		
then the **volume** of water saved per month is				
	7 300	litres		
and the **value** of water saved per month is				
	R58.40			
If the purchase and installation of the device costs			R2 000	
and the real interest rate is			15.0%	per annum, compounded monthly
then the **payback period** is			45	months
		or	**3.7**	**years**

Figure 8.4: Worked example for R2 000 retrofit at 15% interest.

8.3 Discussion of water efficient devices economics at the household level

The most cost-effective time to install a water efficient device is when the house, kitchen or bathroom is being built for the first time, at which time the marginal cost of using the water efficient alternative over the standard option will be low, or the two options may be priced approximately the same. However, as can be seen from the worked examples in Section 8.2 above, some water efficient devices can be economically retrofitted, but not all.

Tables 8.1 and 8.2 below shows the results of analyses of the costs and savings for three water efficient devices. The first is the Hippo Bag, which is a cistern displacement device and which is cheap and easy to install. The second is an aerated shower head, which is more expensive, but also easy to install. The third is a dual flush cistern, which is yet more expensive to purchase and which is expensive to install (assuming it is done as a retrofit).

Table 8.1 is based on the assumption that there is no interest charge for the capital invested. This would be a fair assumption if the instigator (whether private or public) was working with cash, because in future years the value of water saved will in reality increase approximately at the rate of inflation, which is not far off what one can get as an interest rate on low risk investments with the bank.

However, most middle class families (and numerically middle class families are probably the most significant market for water efficient devices) live on credit. They have bonds on their homes, hire purchase agreements on their vehicles, overdrafts on their bank accounts and credit card debt. Therefore, any funds spent have to be valued at the cost of their most expensive loan, which is typically the credit card. Credit card interest rates are high, typically in the order of 10% above the inflation rate. This rate has therefore been used in the analysis for the second scenario, which is reflected in Table 8.2.

In the tables two costs are used for the supply and installation of a dual flush cistern. The higher price, R2 000, reflects the cost of a more expensive unit of the kind which is commonly seen on showroom floors. It also allows for several hours of skilled labour to do the fitting and installation. The lower price, R1 000, reflects the cost of the cheaper dual flush units on the market and assumes that the retrofitting is achieved relatively easily (i.e. not much skilled labour required).

In the calculations the following assumptions have been made:

- The average saving per toilet flush relative to a less efficient toilet is 5 litres. The average number of flushes per user per day is four (waking time is split between home and work, so this should be approximately correct for either).

- The average length of shower is four minutes, with a saving relative to a less efficient shower of 40 litres per shower. The shower fitting costs R300, and is simple to install (simply screw on).

- The average water saving per flush when a Hippo Bag is fitted is 2 litres (it can be as much as 3.5 litres, but it depends in what type of cistern it is fitted).

- The applicable water price is the marginal cost of the middle to higher rates on a rising block tariff. The Msunduzi Municipality's rate of R8.28 plus VAT (i.e. R9.44) is used.

Table 8.1: Payback Periods for Various Water Efficient Devices, with 10% real interest

Item	Cost	Interest Rate	No. Users	Payback Period	Interest Paid
6/3 **Dual Flush Cistern (upscale)**	R2 000	10%	4 8 12	156 months 54 months 33 months	R1579 R495 R299
6/3 **Dual Flush Cistern (economic)**	R1 000	10%	4 8 12	54 months 25 months 16 months	R247.32 R108.02 R70.33
Aerated Shower Rose	R300	10%	1 3 6 9	30 months 9 months 4.5 months 3 months	R39.75 R12.72 R6.92 R4.97
Hippo Bag	R10	10%	2 4	2 months 1 month	N/A N/A

Notes: 1) The assumption is made that each of the above water efficient devices is retrofitted where other devices already exist. If this were not the case (i.e. for new buildings), then the cost of the installations would be limited to the price difference between the water efficient device and a comparable non water efficient device equivalent, which would be much lower (in some instances there may be no price difference).
2) See assumptions used in calculations, above.

Table 8.2: Payback Periods for Various Water Efficient Devices, with 0% real interest

Item	Cost	Interest Rate	No. Users	Payback Period
6/3 **Dual Flush Cistern (upscale)**	R2000	0%	4 8 12	87 months 44 months 29 months
6/3 **Dual Flush Cistern (economic)**	R1000	0%	4 8 12	43 months 22 months 14 months
Aerated Shower Rose	R300	0%	1 3 6 9	26 months 8.5 months 4.5 months 3 months
Hippo Bag	R10	10%	2 4	2 months 1 month

Notes: 1) The assumption is made that each of the above water efficient devices is retrofitted where other devices already exist. If this were not the case (i.e. for new buildings), then the cost of the installations would be limited to the price difference between the water efficient device and a comparable non water efficient device equivalent, which would be much lower (or there may be no price difference).
2) See assumptions used in calculations, above.

The key result from each row in the tables is the time it will take for the savings made from the installation of the device to cover the installation cost. Many of the interviewees in the domestic user survey indicated that they could not afford to install any water efficient device which would take more than 12 months to pay for itself. If this is the criterion used, then only shower roses and Hippo Bags can be considered to have any chance of being taken up by the general public. If a cheaper toilet is selected and if the owner has a longer view, then dual flush toilets still be attractive to some. However, the payback period on the more expensive dual flush toilets is so long that none but the more zealous environmentally minded would consider retrofitting them.

The payback period on a Hippo Bag is very quick, and provided one's toilet is one of the older types where the bag can be installed, this device should pay for itself within one to three months.

In institutional situations (schools, offices, universities etc) where toilets are used by more people, even the more expensive installations will pay for themselves within three years. If the cost of capital is not an issue, they should pay for themselves in less than two years.

Figures 8.5, 8.6 and 8.7 show graphically the payback periods for dual flush cisterns (economic and more expensive) and shower roses, with an without finance costs, for varying numbers of users.

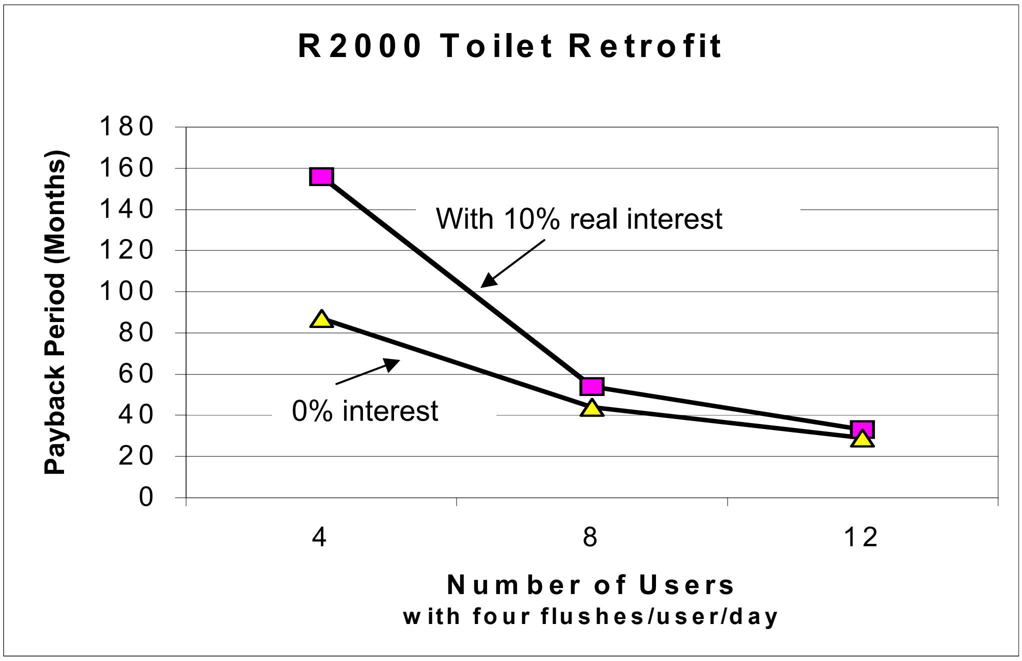


Figure 8.5: Comparative payback periods for R2 000 dual flush toilet retrofit, with varying numbers of users and interest rates.

Figure 8.5 shows that the payback periods are probably too long for the *retrofitting* of the more expensive dual flush toilets to be driven by market forces for family homes. However, for institutions with greater numbers of users the economics are more favourable.

With more economical fittings (Figure 8.6), the retrofitting option is more viable, but the payback periods are still probably too long for any but the more conservation minded of citizens. However, for institutions, the retrofitting is justifiable and viable.

The payback period for water efficient shower roses (Figure 8.7) is much shorter, from just a few months for institutional settings, to a year or two for domestic settings. If one takes into account the energy savings from less use of hot water, the payback period is shorter still.

The above analysis indicates that if there are to be publicly funded campaigns encouraging people to save water, due emphasis should be laid on aerated shower roses and Hippo Bags, being probably the two best water efficient devices to sell the concept of water efficiency to the public.

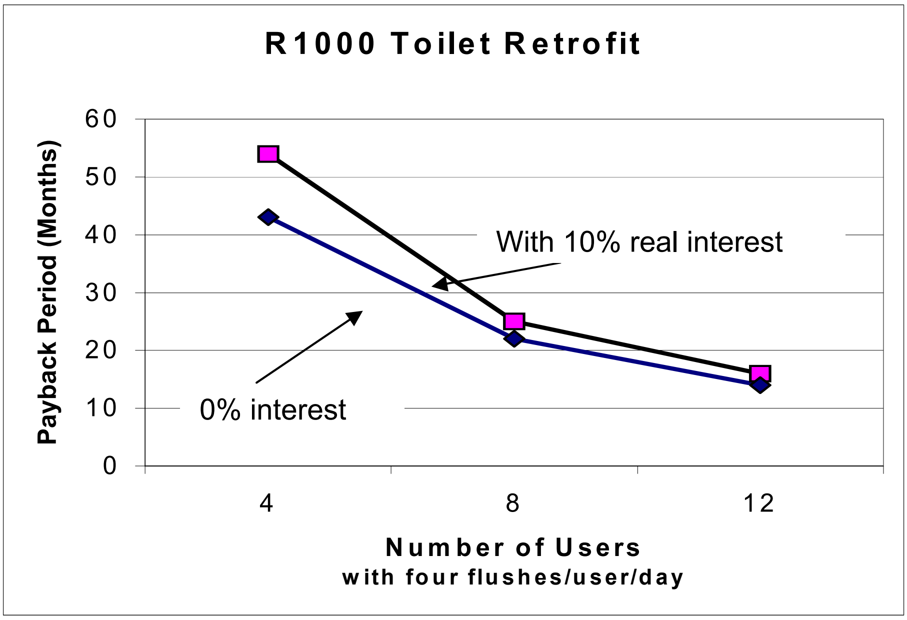


Figure 8.6: Comparative payback periods for R1 000 dual flush toilet retrofit, with varying numbers of users and interest rates.

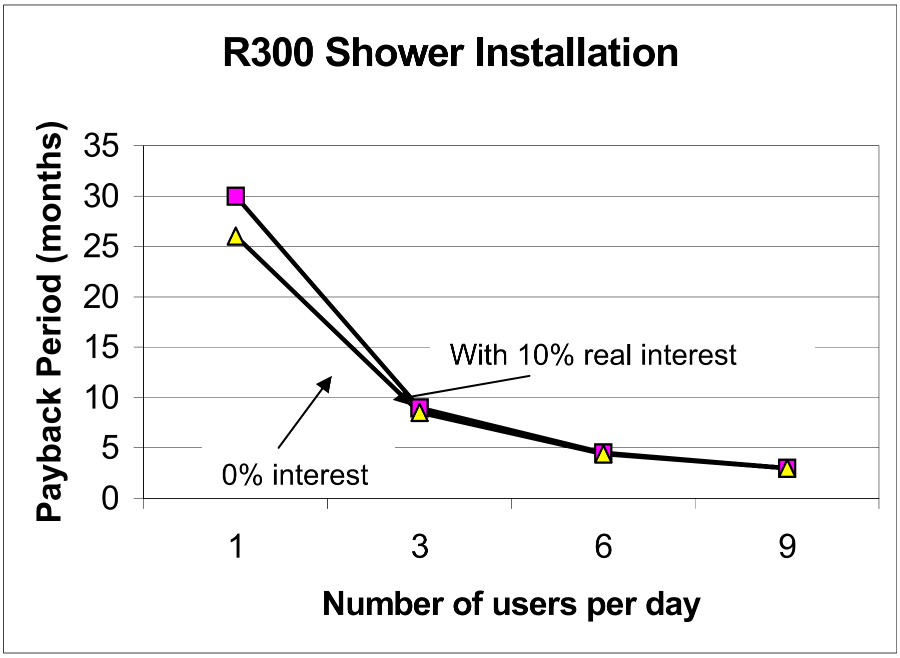


Figure 8.7: Comparative payback periods for R300 aerated shower rose, with varying numbers of users and interest rates.

9 WATER EFFICIENCY: GETTING THE MESSAGE OUT

Research indicates that advertisement campaigns encouraging people to save water can be an effective water demand management strategy. However, advertisement campaigns need to be ongoing because evidence suggests that once the campaign is over, less the half the targeted population would continue to save water (Heiman, no date). This is because traditionally campaigns have focused on techniques to save water and not on water efficient plumbing fixtures. If at least some campaigns focused on water efficient devices, sustained water savings are more likely to be realised.

To compliment an increased public awareness about water efficient devices and plumbing fixtures, a mandatory labelling system on all devices that provide water or use water would be useful. Such a system would help to inform customers of more economical and environmentally friendly plumbing fixtures, provide information on the cost recovery (in terms of water saved) over a time period and be a powerful incentive for manufacturers to develop and promote water efficient technologies. An example of such a system in practice is the mandatory Australian Water Efficiency Labelling and Standards (WELS) Scheme. Introduced by the Australian Government in collaboration with State and Territory governments, all household water using products have to meet minimum performance standards and be labelled accordingly.

It is unrealistic to think that the majority of domestic consumers will adopt more water efficient technologies only if provided with information and guidelines. If water efficient devices are to be widely adopted, local bylaws need to mandate that they are installed, <u>and</u> the bylaws must be enforced.

Individual water utility websites (for example Rand Water or Jo'burg Water) provide domestic consumers with strategies on how to save water and suggest water efficient devices but do not name the devices (to do so would be to invite litigation from those not listed). For example, it is suggested on the Rand Water website that a water efficient shower rose is installed, but there is no indication of who manufactures or sells these devices or how a consumer can be sure they are getting a good quality water efficient shower fixture. Most water utilities in South Africa have an education unit or officer who develops education materials and coordinates water saving campaigns. However, the monitoring and evaluation of the effectiveness of the education programs is not well documented and therefore it is not possible to determine whether they are aiding with the uptake of water efficient devices.

Since the Western Cape drought of 2004 the engineering consultants Ninham Shand have produced a web based tool that allows consumers from the Cape Town, Drakenstein and Stellenbosch areas to assess their current water usage and then provides information about how water can be used more efficiently within the home. The website is interactive, makes people start to think about water use for different functions and provides solutions that are applicable to the individual concerned. However, the user interface is a little complex and confusing at first and requires knowledge about water use within the home. The website can be accessed via http://www.webfoundry.co.za/wdm2/html/ (select "Go to the Challenge").

9.1 Databases as tools for public information dissemination

There are a number of education, awareness and media tools that can be used to provide consumers with information about water efficient devices. Examples are the labelling standards used in Australia, educational messages aired on radio or television, information included on water bills and advertisements by manufacturers of water efficient devices. South Africa recently started airing such advertisements as part of its Waterwise Campaign.

Databases are considered to be efficient for capturing and storing information. A well designed database allows users to search the data set easily using predefined key words. By using the internet, databases can be made publicly available to a large audience without the cost of reproducing potentially large documents. However for databases to be effective, they need to contain current data. This requires ongoing maintenance by someone dedicated to the task as databases that rely on those listed in the database to keep their information current have limited success.

A South African databases of water efficient devices is the CSIR's web-based 'A-Z database'. This database and a commercial database, Autospec, are discussed below. This is followed by an overview of various other water efficient websites and some considerations for developing a revised website for use in South Africa.

9.1.1 A-Z of Water Saving Devices

In 1995 as a component of a National Water Conservation Campaign, DWAF published a booklet entitled 'A to Z of Water Saving Devices'. The booklet was intended as a tool for architects, designers and owners to use so that water use in buildings could be reduced without significantly affecting the life-style of the occupants.

The booklet contained a list of the different types of water efficient devices such as water conserving showers, taps, toilets and grey water systems. The components listed had been approved by the South African Bureau of Standards (SABS) and/or the Joint Acceptance Scheme for Water Installation Components (JASWIC). The booklet also contained a list of manufacturers nationwide of water efficient devices.

The A-Z publication was managed by CSIR Boutek who took over and further developed the A-Z project as an extension of the 'Green Buildings for Africa initiative'. With DWAF's support and involvement, this led to the development of a web-site version of the 'A-Z of Best Practice in Water Installations in Commercial and Residential Buildings in South Africa' (Kelly, 2005). A summary of the number of water efficient devices included on the web-based 'A-Z database' is presented in Table 9.1. Some manufacturers produce more than one category of water efficient device.

Table 9.1: Summary of number of water efficient devices and components listed on the CSIR water conservation web site.

Category	Entries	Number of Manufacturers
Taps	7	1
Tap fittings and accessories	8	3
WC Suites	7	4
Showers	11	3
Other sanitary fittings	3	2
Landscaping and irrigation	2	2
Rainwater harvesting	1	1
Water recycling	2	1
Miscellaneous	1	1
Total	42	n/a

(Source: http://atoz.csir.co.za)

The database does not include any entries for site reticulation or water heaters. The online 'A-Z database' does however include notes on good practice and online assessment tools on projected water use and rain water harvesting.

The CSIR's A to Z website has not been updated since 2003, and the team (Neil Oliver and Mark Kelly) which developed the website and which was knowledgeable about water efficient devices is no longer employed by the CSIR.

9.1.2 Autospec and Specifile

Autospec is a personal computer (PC) or server based building and interior design tool that carries current information on product lines from 425 manufacturers and serves 1 440 registered firms in South Africa (figures correct as at 30 April 2007). These firms are principally architects and quantity surveyors, i.e. those who design and manage the construction of buildings. With several firms having multiple users, the number of licensed individual users in South Africa is currently 6 700. The database is not limited to water efficient devices (or even plumbing devices), but provides useful insights into what is required to maintain a database that is user friendly and meets the demands of builders, quantity surveyors, architects and potentially consumers. A demonstration of Autospec can be viewed at http://www.autospec.com Autospec could potentially be used to enable users to search for current information on water efficient devices that are in the market place. However, the developers cannot introduce filters for "water efficiency" independently, as to do so would prejudice those of their clients who do not sell water efficient devices. If, however, a national body such as DWAF could stipulate what are considered to be water efficient devices, then Autospec could use those criteria to set up the necessary filters and there would then be more incentive for manufacturers to produce such devices. Alternately, if enough large municipalities adopt compatible by-laws for standard items such as toilets and showers, then these could be used as a basis for a filter.

Specifile (http://www.specifile.co.za) have historically been the cataloguer of product information for the building industry. They produce a set of 25 product catalogues for different categories of product, and these are updated quarterly. They also supply subscribers with CDs with product information, and offer an online product information service similar to that offered by Autospec.

9.1.3 Examples of databases on Water Efficient Devices

Developing a database to inform the public about devices to reduce water use, the importance of saving water and sharing ideas on innovative initiatives that have successfully reduced water use can be helpful. Some of the more user friendly and informative databases available on the internet are summarised in Table 9.2 below.

Table 9.2: A summary of Water Efficient Databases and Information resources

Title	**Water Efficiency Experiences Database (WEED)**
Country	Canada
Implementing agent	The Canadian Water and Wastewater Association
URL	www.cwwa.ca/weed/index_e.asp
Objective	Share information and experiences of projects that have successfully reduced water consumption
Additional information	• Includes a data capture sheet for users to add projects • Allows searches categorised by key activities (e.g. Indoor, Outdoor, Infrastructure, Economics, Regulatory)
Last updated	September 2004

Title	**WATCON**
Country	United States
Implementing agent	Environmental Protection Agency
URL (Link)	http://www.epa.gov/grtlakes/seahome/watcon.html
Objective	Program shows effective ways to save water in and outside the house. Topics include efficient toilets, showerheads, faucets; leak detection, water efficient lawn care and gardening; car washing and pool operation. Allows users to calculate how much they will save by installing water efficient devices in their homes.
Audience	Homeowners, teachers, well & septic system owners
Additional information	• Also available in Spanish
Created	1991
Last updated	1 November 2006

Title	**The Water Efficient Landscape Planner**
Country	United States
Implementing agent	Environmental Protection Agency
URL (Link)	http://www.epa.gov/seahome/landscp.html
Objective	Developed to explain the advantages and principles of water efficient landscaping. The program covers the basics of landscape planning and provides guidelines and suggestions to help users select the most appropriate plants for their needs.
Audience	Homeowners, small business, small communities, teachers, well & septic system owners
Additional information	• Also available in Spanish
Created	1991
Last updated	22nd March 2006

Title	**H2OUSE**
Country	United States
Implementing agent	Waterwiser (American Water Works Association)
URL	http://www.h2ouse.org/tour/index.cfm
Objective	Information on how to reduce water consumption and what devices to fit in the bath, kitchen, laundry, garage and basement, pool and spa, patio and landscaping.
Audience	Residential users
Additional information	• Interactive map allows users to navigate through their house. • Each room in house is further divided to include components • Each component has information *FACTS* (including water savings, regulations and policies) and *ADVICE* (where to purchase, installation tips and rebates)
Copyright	2006

Title	**WELS** (Water Efficiency and Labelling Standards)
Country	Australia
Implementing agent	Australian Government
URL	http://www.waterrating.gov.au/about/products.html
Objective	Provides information about Water Efficient Products, legislation and standards. Each product type (for example dishwashers) has a database which can be searched.
Audience	Home owners, developers
Additional information	• Searches can be made by brand name • Users can calculate the water consumption of the device selected
Copyright	Commonwealth of Australia, 2005 Data used on site is updated daily
Last updated	14th July 2006

Title	**A-Z of Best Practice Water Installation**
Country	South Africa
Implementing agent	Rand Water
URL	www.randwater.co.za/Home_and_Garden/Water_Wise_Living.asp
Objective	Promote water conservation (water wise living) in the home and garden
Audience	Domestic users
Additional information	Only in English Pictures and interactive nature make it easy to use and definitely child friendly

Title	**The Household Audit Challenge**
Country	South Africa
Implementing agent	DWAF, Ninham Shand, National Botanical Institute, City of Cape Town
URL	www.wateraudit.co.za
Objective	Users are provided with tools to self-audit their water use. Provides educational information on how to reduce water use and where appropriate the types of water efficient devices that are available
Audience	Domestic users in the greater Cape Town area
Additional information	Only in English. Requires users to have a fair bit of knowledge regarding water use within their homes

9.2 Development of a new South African website dedicated to Water Efficiency

There are three existing websites providing information of water saving in South Africa, some more current and user friendly than others.

There are also two successful private sector developed online databases for a very wide range of building products (Autospec and Specifile). These databases have a number of advantages including:

- They are updated frequently.
- There is a proven and effective incentive for the manufactures and distributors to keep the database managers informed of new product lines.
- End users of these databases receive automated updates on a regular basis. I.e. the user does not have to remember to check for updates.

- These databases are the industry standards. It is unlikely that busy professionals will consult another database when selecting plumbing fixtures.
- Adding additional filters to the existing database will encourage manufacturers to highlight and market water efficient devices and hopefully improve the number of water efficient devices that are standards in terms of design.
- These databases are strategically marketed to ensure the broadest possible client and manufacturer base.
- Unlike many other public campaigns, information dissemination around water efficient devices will continue long after the life span of this project.

It is doubtful whether there would be any value in the production of another paper based database of water efficient products (i.e. an update of the A to Z booklet). The information becomes dated within months of publication, and distribution to the people who might be interested is logistically challenging and expensive. However, a website at least has the advantage that it can be accessed at any time by anyone with an internet connection, and it can be updated at any time for minimal cost.

There is a case for the production of an officially endorsed water saving website which would complement the other websites, public and private sector (and which would provide links to them), local and international. It is recommended that such a website be developed under the aegis of the WRC or DWAF, and that this site is maintained by DWAF or the. The concept of the site is laid out below:

Working Title: "Water Efficiency SA".

URL address: http:///www.waterefficiencysa.co.za

Aims and objectives of the web site:

- Maintain current information and news about water efficient devices available in South Africa.
- Act as an information portal and network for all materials relating to water efficiency in the domestic and commercial sector in South Africa.
- Highlight innovative international "best practices" regarding water demand management including improving the uptake and use of water efficient devices.
- Show case South African commercial enterprises making use of water efficient devices.

- Develop a public awareness of industry codes of practices and affiliations that encourage the commercial sector to adopt water efficient technologies. An informed public can be an important market incentive for industries to improve their environmental standing.
- Link to private sector based databases of domestic and commercial plumbing fixtures (including water efficient devices).

The amount of content loaded on the site can be kept manageable by, as far as possible, making use of links to the sites where the information was originally obtained. This is so that as content is updated on other web sites, users also have access to the latest available information with minimal web management and updating from the webmaster's side.

Principles of an effective web site:

Opinions of what constitutes a "good" web site differ depending on the target audience, the subject matter and what it is hoped the website will achieve. In order to motivate for the form and structure of the site **Water Efficiency SA** the audience and content of the website are summarised below.

The audience

- South African home owners.
- Children and students.
- Architects, Quantity Surveyors and developers.
- Manufacturers and distributors of water efficient devices in South Africa.
- Businesses seeking to improve their bottom line.
- Government departments or municipalities who wish to disseminate information.
- Industry and agriculture (this would be part of the longer term market for the site)

Subject matter

- Water efficient devices for the domestic market.
- Water efficient devices for the commercial market.
- Practical ways to save water and use water more efficiently.
- Case studies and innovative responses to water conservation.
- Current information on trends, new developments and policies pertaining to water efficient devices.
- Educational material (suitable for a range of ages).
- A resource for locating and comparing water efficient devices.
- A resource for locating manufacturers and distributors of water efficient devices.

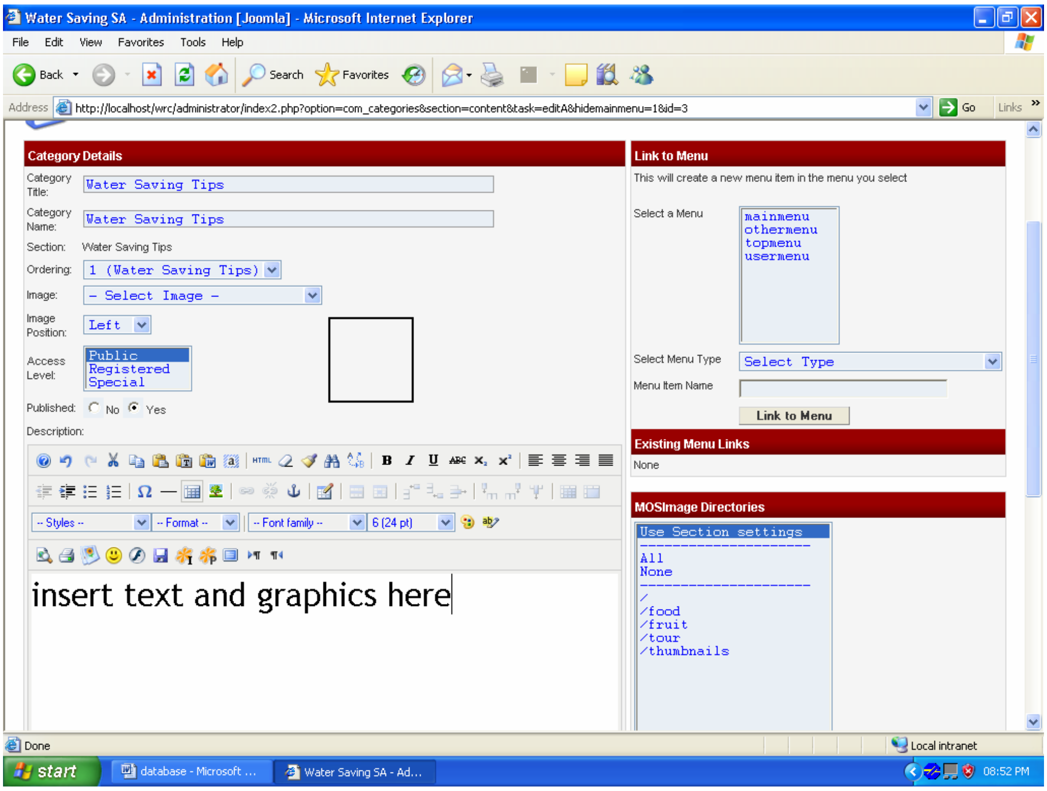


Figure 9.1: Example of the user interface for updating web pages

Proposed Template:

The proposed template is known as “Joomla”. The template is user friendly in that pages can be updated using similar functionality to Microsoft word and other Windows programs. This means that once established, the website can be managed and updated *without needing specialist programming knowledge.*

Text can be typed and edited in either Word or Notepad and copied onto web pages. Content can also be added directly into the web page, but there is no spell check functionality.

