

SINGAPORE'S EXPERIENCE IN WATER DEMAND MANAGEMENT

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Abstract

PUB, the national water authority of Singapore, puts great emphasis on the importance of water demand management. PUB adopts a 2-pronged approach in the management of their water demand, by implementing water conservation measures to keep potable water consumption in check and adopting the efficient management of the transmission and distribution system from water source to the customer tap which consequently minimises the Unaccounted-For-Water.

BACKGROUND

While Singapore can add to its resources and multiply every drop to meet the increasing demand, we know that for sustainability of water supply, there is also the other part to curb water demand growth. In this regard, PUB has in place an efficient water demand management programme to curb water demand growth and stretch its limited water resources to the fullest.

Rise in the population coupled with rapid industrial, economic and social developments has resulted in a quantum increase in water demand. In 1950, the population was slightly over a million while water demand was at 142,000 m³/day. Today, the population has increased 4.5 times to about 4.6 million while water demand has grown more than 9 folds to 1.3 million m³/day.

WATER DEMAND MANAGEMENT

PUB, the national water authority in Singapore, has always adopted a 2-pronged approach in the management of the nation's water supply for sustainability. While the PUB endeavours to develop water sources to meet the needs of the people, it also places great emphasis on the need to manage water demand. Though our water supply has been secured with the 4 Taps – Water from local catchments, imported water (Johor), NEWater and Desalinated Water, there is still a need to control the demand of water so as to stretch our supply sources and make them last.

Again, a 2-pronged approach is also adopted to effectively manage our water demand – by way of implementation of water conservation measures to keep potable water consumption in check and the other through the efficient management of the transmission and distribution system from water source to the customer tap thus minimising the unaccounted-for water.

WATER CONSERVATION

PUB's water conservation strategy in curbing water demand growth takes a multi-prong approach through *pricing*, *mandatory* water conservation *requirements* and *promoting* and encouraging ownership and *voluntarism* through 3P partnership in water conservation.

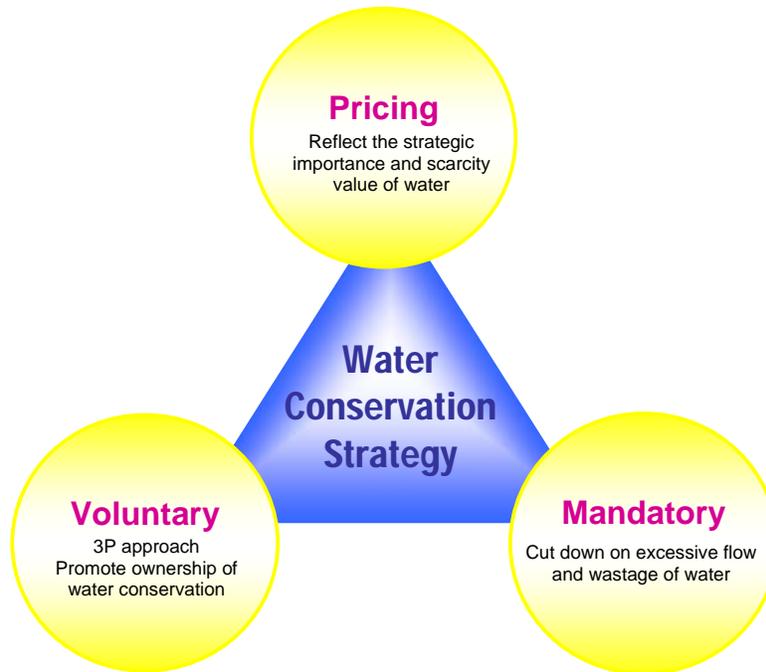


Figure 1 : Water Conservation Strategy

Pricing

Pricing of water is an important and effective mechanism in encouraging customers to conserve water. Water should be treated as an economic good. The water is priced not only to recover the full cost of its production and supply, but also to reflect the scarcity of this precious resource and the high cost of water from developing additional sources. A water conservation tax was also implemented in 1991 to further encourage water conservation. The water tariffs and water conservation tax were restructured over a 4-year period, starting in 1997, to reflect the strategic importance and scarcity value of water. It was also to bring the water tariff to a single rate for both the domestic and non-domestic consumers (except for domestic consumers using more than 40 m³/month).

		With Effect From 1 July 2000	
Tariff category	Consumption block (m³ per mth)	Tariff (¢/m³)	WCT (%)
Domestic	1 to 40	117	30
	Above 40	140	45
Non-domestic	All units	117	30

Table 1 : Water Tariff Table

Mandatory Requirements

Legislative measures have been put in place to deter water wastage. Punitive measures for non-compliance include fines and/or court prosecution. The legislative measures are constantly being reviewed to keep abreast of the latest development in the area of water conservation.

Since 1983, installation of water saving devices such as constant flow regulators and self-closing delayed action taps was made mandatory in all non-domestic premises and common amenities areas of all private high-rise residential apartments and condominiums. Since 1992, low capacity flushing cisterns (LCFCs) that use not more than 4.5 litres of water per flush were installed in all new public housing units. The installation of LCFCs, in place of the conventional 9-litres cistern for all new and ongoing building projects, including all residential premises, hotels, commercial buildings and industrial establishments, was made mandatory in 1997.

To prevent excessive flow rate at the water fittings, PUB limits the maximum allowable flow rates at water fittings. A review was conducted in 2003 and the maximum allowable flow rates at water fittings were reduced by between 25 – 33% to prevent water wastage. PUB has also extended the requirement on limiting the maximum allowable flow rates at water fittings to all domestic premises. PUB conducts spot checks on completed residential developments to ensure compliance of the mandatory requirements.

Area of Usage	Maximum Allowable Flowrate (litres/min)
Basin Tap/Self Closing Delayed Action Basin Tap	6
Sink / Kitchen Tap and Wash Area	8
Shower Tap/Self-Closing Delayed Action Shower Tap	9
Other Areas	8

Table 2 : Mandatory Maximum Flow Rates

Ownership through 3P initiatives

Public Education and Publicity Programme

The Board has an on-going public education and publicity programme to educate the public in the management of our water resources, emphasizing on the importance of water conservation. The main objective of the programme is to effect behavioral change in the way water is being used so that saving water becomes an ingrained habit. The various activities are targeted at both the domestic and non-domestic sectors. Some of the major activities carried out were:

Save Water Campaigns and Sustained Publicity Programmes

Month-long National Save Water Campaigns were held on a need basis, especially during the drier

months, to remind the public of our limited and precious water resources and to use water wisely so as to avoid water rationing. It is also important to reinforce the save water message in between campaigns so as to sustain public commitment to the water conservation effort. In this respect, sustained publicity programmes are carried out. Some of these activities are:

- i) Dissemination of water conservation messages through the media;
- ii) Distribution of publicity materials such as save water leaflets, posters and stickers;
- iii) Set up of save water exhibitions at constituencies, hospitals, community centres, etc; and
- iv) Post save water tips and information on water saving devices on PUB website.

Educating Our Young

The