Colours and Themes:

It should be noted that the general layout, colours and theme of the template cannot be changed once selected. Changing the template will have a significant cost (both in the purchasing of the new template and the person hours to copy the content across).

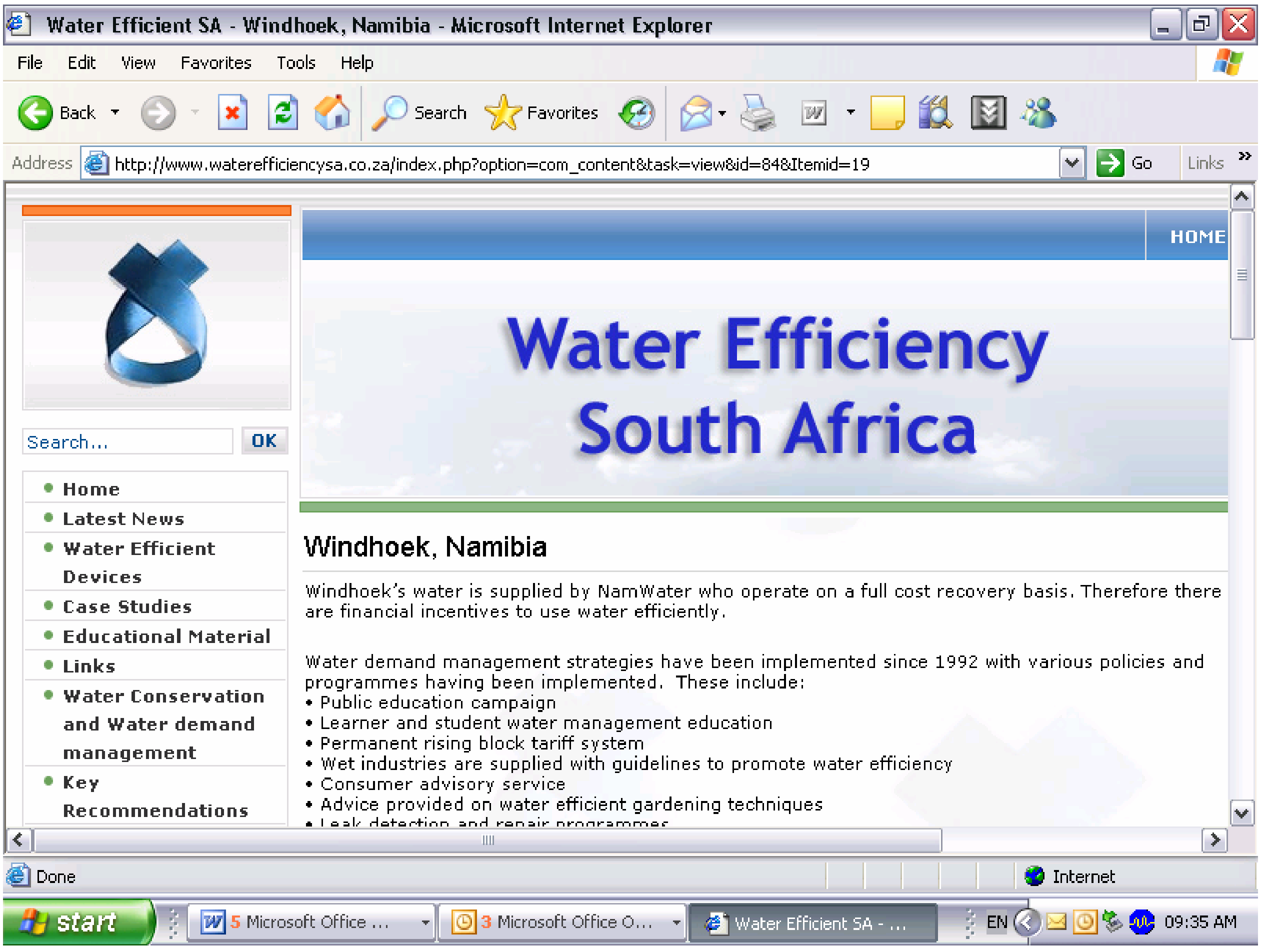


Figure 9.2: An example of a standard page on the website

Current web content

Users of the site will have four main categories from which to choose. The main menu items are as follows:

Figure 9.3: Menu items available to the user

HOME

The front page has the following items:

- Link to the Water Research Commission (WRC) with the WRC logo.
- A definition of the term *water efficient device*
- An introduction (couple of lines) to highlight the importance of water conservation in the South African context and an introduction to water demand management in South Africa.
- A latest news section.
- An indication of when the site was last updated.
- A disclaimer and acknowledgements.

WATER EFFICIENT DEVICES

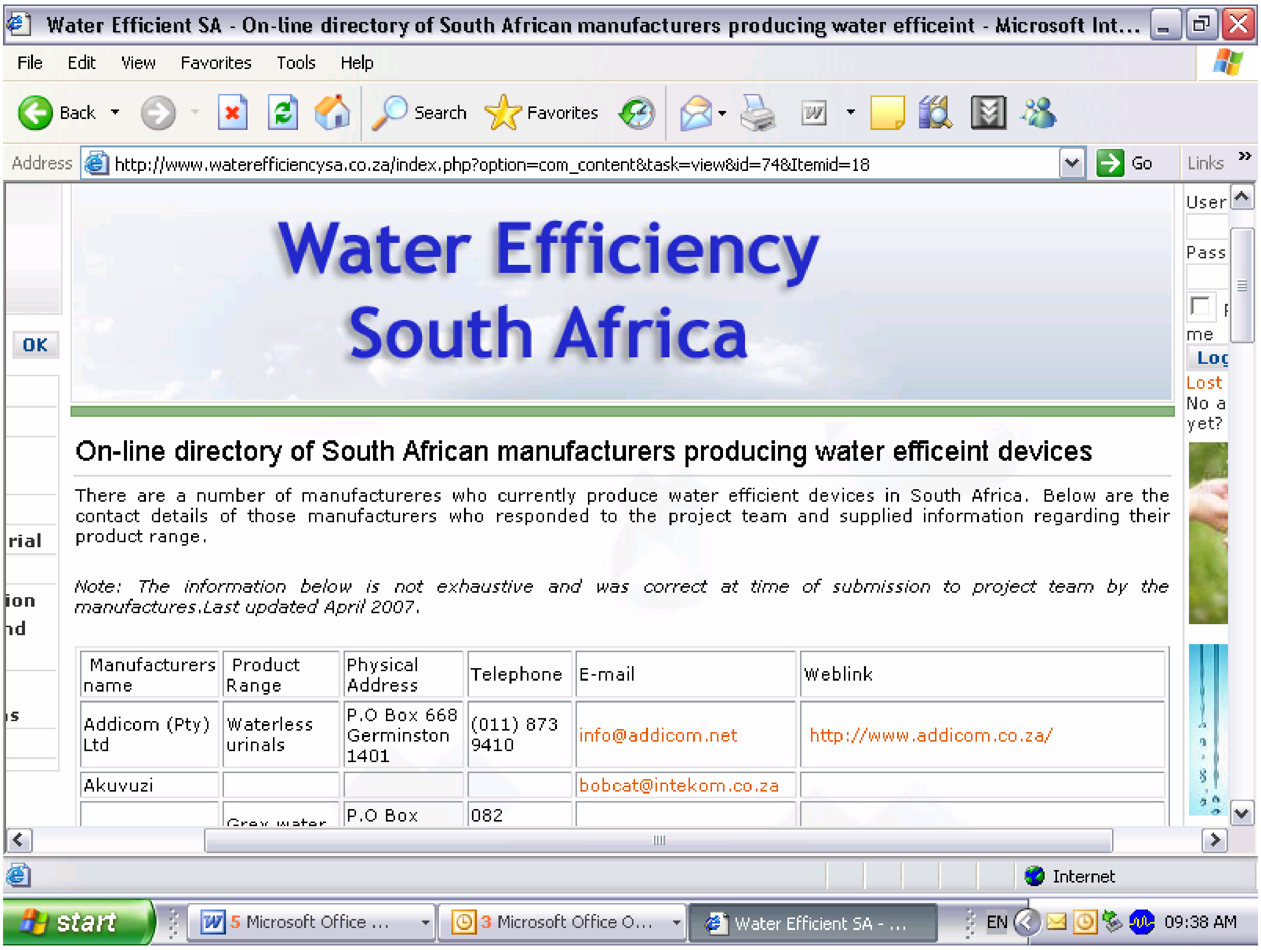


Figure 9.4: A page from the Water Efficient Devices menu item

Under the heading **On-line directory of South African Manufacturers** users will be linked to a table with information on the product line, contact details and a web link to their site (if available).

Similar pages exist for the sections looking at **educational material.** The **links** page is set up as a table.

LINKS

Each link will have the logo positioned on the left and a short description under the title on the right hand side.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Water efficient devices in the overall water conservation context

A water efficient device is one which serves the same function as its standard alternative, without any reduction in performance, while using less water. Traditionally the design considerations for toilets, showers, washing machines, basins, baths and taps have been functionality, aesthetics and cost. Not much attention was given to how much water these items used, because in many of the countries of manufacture water was always thought of as a cheap and abundant resource. However, the world's population has increased fourfold in the last century, and will at least double in the century to come. Along with this increase in population has been the emergence of megacities, sprawling densely populated conurbations with populations numbering in the tens of millions (e.g. Gauteng, with a population approaching 11 million and, at the present growth rate, set to reach 20 million by 2025). With these changes, the adequacy of water resources in many countries has become a matter of critical concern. According to the United Nations Environment Programme, one third of the world's population already live in conditions of water stress, and this proportion can be expected to double within the next twenty five years. Water can no longer be used with abandon, but increasingly needs to be used appropriately, and efficiently.

A water supply authority looking to conserve water and manage demand needs a holistic plan with four main elements, which are in nature

- Structural
- Operational
- Economic and
- Socio-political.

Each of these elements is important, and excessive concentration on one without attention to the others may render the whole programme of limited effectiveness. The *socio-political* part of the campaign requires advertising in all forms of the media, as well as the revision of laws and regulations. Without these "push" factors the market will not by itself move buyers in the direction of water efficiency. Authorities use *economic* methods, comprising pricing changes and penalties, to ensure that marginal water use is given its real marginal value. In South Africa municipalities combine free basic supplies to the poor with stepped tariffs to ensure that those who choose to use above average amounts of water do pay for the privilege. *Operational* methods entail the reduction of supply pressures (which in South Africa are often far higher than the 1 to 3 bar needed for domestic use) and the detection and repair of leaks. A lot of effort is currently being spent by water utilities on this aspect of water demand management, often very effectively. *Structural* methods include the fitting of on-site pressure reduction devices, the use of efficient irrigation systems, the use of recycling systems, and the use of water efficient devices.

There are many examples of water demand management and water conservation campaigns that have been implemented around the world. The city of Seattle in the United States, for example, has reduced its water consumption by 1% each year over the last 23 years despite a 23% increase in its population. In Southern Africa the city of Windhoek has managed to reduce average consumption from 320 litres per person per day to 220 litres per person per day over the last thirty years, in the process pioneering many of the demand management strategies that others are now emulating. In South Africa water conservation programmes carried out in the various municipalities supplied by Rand Water, the largest bulk water utility in Africa, have seen the annual growth rate in the water supply into that region reduce from 3.3% to 0% over the last three years, despite a concurrent 3.3% population growth rate. Cape Town, which has been through several years of water stress in the last seven years, has developed a holistic water conservation strategy, which includes the promulgation of the most comprehensive water conservation bylaws in South Africa.

In one sense it is against a municipality's interests to persuade its customers to use water efficiently and to penalise them financially for high water use, as water sales are a prime source of income for local government structures (in urban areas). However, if water is not used conservatively and as a result demand outstrips supply, then the municipality will end up having to pay for expensive infrastructure to augment its bulk water supply (which augmentation will cost in the billions of Rands for our larger cities). If a large water supply augmentation project can be delayed by five or ten years due to the introduction of good water conservation practice, the capital saving in present day terms will run into hundreds of millions of Rands.

10.2 The status and use of water efficient devices in South Africa – survey results

This study included four different surveys in order to gauge the status and use of water efficient devices in South Africa. Firstly, commercial and institutional settings such as hotels and hostels were investigated; secondly the suppliers of plumbing fittings were studied; thirdly the architectural profession was surveyed; and finally the knowledge and attitude of 1428 home owners in 10 towns and cities in South Africa were tested.

10.2.1 Water Efficient Devices in commercial and institutional settings

In commercial and institutional settings, there is clear evidence that water efficient devices are becoming more common. From the City of Cape Town's programme to replace all the automatic flushing urinals in public buildings and install Hippo Bag displacement devices in all the old large capacity school toilet cisterns, to the sophisticated infrared operated taps and urinals that are becoming standard at airports, there is a move towards water saving and water efficiency. The larger hotel groups are signing onto environmental programmes, of which one component is sustainable water use, and there are encouraging examples where universities and other public buildings are being retrofitted with water saving cisterns, taps and showers. A notable exception to this progress is the Department of Public Works, the "state's landlord", which manages South Africa's government buildings, including major water consumers such as hospitals and prisons. The Department of Public Works has yet to follow the example of the private sector in moving towards water efficiency in the buildings under its care.

10.2.2 Water Efficient Devices in the plumbing supply industry

The increasing market share of water efficient devices is apparent on the showroom floors of the major plumbing suppliers. This is almost in spite of the suppliers, who as a rule do not push water efficiency (as one said, it is not their job to preach to their customers, who buy mainly on functionality, style and cost). In fact many of the more junior showroom assistants would be hard pressed to identify a water efficient device even if it were standing in front of them. The reason aerated taps, dual flush toilets, water efficient baths, basins and showers are increasingly been sold, is that these are becoming the standard in the countries of manufacture in Europe and the East. While South Africans are sometimes still wary of six litre flush toilets ("will it work?") these, or even more efficient designs, are now the standard in parts of the USA, the UK and Europe. It is interesting to note that of all the plumbing outlets visited, the one with the highest share of water efficient devices sold was in the most up-market residential area.

10.2.3 Water Efficient Devices as regarded by the building profession

The building profession (architects, quantity surveyors and builders) is conservative by nature. No-one can afford comebacks from aggrieved customers who do not want to be used as guinea pigs for new inventions, and therefore there is a strong tendency to stick to the tried and tested. It was not easy to get responses to the survey from architects – of the 152 surveys successfully sent out, only fourteen were answered, and most of these only after following up. The CSIR conducted a similar survey in 2002 and experienced an even lower response rate, so perhaps there has been some progress. From these two limited surveys, there is some evidence that architects are moving towards an awareness of sustainable water use. However, as one said in his response to the survey, they work to the building code, and if they are expected to change the way they work then the building code should be changed.

10.2.4 Water Efficient Devices as understood by the general public

Of the 1528 homeowners surveyed, 29% indicated that they had at least one water efficient device in the home. Typically only about 20% of the respondents in the average town believed they might possibly use too much water, but significantly more, 40% to 50%, have considered reducing their water consumption. The factors which *prevent* people from installing water efficient devices include the following:

- they do not know of water efficient devices
- they do not own their own home (i.e. they are renting)
- they can't afford to make changes
- they do not see the need to make any changes
- they are too old to make any changes

Conversely the factors which would persuade people to move to water efficient devices include the following:

- an increase in the price of water
- if rebates were offered for the installation of water efficient devices
- if there were water restrictions
- if they had a better understanding of water efficient devices, and
- (for outdoor use) if the use of hosepipes was banned.

10.3 South African municipal bylaws and Water Efficient Devices

A further part of this study was an investigation into the bylaws of South Africa's major towns and cities in so far as water demand management is concerned. It was found that while some (e.g. Cape Town and Ekurhuleni) give limits for cisterns volumes and shower flows, outlaw automatic flushing urinals and are generally up to date regarding water conservation, others are almost silent on the subject. In reality it is highly unlikely that municipal building inspectors have the time to adequately police these provisions, especially when the neighbouring municipalities have bylaws which are not in line with theirs (e.g. Johannesburg and Ekurhuleni). Leadership at national level is required to update the building code to comply with the more progressive water conservation bylaws, and once this is done then architects, specifiers and builders nationally could all work to the same rules without having to know the details of the by laws in every one of South Africa's 169 Water Supply Authority areas. If such a step could be taken, then the considerable sophistication and power of the existing building materials databases such as *Autospec* could relatively easily be harnessed to enable specifiers to find water efficient products (as defined by the codes), and for suppliers of those products to bring them to the attention of their potential customers.

10.4 The economics of fitting or retrofitting Water Efficient Devices

Meanwhile the economics of retrofitting water efficient devices to *existing* housing stock is very variable, depending on the device and the setting in question. It is relatively inexpensive and easy to swop out shower fittings (in much the same way Eskom has recently being going from house to house and swopping out energy efficient light bulbs for the older incandescent bulbs), and these will typically pay for themselves in water savings within a few years. The economics of changing out-toilet cisterns and pans is rather less attractive, unless they are in a setting where they are used by more users than would be found in the average family home. For this reason large scale changes to the existing housing stock are unlikely, and therefore the penetration of water efficient devices into the South African domestic market is going to be slow and gradual, probably taking a few generations to become the norm.

10.5 Methods of disseminating information about Water Efficient Devices

Online websites and databases

Any database of water efficient products would need to be both on-line and regularly updated to be useful. Such a database could be linked to a website which provides educational material, case studies and links to the many other informative and useful water efficient websites around the world. The project team have developed a prototype for such a website, and will explore options for keeping the site operational in the future.

Product Labelling

A strategy that is used to good effect in more and more countries is to label, for the environmentally aware buyer's benefit, products which are environmentally sound, e.g. products which are water efficient or energy efficient. Australia has its *Water Efficiency Labelling Standard Scheme (WELS),* which was introduced on a voluntary basis in 1998, and then on a compulsory basis in 2003 for showerheads, washing machines, dishwashers and toilets. Such labelling systems are increasingly been introduced in countries in Europe, the Americas and Asia.

10.6 Recommendations for increasing the status and use of water efficient devices

In order for South Africa to move more swiftly and effectively towards the entrenchment of water efficiency, the following actions are recommended:

- **Government must lead by example**

  Some of the worst offenders for high water usage are government buildings. The state sandlord, the Department of Public Works, should embark on an audit on water usage and the presence of water efficient devices in all buildings under their care. This would have an impact firstly on the entire civil service, which employs over a million people[53], but secondly it would impact on the population at large, who would see the state leading by example. The state is also able to take a longer view on the economics of retrofitting water efficient devices than is the average citizen, having access to cheaper capital.

- **South Africa needs a labelling system for Water Efficient Devices**

  South Africa should emulate the water efficiency labelling systems practiced in other countries, of which the most advanced appears to be the Australian WELS label. This label is not just a general “green” label, but includes product specific information and a graded rating from 0 to 6 stars. If such labelling eventually becomes mandatory in South Africa, it will affect the whole supply chain from manufacture, to marketing, to purchasing. This will help not only the public, but also the building trade professionals, from plumbers, to builders, architects and quantity surveyors to become more knowledgeable about water efficiency.

- **SA needs a nationally sponsored public education campaign regarding Water Efficient Devices**

  Apart from the product specific labelling, the state needs to make a case for water saving with the public. This campaign should appeal both to the public’s sense of civic duty (“it’s the right thing to do”), while not underestimating their intelligence (answering questions like, “why don’t we just build bigger dams?”, and “If I am prepared to pay for what I use why can’t I use as much as I want?”).

53 The figure derived from the February 2006 Public Service Commission document entitled “An audit of affirmative action in the public service” is 996 734, but this excludes the departments of Defence and Safety and Security. It also excludes all municipal employees.

- **Information on Water Efficient Devices must be easily obtainable**

The public and even the building industry is still relatively ill-informed about water efficient devices. Water conservation in the built environment should be taught at undergraduate level to architects, and at FET colleges to plumbers. Water saving tips should regularly be distributed with municipal accounts, and should be displayed in appropriate locations. A website with product information, educational material and links to other useful sites offers great potential as a tool to promote water efficiency, provided it can be maintained and updated. The existing online product databases used by the building industry (e.g. *Autospec* and *Specifile*) can be relatively easily made to respond to searches for information on water efficient products, but this can not be done until there is a nationally agreed standard for such devices.

- **Municipal bylaws must include provisions relating to water efficiency and water conservation, and ideally there should be convergence across municipalities**

Of South Africa's 283 municipalities, 169 are Water Services Authorities (WSAs), in other words they have responsibility for the planning and regulation of all water supply in their area of jurisdiction. If the rate at which water is being used in their area is becoming unsustainable, then it is their responsibility to either increase the supply or decrease the demand. One measure at their disposal for decreasing demand is the promulgation of bylaws that promote water conservation. Some of South Africa's bigger municipalities have recently updated their water bylaws, and some of these, such as Ekurhuleni, Cape Town and Tshwane have included sections on water efficiency. It would help if there was more of a consensus between municipalities on water bylaws, particularly in the case of a large conurbation such as Gauteng which spans several municipal jurisdictions.

- **Building codes and bylaws must converge**

Bylaws relating to behavior such as the use of hosepipes for washing paved surfaces (at ant time) or for washing cars or watering gardens in times of water restrictions can be enforced. However, bylaws relating to the types or showers, baths and toilets installed in houses are really only enforceable for new housing stock, and even then it seems unlikely that municipalities have enough building inspectors to do this work adequately. It would be far simpler to inspect at the source, i.e. to control what products are sold by the plumbing suppliers. The supply cannot be controlled as long as there is wide variation in water bylaws, and, moreover, divergence between water bylaws and the building code. The first and most important step would be to add a section to the building code bringing it into line with modern water efficient good practice. If this was done, then the suppliers and specifiers would be able to follow without worrying that they are out of line with standard practice.

- **Retrofit programmes with rebates (where appropriate) should be encouraged**

In South Africa there are many millions of poor people who are not required to pay for their water supply. While the official policy guideline is that each family should get a lifeline amount of water of 6 kilolitres free, in some urban areas the reality is that no water is paid for. For people in these areas there is no incentive to conserve water. In such areas, it may pay a municipality to intervene with schemes to retrofit water efficient devices, even if the full cost were to be borne by the municipality.

- **Water supply pressures must be decreased**

Water supply pressures in South Africa are, in general, far above international norms. No more than four bars of pressure is needed for domestic water supply, and municipalities would save both themselves and their customers money if they took steps to regulate the pressure in their systems down to this level. Owners of buildings in high supply pressure zones would save themselves wear and tear on their plumbing fittings, and would save water, if they installed pressure reducing valves on their properties that brought their pressure down to under the three or four bar level.

- **Informative Billing**

Even educated consumers take little time to attempt to understand or analyse their utility bills, which typically combine water, electricity, refuse removal and sewage charges. For less literate consumers the bills are daunting, to say the least. With modern technology, it is however quite possible to include simple graphic information, like a graph showing how water consumption has varied month on month for the last twelve months. With such easy to read, visual information, consumers can be more easily alerted to leaks or wastage on their properties.

SUMMARY TABLE FOR RECOMMENDED WATER EFFICIENT MEASURES

The following table has been drawn up after reviewing what is available in South Africa and standards elsewhere in the world. This is a draft table which would require discussion between the plumbing industry stakeholders and government before ratification. If ratified, the table could form the basis for an amendment to SANS 0400, the *National Building Regulations*.

Item Description	Specification regarding water efficiency	Notes
Cistern and pan – single flush	No cistern and pan for a new building should require more than 9 litres to clear.	More efficient systems requiring 6 litres or less should be encouraged using a labelling system.
Cistern and pan – dual flush	No cistern and pan with a dual flush mechanism should require more than 6 litres to clear on the full flush setting	
Cistern and pan – Interruptible flush	Cisterns and pans with interruptible flush mechanisms are an acceptable alternative to low flush and dual flush options.	The pan should be able to clear with not more than nine litres.
Shower	Shower roses should not deliver more than 18 litres per second at 4 bars pressure.	Showers should be aerated to improve efficiency. More efficient showers delivering 10 litres or less should be encouraged using a labelling system.
Bath	Baths should not hold more than 250 litres to the *overflow* level.	More efficient bath designs should be encouraged using a labelling system.
Basin	Washroom – limit to 5 litres Bathroom – limit to 10 litres Kitchen – limit to 20 litres	More efficient basin and sink designs should be encouraged using a labelling system.
Urinal	Automatic flushing urinals should be illegal. Urinal flushing should be user activated (either manually or with sensors), and should use no more than 2.0 litres of water per flush/	
Tap – bath	Flows should not exceed 10 litres per minute for single taps and 18 litres per minute for mixer taps at 4 bars pressure.	
Tap – basin	Flows should not exceed 6 litres per minute for single taps and 10 litres per minute for mixer taps at 4 bars pressure. Taps over basins without plugs should not exceed 4 litres per minute flow.	Tap flows should be aerated
Tap – external	Flows should not exceed 20 litres per minute at 4 bars pressure.	Taps located in public places which are not used for irrigation should be self closing after a set time has passed or volume of water has been delivered, according to context.
Hosepipe	Use of hosepipes for washing paved surfaces should be illegal. Hosepipes should be fitted with shut-off valves at the user end.	
Irrigation system	Garden irrigation systems should be switched off using timers and/or soil moisture gauges.	
Pressure reduction	Domestic water pressure should be limited to 4 bars and hot and cold water pressures must be balanced.	

In addition the following water efficiency measures, while not mandatory, should be given official endorsement and promoted.

Item Description	**Notes**
Waterless toilets	Information regarding well tested designs of waterless toilet should be made available and these should be allowed for within the building codes.
Waterless urinals	Information regarding well tested designs of waterless urinal should be made available and these should be allowed for within the building codes.
Water Efficient Dishwashers	More efficient models should be promoted through use of labelling.
Water Efficient Washing Machines	More water efficient models should be encouraged through use of labelling.
Greywater recycling systems	National standards for domestic greywater recycling systems should be developed and certified designs should be promoted.

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APPENDIX A

An example of educational material used in appealing the public to reduce water use

2001
City of Cape Town

SUMMARY
This publication contains suggestions on how to save water at home, at work and in your garden. It can be a simple exercise to save 10% on your annual water bill, without drastically changing your lifestyle.

Here are a few easy suggestions how to save water (and money) at home:

- Close the tap when cleaning your teeth (this saves up to 20 litres of water), or when shaving (this saves up to 45 litres!).
- A bath uses an average of 160 litres of water - a five-minute shower uses 60 litres. Shower rather that bath, but if you have to bath, run a smaller bath or share your bath.
- Ensure your washing machine and dishwasher is fully loaded before starting them.
- Think before rinsing glasses and cutlery under running water.
- Cut down the amount of water flushed down the toilet pan. Installing a "Hippo" bag or putting a 2- litre plastic bottle full of water in the cistern of your toilet could save you up to 7300 litres of water each year.
- Check if your toilet is leaking by adding a few drops of food dye to your cistern - if the colour seeps into the bowl, you have a leak. A toilet leak can waste up to 30 litres of water an hour!
- A dripping tap (one drop per second) could waste up to 30 litres of water an hour - which adds up to 10,000 litres a year!)
- Make a point of checking for toilet and tap leaks in your home, school or workplace and engage a plumber to repair any problems. In most instances the money it will cost to repair the leaks can be recovered through lower water bills over a period of time (usually less than a year).
- Do you wash your car with a hosepipe? Consider using two buckets of water to wash your car. This can save you up to 300 litres of water each time.

Saving water in the garden:

- Lawns are generally grossly over-watered and use up to four times more water than other plants. Check your irrigation system, does your water run down the street?
- Only water your garden before 10:00 or after 16:00.
- Consider re-using your bath water and sink water on your garden. Professional grey-water recycling systems are available on the market.

- Remember this tip: watering your garden less frequently, but deeper (for longer), actually encourages a deeper root system, which results in stronger plants. This practice can make water wise plants out of most established plants.

And for the Industrial and Commercial Sector:

- Does the factory or building you work in, manage, or own, have automatic flushing urinals? These are the ultimate water wasters. If you cannot immediately have these modified to be user activated, please turn off the water after hours and over weekends. As an example schools doing this have saved up to R5 000 on their annual water bill.

- Does your building Manager still wash down forecourts and paved areas with a hosepipe? This practice is literally water down the drain (and that means money too).

- Have you had your plumbing checked for leaks?

- Maintenance on toilet fittings can also save thousands of litres of unnecessarily flushed water. Toilets should flush for two to four seconds and urinals six to eight seconds, maximum.

It can be a simple exercise to save 10% on your annual water bill, without drastically changing your lifestyle.

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APPENDIX B

Specification standards for water efficient devices

Two specification standards are included in Appendix B. These are:

1. JASWIC's Water saving devices for hot and cold water supply systems: **JASWIC R67: 2002 (draft)**
2. Water Sense's Tank-Type High-Efficiency Toilet Specification and High Efficiency Bathroom Faucet (Tap) specification.
   Source: http://www.epa.gov/watersense/partners/specs/faucet_background.htm

1. JASWIC R67: 2002 (draft)

Water –saving devices for hot and cold water supply systems

Scope

This standard specifies the characteristics of water- saving devices for use in conjunction with domestic hot and cold water supply systems and suitable for working pressure of up to 2 000 kPa.

2. Normative references

The following standards contain provisions that, through references in the text, constitute provisions of this standard. At the time of publication the editions indicated were valid .All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the recent editions of the standards indicated below. Information on currently valid national and international standards may be obtained from the South African Bureau of Standards.

SABS 1109-1:1990 Pipe threads where pressure-tight joints are made on the threads – Part 1: Designation, dimensions and tolerances.

SABS 1109-2: 1990 Pipe threads where pressure –tight joints are made on the threads-Part 2: Verification by means of limit gauges.

ISO 6509………………..

3. Definitions

For the purpose of this standard the following definitions apply:

3.1 Acceptable: Acceptable to the parties concluding a purchase contract, but in relation to the certification mark and to inspections carried out by the SABS, acceptable to the South African Bureau of Standards.

3.2 design pressure: The maximum pressure that the body of the device was designed to resist.

3.3 Nominal size: The nominal size of the pipe to which the device is to be connected.

4 . GENERAL Requirements

4.1 Materials

4.1.1 Metallic materials for components in direct contact with water

The metallic material of a component that is direct contact with water shall be either:

(a) a copper alloy that , when tested for dezincification resistance in accordance with clause 7.9 , shows a maximum depth of penetration not exceeding 250µm , or

(b) a stainless steel as given in row 1 to 17 inclusive of tables 10 of SABS 0202: 1985 and that complies with the requirements of the relevant standard.

4.1.2 Non – metallic materials, other than plastics for components in direct contact with water.

Non – metallic materials, other than plastics, for components in direct contact with water shall be of such quality that when the fully assembled device is tested in accordance with clause 7.2, no leakage occurs.

4.1.3 Plastics materials

When tested in accordance with the clause 7. 8, plastics components, other than decorative components, shall show no sign of blistering or weld line splitting and any damage around the injection point shall not penetrate to a depth of more than 50% of the thickness of the material at the injection point.

4.2 Classes of water –saving device

Water-saving devices shall be of one of the following classes:

4.2.1 **Class 1**: Devices which have a water use which is 11% to 20% less than the norm for that type of device ,

4.2.2 **Class 2**: Devices which have a water use which is 21% to 30% less than the norm for that type of device;

4.2.3 **Class 3**: Devices which have a water use which is 31% to 40% less than the norm for that type of device;

4.2.4 **Class 4**: Devices which have a water use which is 41% to 50% less than the norm for that type of device ;or

4.2.5 **Class 5:** Devices which have a water use which is more than 50% less than the norm for that type of device.

4.3 Construction and design

4.3.1 Design pressure rating and performance

The design pressure rating shall be such that, when a device is tested in accordance with 6.2 and 6.4, there is no leakage through the body and no component cracks, breaks or becomes permanently distorted. The general performance of a device shall be such that, when the device is tested in accordance with the clause 6.3, there is no sticking, jamming, permanent distortion or failure of any component or any other malfunctioning of the device and there is no sign of weeping through the body or of any other leakage.

4.3.2 **Nominal working pressure**

The nominal working pressure for all devices subjected to mains pressure shall be 1 500 kPa.

4.3.3 Connections

4.3.3.1 Size of connections

The nominal size of the inlet and outlet water connections shall be not less than 15 mm.

4.3.3.2 **Types of connection**

Any connection intended for joining the device to water pipes shall be:

(a) a copper alloy compression type which complies with the requirements of SABS 1067-1

(b) a connection with a thread that complies with the requirements of SABS 1109-1 or SABS 1109-2 (or both); or

(c) a soldered capillary connection complying with the requirements of SABS 1067-2.

4.3.4 Threads

Connecting threads shall be capable of withstanding a torque of 20 Nm without stripping. The threads shall be such that leak proof joints can be made between the device and the mating pipework without the application of such force as may cause distortion of, or undue strain on, the device.

4.3.5 Joints

The fit at mechanically made the joints shall be acceptably close and the joints shall be free from the warp and the other distortions. Soldered, brazed and welded joints shall be clean, smooth and free from porosity. Welded joints shall, in addition, be free from the slag, weld spatter and undercut.

4.3.6 Finish

Components that are cast or hot –pressed shall have an acceptably smooth surface and shall be free from the blow- holes, sand, burns and other defects.

4.3.6.1 Components formed from the sheet metal, plastics material, fibre -glass etc. shall have clean-cut edges and shall be free from the burrs, cracks, warps, dents, buckles and other defects.

5 **Packing and marking**

5.1 Packing

Each device shall be so packed that it is protected from the damage during the normal handling, transportation and storage. All openings shall be covered in an acceptable manner to prevent the ingress of foreign matter.

5.2 **Marking**

5.2.1 **General**

Each device shall bear, or be accompanied by, the following information in legible and indelible markings:

(a) the manufacturer’s name ,trade name or trade mark;
(b) the year of manufacture;
(c) the type of the function
(d) the nominal working pressure;
(e) the class of the device;
(f) any other information required for the correct , safe and satisfactory installation , operation , regular maintenance of the device.

5.2.2 **Method of marking**

The information required in terms of clause 5.2.1 shall be given in the following manner:

(a) clause 5.2.1(a);stamped or embossed on the body of the device;
(b) clause 5.2.1(b) ,(c), (d) ,and (e); stamped or embossed on the body of the device or given on a durable metal label closely and securely attached to the valve in an acceptable manner ;and
(c) clause 5.2.1 (f) ; given in a leaflet or booklet attached to, or packed with, the device.

6 Inspection and methods of test

6.1 Inspection

Visually examine and measure each device in the sample for compliance with all the applicable requirements of this standard for which tests to assess compliance are given in clauses 6.2 to 6.6 inclusive.

6.2 Hydraulic test

Connect the inlet of the device to a water supply the pressure of which can be adjusted up to 2000 kPa. By appropriate adjustment of the water pressure, allow the device to completely fill the water, ensuring that no air is entrained. Plug the outlet and secure the device in its normal operating position. Adjust the water pressure to between 2 500 kPa and 2 520 kPa and maintain this pressure for 3 min and, while the device is under pressure inspect it for compliance with the relevant requirements of clause 4.1.2(a) and clause 4.3.1.

6.3 Performance test

Install the device in the manner appropriate to the category of the device and then measure the water used in the operation of the device to determine the appropriate classification.

6 Strength test for end connections

6.4.1 **Apparatus**

Calibrated torque wrench of capacity exceeding 30 Nm.

6.4.2 Procedure

Fix the device in a rigid manner

Fit a standard nipple or socket, as relevant of size appropriate to the size of the connection to be tested, to the appropriate connection and tighten the nipple or socket with a torque of 20 Nm. Check for compliance with clause 4.3.1

6.5 Test for resistance of plastics components to heat

6.5.1 **Apparatus**

6.5.2 Air circulation oven maintained at a temperature of 150ºC ± 2º C.

6.5.3 Procedure

Dismantle the device place all the plastic components in the oven for 60 min ± 1 min and then inspect each item for compliance with clause 4.1.3.

6.6 Test for dezincification resistance

Using the method given in ISO 6509, test the relevant component of the valve as indicated below:

6.6.1 In the case of cast components, take a test specimen from both the thickest and the thinnest section of the component

6.6.2 In the case of other components, takes only one test specimen from the component.

6.6.3 Determine the maximum depth of penetration and check for

6.6.4 Compliance with clause 4.1.1(a).

2. Water Sense

EPA WaterSense

Tank-Type High-Efficiency
Toilet Specification

Tank-Type High-Efficiency Toilet Specification

1.0 Scope and Objective

This specification establishes the criteria for a tank-type high-efficiency toilet (HET) under the U.S. Environmental Protection Agency WaterSense[SM] program. It is applicable to:

- Single flush, tank-type gravity toilets;
- Dual flush, tank-type gravity toilets;
- Dual flush, tank-type flushometer tank (pressure-assist) toilets;
- Tank-type, flushometer tank (pressure-assist) toilets;
- Tank-type electrohydraulic toilets; and
- Any other technologies that meet these performance specifications.

The specification is designed to ensure both sustainable, efficient water use and a high level of user satisfaction with flushing performance.

2.0 Summary of Criteria

Toilets must meet criteria in three areas:

- Effective flush volume shall not exceed 1.28 gallons[1] (4.8 liters), as specified in Section 3.0;
- Solid waste removal must be 350 grams[2] or greater, as specified in Section 4.0; and
- The toilet must conform to the adjustability and other supplementary requirements specified in Section 5.0.

3.0 Water Efficiency Criteria

3.1 Single Flush Toilets - The effective flush volume shall not exceed 1.28 gallons (4.8 liters). The effective flush volume is the average flush volume when tested in accordance with ASME A112.19.2[3].

3.2 Dual Flush Toilets - The effective flush volume shall not exceed 1.28 gallons (4.8 liters). The effective flush volume is defined as the composite, average flush volume of two reduced flushes and one full flush. Flush volumes will be tested in accordance with ASME A112.19.2 and ASME A112.19.14.

[1] The effective flush volume has been established as 1.28 gallons, which is a 20 percent reduction from the 1.6 gallons per flush standard that became mandatory pursuant to the 1992 EPAct.
[2] A qualified HET must provide superior flushing performance while saving significant volumes of water. Based on data contained in the medical study *Variability of colonic function in healthy subjects*, 1978, J.B. Wyman, K.W. Heaton, A.P. Manning, and A.C.B. Wicks of the University Department of Medicine, Bristol Royal Infirmary, the greatest single 'loading' of the 20 study participants was approximately 450g, and the 99.5 percent confidence level of the men in the study equates to a loading of approximately 350g.
[3] References to this and other ASME standards apply to the most current version of that standard.

EPA WaterSense

Tank-Type High-Efficiency
Toilet Specification

4.0 Flush Performance Criteria

4.1 Toilet model performance is identified as either a Pass or Fail depending upon whether it can successfully and completely clear all test media from the fixture in a single flush in at least four of five attempts. Only toilet models that Pass qualify for the EPA WaterSense label. Flush performance testing shall be conducted in accordance with the test protocol provided in Appendix A.

4.2 Test media consists of seven test specimens, 50 ± 4 grams each, consisting of soybean paste forming a 'sausage' approximately 4 ± 0.5 inch (100 ± 13 mm) in length and 1 ± 0.25 inch (25 ± 6 mm) in diameter and four loosely crumbled balls of toilet paper as defined in Appendix A.

4.3 The flush performance criteria apply to single flush toilets, and to the full flush option of dual flush toilets. No solid waste removal requirement applies to the reduced flush option on dual flush toilets.

5.0 Supplementary Requirements for Flush Volume Adjustability

5.1 All single flush toilets must conform to ASME A112.19.2 and all dual flush toilets must conform to ASME A112.19.14.

5.2 The criteria in this section apply to tank-type gravity toilets.

5.2.1 Must conform to ASME A112.19.5.

5.2.2 Fill Valve
The fill valve shall be the pilot valve type only, or, alternatively, the fill valve shall meet the performance requirements of the fill valve test protocol in Appendix B. All fill valves must conform to ANSI/ASSE 1002.

5.2.3 Tank Capacity

5.2.3.1 Any barrier, bucket, dam, displacement device, or similar fixture used in a toilet tank to affect flush volume shall be tamper-resistant and permanently affixed to the tank. Any device that can be tampered with or removed such that the toilet can be made to flush with greater than the maximum flush volumes specified in Section 5.2.3.2 shall be deemed noncompliant.

5.2.3.2 The maximum volume of water that may be discharged by the toilet, when field adjustment of the tank trim is set at its maximum water use setting, shall not exceed the following amounts:

- For single flush fixtures: 1.68 gallons (6.4 liters) per flush[4]
- For dual flush fixtures: 1.40 gallons (5.3 liters) per flush[5] in reduced flush mode and 2.00 gallons (7.6 liters) per flush[6] in full flush mode.

[4] Value based on a maximum effective flush volume of 1.28 gallons (4.8 liters) per flush, with no more than 0.40 gallon (1.6 liter) increase with tank trim adjusted to maximum water use settings.
[5] Value based on the reduced flush requirement in ASME A112.19.14-2001.

- The maximum volume of water discharged, using both original equipment tank trim and using after market closure seals, shall be tested according to the protocol in Appendix C.

6.0 Effective Date

This specification is effective on January 24, 2007.

7.0 Future Specification Revisions

EPA reserves the right to revise this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. Revisions to the specification would be made following discussions with industry partners and other interested stakeholders.

8.0 Definitions

Definitions within ASME A112.19.2 and ASME A112.19.14 are included by reference.

- **Electrohydraulic toilet**: A toilet fixture of siphonic or washdown design that uses a motor, pump, and controller to assist flushing action.
- **Pressure-assist toilet**: A flushometer tank toilet as defined in ASME A112.19.2.
- **Rated flush volume**: The stated flush volume of the toilet, as certified.

[6] Value based on the requirement in the Los Angeles Department of Water and Power Supplementary Purchase Specification, adopted in 2000 and as amended in 2005.

Appendix A: HET Fixture Performance Testing Protocol[7]

1.0 Scope of Testing

1.1 Toilet model performance is identified as either a **Pass** or a **Fail** depending upon whether the test fixture can successfully and completely clear all media (350 grams) from the fixture in a single flush in at least four of five attempts.

1.2 Tests where toilet sample clogs, plugs, or fails to restore a minimum of a 2 inch (50 mm) trap seal following each flushing test will be deemed a failed test.

1.3 Test media is comprised of the following:
- 1.3.1 Seven test specimens at 50 ± 4 grams per test specimen ("test specimen") consisting of soybean paste forming a "sausage" approximately 4 ± 0.5 inch (100 ± 13 mm) in length and 1 ± 0.25 inch (25 ± 6mm) in diameter. The total mass of test media used for each test shall be 350 ± 10 grams.
- 1.3.2 Four loosely crumpled balls of toilet paper ("paper").

2.0 Testing Protocol

2.1 Fixture Model Selection
The product sample tested to these requirements shall be selected according to the procedure provided in Section A4 of ASME A112.19.2, Nonmandatory Appendix A, Demonstrating Compliance to ASME A112.19.2.

2.2 Set-Up
- 2.2.1 Samples shall be assembled according to manufacturer's written instructions as contained within the product packaging, and placed on test rig, ensuring tank and bowl are level.
- 2.2.2 Tank water level shall be adjusted to the level specified by manufacturer in the manufacturer's instructions (e.g., set to waterline) where applicable.
- 2.2.3 Static water supply pressure shall be set to 50 ± 3 PSIG.
- 2.2.4 Inlet water temperature shall be 65 to 80°F (18 to 27 °C).
- 2.2.5 Flush sample a minimum of three times prior to commencement of testing.
- 2.2.6 Re-adjust tank water level to proper level if required.

2.3 Flush Volume Measurement
- 2.3.1 Measure and record flush volume of sample (sample set-up as outlined in Section 2.2). Repeat the test two additional times and record the results and the average of the three test replicates. A receiving vessel may be used, either calibrated in increments not exceeding 0.025 gallon (0.1 L) or

[7] Testing protocol based on Maximum Performance (MaP) Testing Protocol, Version 3, January 2006, by Bill Gauley, Veritec Consulting, Inc., and John Koeller, Koeller and Company.

placed on a load cell with a readout in increments not exceeding 0.025 gallon (0.1 L). Other methods capable of measuring volumes to within in 0.025 gallon (0.1 L) shall be acceptable.

2.3.2 Samples with average flush volumes in excess of 0.10 gallon (0.4 L) greater than their rated flush volume shall be deemed to fail testing requirements due to excessive flush volume[8].

2.3.3 Samples with average flush volumes less than 0.10 gallon (0.4 L) greater than their rated flush volume shall be adjusted, if possible, to their rated flush volume prior to performance testing.

2.3.4 Samples with average flush volumes less than their rated flush volume shall be tested at measured volume and this volume shall be recorded on test report.

2.4 Waste Extraction Test

2.4.1 Test specimens shall be formed such that they are roughly cylindrical in shape and uniform in diameter.

2.4.2 A test specimen drop guide shall be placed across the top of the bowl, with the centerline of a 2 inch (50 mm) diameter opening 6 inches (15 cm) in front of the center of the seat post holes, equidistance from each hole. Drop guide may be made of plastic or other rigid material, to be no more than 0.5 inch (12 mm) thick, and be of sufficient length to span top of toilet bowl.

2.4.3 Seven (7) test specimens (350g) shall be freely dropped in a vertical orientation through opening in drop guide into bowl.

2.4.4 Immediately remove drop guide and freely and randomly drop four balls of crumpled toilet paper over center of bowl sump.

2.4.5 Wait 10 ± 1 seconds.

2.4.6 Flush sample.

2.4.7 Record test as **Pass** or **Fail** (test is a **Fail** if any waste remains in the bowl or trap, or if minimum 2 inch (50 mm) trap seal has not been restored).

2.4.8 Flush sample to clean bowl and trapway and fully restore trap seal.

2.4.9 Repeat testing until toilet sample either (i) achieves four **Pass** grades or (ii) achieves two **Fail** grades.

2.4.10 Models must **Pass** at least four of five attempts to qualify for the EPA WaterSense Program.

3.0 Test Media Specifications

3.1 Soybean Paste Nominal Specifications:
35.5 percent water, 33.8 percent soybean, 18.5 percent rice, and 12.2 percent salt, and having a density of 1.15 ± 0.10 g/mL (i.e., density greater than that of water).

3.2 Test Specimens:

[8] For example, fixtures rated at 1.28 gallons per flush (the HET maximum) but flushing at greater than 1.38 gallons (5.2 L) when adjusted to water line shall be deemed to have "failed" the requirements of this specification.

Appendix B: HET Fill Valve Integrity Test Protocol[9]

1.0 Scope of Testing

This requirement shall apply to all fill valves that are not otherwise classified as pilot valves. Samples must conform to both Sections 2.0 and 3.0 of this appendix.

2.0 Consistent Water Level

2.1 Purpose of Test: To determine whether or not the fill valve shuts off at a consistent water level in a toilet tank independent of any change in inlet water supply pressure.

2.2 Test Procedure

- 2.2.1 Install the fill valve in the toilet tank provided, install the tank on a leveled test stand, and adjust the water level per the manufacturer's recommendation at an inlet water pressure of 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product literature and product packaging.
- 2.2.2 Flush the tank to verify and mark water level after completed refill.
- 2.2.3 Increase the inlet water pressure to 60 ± 2 PSIG.
- 2.2.4 Flush the tank.
- 2.2.5 Measure any difference in water level after completed refill.
- 2.2.6 Repeat steps 2.2.3 to 2.2.5 utilizing 80 ± 2 PSIG inlet water pressure.

2.3 Performance Requirement: The fill valve shall shut off at the same water level ± 0.5 inch (± 12 mm) for all three inlet water pressures. In addition, water shall not enter the overflow tube or flow out of the tank at any of the three tested inlet pressures.

3.0 Shutoff Integrity with Increased Water Pressure

3.1 Purpose of Test: To determine whether or not the fill valve shuts off at a consistent water level in a toilet tank independent of changes in inlet water supply pressure.

3.2 Test Procedure

- 3.2.1 Install the fill valve in a toilet tank and adjust the water level per the manufacturer's recommendation at an inlet water pressure of 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product literature and product packaging.
- 3.2.2 Flush the tank to verify and mark water level after completed refill.

[9] Testing protocol based on Appendix B to Los Angeles Department of Water and Power Supplementary Purchase Specification, November 16, 2005 version.

3.2.3 Increase the inlet pressure to the fill valve from 20 (or recommended minimum pressure) to 60 PSIG, then to 80 PSIG at a rate of less than 10 PSIG per second.

3.3 Performance Requirement: The water level shall remain at the initial mark ± 0.5 inch (± 12 mm). In addition, water shall not enter the overflow tube or flow out of the tank.

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Appendix C: Tank Trim Adjustability Testing Protocol[10]

1.0 Scope of Testing

All tank-type gravity toilet fixtures must conform to the requirements of Section 2.0 of this appendix, which address the adjustability of original equipment tank trim and the resulting flush volume of the toilet fixture. All tank-type gravity toilet fixtures with flush seals must conform to the requirements in Section 3.0 of this appendix, which address the flush volume resulting from the replacement of original equipment seals with seals available in the after market.

2.0 Tank-Type Gravity Toilets With Original Equipment

2.1 Purpose of Test

The objective of this tank trim adjustability test is to determine the upper limit to the volume of water that may be discharged by the field adjustment of tank trim components. The maximum volume of water that may be discharged by the toilet, when field adjustment of original equipment tank trim is set at its maximum water-use setting, shall not exceed the following amounts:

- For single flush fixtures – 1.68 gallons (6.4 liters) per flush
- For dual flush fixtures:
  - Reduced flush ("short flush") mode – 1.40 gallons (5.3 liters) per flush
  - Full flush mode – 2.00 gallons (7.6 liters) per flush

The following test procedure shall be used to verify that the toilet sample meets these requirements.

2.2 Test Procedure

Test shall be conducted per section 8.4 of ASME A112.19.2 with the following modifications:

2.2.1 The toilet shall be installed on a leveled test stand and all adjustable tank trim components (any field adjustment features in the tank that might increase the toilet flush volume) shall be adjusted to the maximum water use setting, while taking care not to damage or alter the parts.

2.2.2 The water level in the tank shall be set to 0.25 ± 0.06 inch (6 ± 2 mm) below the top of the overflow tube. Where the tank utilizes an internal containment vessel and does not possess an overflow tube, the vessel shall be filled to a level 0.25 ± 0.06 inch (6 ± 2 mm) below the top rim of the vessel or to the manufacturer's designated water line, whichever is higher.

2.2.3 The static pressure of the water supply shall be adjusted to 80 ± 2 PSIG.

2.2.4 The toilet shall be flushed maintaining the activator in the flushing position for a period of one (1) second, the water being drained into a container.

2.2.5 After the flush cycle is complete, the total flush volume shall be observed and recorded.

[10] Testing protocol based on Los Angeles Department of Water and Power Supplementary Purchase Specification, 16 November 2005 version, modified to reflect the deletion of certain trim durability and marking requirements incorporated into ASME A112 19.5.

2.2.6 This procedure shall be repeated until five (5) sets of data are obtained.

2.2.7 The static pressure of the water supply shall be adjusted to 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product literature and product packaging, and test procedure steps 2.2.4 to 2.2.6 shall be repeated.

2.2.8 For dual-flush toilet fixtures, this test shall be conducted at both full flush and reduced flush modes.

2.3 Report: The five (5) individual flush volumes and the average of the five (5) runs shall be reported for each of the two static water supply pressures specified.

2.4 Performance Requirement: The average total flush volume for five (5) test runs for each of the two static water supply pressures shall not exceed the following:

For single-flush fixtures – 1.68 gallons (6.4 liters) per flush

For dual-flush fixtures:

Reduced flush ("short flush") mode – 1.40 gallons (5.3 liters) per flush

Full flush mode – 2.00 gallons (7.6 liters) per flush

The volume of water may be determined visually using a graduated container or by weight calculated as a unit to volume unit.

3.0 Tank-Type Gravity Toilets With After-Market Closure Seals

3.1 Purpose of Test

The objective of this tank trim adjustability and after-market seal test is to determine the upper limit to the volume of water that may be discharged when an off-the-shelf replacement flush valve seal/flapper is installed on the toilet. The maximum volume of water that may be discharged by the toilet, when the original equipment flush valve seal (flapper or other sealing device) is replaced with a standard (buoyant) seal available in home improvement centers and hardware stores, and the field adjustment of tank trim is set at its maximum water-use setting, shall not exceed the following amounts:

For single flush fixtures – 1.68 gallons (6.4 liters) per flush

For dual flush fixtures:

Reduced flush ("short flush") mode – 1.40 (5.3 liters) gallons per flush

Full flush mode – 2.00 gallons (7.6 liters) per flush

The following test procedure shall be used to verify that the toilet sample meets these requirements.

3.2 Test Procedure

Test shall be conducted per section 8.4 of ASME A112.19.2 with the following modification:

3.2.1 The toilet shall be installed on a leveled test stand and all adjustable tank trim components (any field adjustment features in the tank that might increase the toilet flush volume) shall be adjusted for maximum water use, while taking care not to damage or alter the parts.

3.2.2 Remove the original equipment flush valve seal and replace it with a standard (buoyant) non-adjustable after-market seal/flapper for that toilet where possible. In the case of a standard configuration 2-inch flush valve, a Fluidmaster Bullseye Super flapper (part no. 501) or a Coast Foundry Ultra Blue flapper shall be used. For non-standard flush valves, including 3-inch flush valves, one or more replacement seals available at hardware, plumbing supply, and building supply stores or from the manufacturer or other recognized source shall be used[11].

3.2.3 The water level in the tank shall be set to 0.25 ± 0.06 inch (6 ± 2 mm) below the top of the overflow tube. Where the tank utilizes an internal containment vessel and does not possess an overflow tube, the vessel shall be filled to a level 0.25 ± 0.06 inch (6 ± 2 mm) below the top rim of the vessel or to the manufacturer's designated water line, whichever is higher.

3.2.4 The static pressure of the water supply shall be adjusted to 80 ± 2 PSIG.

3.2.5 The toilet shall be flushed maintaining the activator in the flushing position for a period of one (1) second maximum, the water being drained into a container.

3.2.6 After the flush cycle is complete, the total flush volume shall be observed and recorded.

3.2.7 This procedure shall be repeated until five (5) sets of data are obtained.

3.2.8 The static pressure of the water supply shall be adjusted to 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product literature and product packaging, and test procedure steps 3.2.5 to 3.2.7. shall be repeated.

3.2.9 For dual-flush toilet fixtures, this test shall be conducted at both flush modes (full flush and reduced flush).

3.3 Report: The five (5) individual flush volumes and the average of the five (5) runs shall be reported for each of the two static water supply pressures specified.

3.4 Performance Requirement: The average total flush volume for five (5) test runs for each of the two static water supply pressures shall not exceed the following:

For single-flush fixtures – 1.68 gallons (6.4 liters) per flush

For dual-flush fixtures:

Reduced flush ("short flush") mode – 1.40 gallons (5.3 liters) per flush

Full flush mode – 2.00 gallons (7.6 liters) per flush

The volume of water may be determined visually using a graduated container or by weight calculated as a unit to volume unit.

[11] Where neither the Fluidmaster Bullseye Super flapper nor the Coast Foundry Ultra Blue flapper fit the flush valve, where a 3-inch flush valve is employed, or in the case of a toilet fixture with a non-standard flush valve seal, the testing laboratory shall have discretion as to which after-market flapper or seal shall be used in the test.

EPA WaterSense

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Appendix D: Informative Annex for WaterSense Labeling

The following requirements must be met for products to be marked with the WaterSense label.

1.0 WaterSense Partnership

The manufacturer of the product must have a signed partnership agreement in place with EPA.

2.0 Conformity Assessment

Conformance to this specification must be certified by a body either accredited by ANSI in accordance with the WaterSense certification scheme, or otherwise approved for that purpose by EPA.

3.0 Prior Testing

Products previously tested under the predecessor UNAR specification[12] must still be certified under this specification.

[12] Uniform North American Requirements (UNAR) for toilet fixtures, a supplementary specification developed in 2005 for water utilities.

High-Efficiency Bathroom Sink Faucet Specification

1.0 Scope and Objective

This specification establishes the criteria for a high-efficiency bathroom sink (lavatory)[1] faucet under the U.S. Environmental Protection Agency (EPA) WaterSense[SM] program. It is applicable to all types of lavatory faucets, lavatory faucet accessories[2] specifically designed to control the flow of water, and any other lavatory faucet technologies that meet these performance specifications.

The specification is designed to ensure both sustainable, efficient water use and a high level of user satisfaction with lavatory faucet performance.

2.0 WaterEfficiency and Performance Criteria

Lavatory faucets and lavatory faucet accessories must conform to applicable requirements in ASME A112.18.1.[3] In addition, the flow rate shall be tested in accordance with the procedures in ASME A112.18.1 and shall meet the following criteria:

- The flow rate shall not exceed 1.5 gallons per minute (gpm)[4] (5.7 liters per minute) at a pressure of 60 pounds per square inch (psi) at the inlet, when water is flowing; and
- The flow rate shall not be less than 1.2 gpm (4.5 liters per minute) at a pressure of 20 psi at the inlet, when water is flowing:

The flow rate, tested at 60 psi in accordance with the procedures in ASME A112.18.1, shall not vary beyond +/- 0.1 gpm of the certified flow rate of the product.

3.0 Effective Date

This specification is effective on July 1, 2007.

4.0 Future Specification Revisions

EPA reserves the right to revise this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. Revisions to the specification would be made following discussions with industry partners and other interested stake holders.

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[1] Lavatory, other than public lavatory or metering.
[2] Accessory, as defined in ASME 112.18.1, means a component that can, at the discretion of the user, be readily added, removed, or replaced, and that, when removed, will not prevent the fitting from fulfilling its primary function. For the purpose of this specification, an accessory can include, but is not limited to lavatory faucet flow restrictors, flow regulators, aerator devices, laminar devices, and pressure compensating devices.
[3] Reference to this ASME standard applies to the most current version.
[4] The maximum flow rate has been established as 1.5 gpm, which is a 32 percent reduction from the 2.2 gpm standard codified under 10 CFR Part 430 (63 FR 13307; March 18, 1998).

5.0 Definitions

Definitions within ASME A112.18.1 are incorporated herein by reference.

Certified flow rate: The intended flow rate at a pressure of 60 psi, when water is flowing, based on the design of the product, as marked on the product or product packaging.

APPENDIX A

Informative Annex for WaterSense Labeling

The following requirements must be met for products to be marked with the WaterSense label.

1.0 WaterSense Partnership

The Manufacturer[5] of the product must have a signed partnership agreement in place with EPA.

2.0 Conformity Assessment

Conformance to this specification must be certified by a body either accredited by ANSI in accordance with the WaterSense certification scheme, or otherwise approved for that purpose by EPA.

[5] Manufacturer, as defined in the WaterSense program guidelines, means "Any organization that produces a product for market that might be eligible to meet WaterSense criteria for efficiency and performance. Manufacturers may also produce "private label" products that are sold under the brand name of a separate organization, which is treated as a separate partner/application from the original product manufacturer."

APPENDIX C

Case Study: The status and use of water efficient devices in hospitals

Executive Summary

Data on water use was gathered from several hospitals in Gauteng and KwaZulu-Natal. The primary purpose of the study was to ascertain the prevalence of water efficient fittings in hospitals. A secondary aim was to look more generally at the way in which water use was managed in the healthcare environment.

The findings were that there is low usage of water efficient fittings in hospitals. The reasons given for this low usage were:

- Lack of awareness of the fittings.
- Lack of knowledge on whether they would operate satisfactorily and justify the increased cost of procuring them.
- Availability and cost of the fittings.
- Concern and uncertainty about the effect on the *legionella* risk

A short calculation was performed, using data from Johannesburg Hospital, to estimate the potential savings if the installed showers roses were replaced with water efficient ones. The results suggested that it could be possible to save up to 62 Mℓ per annum, which is 8.5% of the water consumed

Water use efficiency is not afforded a high priority in hospitals.

- Some effort is made in the private sector. Water consumption is monitored on a monthly basis. Water saving projects are done and implemented if found to be cost effective.
- Very little attention is paid to water management in the public sector. Some attention is paid to reducing costs by ensuring that the billing is correct, but not through reduction in use.

The performance of three South African Hospitals was compared to a United Kingdom benchmark. There are some reservations about the comparability of the results, due to the use of floor area as the variable function. However, the large difference in the apparent efficiencies between the South African hospitals and the benchmark supports deeper investigation into the seemingly poor performance.

Contents

Introduction

Water use efficiency, or the reduction of waste in the use of water, has two components. The first is the management of water, which is comprised of many aspects. Included under this heading are the operational processes, management processes, water policy and the behavioural approach of the individuals in the population. The second aspect is the technology, such as the water efficient supply fittings that are the subject of this study.

For the purposes of this study the fittings considered as water efficient were taps fitted with aerators, shower roses with a controlled flow of 10 litres per minute, dual flush toilets, low flush toilets and metering taps. The many other technologies available that can also be considered as water efficient were not included. These technologies include pressure control, water and energy efficient domestic washing machines and industrial dish and laundry washers. In many instances these are capital items or would be part of a comprehensive renovation and would be part of a specific project. The separation is simply for convenience within this project.

Revitalisation of public hospitals

The aim of the Hospital Revitalisation programme is to improve infrastructure, equipment and management within hospitals. A 1996 audit of hospitals found that two thirds of public hospitals were in need of upgrading or replacement. Subsequently 18 new hospitals have been built and 190 facilities have been upgraded. Despite the programme, clinic infrastructure remains poor; 20% of clinics do not have piped water.
(Source: Strategic Priorities for the National Health System, 2004-2009 accessed via http://www.doh.gov.za/docs/policy/stratpriorities.pdf)

It was anticipated that most of the establishments would not have these fittings. Hence data was also gathered so that a water balance could be generated. This would enable an estimate to be made of the possible water savings if water efficient fittings were installed. This data included the overall consumption of the hospital, definition of all the areas within the hospital where water is consumed, any consumption figures from sub metering (zonal consumptions) and the number of people using the hospital.

Methodology

In the case of the public hospitals, the CEO was contacted and authorisation sought for the data gathering. This was deemed to be the most appropriate course as experience has shown that direct contact with staff is usually referred to the CEO for authorisation. In several cases the CEO referred the enquiry to the regional research section (Gauteng and Limpopo Departments of Health). At the time that the research project ended, no response had been received from the departments.

In the private sector the Technical Managers usually have more autonomy, and contact was made directly with them or with the regional Technical Manager.

The available hospitals were visited and a brief interview held with the relevant people. A short tour of the hospital was done if the hospital staff were available.

Overall water consumption figures were obtained from the municipal accounts. In the case of Chris Hani Baragwaneth and Johannesburg Hospitals these figures were obtained directly from Joburg Water, the company which provides water to the Johannesburg Metro area. The volumes from zonal metering, where it exists, were obtained from the hospitals' technical department.

Hospitals contacted

For the urban hospitals, Chris Hani Baragwaneth (CHB) hospital was selected as it is known to be a high water user. Johannesburg Hospital was thought appropriate as a comparison to

CHB as it is also a large Level 3[54] hospital. At the start of the study representative hospitals from the three large companies in the Gauteng area were targeted. Examples were selected randomly within the companies. The only criteria used was that they should provide an extensive service and be as large as possible. However this was only loosely applied.

The hospitals for which data was supplied are:
- Chris Hani Baragwaneth (Gauteng)
- Johannesburg Hospital (Gauteng)
- Prince Mshiyeni (KwaZulu-Natal)
- Private Hospital 1 (Gauteng)
- Private Hospital 2 (Mpumalanga)
- Private Hospital 3 (Gauteng)

The Private sector hospitals are not specifically identified on their request.

As some information was also available from two rural hospitals, this is also included. These hospitals are in northern KwaZulu-Natal and are:
- Mseleni Hospital
- Manguzi Hospital

Survey Results

Prevalence of water efficient fittings

Within the hospitals the most appropriate places to use water efficient fittings are in the wards, the administration areas and the support areas. As with residential properties, water use in landscaped areas (particularly at private hospitals) is likely to be significant and an area in which water conservation strategies can be implemented without jeopardizing patient care. In the clinical areas, water is used as part of the infection control process, so it is not recommended that water use is reduced in these areas.

The data gathered from the hospitals indicated that in general water efficient fittings are not used in hospitals. In the examples where these fittings were installed, it was due to the initiative of the Technical Manager, and not as a result of a policy in the hospital to use such fittings. Water conservation does not form a significant part of the official operational policy, in either the public or private sectors. There is, however, an appreciation of the need to reduce and control water consumption. Mostly this is due to pressure to reduce costs.

Hospital Data

Chris Hani Baragwaneth Hospital

The hospital covers an area of 173 acres, and consists of some 430 buildings, which are predominantly single story. As most of the structures were built in the late 1940's, the water reticulation system is old and few drawings of the layout exist. These factors make maintenance costly and difficult. Water pressure is provided by the municipality and controlled at the supply by a pressure reducing valve set at 4.5 bar. This leads to problems such as excessively leaking taps and bursts due to high pressure at the start of the reticulation, and low pressure at the extremities.

The water distribution system at the hospital is quite complex, in that it supplies several satellite facilities that are not administratively connected to the hospital. These include the

[54] A level 3 facility or tertiary hospital provides specialist and sub-specialist care. Of the 388 public sector hospitals in South Africa there are currently only 12 level 3 facilities (Source: Health-e News Service, January 2006).

laundry, the canteen, the Lillian Ngoyi clinic, the Pathology Laboratories and the University of the Witwatersrand research units. Only some of these facilities are metered.

The hospital does not have any water efficient fittings installed, although the Technical Department is aware of them and would consider installing them. The concern the Department has is the effect the fittings will have on the risk of *Legionella* infection through the water distribution system.

The hospital does not have any policy on water conservation or efficiency, but was the subject of a water conservation case study undertaken by the South African- Netherlands co-operation on water management (SANOW). According to the hospital staff contacted, the study did not have any influence on water management at the hospital. Attempts to obtain a copy of the report from the hospital and the Department of Water Affairs and Forestry were unsuccessful (DWAF), although DWAF was aware of the study.

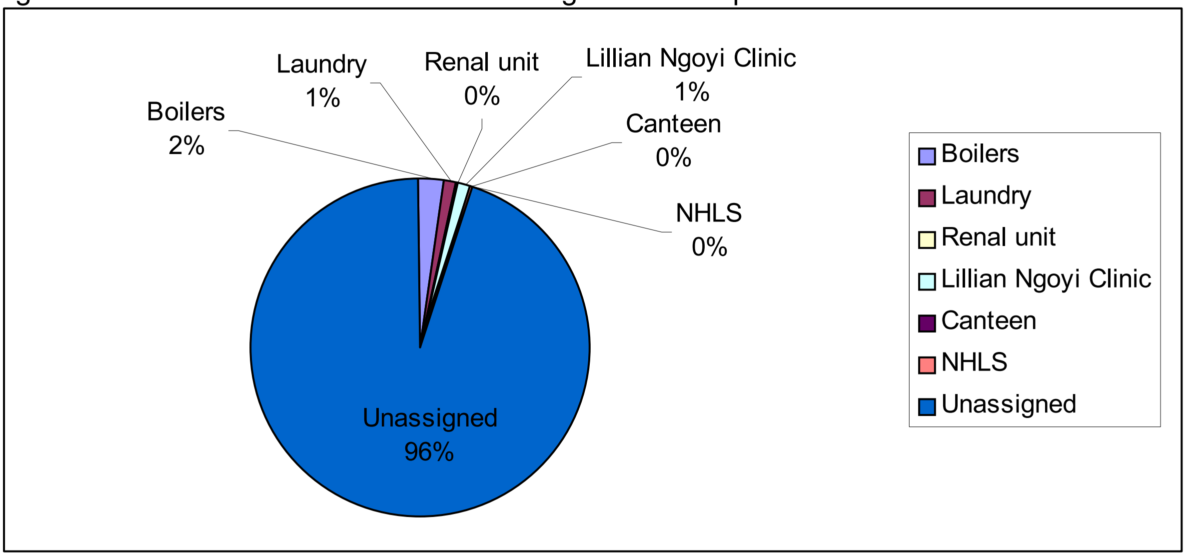
A utilities management consultant[55] [1] is employed to reduce the cost of utilities. This activity, however, is related to the accuracy of the municipal billing. While it has been successful in reducing costs, this has not been achieved through a reduction in utilities consumption due to the consultant's intervention.

All the consumption data that is recorded by the Technical Department was made available for this study, and is given in Table 1 below. The derived water balance is presented in Figure 1.

Table 1: Monthly total and sub-metered water consumption figures

Total Consumption (kℓ)	Boilers (kℓ)	Laundry (kℓ)	Renal unit (kℓ)	Laboratories (kℓ)	Clinic (kℓ)	Canteen (kℓ)	Unassigned (kℓ)
101501	2511	1230	222	224	1019	69	96225

Figure 1: Water balance for Chris Hani Baragwaneth Hospital



The above figure highlights the fact that introducing water efficient devices in some areas of the hospital, such as the renal unit and the canteen would have a negligible impact on overall water consumption. The facilities which contribute to the unassigned water use are tabulated below in Table 2.

[55] The consultant represented Energy Management Pty (Ltd).

Table 2: Facilities where water consumption is unmetered

Wards	Theatres	Cooling Towers	Autoclaves	Landscaping	Residence

Cooling towers, autoclaves, landscaping and residences are likely to offer the greatest scope for reducing water consumption.

The number of people at the hospital is given in Table 3. The volume of water used by each individual will depend on the reason they are at the hospital, so these numbers were categorised. The visitor figures were obtained from the security control at the main entrance, and should be viewed as estimates. The values are numbers per day.

Table 3: Daily occupational loading (People per day)

Available beds	Occupancy %	Staff	Visitors	Residents
2888	78 %	5071	1500	970

Johannesburg Hospital

Johannesburg Hospital is built on a much smaller area than Chris Hani Baragwaneth. It consists of multistory ward and theatre blocks, the Nurses residence, and support buildings. Water outlet fittings are standard Cobra Pillar taps and shower heads, and flush valves are used on urinals, toilets and in the sluice rooms. Water pressure is provided by roof tanks on each of the blocks, and generally no sub-metering is installed in the water reticulation system. The treated water to the boilers, cooling towers and renal dialysis unit is provided by an external contractor and is metered for billing purposes. A consultant[56] is employed to monitor the municipal bills to reduce the utilities cost.

The kitchen is used as a depot to receive and prepare frozen meals cooked off site and for storage of fresh fruit. No meals are cooked on site. The meals are distributed to 22 satellite kitchens at the wards. The contribution of the kitchen to the total consumption is going to be lower than in other hospitals where the meals are prepared directly in the kitchens.

The Utilities department provides steam to the adjacent Johannesburg College of Education and the University of the Witwatersrand Medical School. This amount was estimated at 30% of the steam produced by the hospital.

At the time of the study 40% per cent of the wards were scheduled to be renovated, including replacement of all taps, toilets and shower fittings. The specification for the new fittings did not include a requirement that they be water efficient. The criteria were stated to be that they were similar to the existing fittings aesthetically and in their maintenance requirements.

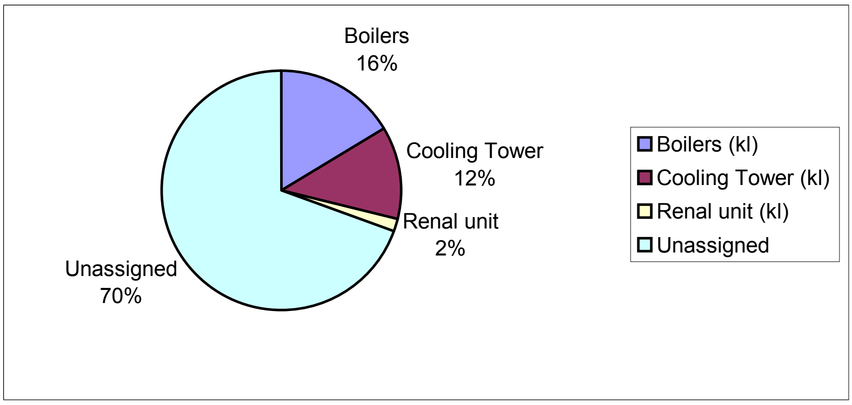
The measured water consumptions are given in Table 4, and the derived water balance in Figure 2 below.

Table 4: Monthly total and sub-metered water consumption figures

Total Consumption (kℓ)	Boilers (kℓ)	Cooling Towers (kℓ)	Renal unit (kℓ)	Swimming pool	Unassigned (kℓ)
60016	9831	7500	1050	60 kℓ capacity	41635

[56] The consultant is from Energy Management Pty (Ltd).

Figure 2: Water balance for Johannesburg Hospital



As with the CHB Hospital, reducing water use in the renal unit is unlikely to make a significant contribution to water conservation. Attention should be focused on the cooling towers, boilers and some of the other currently unmetered facilities, including

- Landscaped areas
- Wards
- Theatres
- Vacuum plant
- Autoclaves
- Kitchen
- Laboratories
- Residence

The number of people at the hospital is given in Table 5 below. The visitor figures were obtained from the security control, and include people entering through the main entrance and the parking garage. The figures should be viewed as estimates. The values are numbers per day.

The Hospital houses several departments from the University of the Witwatersrand Medical School. The staff and student numbers of these departments were not available.

Table 5: Daily occupational loading at Johannesburg Hospital

Available beds	Occupancy %	Staff	Visitors	Residents
954	90	3599	7200	1420

Private Hospital 1

This hospital consists of two multistory blocks (3 and 4 stories) and a small administration block. The one block houses the wards, theatres and some consulting rooms, while the second houses administration departments and additional consulting rooms.

The wards were equipped with aerated taps and flush valves on the urinals and toilets. The kitchen used water efficient equipment. The meters for the municipal supply, the cooling towers and the landscaping were read on a weekly basis. These consumptions were monitored to detect leaks, in addition to other operational purposes. It was stated that there was not an official company policy on the use of water efficient fittings, but that the Technical Managers are authorised to install them if it is economical and does not interfere with patient health and comfort.

There are no water conservation projects currently being implemented, but consideration is being given to recycling water for use in landscaping.

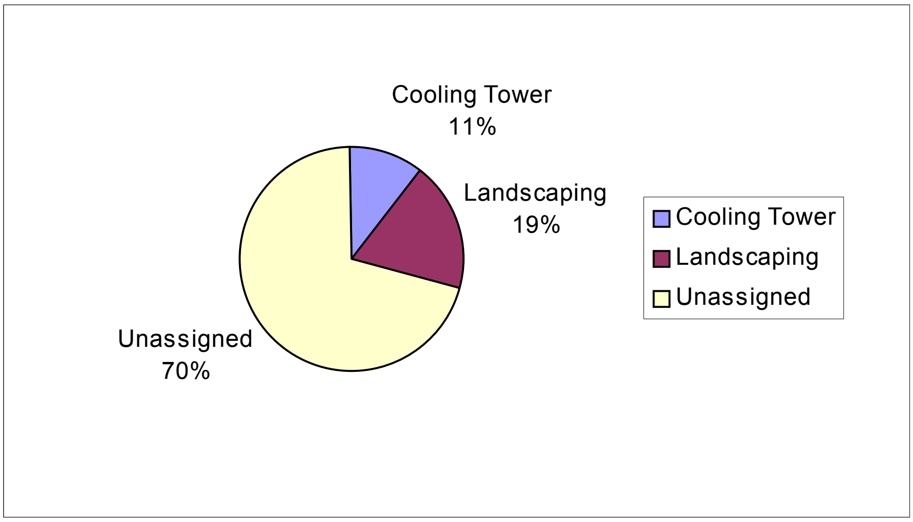
The measured water consumptions are given in Table 6 below.

Table 6: Monthly total and sub-metered water consumption figures

Total Consumption (kℓ)	Cooling Towers (kℓ)	Landscaping (kℓ)	Unassigned (kℓ)
4043	442	750	2851

Using the above figures a water balance for the hospital was constructed and is depicted in Figure 3 below

Figure 3: Water balance for Private Hospital 1



Those facilities which were identified as consuming water, but for which water consumption is not measured, include:

- Wards
- Theatres
- Boilers
- Autoclaves
- Kitchen
- Laboratories

The water consumed by these facilities will be accounted for in the balance of the water used.

The number of people at the hospital is given in Table 7. The number of visitors to the facility is not recorded.

Table 7: Daily occupational loading

Available beds	Occupancy %	Staff
260	60	555

Private Hospital 2

The metered area is a single double story building housing the wards, theatres and support. No water efficient fittings are installed in the hospital, although flush valves are used on the urinals, toilets and in the sluice rooms. Standard fittings were installed when the hospital was built. The Technical Manager was not aware of the availability of water efficient alternatives for replacement or retrofit purposes. The water consumption is monitored on a monthly basis by the Technical Department. Landscaped areas are irrigated with municipal water as the borehole on site is not considered reliable enough to regularly meet all the irrigation requirements.

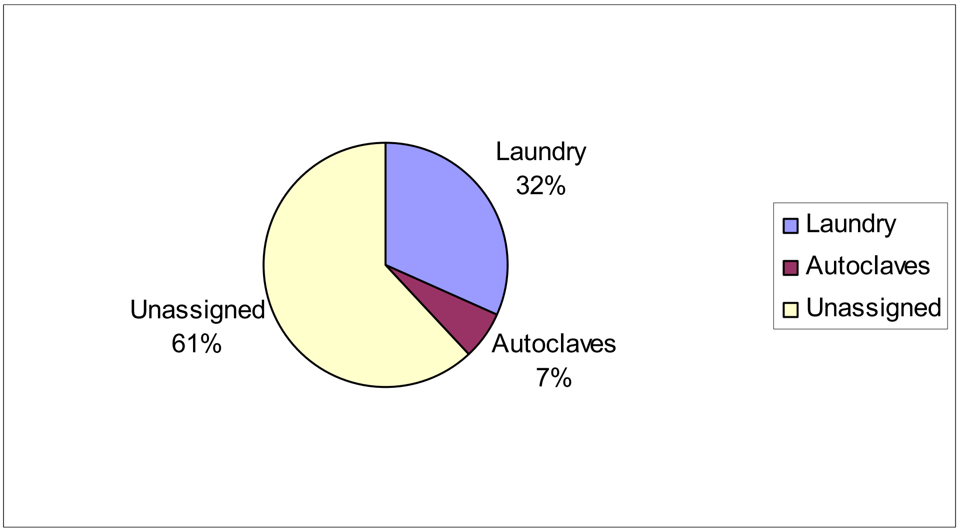
The management of water use is supported by the company administrative structures, and projects are undertaken to evaluate methods to improve water efficiency. There is currently a proposal to modify the autoclave system to allow for the vacuum water to be recycled.

The measured water consumptions are given in Table 8 and the derived water balance in figure 4 below.

Table 8: Monthly total and sub-metered water consumption figures

Total Consumption (kℓ)	Laundry (kℓ)	Autoclaves (kℓ)	Unassigned (kℓ)
1668	526	110	1032

Figure 4: Water balance for Private Hospital 2



Those facilities which were identified as consuming water but for which water consumption is not measured are:

- Wards
- Theatres
- Landscaped areas
- Kitchen

The number of people at the hospital is given in Table 9 below.

Table 9: Daily occupational loading

Available beds	Occupancy %	Staff
202	74	210

Private Hospital 3

This hospital is a two story structure with all water supplied by the municipality. The fittings are standard taps and shower heads, with the urinals, toilets and sluice rooms fitted predominantly with flush valves. About 10% of the toilets are equipped with 9 litre cisterns. As an additional water saving activity, small weights have been installed in those cisterns with the appropriate flush mechanism. These weights cause the valve to close early and this reduces the amount of water used in the flush.
The water in this area is hard, causing a considerable deposit build up on the showerheads. This has affected their performance and aesthetics. The solution has been to replace the shower heads and hand showers with low flow aerated units[57]. This retro fit commenced shortly before the hospital was visited and was being done one ward at a time with three wards having been completed.

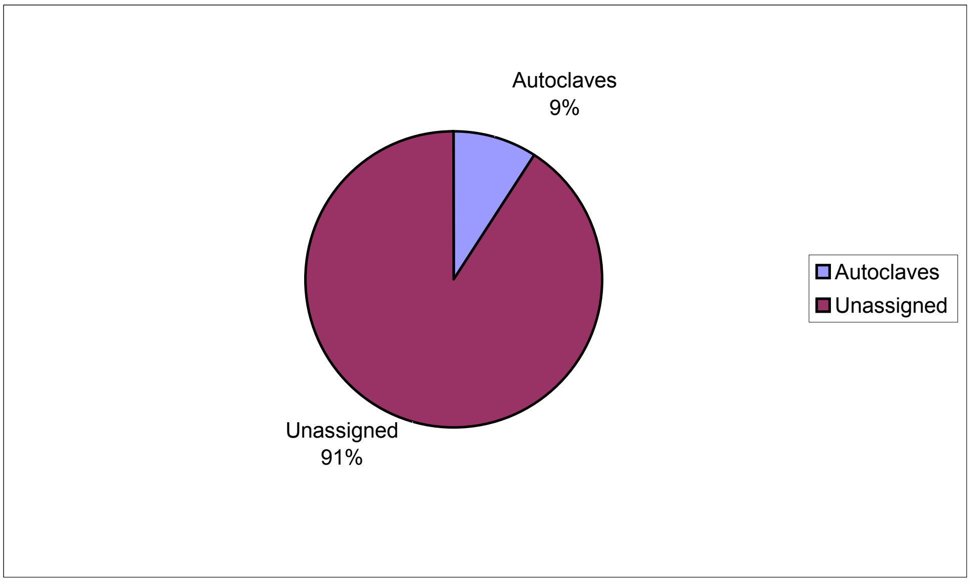
Little data is available to determine the effect of these fittings on the water consumption. The consumption of the hospital in the most recent account has risen by 25%, suspected to be because of a leak in the reticulation network. The intention is to install a meter on a ward to directly determine the effect of the retrofit has been on the water consumption.

The measured water consumptions are given in Table 10 and the derived water balance in Figure 5 below.

Table 10: Monthly total and sub-metered water consumption figures

Total Consumption (kℓ)	Autoclaves (kℓ)	Unassigned (kℓ)
3928	356	3570

Figure 5: Water balance for Private Hospital 3



Those facilities which were identified as consuming water, but for which water consumption is not measured, are:

- Wards
- Theatres
- Laundry
- Renal unit
- Landscaped areas
- Kitchen

[57] The plumbing fixtures installed are manufactured by RST and include shower heads and hand held showers, both delivering 8 litres per minute.

- Laboratories

The number of people at the hospital is given in Table 11 below.

Table 11: Daily occupational loading

Available beds	Occupancy %	Staff
230	75	505

Prince Mshiyeni

Some data was gathered from Prince Mshiyeni Hospital in Durban. Although the data set is incomplete, sufficient information was given to allow some comparisons to be made with the other hospitals. No water efficient fittings are used in the hospital, and no policy exists relating to water conservation or the future use of water efficient fittings. There is no sub-metering in the hospital. The consumption figures given for the laundry are based on estimates as the laundry is not metered. The municipal accounts are not used in any way to monitor or manage the water consumption.

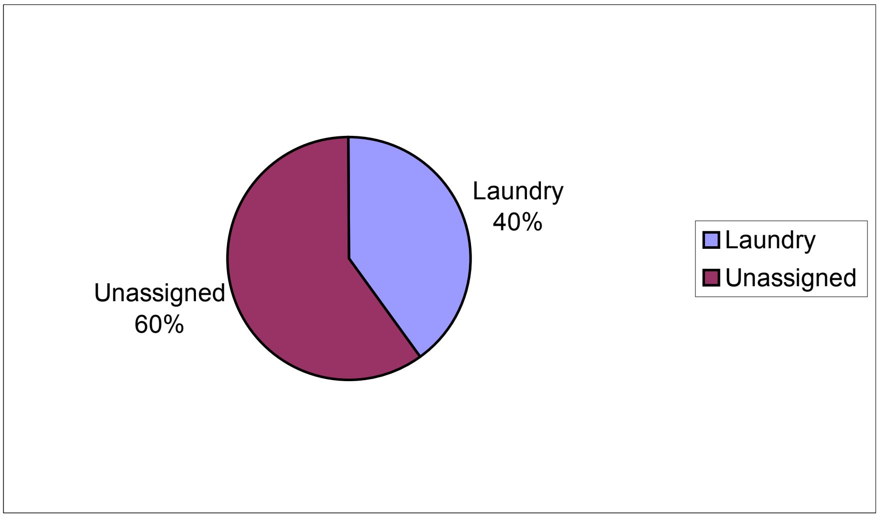
There is a residence on site which has a population higher than its nominal capacity. However, the actual numbers are unknown. Staffing figures have not been provided.

The available water consumptions are given in Table 12, and the derived water balance in Figure 6 below.

Table 12: Monthly total and sub-metered water consumption figures

Total Consumption (kℓ)	Laundry (kℓ)	Unassigned (kℓ)
48152	19000	28890

Figure 6: Water balance for Prince Mshiyeni Hospital



Those facilities which were identified as consuming water, but for which water consumption is not measured, are:

- Wards
- Theatres
- Boilers
- Cooling Towers
- Autoclaves
- Landscaped areas
- Kitchen

- Laboratories
- Residence

The number of people at the hospital is given in Table 13 below.

Table 13: Daily occupational loading

Available beds	Occupancy %	Staff	Visitors	Residents
1080	80	unknown	unknown	500

KwaZulu-Natal rural Hospitals

Data for two rural hospitals, Mseleni and Manguzi Hospitals, was supplied and is given in Tables 14 and 15, respectively.

Table 14: Consumption, capacity and people numbers for Mseleni Hospital

Total Consumption (kℓ per month)	Available beds	Occupancy* %	Staff	Residents	Children's home
13048	190	69	400	100	46

* Source: http://www.kznhealth.gov.za/Mseleni/stats.pdf and calculated for the period April 2005 to March 2006.

Table 15: Consumption, capacity and people numbers for Manguzi Hospital

Total Consumption (kℓ)	Available beds	Occupancy* %	Staff	Residents
1890	251	80	460	162

*Source: http://www.kznhealth.gov.za/epibulletin7.pdf calculated for financial year 2001/2002

The two hospitals are not directly comparable, as Mseleni has a laundry and supplies 75 private connections as well as 3 tap stands. No other information about the services provided by the hospitals was supplied.

Monthly consumption

All the hospitals supplied monthly water consumption data for 2004 and 2005. This data was used to look for annual trends in water consumption. It was found that the data was generally not sensitive enough to display any obvious trend. The origin of the data was the municipal accounts and several situations reduced the usefulness of the data. Missed readings, averaged consumption, estimates and corrections and failed meters all occurred. It is obvious from this exercise that the municipal accounts themselves are not always a particularly useful tool for water management. It seems to be necessary for the institution staff to take readings themselves for reliability. This was not done in most cases. This situation also demonstrates that little effort is put into water management.

The consumption figures are included in Appendix 1 for completeness.

Discussion of Results

The prevalence of water efficient fittings.

The prevalence of water efficient fittings in the hospitals that were studied was low. These fittings were used in only two cases, both Private Hospitals.

It was found in both public and private hospitals that it was not company policy to use water efficient fittings if existing fittings needed to be replaced. In two instances, refurbishment work was being done but water efficient fittings had not been specified. However, company policy also did not exclude the use of the fittings.

In the Johannesburg Hospital refurbishment project, described above, the consulting architect had included water efficient fittings in one proposal but these had been rejected by the hospital representative. The basis for the rejection appeared to be a lack of precedent in other public sector hospitals. The hospital representative was not prepared to make the decision to install a type of fitting that had not already been used in a hospital environment. The decision making process in the provision of facilities in the public sector, as described by the consulting architect, also complicates the introduction of new technology. The development of the project includes the Departments of Health and Public Works, the hospital administration and any consultants that may be appointed. However, it seems that the final decision rests with the hospital authorities, unless the item is included in a departmental specification. The decision is outside the direct authority of the department of Public Works, although they have to maintain the facility and presumably have a wide experience of the availability and operation of fittings. The most effective approach to introducing water efficient fittings into the public health environment would seem to be through the introduction of a specification by the Department of Health.

In the private sector hospitals that formed part of the study, the Technical Managers had sufficient autonomy to install water efficient fittings if they could justify the cost, as was the case in Hospital 3. In the other hospitals the Technical Managers were either aware of them, but had no reason to replace the existing fittings, or they were not aware that the fittings existed. In general, the three companies that were contacted had no policy related to the installation of water efficient fittings, either for or against. In some of the companies the Regional Technical Managers were contacted and confirmed that the use of water efficient fittings was not wide spread in the company.

An issue that needs attention is the risk of propagating Legionnaires' disease. Of particular interest to this study is whether, and by how much, the risk is increased if fittings with aerators are installed. A brief examination of the literature available on the internet provided some information. The disease is contracted through breathing in a mist or vapour that is contaminated with the bacteria (CDC, 2003). Taps, showers and sprayers are thought to be disseminators of the bacteria (Beare et al., 1980, Gesundheitswesen, 1993). The *Legionella* bacteria inhabits the slime layer that forms in the fittings, and restrictors are suggested to promote this formation (Ciesielski et al., 1984). The risk of infection is increased for many hospital patients who already have depressed immune systems. Guidelines (CDC, 2003) on water reticulation in hospitals seek to minimise this risk by reducing aerosolising fittings, such as showers. Many of the published health guidelines consulted recommend no showering for hospital patients who are at risk, as a precaution against contracting the disease.

While water conservation still has a relatively low priority, there is increasing attention being paid to it, particularly in the private sector.

Estimation of potential savings

A useful component of this study is to estimate what potential savings are possible with the use of water efficient fittings. Unfortunately very little measured data is available with which to make the necessary calculations. Hence some assumptions are made.

Within the domestic environment, water is consumed for personal use, cleaning in the sluice rooms, and infection control in the wards and theatre scrub rooms. Infection control in hospitals is of paramount importance, so those processes are excluded from consideration in this exercise.

As the fittings considered in this study are mainly for personal use, some comparison can be drawn from work done in the domestic environment. Surveys of water use have shown that toilet use accounts for approximately 30% of water consumption and showers for approximately 25 % (Gleick et al., 2003 and SABS, 2002). The amount used through taps is small by comparison and is not considered, but will contribute to water efficiency to some extent.

Flush valves are used predominantly to flush the toilet pans in the hospitals and these can be suitably efficient if set and maintained properly. In cases where cisterns are used other criteria must also be met if low flush mechanisms are retrofitted. The pan must be of a design that will clear efficiently with a small flush volume. Conformance to the SANS 1733 specification is necessary in this instance [9]. The hydraulics of the waste system must also be able to transport the solids with the reduced flow volume.

However, from a water reduction perspective changing the shower roses remains a reasonable option. Johannesburg Hospital is used as an example as most of the required information was available.

There are shower roses in the wards and in the Nurses Residence, and the calculation is based on replacing all of them. The flow rate for a shower rose depends on the setting chosen by the user, the type of rose and operating pressure. Some roses will deliver up to 50 litres per minute if the reticulation can deliver that volume. A reasonable flow rate for a standard rose, however, is 25 litres per minute. For the purposes of the calculation it is assumed that all patients and resident staff will all take one shower per day. The water tariff quoted is from the Joburg Water 2005-2006 tariff list.

Table 16: Parameters used to calculate water savings using low flow shower roses

Item	Value
Number of shower roses	433
Number of people showering (per day)	2280
Standard shower rose flow rate (ℓ/m)	25
Low flow shower rose flow rate (ℓ/m	10
Cost of new shower rose	R220.00
Cost of replacement roses	R95 260.00
Water tariff (R/kℓ)	R6.70
Length of shower (minutes)	5
Number of showers per person (per day)	1

The calculated water and cost savings are presented in Table 17 below.

Table 17: Projected savings arising from low flow showerheads

Type of Shower rose	Shower volume (ℓ)	Volume per day (ℓ)	Cost per day	Saving (per day)		Pay back time (days)
				Rands	Volume (ℓ)	
Standard	125	285000	R1 909.50			
Low flow	50	114000	R763.80	R1 145.70	171000	83
50% values				*R572.85*	*85500*	*166*

In this scenario, changing shower roses gives a saving of 171 kℓ per day, or 62 Mℓ per year. The financial saving is R1145 per day, or an annual cost reduction of R418 180. The sum spent on water by the hospital is approximately 5,5 million rand, so the projected saving is 7.6% per annum. Even if the rate of showering is halved the savings are still reasonable. In addition to the water supply saving there will be an approximately equal saving in sewerage charges.

Although the simulation shows the potential saving, there are several weaknesses in the scenario. It is unlikely that all the patients and resident staff will shower every day. Some will use the bath, some will not wash. Some may also wash more than once per day. The shower time may be longer or shorter than five minutes. The residence numbers are also suspect. The Logistics Manager estimates that the number in the residence could be up to three times higher than the official capacity. However, the validity of the exercise remains and clearly demonstrates that this would be a reasonable intervention. The change to dual-flush or low flush toilets would probable save even more water.

While it is accepted that implementing water savings within hospitals face certain constraints because of the need for water be used for hygiene, water use outside of the hospital is no different from any other public building. Rainwater can be harvested and water from the autoclaves could be reused to irrigate landscaped areas. Herbet (2003) suggested that a hospital with six autoclaves using an average of 400 litres per cycle, operating 20 cycles per day would have at its disposal 8 000 litres per day for outdoor use.

<u>Water use in hospitals</u>

From a broader water conservation perspective, some of the information gathered during the visits was used to evaluate the overall water use of the hospitals. The highest consumer is Mseleni hospital, a KwaZulu-Natal rural hospital. These results are compared in Table 18 below.

There is a general increase in consumption levels as the size of the hospital increases and the services offered broaden. The smallest of the urban hospitals, Private 2, has a consumption only slightly higher than that of Manguzi, possibly indicating that rural and urban demands are similar. The three public sector hospitals are all large teaching hospitals, and water consumption would be expected to increase in line with the services offered as well the need for more demanding engineering services, such as central air-conditioning. Another major difference between the public and private sector hospitals is the supply of on-site accommodation to staff members by the public sector hospitals. All three public hospitals have nurse's residences and Chris Hani Baragwaneth has a supply of houses for visiting doctors. In all cases, the supply of water is not recorded and the actual numbers in the residences are unknown. It is likely that this adds between 100 and 150 litres per person per day to the consumption, which will be included in the volumes given in Table 19.

Unaccounted for water, including leaks, is included in the un-assigned water in the water balances above. As water consumption at public hospitals is not monitored by the technical departments, leaks are only detected by chance. In the private sector water consumption is monitored more closely by the technical departments and leaks are likely to be detected more quickly. In the public hospitals, less attention is paid to minor maintenance tasks, such as leaking taps, and this will also increase consumption.

Table 19: Comparison of water consumption to UK benchmarks

Hospital	Category	Annual Consumption (kℓ) (less laundry)	Area (m^2)	Low Value	High Value	Benchmark
Chris Hani	Large acute or teaching hospital	1203324	222496 212981	5.22	5.75	1.66
Johannesburg	Large acute or teaching hospital	720192	378634 353185	1.90	2.04	1.66
Private 3	Small acute or long stay hospital without personal laundry facility	13716	5188	2.64	-	1.17

Comparison to a United Kingdom Benchmark

A project to establish water consumption benchmarks was undertaken in the United Kingdom between 2000 and 2003. This project established benchmarks for several building categories, including hospitals (OGC Buying Solutions, 2003). These benchmark values where determined by statistically analysing the consumptions of the hospitals that agreed to take part in the project. The Benchmark value is the median of the sample, and the Best Practice is the value of the first quartile line. The values are expressed as a function of floor area, as this was found to give a better correlation coefficient in the sample set than patient or occupant numbers. Unfortunately, in the published report there was no indication of what functions were included when determining the floor area. These benchmarks are presented in table 20 below.

Table 20: UK benchmarks for water consumption at hospitals. All values are m^3/m^2 floor area/annum

Category	Benchmark	Best Practice
Large acute or teaching hospital	1.66	1.38
Small acute or long stay hospital without personal laundry facility	1.17	0.90
Small acute or long stay hospital with personal laundry facility	1.56	1.24
For hospitals with central laundry facilities, **add 8.2 litres per laundry article** processed per annum		

The floor area was obtained for several of the hospitals used in the study where laundry consumption was known. These are listed in Table 19 above, together with the calculated specific water consumption. The situation with Chris Hani Baragwaneth and Johannesburg Hospitals is complicated somewhat by the presence of the residences, which are not metered and have unknown populations.

Two values for the two public hospitals were calculated. The Low Value was calculated using the total constructed area, while the High Value was calculated using an area that included the clinical, administrative and plant functions only. Areas such as covered walkways and parking garages were subtracted from the constructed areas, as these will not occur routinely at hospitals.

Comparison of the performance of the South African hospitals to the UK Benchmark suggests that the hospitals operate with poor water use efficiencies, particularly Chris Hani Baragwaneth.

Caution should be exercised, however, and care should be taken to ensure that similar entities are being compared.

The use of area as the factor in determining the specific consumption raises some concern when considering the hospitals listed in Table 20. This is illustrated by comparing Chris Hani Baragwaneth and Johannesburg hospitals.

- Johannesburg hospital has a larger constructed area, which will reduce the specific consumption, yet accommodates half the number of patients. Calculating an area per patient for each hospital, it is seen that 77 m^2 is used at Chris Hani Baragwaneth and 397 m^2 at Johannesburg Hospital.
- If per patient volumes, given in Table 21, are used to compare the relative performance, Chris Hani Baragwaneth is 55 % better.

The two examples above demonstrate that if benchmarks are to be applied, these should be determined specifically for South African conditions.

Conclusions

The prevalence of water efficient fittings in the hospitals visited for this study is low, and was restricted to only one private hospital.. In addition senior technical managers in both the public and private sectors were unaware of other hospitals where these fittings had been installed.

There were a range of reasons for the low prevalence, including:

- Lack of awareness of the fittings.
- Lack of knowledge on whether they would operate satisfactorily and justify the increased cost of procuring them.
- Availability and cost of the fittings.
- Concern and uncertainty about the effect on the *legionella* risk.

The drive for greater efficiency or even water conservation generally, is not a high priority at present. It is, however, starting to receive attention, particularly in the private sector. The primary driver is financial benefit for the organisation, although there is an awareness of the water supply security issue. There was no policy in either the public or private sector that required the use of water efficient fittings in new construction of renovations. In the public sector, the low priority was ascribed to the pressing need to deliver healthcare services and most of the attention is directed there. However, even within these constraints there is possibly still the resource to achieve better water use efficiencies.

The comparison of those performance figures that could be calculated with benchmarks developed in the United Kingdom suggests that the hospitals are running at a low water use efficiency. The opportunity therefore exists to improve the water use, probably at most South African hospitals. It would be necessary to first do an in depth assessment of water use at the hospitals. The water conservation case study done at Chris Hani Baragwaneth by the South African Netherlands Cooperation in Water Management would be an appropriate starting point.

If the use of these fittings is to be promoted in hospitals, the *Legionella* risk and how the use of aerators in fittings modifies the risk should be further evaluated.

Recommendations

Within the healthcare environment there is some awareness of the existence of these types of fittings. However, it is lower than it could be. Readily available information on type and performance is necessary, such as through a building products compendium. In this regard, the people to target are the specifiers and the decision makers in the hospital or healthcare group, such as Regional Technical Managers, Procurement Managers and consulting architects.

Lack of available and specific performance measurements was sited as a reason not to include water efficient fittings in a recent Public Sector renovation. Development and publication of local case studies would provide support for introducing these fittings into the healthcare environment. Similar case studies in areas such as the hospitality industry, school hostels or even shopping centres would also be supportive. There have been many case studies on techniques used to improve water efficiency. Some of these are also applicable to promoting these fittings.

More detailed and comprehensive information is needed to fully understand the *legionella* issue. Work has been done, and continues to be done, in this area, and promotion of water efficient fittings incorporating aerators must take account of the possible impact in the healthcare environment.

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Appendix 1

Figure A1: Two year water consumption profile for Chris Hani Baragwaneth Hospital

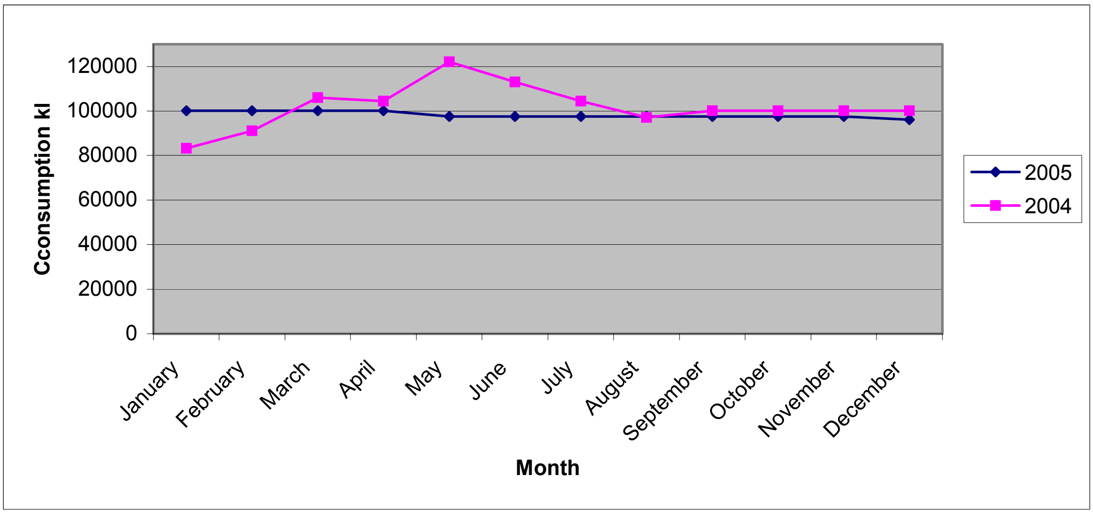


Figure A2: Two year water consumption profile for Johannesburg Hospital

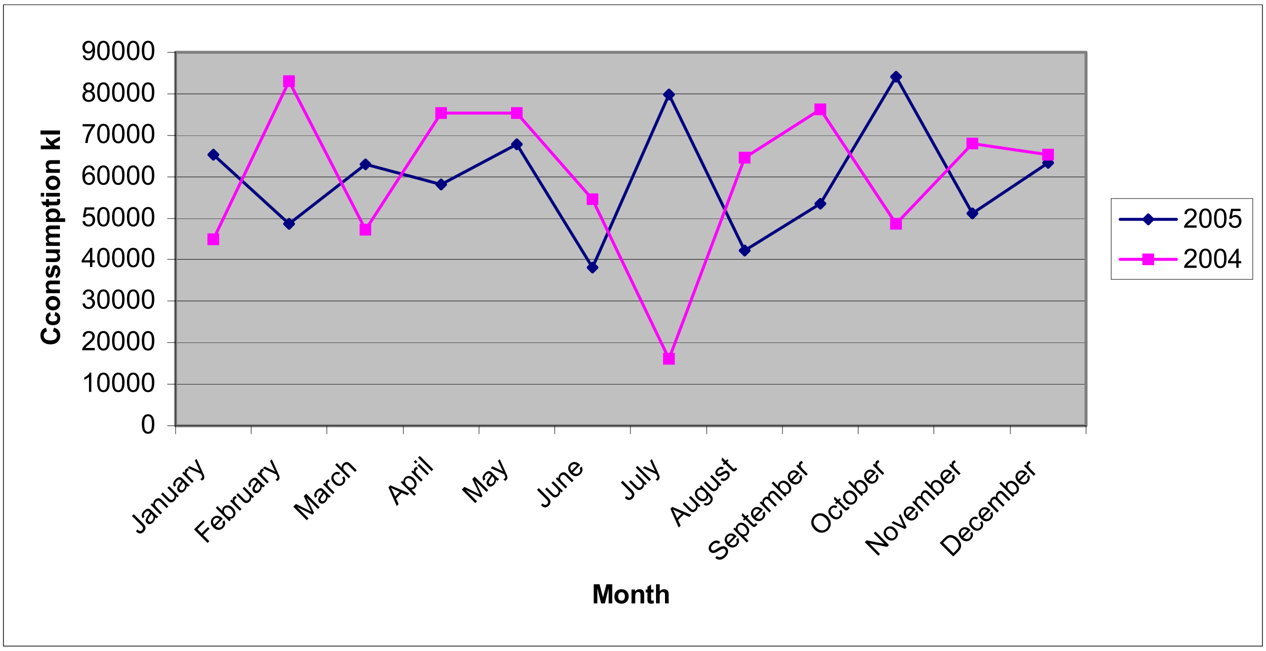


Figure A3: Two year water consumption profile for Private Hospital 1

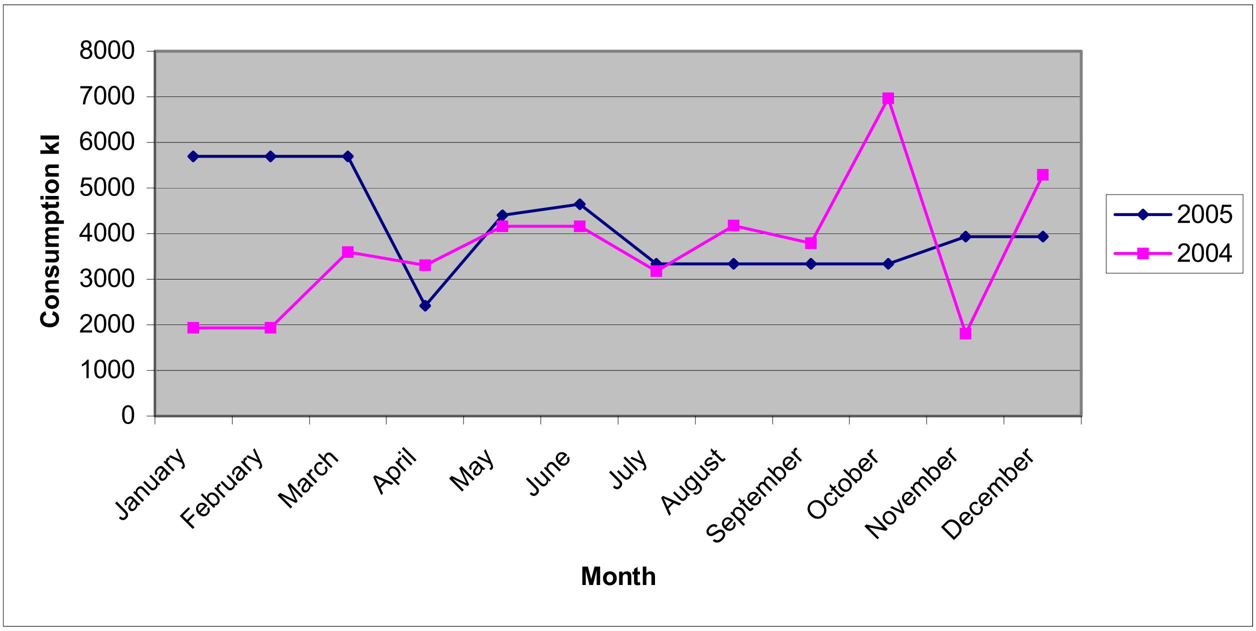


Figure A4: Two year water consumption profile for Private Hospital 2

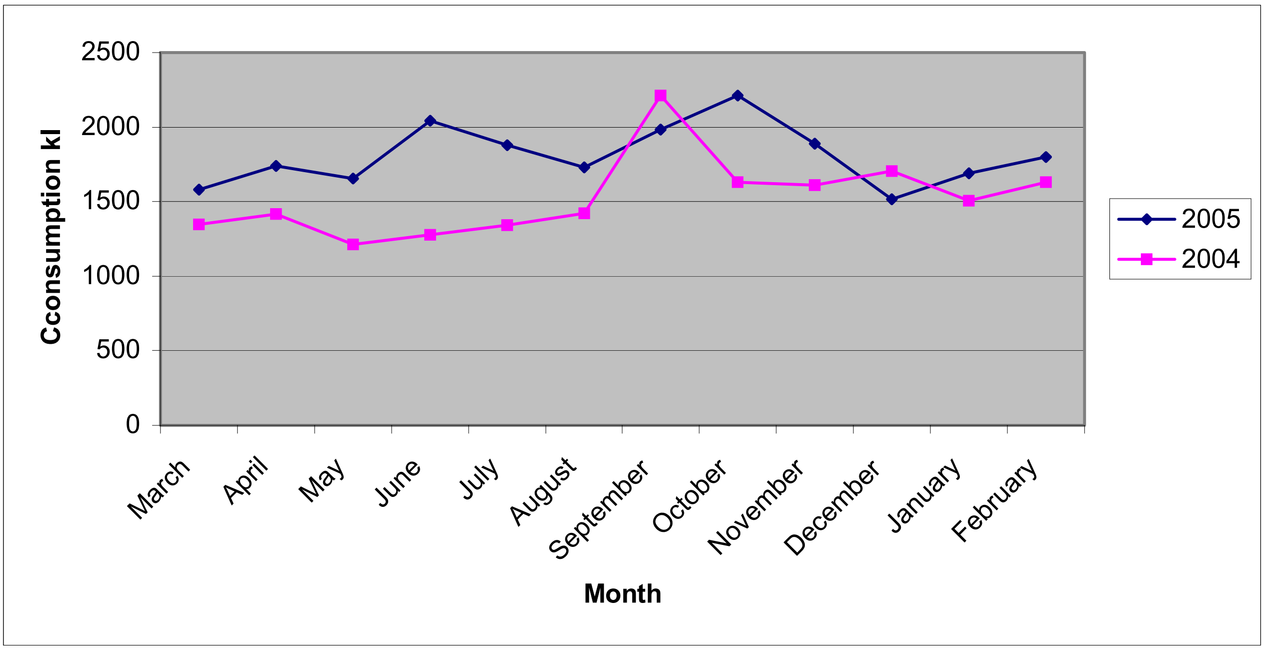


Figure A5: Two year water consumption profile for Private Hospital 3

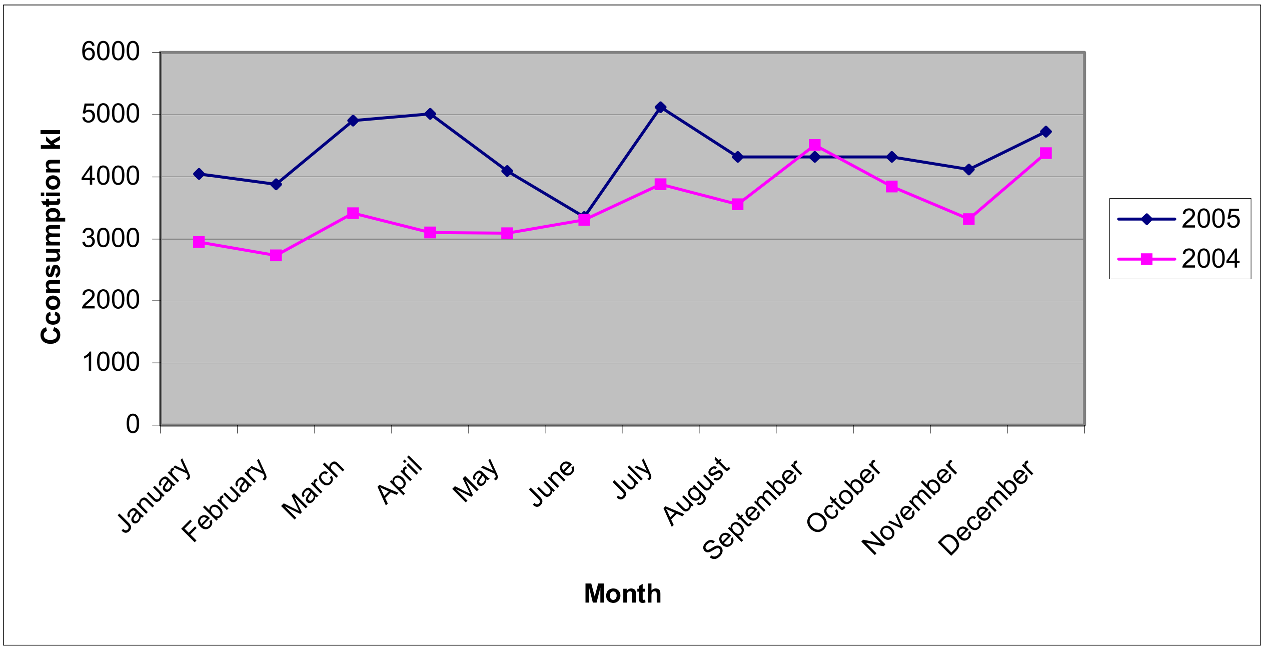
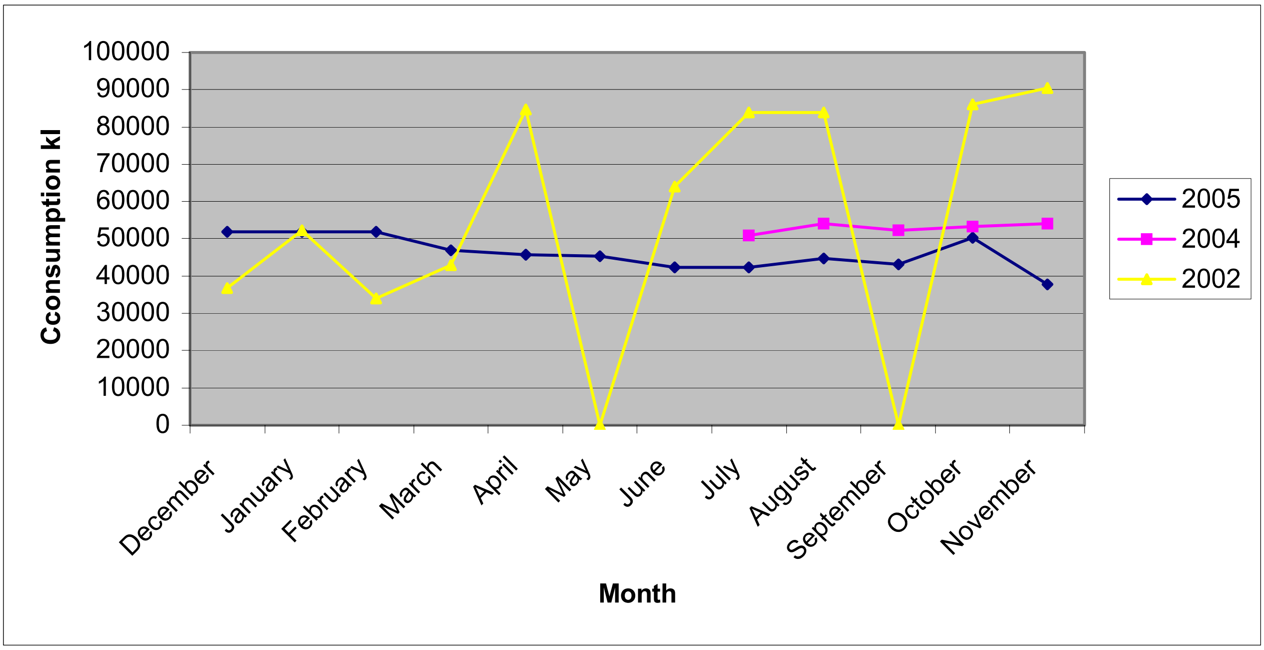


Figure A6: Three year water consumption profile for Prince Mshiyeni Hospital



APPENDIX D

Average daily water demand figures for South African prisons (excluding gardening except where shown)

DESCRIPTION	REFERENCES				
	RED BOOK	*SABS 0252*	*DPW*	*OTHER*	*DESIGN VALUE*
Prisoners	150 ℓ/p/d	-	375 ℓ/p/d	200 ℓ/p/d	200 ℓ/pr/d
Residential Wardens	900 – 2700 ℓ/erf/d incl. gardening for 500m² to 2000m² erven	-	-	-	As per fig 9.7 Red Book
Single Quarters	600 – 1000ℓ/u/d	300 – 400ℓ/u/d or 135 – 200 ℓ/p/d	-	150 – 220ℓ/p/d	400 ℓ/u/d
Administration	400 ℓ/100m²/d	7 – 10 ℓ/10m²/d	4 kℓ/d	70 ℓ /p/d (10m² = 1p)	70 ℓ/p/d personnel
Kitchen and dining	65-90 ℓ/seat	8-12 ℓ/meal 26 – 34 ℓ/p/d	41 ℓ/seat	25 - 31 ℓ/p/d	90 ℓ/p/d
Clinic	40-60 ℓ/bed/day	450-550 ℓ/bed/d	3.7 kℓ/d	50 ℓ/bed/d 250 ℓ/bed/d	250 ℓ/bed/d
Laundry	-	10 –15 ℓ/p/d	7,6 ℓ/pr/d 4 kg/pr/d	15 ℓ/kg and 18kg/p/w =39ℓ/p/d	15 ℓ/pr/d
Admissions/Prisoner holding cells	-	-	12.5 kℓ/d	-	100 ℓ/p/d admitted
Educational	15 – 20 ℓ/p/d	40-50 ℓ/p/d	855 ℓ/d	45 ℓ/p/d	45 ℓ/student/d
Visiting	-	-	768 ℓ/d	10 ℓ/p/d - 20 ℓ/p/d	20 ℓ/visitor/d
State Vehicle Carwash	-	3 – 6 ℓ/p/d	-	200 - 300 ℓ/car	200 ℓ/car
Maintenance	-	100-200 ℓ/p/d	210 kℓ/d	-	1,5% of total water demand
Canteen	-	10-15 ℓ/10m²/d	1080 ℓ/d	175 ℓ/p/d	60 ℓ/10m²/d
Vocational	-	-	-	300 ℓ/100m²/d or 95 ℓ/p/d	100 ℓ/trainee/d
Industrial Manufacturing	-	-	-	220 ℓ/100m²/d 300 ℓ/100m²/d	400 ℓ/100m²/d
Chapel	-	-	-	20 ℓ/p/d	20 ℓ/p/d attending
Logistics including meat processing	-	-	-	100 - 220 ℓ/100m²/d	5 ℓ/pr/d

Continued on next page

DESCRIPTION	REFERENCES				
	RED BOOK	*SABS 0252*	*DPW*	*OTHER*	*DESIGN VALUE*
Commercial (shops incl. petrol station)	400 ℓ/100m²/d	14 – 18 ℓ/10m²/d	-	70 ℓ/p/d	10 ℓ/10m²/d
IRRIGATION FOR:				**In mm/m²/a**	**In kℓ/ha/a**
Vegetables	-	-	8000 kℓ/ha/a	264 – 779	2640 – 7790
Pastures	-	-		650 - 980	6500 - 9800
Sports grounds	1,25 kℓ/ha/d	-	-	1399	13990
Developed parks	1,25kℓ/ha/d	-	-	1407	14070
Undeveloped parks	1,25 kℓ/ha/d	-	-	200	2000
Fruit Trees	-	-	2000 kℓ/ha/a	1329 – 1690 mm/m²/a	13290 - 16900 kℓ/ha/a
ANIMAL AND FLOCK HOUSING CLEANING					
Horses stables	-	-	-	-	25 ℓ/horse/d
Pigs	-	-	-	-	100 ℓ/pig/d
Dog kennels	-	-	-	-	90 ℓ/dog/d
Poultry	-	-	-	-	5ℓ/bird/month
ABATTOIRS:					
Cattle	-	-	-	1,31 – 4,19kℓ/u	3500 ℓ/cattle
Pigs	-	-	-	0,52 – 1,68kℓ/u	1400 ℓ/pig
Sheep	-	-	-	0,22 – 0,70kℓ/u	600 ℓ/sheep
Poultry	-	-	-	15 – 30ℓ/u	25 ℓ/bird
Dairy Industry	-	-	-	1,4 - 9,5 kℓ per kℓ milk	7 ℓ/ℓ milk
Egg Production	12 ℓ/b/d	-	-	-	15 ℓ/bird/d
Meat Cattle drinking	50ℓ/cattle/d	-	-	-	50 ℓ/cattle/d
Dairy Cattle drinking	120ℓ/cattle/d	-	-	-	120 ℓ/cattle/d
Horse drinking	50ℓ/horse/d	-	-	-	50 ℓ/horse/d
Pig drinking	-	-	-	31 ℓ/pig/d	31 ℓ/pig/d
Dog drinking	-	-	-	-	20 ℓ/dog/d
Sheep drinking	12ℓ/sheep/d	-	-	-	12 ℓ/sheep/d
Broiler drinking	-	-	-	-	0,35 ℓ/broiler/d
Sewage pre-treatment wash water	-	-	-	-	50% animal of and flock housing & abattoirs & dairy water (10kℓ/d min)

GENERAL NOTES:

1. Actual irrigation requirements shall be calculated for the specific region based on climatic, rainfall and soil conditions.

2. In general 10m² of floor space is equivalent to 1 person

3. Legend :

p	= person	pr	= prisoner
u	= unit	a	= annum = year
d	= day	kℓ	= kilolitre
ha	= hectare	ℓ	= litre

(Source: Department of Public Works, March 2004)

APPENDIX E

A comparison of municipal bylaws dealing with water conservation and water efficiency

TABLE 1: **Comparison of Water Use Restriction Measures**

TABLE 2: **Comparison of Measures to Prevent Wastage of Water**

TABLE 3: **Comparison of Water-Saving Measures**

TABLE 4: **Comparison of Maximum Penalties which court entitled to impose for Contravention by any person of provisions of Water-Supply Bylaws**

for the following sets of bylaws

DWAF MODEL BYLAWS

CAPE TOWN

ETHEKWINI

UMSUNDUZI (PIETERMARITZBURG)

TSHWANE (PRETORIA)

EKURHULENI (EAST RAND)

OVERSTRAND (HERMANUS)

UMHLATHUZE (RICHARD'S BAY)

MBOMBELA (NELSPRUIT)

JOHANNESBURG

BLOEMFONTEIN

SOL PLAATJIE (KIMBERLEY)

EMFULENI (VANDERBIJLPARK)

POLOKWANE (PIETERSBURG)

NELSON MANDELA (PORT ELIZABETH)

TABLE 1: COMPARISON OF WATER USE RESTRICTION MEASURES

	RELEVANT SECTION IN BYLAWS	Description of Specified Circumstances Under Which Municipal Authority Empowered to Apply Restrictive Measures, BY NOTICE	Prohibit/ Restrict water use, on specified hours or days, or for specified purpose/ manner	Impose: *Special tariff for consumption in excess of limit *General surcharge	Install or Order consumer to install at own expense: *meters *restrictive devices	Restrict or prohibit of use of appliances, and their connection to water supply	Discontinue or cut off of water supply to premises in event of non-compliance with notice of restrictive measures	Limit quantity of water consumed over specified period
MODEL BYLAWS	S 49	*Prevent wasteful use of water *in event of water shortage, drought or flood	Y	Y	Y	Y	Y	Y
CAPE TOWN	S 41	*Scarcity of water *any other good cause	Y	Y	Y	Y	Y	Y
ETHEKWINI	CH II S 25	Simply made subject to approval of Minister Local Govt & Housing	Y	Y	Y	Y	Y	Y
UMSUNDUZI NOTE: priority specified for the preservation of domestic supply	S 43	*Scarcity of water *Emergency in relation to availability of water for distribution and supply to consumers	Yes. Power to 'discontinue' included in addition to prohibition and restriction	Yes, in respect of non-domestic users which includes hotels and boarding houses, as well as business trade and industrial users	Yes but does not specify at consumer's own cost	Y	Yes, but not related to non-compliance - rather a general power to 'discontinue'	Y
TSHWANE	S 19	No circumstances specified	Y	y	Y	Y	Y	Y
EKURHULENI	S 12	*as the Council may consider expedient		Y	Y	Y	Y	Y
OVERSTRAND (HERMANUS)	NO PROVISIONS	–	–	–	–	–	–	–

	RELEVANT SECTION IN BYLAWS	Description of Specified Circumstances Under Which Municipal Authority Empowered to Apply Restrictive Measures, BY NOTICE	Prohibit/ Restrict water use, on specified hours or days, or for specified purpose	Impose: *Special tariff for consumption in excess of limit *General surcharge	Install or Order consumer to install at own expense: *meters *restrictive devices	Restrict or prohibit use of appliances, and their connection to water supply	Discontinue or cut off of water supply to premises in event of non-compliance with notice of restrictive measures	Limit quantity of water consumed over specified period
UMHLATHUZE (RICHARDS BAY)	S 63	-Municipality 'may' -'subject to other applicable legislation' -'prohibit or restrict consumption of water for specified purposes or otherwise..'	Y	Y - may determine & impose additional fees in respect of supply of water in excess of specified limit -may impose general surcharge on prescribed fees	Y	Y	Y	Y
MBOMBELA (NELSPRUIT HAZYVIEW WHITE RIVER)	S 19	-At any time -For any specific purpose or for any purpose other than specified	Y	–	–	–	–	–
JOHANNESBURG	S 44 read with S 83A of Local Govt Ord 17 of 1939 as amended	Council may prohibit or restrict use of water whenever there is a 'scarcity of water under its control or management', or in an emergency relating to availability of water to consumers	Y	–	–	–	No specific power to cut off water supply in event of non-compliance with water restrictive measures is mentioned in this section. However section 11 does empower Municipality to cut off water supply where there is 'material abuse'	Y

	RELEVANT SECTION IN BYLAWS	Description of Specified Circumstances Under Which Municipal Authority Empowered to Apply Restrictive Measures, BY NOTICE	Prohibit/ Restrict water use, on specified hours or days, or for specified purpose	Impose: *Special tariff for consumption in excess of limit *General surcharge	Install or Order consumer to install at own expense: *meters *restrictive devices	Restrict or prohibit use of appliances, and their connection to water supply	Discontinue or cut off of water supply to premises in event of non-compliance with notice of restrictive measures	Limit quantity of water consumed over specified period
BLOEMFONTEIN	–	–	–	–	–	–	–	–
SOL PLAATJIE (KIMBERLEY)	S 48	*To prevent wasteful use of water *in the event of water shortage, drought or flood	Y	Y	Y	Y	Y	Y
EMFULENI (VANDERBIJL-PARK)	–	–	–	–	–	–	–	–
POLOKWANE	S 53	Council may prohibit or restrict use of water whenever there is a 'scarcity of water under its control or management', or in an emergency relating to availability of water to consumers	Y	–	–	–	–	Y
PORT ELIZABETH	S 44	No special circumstances mentioned: Council may prohibit or restrict consumption of water for specified purposes or otherwise than for specified purposes	Y	Y	Y	Y	Y	–

TABLE 2: COMPARISON OF MEASURES TO PREVENT WASTAGE OF WATER

	Prohibition on consumer re: *wasteful discharge, *leaking or defective fittings, *persisting overflow, *persisting inefficient use	Power of municipality to compel owner of premises, on notice, to repair or replace pipes or fittings in disrepair so as to cause any form of water wastage	Obligation on consumer to ensue that equipment or plant using water does so in efficient manner Power of municipality to prohibit the use of such equipment if it is inefficient	Duty on public to report situation that may cause wastage of water	Power of Municipality to cut off water supply to any premises to prevent wastage of water, if necessary and urgent	Power of Municipal official to enter premises to do emergency / urgent work at owner's expense, to prevent wastage of water	Prohibition on use by consumer of inefficient water installation
MODEL BYLAWS S 50 S 14(1) S 23(4)	Y	Y Framed as general obligation on owner of premises - requirement of notice by municipality not included	Y	N	Y	Y	Y
CAPE TOWN S 42 S 10 S 9	Y	Y	Y	Y	Y	Y	Y
ETHEKWINI CH VII S 1 CH I S 13 CH 11 S 5	Y	Y	Y	N	Y	Y	Y
UMSUNDUZI S 44 & 45 S 98(1)(c) S 11	Y	Y	Y	N	Y	Y	Y
TSHWANE S 54 S 50 S 9(1)	Y	Y	Y	N	Y Municipality has power to discontinue water supply after consumer's continued failure to comply with any provision of bylaws, after being given notice to comply	Y	Y
EKURHULENI S 34 S 11 S 88(2)	Y But persistent inefficient use not mentioned	Y	Y	N	Y	Y	Y
OVERSTRAND (HERMANUS) S 13	Y Person to whom water supplied may not allow plumbing to be in such a state of disrepair as to cause waste of water. Also general prohibition on water wastage.	Y Power to direct repair of plumbing system	N	N	N	N	N

	Prohibition on consumer re: *wasteful discharge, *leaking or defective fittings, *persisting overflow, *persisting inefficient/wasteful use	Power of municipality to compel owner of premises, on notice, to repair or replace pipes or fittings in disrepair so as to cause any form of water wastage	Obligation on consumer to ensure that equipment or plant using water does so in efficient manner. Power of municipality to prohibit the use of such equipment if it is inefficient	Duty on public to report situation that may cause wastage of water	Power of Municipality to cut off water supply to any premises to prevent wastage of water	Power of Municipal official to enter premises to do emergency / urgent work at owner's expense, to prevent wastage of water	Prohibition on use by consumer of inefficient water installation
UMHLATUZE (RICHARDS BAY) S58 S106(1)	Y	Y	Y	–	Municipality empowered to cut off supply of water to a premises where a notice restricting use is not adhered to by consumer	Y Included under powers of authorised official:- see S 7(2)(b) & S 106(1)(c)(ii)	Y
MBOMBELA (NELSPRUIT HAZYVIEW WHITE RIVER) S 53a	No person shall cause or permit any tap, pipe, or fitting to leak	–	–	–	S 16 Mentions power of Service Provider to cut off water to consumer where consumer breaches any provision of these bylaws	–	–
JOHANNESBURG S 45 S 46	Y	Y	Y Also mentions obligation on consumer to repair or replace any part of water installation that is causing or likely to cause wastage	–	–	Y S 104(2)(b) & S 105(1)(c)(ii)	Y

	Prohibition on consumer re: *wasteful discharge, *leaking or defective fittings, *persisting overflow, *persisting inefficient/wasteful use	Power of municipality to compel owner of premises, on notice, to repair or replace pipes or fittings in disrepair so as to cause any form of water wastage	Obligation on consumer to ensure that equipment or plant using water does so in efficient manner. Power of municipality to prohibit the use of such equipment if it is inefficient	Duty on public to report situation that may cause wastage of water	Power of Municipality to cut off water supply to any premises to prevent wastage of water	Power of Municipal official to enter premises to do emergency / urgent work at owner's expense, to prevent wastage of water	Prohibition on use by consumer of inefficient water installation
BLOEMFONTEIN S 25 S 26 S 54	No person shall:- *deliberately or negligently waste or misuse water *allow appliance to become defective and waste water	–	Obligation on consumer to stop wastage, leak or misuse	–	Where consumer or owner fails to take steps to prevent wastage, leakage, or misuse, after being given notice, City Council may cut off water supply.	*Where notice not complied with, City Council may have necessary repairs carried out at expense of owner or consumer *where pipes are found to be in a condition that could cause wastage, the City Council may compel owner or consumer to replace/modify, within 14 days of written notification, and should owner or consumer fail to comply, City Council may do work at owner/consumer's expense	–
SOL PLAATJIE (KIMBERLEY) S 49 S 23 S 14	Y	Y	Y	–	Council may cut off water supply after failure to comply with notice to comply with any provision of bylaws	Y	Y

	Prohibition on consumer re: *wasteful discharge, *leaking or defective fittings, *persisting overflow, *persisting inefficient/wasteful use	Power of municipality to compel owner of premises, on notice, to repair or replace pipes or fittings in disrepair so as to cause any form of water wastage	Obligation on consumer to ensure that equipment or plant using water does so in efficient manner. Power of municipality to prohibit the use of such equipment if it is inefficient	Duty on public to report situation that may cause wastage of water	Power of Municipality to cut off water supply to any premises to prevent wastage of water	Power of Municipal official to enter premises to do emergency / urgent work at owner's expense, to prevent wastage of water	Prohibition on use by consumer of inefficient water installation
EMFULENI (VANDERBIJL-PARK) S 92 S 99	Y	Y	Obligation on owner to repair or replace any part of water installation which is causing water wastage	–	Council may cut off water service following failure to comply with notice to comply with any provision of bylaws	Council may undertake work at owner's or consumer's expense, after failure of owner consumer to comply with notice	–
POLOKWANE (VANDERBIJL-PARK) S 54 S 55 S 19	Y	Y	Y	–	S 19 Council may cut off water supply if there is material abuse by consumer	–	Y
PORT ELIZABETH S 30 S 90	Y	Y	Y	–	Y	–	Y

TABLE 3: COMPARISON OF WATER-SAVING MEASURES

	HOSEPIPES	CAR WASH	WASH BASINS & SHOWERS	WC CISTERNS & URINALS	OVERFLOW PIPES & TERMINAL FITTINGS	HOT WATER SYSTEMS	FIRE FIGHTING INSTALL	MISCELLANEOUS
MODEL BYLAWS	–	–	–	–	–	–	–	–
CAPE TOWN Schedule 2: Water Demand Management	*No watering between 10h00 & 16h00 *Controlling device such as sprayer to be attached to hose end, for irrigation *No hosing down of hard surfaced or paved area *Hose used for washing vehicles must have automatic self-closing device	50% recycling required	*Public wash basins and showers to be fitted with demand-type valves *max flow rate basin tap may not exceed 6 ℓ/min *max flow rate showerhead 10 ℓ/min	*WC cistern capacity may not exceed 9.5ℓ *No automatic cistern or tipping tank may be used for flushing urinal * 2 yrs to replace automatic flushing cisterns in urinals	*Terminal fittings fitted outside buildings other than residential must : -self closing device -removable handle -lockable -demand type which limits quantity water per discharge	*Water used as heat exchange may not be allowed to run continuously to waste, except for maintaining prescribed dissolved solids level in a recirculating plant	*Director: Water may disconnect fire installation from main supply if used for purposes other than fire fighting	*Automatic top up of pools & garden ponds by float valve system not permitted *Potable water may not be used to dampen building sand / building material to prevent it blowing away *standing taps to be at height of min 450 mm
ETHEKWINI CH VII S 1 - 8 CH IX S 1 CH IX S 1	-	–	*battery of 3 or more washbasins requires metering tap on each basin which limit discharge to 1ℓ per usage *Battery of 2 or more showers shall be fitted with metering valve to each shower, limiting discharge per usage to 2.5ℓ	*WC or urinal flush shall be manual or non manual by means of approved apparatus which flushes after each use *WC flush shall discharge more than 9.5ℓ or less than 8.5ℓ in one flush, and shall be connected so that pan cleared in one flush *non manual flush must be designed so that no flush occurs if malfunction *no auto cistern or tipping tank shall be used for flushing *separate flush device for stall, wall-mounted & 1.8 metre slab urinal *flushing device for urinal shall not disch more than 2ℓ or less than 1ℓ during one complete flush	*terminal water fitting other than float valve serving cistern or storage tank, shall discharge water visibly *overflow from WC cistern shall discharge visibly outside building *outside terminal water fitting on non-residential premises must: -self closing device -removable handle -be lockable -demand type	*Same as above re use of water as heat exchange medium *Pipe conveying hot water to terminal fitting shall not contain more than 4ℓ *heat element fixed water heater over 500ℓ shall be removable without loss water	*Prohibition on use unmetered fire fighting installation, & levy for unauthorised use *Council may install device to measure use of water, *Council may seal hydrants and hose reels *	–

	HOSEPIPES	CAR WASH	WASH BASINS & SHOWERS	WC CISTERNS & URINALS	OVERFLOW PIPES & TERMINAL FITTINGS	HOT WATER SYSTEMS	FIRE FIGHTING INSTALL	MISCELLANEOUS
UMSUNDUZI S 57 S 60	–	–	–	–	–	–	*private fire hydrants and hose reels to be sealed, and water used after breaking of seal for purpose other than fire-fighting shall be paid for by consumer *Council entitled to install meter in any connection pipe used solely for fire purposes at owner's cost, if it appears that water drawn from it for purpose other than fire-fighting	–
TSHWANE S 35 : Water Demand Management				*No flushing urinal that is not user-activated may be installed or continue to operate *Any flushing urinal not user activated installed prior to bylaw, must be converted to user-activated flushing within 2 yrs of commencement of bylaw *Cistern and pan may not be installed if capacity of more than 9ℓ. *Any cistern with a capacity of more than 4.5ℓ, and not for public use must be fitted with interruptible or multiple flushing device *Shower head with max flow rate of more than 10 ℓ/min may not be installed, if dynamic water pressure is more than 200 kPa at shower control valve in a system where plumbing designed to balance water pressures on hot & cold water supply to shower control valve *max flow rate from any basin tap may not exceed 6ℓ/min			City Engineer entitled to install meter in any connection pipe used solely for fire extinguish purposes at owner's cost, if it appears that water drawn for purpose other than fire-fighting	

	HOSEPIPES	CAR WASH	WASH BASINS & SHOWERS	WC CISTERNS & URINALS	OVERFLOW PIPES & TERMINAL FITTINGS	HOT WATER SYSTEMS	FIRE FIGHTING INSTALL	MISCELLANEOUS
OVERSTRAND (HERMANUS) S 44 S 57	–	–	–	–	*Point of discharge of all pipes must be clearly visible and at least 2 feet above ground *No tap, stop-cock or pipe shall be fixed in position to discharge so that water might run to waste without being noticed *Overflow pipes must be carried through outside walls below eaves of roof and discharge into open air so that clearly visible from outside	–	No person shall use a fire extinguishing system for any other purpose except extinguishing fires	
UMHLATHUZE (RICHARDS BAY) S 57 S 59 S 61 S 62	No person shall without Municipal authority, water garden, sport field, park or other grassed or horticultural area between hrs 11h00 and 15h00, between October & March inclusive, irrespective of source of water used	Commercial car wash must recycle 50% of water used	*hand wash basin max flow rate shall not exceed 6 litres/ minute *shower head max flow rate 10 litres/ minute (where dynamic water pressure more than 200 kPa, & plumbing designed to balance water pressures on hot & cold supplies)	*cistern capacity limited to 6 litres *flushing urinals must be user activated	–	–	*water consumption from private fire hydrant other than in course of testing by Municipality, must be paid for by consumer *Municipality must determine quantity of water consumed (this provision implies the installation of a meter by the Municipality)	–
MBOMBELA (NELSPRUIT HAZYVIEW, WHITE RIVER) S 53 S 58 S 65 S 79	–	–	–	–	*No tap or fitting shall be installed in a position where leakage cannot readily be detected *no rebate for wasted water **Position of cistern or tank overflow pipe shall be such that discharge of water can readily be detected *Outlet from boiler, hot-water tank or other water-heating apparatus shall have its outlet either in the open air or a position where discharge can easily be detected	–	*Private fire hydrants shall be sealed by Service Provider and seals only to be broken by authorised personnel in course of testing, except for use in case of fire *All fire hydrants shall be fitted with meter *consumer to pay for consumption not arising from testing or fire	Cisterns other than wc or sanitary cisterns: these must have stop cock on outlet pipe so that repairs can be effected without emptying the cistern or tank.

	HOSEPIPES	CAR WASH	WASH BASINS & SHOWERS	WC CISTERNS & URINALS	OVERFLOW PIPES & TERMINAL FITTINGS	HOT WATER SYSTEMS	FIRE FIGHTING INSTALL	MISCELLANEOUS
EKURHULENI S 35 - 42 S 71	Council may limit use of water for garden irrigation	70% potable water used in car wash business shall be recycled	*Washbasins in batteries of three or more on premises other than residential shall be fitted with metering tap which limits the discharge to 1ℓ per usage *Showers on non-residential premises in batteries of two or more shall be fitted with metering valve which limits the discharge to not more than 2.5ℓ per operation *Showerhead max discharge rate on any premises including residential shall not exceed 10ℓ per minute. *Showers and taps to be brought into conformity with above requirements by owner of premises by set date	*Flushing devices in WC pans or urinals must be manually activated, or automatically activated after each use *Single flush device in WC shall not be capable of discharging more than 6ℓ of water in one complete flush *DUAL FLUSH UNIT: -full flush level may not discharge more than 6ℓ in complete flush -low flush level may not discharge more than 3 ℓ in complete flush *automatic flush device shall be designed so that no flush occurs if it malfunctions *urinal flushing device shall not discharge more than 2ℓ and less than 1ℓ during one complete flush *No automatic cistern or tipping device may be used to flush urinal *Owner of premises to bring flushing devices into conformity with these requirements by set date	*Overflow from water heating system must be readily visible & not discharge into sewer or storm water system *terminal water fittings must be installed so that discharge of water readily visible and not into storm water or sewer *Overflow from WC cistern must be readily visible and not into storm water or sewer *Terminal water fittings outside buildings on non-residential premises shall: -incorporate self-closing device -have removable handle -limit quantity of water discharged with each operation -be lockable *Provision made for exterior terminal water fittings to be brought into conformity with the above requirements by owner of the premises by set date	*Water used as heat exchange may not be allowed to run continuously to waste, except for maintaining prescribed dissolved solids level in a recirculating plant *Pipe conveying hot water to terminal fitting shall not contain more than 4ℓ *heat element fixed water heater over 500 ℓ shall be removable without loss water	*Provisions for installation of meter, isolating valve *water connection for fire fighting may not be used for any other purpose	

	HOSEPIPES	CAR WASH	WASH BASINS & SHOWERS	WC CISTERNS & URINALS	OVERFLOW PIPES & TERMINAL FITTINGS	HOT WATER SYSTEMS	FIRE FIGHTING INSTALL	**MISCELLANEOUS**
JOHANNESBURG	–	–	–	–	–	–	S 27 *Council must authorise temporary supply of water to be taken from fire hydrants *application must be made for such temporary supply except in emergency S 58 *Council entitled to install meter in any connection pipe used solely for fire extinguishing purposes, and owner liable for cost if water not used in emergency S 61 *If no meter installed, Council must seal private hydrant / hose reel *Consumer pays for water used if not consumed during testing or emergency	–
BLOEMFONTEIN	–	–	–	–	–	–	–	–
SOL PLAATJIE (KIMBERLEY)	–	–	–	–	–	–	–	–
EMFULENI (VANDERBIJL-PARK)			S 31 *shower head - max flow rate 10 litres per minute – in any water installation where pressure over 200 kPa, and plumbing designed to balance water pressures on hot and cold water *hand basin taps – max flow rate 6 litres per minute	S 85 *flushing urinals – may not be installed, or permitted to continue to operate, unless user-activated. *all non-user activated flushing urinals to be converted within two years of commencement of these regulations, to user activation system *cisterns and pans – may not have capacity greater than 9 litres. *cisterns not intended for public use shall have interruptible or multiple flush devices, unless cistern capacity is 4.5 litres or less			S 43 *Private fire hydrants & hose reels shall be sealed by Municipality, and shall only be broken by Municipality during testing, or in case of fire	

TABLE 4: COMPARISON OF MAXIMUM PENALTIES WHICH COURT ENTITLED TO IMPOSE FOR CONTRAVENTION BY ANY PERSON OF PROVISIONS OF WATER-SUPPLY BYLAWS

MODEL BYLAWS	SECTION 26 *Fine up to R2000, or in default in payment, imprisonment up to 4 months *Further fine of R1000 in event of continued offence, for every day during continuance of such offence *Fine of up to R4000 in event of second offence, or in default of payment to imprisonment up to 8 months
CAPE TOWN	SECTION 14 *Mere liability for a fine mentioned - no amount specified in Section 14 of the bylaws
ETHEKWINI	CHAPTER 1 SECTION 15 *As per prescribed maximum penalty in section 266(7)(a) of the Local Authorities Ordinance 25 of 1974:- -Maximum fine R500 or maximum sentence of imprisonment of 6 months, in event of first offence -Maximum fine of R1000, or maximum imprisonment 1 year, or both, in respect of second offence or subsequent offence
UMSUNDUZI	SECTION 112 *Unspecified fine for first offence, and in default of payment, maximum 6 months' imprisonment *Further fine of up to R50 in event of continuing offence, in or default of payment, up to 1 day's imprisonment for every day of continuance of offence *Unspecified fine in event of second offence, or in default of payment, maximum 6 months' imprisonment
TSHWANE	SECTION 59 *Fine of up to R5 000, or imprisonment up to 4 months *Fine of up to R5 000 for each day on which offence continues, in event of continued offence
EKURHULENI	SECTION 90 *Fine up to R20 000, or imprisonment up to 6 months
OVERSTRAND (HERMANUS)	SECTION 68 *Fine of up to 50 pounds *Fine of 1 pound per day for each day of continuing offence
UMHLATHUZE	SECTION 118 *Fine – unspecified amount - in default of payment, imprisonment up to 6 months *Further fine up to R50 per day of continuation of offence & after notice to discontinue, or in default of payment imprisonment of 1 day per day of continuation of offence & after notice to discontinue *Fine – unspecified amount – for second or subsequent offence, and in default of payment, imprisonment up to 6 months
MBOMBELA	SECTION 87 *Fine up to R300 – in default of payment, imprisonment of up to 3 months *Further fine up to R50 per day of continuation of offence after written notice issued by Municipality, *Fine of up to R1000, and imprisonment up to 6 months in default of payment, for second or subsequent offence
JOBURG	No offence created for contravention of bylaws, save for non-payment of fees for use of sewers and sewerage purification plant
BLOEMFONTEIN	SECTION 54 *Fine up to R100, or imprisonment up to 6 months *Council may recover expenses incurred *Further fine of R4 per day for continuing offence
SOL PLAATJIE	SECTION 26 *Fine – unspecified amount – in default of payment imprisonment up to 1 year *Further fine up to R1000 per day for continuing offence after written notice issued *Fine – unspecified amount – or in default of payment, imprisonment up to 2 years, in event of second offence
EMFULENI	SECTION 101 – DOMESTIC CONSUMERS *Fine up to R4000, or imprisonment or community service up to 4 months *Further fine of R2000 per day of continuing offence, SECTION 102 – COMMERCIAL CUSTOMERS *Fine up to R40 000 *Further fine up to R20 000 for every day of continuing offence
POLOKWANE	SECTION 126 *Fine up to R10 000, or in default of payment, imprisonment up to 6 months, or such imprisonment without option of fine, or both *Further fine of R500, or imprisonment not exceeding 10 days, or imprisonment without option of fine, or both, for each day of continuation of offence, or in default of payment, to imprisonment not exceeding one day, for every day during the continuance of such offence after a written notice has been issued by the Council
PORT ELIZABETH	SECTION 15 *Maximum penalty prescribed for an offence by section 189(23) or the Municipal Ordinance, 1974 (Ordinance 20 of 1974)

APPENDIX F: Domestic User Survey Questionnaire

Domestic User Survey

Q1	Do you know what water saving/water efficient devices are?	Y	N
Q2	Do you think your household uses too much water?	Y	N
Q3	Have you considered reducing your water consumption?	Y	N
Q4	Why?		

Name of interviewer: ____________

Time of call		Date	
Code		Tel No	
Age		City	
Gender		Suburb	

	Q5 Have you heard of ?	Q6 Do you have?	Q7 If **YES,** would you recommend it to others?	Q8 **If YES,** have you encountered any problems with device?			Q9 If **NO**, Would you like to install one?	Q10 How much would you be prepared to pay?					Q11 Would you install one if it paid for its cost in			
				Maintenance problems	Inconvenience	Not as good		<R200	<R500	R500 — R1000	R1000 –R2000	> R2000	< 1 yr	1-2 yrs	2-3 yrs	5 yrs
Low volume flush toilet																
Dual flush toilet																
Low flow shower																
Aerated Tap																
Cistern displacement device (e.g. hippo bag/brick)																
Water efficient wsh mch																
Other																

Q12 Do you use a front or toploader washing machine?	Front	Top	Age of machine
Q13 Do you use the water saving cycles on the machine?	Y	N	

Q14 What are some of the reasons you do not have water efficient devices in your home?

Q15	Do you have a swimming pool?	Y	N
Q16	Do you cover your pool to reduce evaporation?	Y	N
Q17	Do you collect rainwater?	Y	N
Q18	If YES, what do you use the rainwater for?		

Q19 What would motivate you to fit WED in your home?

Increase in price of water		Rebates		Water restrictions		Better understanding how devices work		Other (specify)	

Q20 Do you have a garden? If **YES,** continue	Q21 Have you heard of doing the following to reduce water use in the garden?	Q22 Have you tried?	Q23 Which of the following might you do to save water in the garden?
Mulching around plants			
Planting indigenous plants			
Watering early in the morning of late evening			
Re-using household water to water plants			
Watering with a watering can/bucket			

Q24 What would motivate you to use less water in your garden?

Increase in price of water		Rebates		Water restrictions		Better understanding how to save water		Laws prohibiting hosepipes		Laws prohibiting filling your pool		Other (specify)	

Thank you for your time.

APPENDIX G

Built Environment Professionals Survey: Questionnaire

Code		**Skilled professionals: Survey**	Name	
Date			Profession	
Tel no.			Company	

Q1	What do you consider to be the three most important criteria to use in the selection of water components in domestic building projects?		
	1.		
	2.		
	3.		
Q2	Do you consider water efficiency in your design? (Generally)	Y	N
	Specifically for Low-Cost housing developments?	Y	N
	Specifically for Middle Income housing projects?	Y	N
	Specifically for Upmarket developments?	Y	N
Q3	Do clients usually ask for water efficient options? (Generally)	Y	N
	Specifically for Low-Cost housing developments?	Y	N
	Specifically for Middle Income housing projects?	Y	N
	Specifically for Upmarket developments?	Y	N

	Q4	**Q5**
	Have you made use of?	If NO, why not?
Low volume flush toilet		
Dual flush toilet		
Leak free toilet		
Low-volume urinals		
Waterless Urinals		
Low flow shower head		
Aerated Tap		
Spray taps		
Low pressure geysers		
Rainwater collection tanks		
Grey-water recycling		

Q6	Which WED are you most likely to use?	Why?
	1.	
	2.	
	3.	
Q7	Which WED are you least likely to use?	Why?
	1.	
	2.	
	3.	

Q8	Where do you get information about new WED or improvements to WED from?
	1.
	2.
	3.

Q9	Do you think your profession takes enough responsibility for ensuring water efficiency within peoples homes?	Y	N	**Thank you**

APPENDIX H

Covering letter and Questionnaire sent to retail and wholesale plumbing agents

Dear Sir/Madam

Subject: WRC project on the status and use of Water Efficient Products in South Africa

Attached is a short two page questionnaire on the status and use of water efficient products in the domestic and commercial environments of South Africa. It is being sent to you on behalf of the South African Water Research Commission.

Please spend 10 to 15 minutes completing the first 3 sections of the questionnaire to help us have a better understanding of you selling environment and to help us develop recommendations and strategies to enhance the use of water efficient products in our water scarce country. The answers submitted to these 3 sections will be regarded as confidential at the company level, and only the overall results of the survey will be published.

You are also encouraged to complete the final (4th) section of the questionnaire to give us additional information and **to help you** promote the water efficient products you sell. Do not be discouraged if you specialise in a particular section of the market. Just submit the information on the products you sell. We intend to publish the best information received for this section and the source of any information so used will be fully acknowledged.

Please submit your replies on or before Friday 9 March

Thanking you in anticipation

Regards

Derek Hazelton

Derek Hazelton
Manager TSE Water Services
Tel/fax: 011-640-6543
Email: tsewater@icon.co.za
pp Partners in Development, KZN
Maluti GSM Consulting Engineers EC and WC
TSE Water Services GP

Section 1: Details of respondent

Date:	
Name of company:	
Name of representative:	Cell No:
Tel no:	Fax no:
Email:	Website:
Postal address:	Street address:

Section 2: Critical product criteria

Please rank the following criteria from 1 (= most important) to 9 (= least important) to show how important you believe they are to your customers:

Our customers want our products to be:

Easy to install	
Easy to maintain	
Elegant and stylish	
Priced competitively	
Robust and durable	
Supported by superb customer service	
Use water efficiently	
Work effectively	
Other *please specify*	

Section 3: The showroom, sales personal and sales

3.1 Do you display many products, on your showroom floor, that are specified meaningfully by their manufacturers as being water efficient?	Yes or No	
3.2 Do you display water efficient products, on your showroom floor, with labels clearly indicating that they are water efficient products?	Yes or No	
3.3 Do products displayed on your showroom floor generally have labels stating how much water they use?	Yes or No	
3.4 Do you have any (additional) advertising or educational displays on your showroom floor relating to the efficient use of water or energy?	Water: Yes or No	
	Energy: Yes or No	
3.4a If yes, describe any display in a few words: Water efficient use display:		
Energy efficient use display:		
3.5 Do your sales staff generally know how much water displayed-products use	Yes or No	

3.6 For the following products, what percentage do you think have been purchased with water efficient usage being a significant reason for the customer's choice:		
Toilets	%	
Taps	%	
Shower heads	%	
3.7 Are such water efficient products capturing a greater share of the market now compared with a couple of years ago?	Yes or No	

Section 4: Please submit two product-code lists, one for a domestic household buyers and one for a commercial institutional buyers who have specified efficient water usage as a critical criterion.

Notes:

1 **The codes entered in each of the two lists are to identify the model and the size of each product offered definitively**

1 More that one product may be offered to give the customer a final choice, e.g. for the domestic household one could offer a dual flush toilet and a dry eco-san composting toilet.

2 Alternative similar products may be offered, such as different size baths, with a short motivation for the alternatives offered

3 Additional products such as a bidet or a water re-cycling system may be offered

4 **A specification sheet giving the water usage rate or capacity of each product offered is to be submitted**

5 Additional literature describing in a non-technical way the advantages (and disadvantages) of any product or giving **any** additional tips for indoor water saving practices would be welcomed

6 No prices or delivery periods are required

Item no & area lists **Product code**	**Domestic**	**Commercial**
Bathroom area(s)		
01 Toilet		
02 Urinal		
03 Hand-washing basin		
04 Tap(s) for the hand-washing basin		
05 Basin for more general use		
06 Tap(s) for the 2nd basin		
07 Shower head		
08 Mixer tap for shower		
09 'Soaping time' isolating tap for shower		
10 Bath		
11 Tap(s) for the bath		
Kitchen area		
12 Sink unit mainly for dish washing		
13 Tap(s) for the above sink		
14 Sink unit mainly for washing vegetables		
15 Tap for the above sink		
Laundry area		
16 Unit for hand washing clothes		

17 Tap(s) for the above unit		

Please send completed questionnaires and supporting documentation to:

Derek Hazelton, Manager TSE Water Services, 57 Twelfth Street, ORANGE GROVE, 2192 South Africa
Tel/fax: 011-640-6543 Email: tsewater@icon.co.za
Thank you for your time and effort: Your cooperation is greatly appreciated

Appendix I

Report on visits to four plumbing outlets in Gauteng.

by Derek Hazelton

March 2007

On Tap Pretoria

On Tap's Pretoria franchise to the east of the city was the first supplier visited. The visit was on Thursday 15 March. The premises, situated on an agricultural holding, are modest with an undeveloped ample parking area. On arrival in the early afternoon mid-week one notices that the majority of customers are builders who know the staff well and trust their advice.

Once inside I spoke to Dino Procos, one of the two founding directors. He knows the business well, including details of products that he does not stock but which are sold by competitors. He spoke openly and freely about their customers, about how he and other staff serve them (listening carefully and only giving advice where they feel it will be well received).Lastly he spoke about On Tap's attitude with respect to water being a product that should not be wasted and about the place of water saving devices within that framework.

The Interview:

General philosophy: Dino: *Our philosophy is that everything we sell must work well, and be robust and durable. A core part about the robust and durable side is directly related to the fact that we do not want our customers to waste water through products failing.*

Our customers buy on elegance, elegance and elegance. If they know us, which most of our customers do, they rely on us to only sell them products that work well, are robust and durable, and give real value for money.

The price of water and even electricity in South Africa are low. This means basically that it does not pay to go to extremes about water or energy efficiency. And what do our customers think? Water efficiency is moderately important to some of them, but most don't think about it or they are nervous that water efficient products will work less well.

Figure 5: Dual 3/6l flush toilets

Toilets: Dino: *You can see that with respect to toilets we only have 6-7/3-4 litre dual flush cisterns on display. That is because we believe these products truly give value for money. They mostly come from Turkey. A few come from Egypt. The local sanitary ware manufacturing industry has given both dual flush and low flush toilets a bad name because they have done no studies to make sure that their toilet bowls will flush out faeces and loo-paper properly with a 6 litre flush. Also on their dual flush toilets they tend to use rubbish imported flushing mechanisms that jam and fail. Because of this, despite our display, the dual flush toilets do not sell very well. We sell many more 9 and 11 litre units.*
Interviewer: *Do you know of any cisterns fitted with double action buttons, instead of a dual flush system, so that when you press the button for the first time it starts the flushing but if you press it a second time the flushing stops immediately regardless of how much water is left in the cistern?*
Dino: *No. but let me say immediately, I have noted your question and sometime in the future I will check the availability of such a feature, especially for cisterns that do not have a low volume. That would be worthwhile, and in our modern world would be more acceptable to customers than a lever which must be held down for as long as you want the flushing to continue.*

Showerheads: Dino: *We basically market two types of showerhead; the normal spray shower that is usually mounted at an angle towards your body with the spray tending to broaden out the further it gets from the showerhead and what we call a rain shower with a broader stream of parallel droplets that fall straight down on your head. The former are better for large cubicles and for hand held use; the latter are better for small cubicles and are good for fixed showerheads fitted over a bath (not common in South Africa). However, we usually sell them on the basis of what the customer likes the feel of. Coming back to what you are here to discuss: the flow rate is not fixed with either of these show heads, it depends on the pressure. They are designed to work at 3 bar and are fine up to about 4 bar. Above that they use additional water and do not work so well. For the latter reason, both types of showerhead have a place, well away from the head, for fitting a simple restrictor orifice. Basically these restrictors are for systems working at 6 bar, the highest pressure rating for standard hot water geysers sold in South Africa. This can be easily fitted or removed by the customer as he/she wishes. The flow rate from the normal spray shower tends to be greater than for a rain shower; but there is a catch! On average people stay longer under a rain shower because the rain is gentler than the spray from a spray shower. The spray shower is best for when you are in a rush and just want to freshen-up. So which uses less water? I am not sure. But I do know that the really fancy aerated regulated ones are designed to save water (and to make you really relax!) They probably do save water but not as much as you would expect.*

Taps: Dino: *All the taps we market are aerated because they splash less and generally work better for all sorts of washing and rinsing. None of them have flow limiters because we believe people should know not to put a tap full on unless they are running a bath or putting water in a basin or kitchen sink with the plug in.*
Interviewer: *Do all your lever operated mixer taps have ceramic discs inside them or do some of them have discs made of other materials?* (The question was asked because Johannesburg Water reported that for their retrofit programme they were installing lever operated mixer taps in Soweto with non ceramic discs.)

Dino: *No, all our lever operated mixer taps have cartridge type ceramic discs. I do not know of any make with discs that are not made of ceramics. If such a tap were made it would probably not last very long.*

By the way, if workmen fixing a burst main do not scour the pipeline properly after they have finished the repair, grains of sand can get into your house connection. Thereafter if the strainer upstream of the geyser pressure control valve is not fine enough and that sand gets near the ceramic discs of your mixer tap it can chip them at the edge and cause the tap to leak. For this reason some of our mixer taps come fitted with a sieve to protect them.

Another thought; showers and mixer taps work much better with a balanced pressure. This means that the pressure control valve for your geyser should be installed to so that it regulates the pressure to the cold water side of fittings and not to the geyser only. It also means that if some of people are using mixer taps without a hot water connection they should connect the cold water to both inlets, not just one.

Thermostatically controlled mixer taps for showerheads, basins and sinks: Dino: *No, we don't market them. They are not worth the cost even from a convenience and an energy saving point of view combined. If you want one we will sell it to you but they do not fit in with our philosophy of marketing products that give real value for money.*
Interviewer: *What would you recommend with respect to mixer taps on showers, so that the water can be turned off whilst one is putting the soap on.*
Dino with a smile: *The few times I have been asked, I have suggest a simple elegant quarter turn isolating valve downstream of the mixer tap and that suggestion has been accepted. If I am not asked I say nothing.*

Figure 6: Small volume cloakroom wash-hand basin

Figure 7: Neat Victorian style wash-hand basin

Figure 8: Medium volume modern style wash-hand basin

Baths, basins and kitchen sinks: Dino: *Look around what do you see? A 1,7 metre by 700 mm wide bath nicely curved in at the sides and ends for perfect relaxation without actually wasting any water. If a customer asks me for a longer or wider one I will sell it to him/her but I don't display them. Basins: Again what do you see? Really dainty ones for the cloakroom to rinse your hands: a variety of different elegant ones for the bathroom. They are all modern designs made to be elegant made for holding the right amount of water without taking too much room. We are very proud of our stainless steel kitchen units which are all made in South*

Africa by a Swiss company called Franke. Again they are compact and designed for multi-purpose tasking using Franke accessories so that you can do everything easily in a smaller kitchen. This means that for a new house you can save on building costs. A few of them might hold a little bit too much water although I don't think so. It is better to have that extra size for washing large pots and pans. You can always wash smaller items or vegetables in a suitably sized plastic basin or bowl.

Figure 9: Kitchen sink European design, South African manufacture
((Source: www. Franke.co.za refer also figure 38)

Plumblink - Bathrooms by Design - Midrand

Plumblink's Midrand branch to the North of Johannesburg was the second supplier visited. The visit was on Monday 19 March early in the afternoon. The premises are large with separate parking for deliveries and bulk collections behind a manned security fence, on the one hand, and for staff, retail customers and architects coming to view the spacious showroom, on the other. On Tap's Pretoria franchise is a little remote from shopping complexes but is on a main road where potential customers are likely to see it when they visit the nurseries in the area. Plumblink's Midrand Branch is equally remote but at the end of a cul-de-sac without any signage directing potential customers. Thus people would have to make a specific visit to the branch after obtaining prior information about its existence.

On entering the showroom the first thing you notice is that it is large and that staff numbers dominate rather than customers. The staff are in offices or in the middle of the open large display area behind a single large counter, where one goes to have orders recorded and/or to pay for purchases. Around the edges of the display area are smaller discrete areas laid out as bathrooms and one Franke kitchen. Ones feel a bit lonely walking round looking and taking a few photographs. Most of the toilets are dual flush but flush volumes are not given. In fact only a few items have labels. These state the price and/or the name of the manufacturer. After looking round I went to an office up stairs to speak to the manager, Alan Lane, in his office. Unlike at On Tap, the whole interview took place without an interruption; the phone did not ring and nobody came in, but like at On Tap, Alan spoke freely about their customers and how they serve them.

The interview

General: Alan: *Our customers are mostly architects responsible for domestic cluster developments and a broad range of commercial and institutional developments. There is lots of building going on and these architects spend a lot of money, especially on bath rooms, so business is good. They are all very conservative and you can basically say water efficient products are a no, no. They will not risk installing anything that might not work well and result in the client asking them to remove it. Who can blame them, many water efficient products, especially the local South African were functionally poor when they first came on the market. Yet, we mostly sell locally manufactured conventional items, which sometimes embody foreign components, but we do also sell quite a few products that I source from Dubai which are good value for money. Like our local manufacturers, our Dubai manufacturer, uses components, such as the flushing mechanism on the toilets, and the closing mechanism on the mixer taps, that are made in Europe.*

Figure 10: A locally supplied toilet with an imported dual flush mechanism

Toilets: Alan: *Despite nearly all the toilets on show being dual flush we mainly sell conventional toilets with an 11 litre cistern. You can set many of them to stop filling at the 9 litre level and people that want to save water should do that and check how it works. They can always go back to 11 litres later if it doesn't. Or there is the Hippo displacement bag, which is another way people can try a lower volume flush. The dual flush toilets have a 9 litre cistern and are set to flush 9 and 6 litres. I can see that you are enthusiastic about water efficient devices and that you are not just here because you have a job to do. I would recommend a Dubai dual flush unit to you. They work well, but I am still not too sure about our locally manufactured units.*

Interviewer: *And what if I asked you for a 6/3 litre dual flush unit?*

Alan: *I would get you one and do my utmost to ensure that it was one that worked well. It would probably be fine, and I would tell you that whilst explaining that I would only guarantee it to the extent that the supplier guaranteed it.*

Interviewer: *Have you heard of toilets where you can stop the flush by pressing the button a second time.*

Alan: *Yes, historically the dual flush toilets came on the market first. When many of them did not work, they were replaced by "interruptible flush" toilets. Then when improved dual flush toilets were introduced, the manufacturers kept the interruptible flush ones on the market but I expect the idea will fall away because very few of them are bought today.*

Showerheads: Alan: *No. we do not sell any shower heads that have been designed to save water. We do not sell many hand held shower heads either, which tend to use less water. Nearly all of them are fixed head types for installing in a cubicle.*

Taps: Alan: *Nearly all the taps we sell are aerated, but that is because most quality taps are made that way today because people prefer them.*

Interviewer: *Do all your lever operated mixer taps have ceramic discs inside them or do some of them have discs made of other materials?*

Alan: *I am not sure, because no matter what the make, our lever operated taps all come with similar sealed cartridge type operating mechanisms which are manufactured in Europe. On the very rare occasion that they leak we just replace the whole cartridge for the customer. We do not attempt to fix them. I believe the Chinese do not import mechanisms from outside their country. They make everything themselves but the quality is still poor so we do not sell any Chinese products at the moment, but we are keeping an eye on them.*

We sell a different range of taps for many commercial and institutional buildings. In the old days they were ones that you had to press hard to get water to flow and then they closed off before you had finished washing your hands. Then we started selling units which were easier to operate, and stayed open for a longer fixed period that can be adjusted by the plumber installing the tap. The latest are taps that operate like hand drying machines. The water flows whilst your hand is under it and it stops again when you remove your hands. The architects tell me people no longer want to touch the taps in public places because of things like Asian 'flu but if it's true at all I guess it is because they fear getting HIV-AIDS.

Figure 11: Heated towel rails

Thermostatically controlled mixer taps for showerheads, basins and sinks: Alan: *No, we don't sell them for the domestic market because they are outrageously expensive. There is one thermostatically controlled shower on the showroom floor and it has been there for years. Anyway people would only use them as a convenience not to save energy. We sell heated towel rails, and I believe some people leave the heating on all the time, even in summer.*

Interviewer: *What would you recommend with respect to showers, so that the water can be turned off whilst one is putting the soap on?*

Alan: *Just a standard lever operated mixer tap. They are easy to put on and off without the temperature changing.*

Alan: *For the commercial sector I have sold a number of inline thermostatically controlled valves, mainly for banks of showers in hostels. The temperature is set fairly low and in theory they work very well and save energy. In practice they are not so good because if they are installed upstream of a bank of mixer taps and people don't know they have been installed there is a problem. This is because the users don't know that they need to put the hot on full without introducing any cold water to get reasonably hot water.*

Figure 12: A thermostatically controlled shower

Figure 13: A typical not too fancy wash-hand basin

Figure 14: A modern average sized bath

Baths, basins and kitchen sinks: Alan: *Kitchen sinks are still fairly large but if you are washing something small you should put a plastic basin in the sink and just use that. Then there won't be any wastage. Wash-hand basins come in all shapes and sizes today but generally they are smaller than they were than ten years ago. But I think it is just the current fashion and sometimes space. It is not to save water. Baths: we have standardised on 1700 x 700 mm. We sell various shapes, but assuming they are conventional baths, and not saunas, the volume is roughly the same as for a standard bath.*

Platinum Plumbing Supplies, Benoni

Platinum Plumbing Supplies Benoni is one of two branches of a family business founded in 2000 on the East Rand, Gauteng. Its business is very different from the first two visited in that 95 % of sales are to families refurbishing their bathrooms or plumbers buying on behalf of such families. The spares part area at the back of the showroom was also different from the previously visited places that gave the impression that all products lasted for ever.

The manager, Sagren, spoke openly from the showroom floor. Again there were no interruptions but this was because there were always other staff members to hand.

The interview

Toilets: Sagren: *Nearly all our sales for new cistern and bowl sets are for the dual flush type with the full flush being 9 litres and the 'half' flush being either 6 or 4,5 litres depending on the make. Even customers that are unfamiliar with dual flush are interested when they see them on the showroom floor. However, unless they are buying a matching bowl as well, I sell them an 11 litre single flush cistern. Most old bowls need about 11 litres to flush properly. When customers complain about installing an 11 litre cistern, which many do, even when replacing a 13 litre one, I tell them that customers with dual flush toilets rarely use the half flush, which I think is mostly true, and that they can always check if a lower flush will work for them by placing a Coke bottle or two filled with stones and water in the cistern. No, I don't know anything about toilets with start-stop buttons. We do have one cheap 9 litre single flush cistern model in stock, which, despite it appearance, sells itself without us pushing it. A few customers have returned them also. I am not sure if it's because I have been proved right and 9 litres not being enough to flush an existing bowl or if it's because they leaked.*

Figure 15: 9/6 & 4,5 litre dual flush toilets

Figure 16: 9 litre single flush cistern

Showerheads: Sagren: *All the shower heads I sell are of a simple standard design, fitted with a 'water saver' restrictor. I and my staff always tell customers about the restrictor and recommend that it be left in place unless the customer really believes the shower in not working nicely. About*

10 % of customers force us to remove the restrictor before taking the showerhead away.
Interviewer: *And making provision for turning off the water whilst one soaps?*
Sagren: *If the shower is fitted with a two spindle tap mixer rather than a single lever tap mixer we may suggest to the customer that they might like to fit a simple ball or plug valve after the mixer. However, the suggestion is so rarely taken up. I think we often forget to make the suggestion.*

Taps: Sagren: *We sell a great variety of taps: single spindle taps with and without a means of fixing a garden hose to it, two spindle mixer taps and single lever mixer taps. All the mixer-taps are aerated, as are some of the spindle taps but this is to make the water flow from them better. It really does not save water, no matter what other people say. A spindle tap with a restrictor would have some affect but customers don't want that, so really none of our taps actually save water. In fact customers do not want low flow taps and they cost extra money.*

Figure 17:
Miscellaneous taps and showerheads

Thermostatically controlled mixer taps for showerheads, basins and sinks: Sagren: *No, we don't sell any. They are too expensive. If a customer asked us for one, we could get it quickly.*

Baths, basins and kitchen sinks: Sagren: *People are funny, when they see the standard 1700 x 700 mm baths displayed vertically they complain that they are too narrow and want to buy a wider one. That is why two are on the floor now so that people can get in and check them out. As a result practically all the baths we sell are the standard size, neither bigger nor smaller. We sell a few shorter ones but that is because people do not have the space, not so that they can save water.*

Sagren: *I think modern fashions dictate that people install smaller basins than they used to. The Franke kitchen ware range is also fairly discrete but they do hold more water than a standard basin.*

Figure 18:
Modern SA manufactured Cobra® mixer tap
(Source: www.cobra.co.za)

Water Comfort Bryanston

The fourth and final supplier visited was Water Comfort in Bryanston. This is a group founded in 1996 that has six outlets and two trading partners in the more wealthy and style conscious areas of South Africa. The showroom in Bryanston has state of the art architecture with water features and ample parking in front for customers' cars. It is only a showroom and sales office; therefore there is no visible area for deliveries or for customers to take away what they have bought. In the entrance products are displayed in mock installation bathroom sets under strong spot lights. Most staff members, mainly women, have discrete work stations set out between the displays. Towards the back, after passing through a smart canteen like area, there are more displays of a few specific products such as showers, basins and the ubiquitous Franke kitchen ware and accessories. The receptionist arranged for another staff member to take me up stairs to Karen Venter, one of two managers with spacious offices, outside of which are the workstations of three personal assistants in an open plan area. As we walked up the stairs, the staff member told me about the wonderful modern designer low volume flush toilets which through their ability to suck out-performed any other toilet on the market even those that used twice as much water.

When I walked in, Karen was on the phone to an architect from some cluster housing development discussing what might be done about the toilets delivered to site because they were too tall to fit under the windows. Karen explained that if he really wanted something to fit under the window they would have to replace the 3/6 litre dual flush toilets with low profile 9 litre single flush units; 6 litre flush needed the extra head to work perfectly every time. She was at pains to explain that there was no problem about collecting all the toilets delivered to site and replacing them with the low profile units but was it right that the end users had to have a product that was less attractive visually and used 50 % more water than the dual flush used when the full flush was activated. Did he not want to go back to the drawing board and change the window design she asked, apparently to no avail!

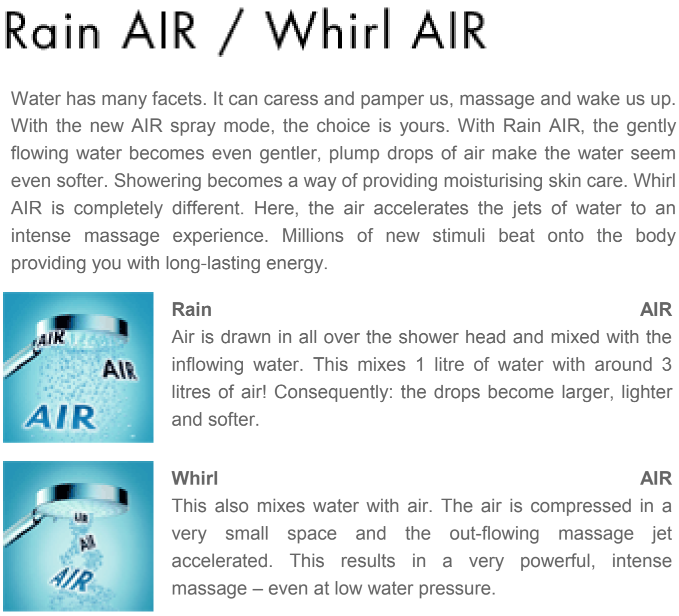
Like the other three managers I spoke to Karen was very friendly and open in her comments about the products they market. We spoke leisurely without any interruptions, possibly because of the PAs outside. Despite her earlier telephone conversation, she had a more optimistic view of architects views on water efficient products than either of the first two managers interviewed.

The interview:

General: Karen: *About 95 % of our sales are to architects or project managers for new housing or commercial developments; at least 75 % housing, just under 20 % commercial and 5 % for single house projects with the home owner and the architect usually visiting us together. We definitely serve the upper end of the market but a broader spectrum would do well to take a look at our entry level products. I like your use of the description "water efficient products" because that is one of the essential features of everything we sell. We start with a visual form from Europe's top designers. This is then backed by the latest German technologies and quality manufacture to support your comfort and an elegant lifestyle but that always recognises water as a precious, and sometimes scarce, resource not to be wasted. I think water efficiency, backed by all the other features I spoke about, is why we are so popular with good architects.*

Toilets: Karen: *All the toilets we market now are 6/3 litre dual flush toilets. They work really well, better than the older larger volume single flush. We only sell something different when an architect makes a mistake like the one I was speaking to on the phone when you came in. But it is getting rarer every day as the architects know all the installation requirements of the 6/3 litre units. By the way, it's the low volume full flush that is important. I don't think people use the half flush very often.* Interviewer: *Wouldn't a start-stop flush unit have been a possible compromise for the architect you were talking to on the phone?* Karen: *No, dual flush has really taken over* *from the start-stop units and if the latter are still available through us they will have the taller 6 litre volume cisterns.*

Figure 19: Concealed cistern dual flush 6/3 litre unit and bidet



Rain AIR / Whirl AIR

Water has many facets. It can caress and pamper us, massage and wake us up. With the new AIR spray mode, the choice is yours. With Rain AIR, the gently flowing water becomes even gentler, plump drops of air make the water seem even softer. Showering becomes a way of providing moisturising skin care. Whirl AIR is completely different. Here, the air accelerates the jets of water to an intense massage experience. Millions of new stimuli beat onto the body providing you with long-lasting energy.

Rain AIR
Air is drawn in all over the shower head and mixed with the inflowing water. This mixes 1 litre of water with around 3 litres of air! Consequently: the drops become larger, lighter and softer.

Whirl AIR
This also mixes water with air. The air is compressed in a very small space and the out-flowing massage jet accelerated. This results in a very powerful, intense massage – even at low water pressure.

Figure 20: Abstract on showerheads from the Hans Grohe® website

Showerheads: Karen: *This is the area where luxury really comes into its own with our Hans Grohe range of showers. The top of the range Raindance® units sold in South Africa have a choice of main heads ranging in size from 100 to 210 mm. There can be up to six additional subsidiary horizontal heads plus yet another head that is for holding in your hand. The temperature is thermostatically set to 38°C but can be increased or lowered at will by simply turning a dial. The shower delivers 3 litres of air with every litre of water. By just moving a lever less than a quarter of a turn, you can adjust the way the air interacts with the water to get soft rain, heavy rain or a lashing massage storm (refer figures 20 and 22). These fancy units are very popular and turnover value wise they represent the majority of our shower sales.*

Figure 21: Entry level shower
Figure 22: Top of the range Hans Grohe® shower ⟶

I am not saying that these top of the range showers use less water than a standard shower only that they really use it efficiently. Even with the exclusive use of water efficient products, Hans Grohe expects an up market family of five or six people to use only about 36 kilolitres of water per month between the home and garden. That is why internationally they are into grey water recycling in a big way. This will reduce the 36 kilolitres of water per month to about 18 kilolitres per month. Although we do not sell these recycling units we do let architects know about Akwadoc, the South African company that does.

Whilst our top of the range showers may not actually save water our entry level ones certainly do. They may not be as exciting as our top of the range units but they do have all the Raindance® features available by turning the outer casing of the head, so once you have tried one, you will never go back to a water inefficient showerhead again. All the architects in South Africa should be coming to us so they can install them in middle income developments. Basically they are the handheld unit from the top of the range showers mounted on vertical rod. The height and angle can be adjusted on the rod of if the user prefers it can just be lifted out of its socket and hand held. There is no thermostatic control, so the temperature is adjusted using one of our lever tap mixers. If you want information on the flow rates and the best pressures for operating these showers do phone Hans Grohe themselves. All their staff are very knowledgeable and friendly.

Taps: Karen: *Our top of the range taps are thermostatically controlled and designed not just to be energy efficient but to save water also. This is done by incorporating a lever stop which reduces the water flow to less than half the flow at full open. One can override the stop by pressing a button at the back. Unlike the showers, we sell very few of these top of the range taps. Architects generally prefer simpler aerated lever operated mixer taps, relying more on the visual appearance to make their final choice for different applications. The only additional technical feature incorporated in many of the taps we sell is a preset adjustable anti-scald set point. This ensures sufficient cold water is mixed with the hot water to maintain a maximum temperature of about 38°C. The temperature is roughly set at the factory with final commissioning being done on site after the geysers have been installed and the power and water have been switched on.*
Interviewer: *But, if there is no thermostat in the unit, won't this mean the end user may be left with colder water than they want or than is necessary after the municipality has turned off the geyser using a ripple controller?.*
Karen: *I am not sure, but you may be right, because we have had end users asking us to reset the taps to a higher temperature after they have personally agreed on the earlier setting*
Interviewer: *And taps for commercial applications?*

Karen: *Excluding those bought for 5 star hotels, the taps we sell for commercial developments are similar to those we sell for domestic developments except that the architects always choose the more compact designs because, although they are sometimes, but not always, less elegant, they are less prone to vandalism.*
Interviewer: *And self-closing taps or ones which only deliver water whilst the user's hands are under the outlet.*
Karen: *No, they both require more maintenance than a simple sturdy lever mixer tap, which essentially requires none, and they are more prone to vandalism. For all our products, you can say that for commercial applications we consider the vandalism issue more carefully and that thereafter entry level products, rather than top of the range products, tend to prevail. For toilets for example; we mostly sell 6 litre single flush concealed cisterns with the bowls mounted firmly on the floor rather than being wall mounted which for domestic developments is probably more common with concealed cisterns. Oh yes, we basically only sell urinals for commercial developments and they are nearly all waterless.*

Baths, basins and kitchen sinks: Karen: *We are the exclusive distributors of Duravit® ceramic bathtubs, basins and other sanitary ware in South Africa* (Duravit 2006). *Most of the baths we market are simple rectangular Duravit® ones, with clean lines. To suite our customers' tastes many are just a little larger than a standard bath but not excessively so. We also market another German range of steel-enamel baths by Bette®* (DeB website). *There is a very nice one in the showroom. Externally it is 1600 mm long, slightly shorter than a standard bath, and the standard 700 mm wide, but internally it tapers towards the plug end and is nicely curved at the bottom. It really gives one maximum comfort for minimum water volume.*

Figure 25: A low volume Bette® bath

Figure 26: Low volume shallow bathroom and cloakroom basins

Karen: *To match the baths we market a range of shallow rectangular basins. Sales were really high at one time but now have fallen off slightly as feedback tells us they are not so functional. However as you can see in the showroom we have a very wide range of basins. Most have modest volumes - fashion is on our side.*

Figure 27: Typical basins on display at Water Comfort®

Appendix J

System operating pressures

Water usage efficiency starts with selecting a suitable operating pressure for the water supply systems used in people homes and ideally their gardens. The next couple of paragraphs shed some light on international practice in English speaking countries.

Traditionally in the USA, England, Ireland and Australasia hot water systems are not pressurised from the utilities water main but are fed by gravity from a cold water tank usually mounted in the space just below the roof of the house. Sometimes the cold water system is still connected to the utilities water main as for example shown on the right hand illustration of Figure 1. In such cases showers and other two-hole spindle operated mixer taps are operated from these systems and the cold water pressure is controlled to about 100 or 200 kPa depending on whether or not a small booster pump has been fitted to showers. The main purpose of these pressure settings is balance the pressures so sufficient hot water is delivered. Note the left hand illustration of figure 28 corresponds to eThekwini's semi-pressure water supply system.

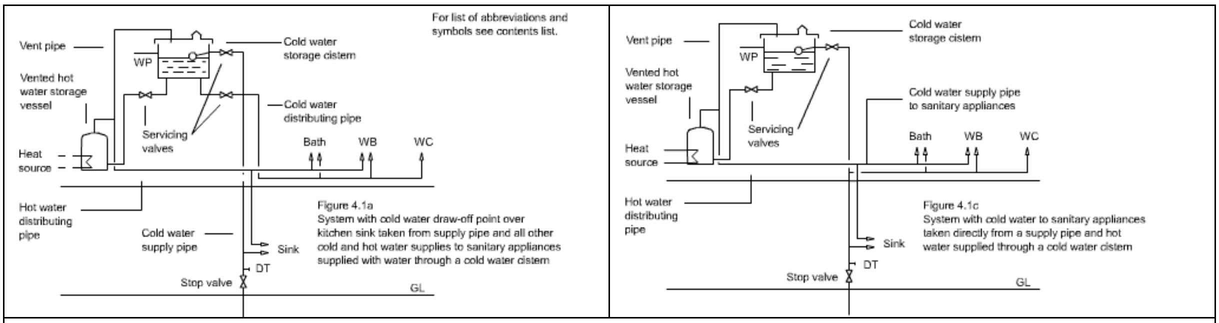


Figure 1: Two examples of gravity fed hot water systems in use in UK homes

Such systems are still common in these countries and are described in the UK Government guideline (DEFRA, 1999b) to the latest 1999 National Water Supply Fittings Regulations (DEFRA, 1999a) but gradually more pressurised systems, similar to those used in South Africa, are being installed. Neither the guideline to the regulations nor the regulations themselves recommend any operating pressure for domestic systems where the hot and cold supplies are both connected to the utilities water main but utilities have been advising their customers to set the pressure to the **minimum** required by the fittings and appliances customers use in their homes to reduce water bills and to save water. In the USA it is illegal to allow pressures in excess of 560 kPa to enter ones home. Pressures for fully pressured systems there are normally set to between 280 and 420 kPa (NACHI, 2005). In addition, quality household fittings, including showers, are now all designed to work satisfactorily at 200 kPa and if not fitted with flow limiters they tend to work less well and to deliver water at excessive rates at pressures in excess of 300 kPa (Martin, 2007).

What is not clear from the above is the number of homes in which eThekwini's semi-pressure system and other systems with a working pressure set at 200 kPa, or less, would be a better option. However, from the experience of other countries using the systems shown in Figure 1 the answer is most low and middle income households with an in house supply. In these cases matching low pressure loss fittings, such as knob operated spindle taps rather than lever operated ceramic disc lever and simple shower heads rather than highly aerated modern ones. Despite being significantly cheaper than the more modern designs, when of good quality, such fittings work fine and are long lasting at their low operating pressures. In addition to choosing matching fittings, more care must also be taken with the pipework layout, the prevent air locks, especially in the hot water sections. A bonus of the figure 28 systems is that one does not have 'a bomb' in your house. Insufficient maintenance on any system causes unnecessary leakage, but an additional hazard of pressurised hot water systems is that if the geysers are not installed correctly or if they are not maintained properly they are likely to explode, causing serious damage to the property and endangering the lives of those in the house at the time.

In contrast to non- pressurised systems, setting a pressurised system's operating at pressures in excess of 300 kPa always gives negative results. Apart from excessive water consumption and bills, and quality fittings working less satisfactorily, higher levels of maintenance are required. If maintenance is not implemented painstakingly, the resulting leakage will be worse than that occurring on systems working at a lower pressure. In theory many of the negative outcomes can be overcome by installing flow limiters to every water outlet in the home (Refer to the paragraphs on **variable orifice flow limiters** which appear later in this section). This theory implies that there will in fact be an overall benefit, in that all fittings will work at top efficiency no matter how many are turned on simultaneously. But the theory has one difficulty; it assumes that the utility always supplies water at high pressure. If this is not the case the 150 kPa pressure drop across the flow limiter to attain its rated flow will cause the pressure at the water outlets to drop lower than in a neighbouring house where the working pressure has been set lower but no flow limiters have been installed.

Low utility water pressures are likely to become more common in future as water demands increase through densification, and as utilities manage their own working pressures more stringently to reduce leakage losses. The more homes there are with pressures set in excess of 300 kPa, without flow limiters, and probably using water inefficient fittings, the more utilities will be forced to manage the pressures on their systems more stringently to curb excessive consumptions and to ensure that customers at high points and towards the far end of the reticulation always receive sufficient water. Apart from the above natural circumstances encouraging utilities to lowers their operating pressures, DWAF's guidelines for the compulsory regulations promulgated under section 9 of the Water Services Act, no 108 of 1997, state that utility *reticulation systems …... should be designed to operate ……, if feasible, below 600 kPa* (DWAF, 2002). Should utilities respond to these guidelines positively, which they are likely to do because of the resultant lower operating and maintenance costs, many points on the system are likely to experience pressures in the order of 400 kPa or less, even during periods of average demand.

- Note: the guidelines (DWAF, 2002) place the use of pressure reduction first in the list of activities that utilities should encourage to ensure their customers to save water. From this and the earlier discussion it would appear that all households with pressurised systems and sophisticated good quality fittings should set their operating pressure at a maximum of about 250 kPa. However, it is not that simple. Apart form the flow induced drop in pressure in the pipework within people's houses, the outlet pressure of direct acting pressure control valves as normally used for domestic water supplies also drops as flow increases (Figure 2). Alternatively, a pilot operated valve could be used, which does give accurate downstream pressure control (whilst still having a similar increasing pressure drop across the device with increasing flow).

But regardless of which type of pressure control valve is used the following is recommended:

- Ensure the valve is adequately sized for peak demands, but not oversized as this can cause cavitational damage to the valve at low flows. A 15 mm nominal size valve is ideal for single household installations
- Similar to the valve shown in Figure 2, install a model with an easily adjustable outlet pressure and whose maximum outlet pressure is 400 kPa or equal to the maximum working pressure of the household geyser **whichever is the lower**
- Ensure the valve is fitted with an outlet pressure gauge

- An upstream pressure gauge is also useful but not essential as the pressure control valve should be installed with isolating valves upstream and downstream, to make it possible to service the pressure control valve without having to drain any of the system. Closing the downstream valve and reading the outlet pressure gauge will confirm if the control valve's upstream pressure is less than the outlet control pressure is normally alone needs to check.

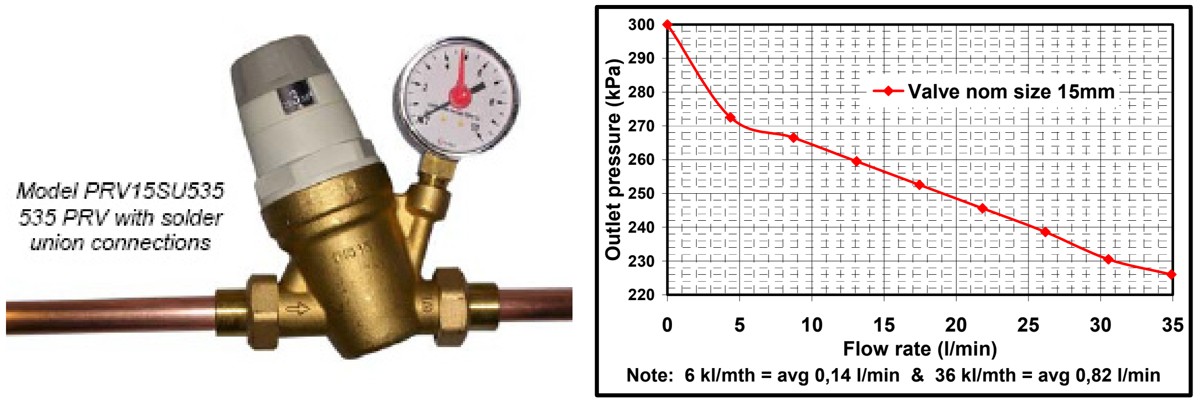


Figure 2: Direct acting pressure control valve & outlet pressure characteristic curves
(Source: Adapted from AV website)

The system should then be commissioned by setting the control valve's outlet pressure at 200 kPa, and only increasing this pressure if necessary to the minimum pressure required for the satisfactory operation of the household's shower and taps during periods of relatively high demand, but a little below the particular households normal peak demand. Always make sure such adjustments are done when the pressure control valve's upstream pressure is in excess of the new setting being evaluated

Variable orifice flow limiters

Another means of limiting the flow to any water outlet or appliance, existing or new, is to install a variable orifice type flow limiting device. These can be fitted in specially designed servicing valve assemblies installed upstream of the item to which it is desired to limit the flow (Figure 3). The assemblies comprise a quarter turn isolating ball valve capable of accepting an automatic flow limiting cartridge, suitable for both cold and hot water services up to 60°C. The cartridge can also typically include a 260 or 570 :m strainer. A side port allows the cartridge to be fitted and removed whilst the system is under pressure without draining it. A colour shoulder cap indicates the permitted flow rate of the inserted cartridge. Figure 3 indicates that for the brand name illustrated green corresponds to 0.28 ℓ/s = 16 ℓ /min. (This flow rate coding system should not be confused with the SANS pressure rate colour coding system for geysers)

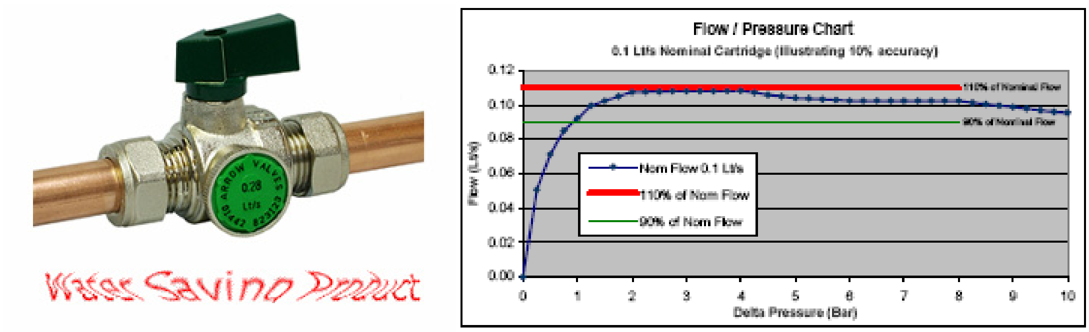


Figure 3: Flow limiting isolating valve assembly and pressure flow chart
(Source: AV website)

Whilst not a substitute for sound pressure control, these valves sometimes have uses in balancing the flows to a number of items being used simultaneously and for designing least cost, reduced maximum demand, reticulation systems for simple residences, large complex multi story buildings and even whole suburbs. This is especially true where incoming pressure control valves have been set at a figure in excess of 350 kPa (which they normally shouldn't). When a setting of less than 350 kPa is used, the lower outlet pressure from the incoming pressure control valve is often sufficient to balance flows, whist in such cases if a flow limiter is installed the additional pressure loss of about 100 kPa across it may cause some items, such as showers, not to function properly. Even where incoming pressure control valves are set at a low pressure, flow limiters are ideal for limiting the flow rate to toilet cisterns and appliances such as clothes washing machines and dish washers to the lowest satisfactory level. They can also be beneficially used on cold water taps, although it is impractical to fit an override like that commonly fitted to taps for basins and baths that are provided with a plug. They should be used on garden taps, if these are upstream of the household's incoming pressure control valve. Placing the household's pressure control valve downstream of garden taps can sometimes allow the use of a lower sized pressure control valve but it does mean the connection to the utilities main is at full pressure for a greater distance.. Flow limiters have more limited application when fitted upstream of mixer taps because for complete flow limitation a flow limiter has to be fitted to each of the two water supplies. If the cold water side is not generously sized it is likely to result in additional hot water usage as users increase the hot water flow to obtain the total flow they want even when hotter water is not what they seek. Thus in such circumstances they can only satisfactorily protect against very high discharge rates. Fitting them to the hot water side only can help with energy saving and anti-scald protection. An exception to the above is the installation of a single flow limit cartridge (without the isolating valve) downstream of mixer taps. This is suitable for shower installations because there is plenty of distance between the mixer tap and the shower head. Standard flow rates for this application are 6, 8 and 10 ℓ/min of which 8 ℓ/min is the most popular in the UK. The availability of variable orifice cartridges for the outlet of standard mixer taps is unknown. But remember, a lower pressure control valve setting, combined with taps and showers with matching pressure requirements and no flow limiter in the shower will nearly always achieve a better outcome.

Common service isolating valve sizes are 15 and 22 mm. Each of these can be fitted with a cartridge corresponding to about 8 different flow rates. Typical rates are 4, 6, 8, 10, 12, 15, 18 and 26ℓ/min. The last three sizes are sometimes used to supply more than one outlet/appliance, all of which are not intended to operate simultaneously e.g. the water supply to a bachelor flat especially in inner city buildings.

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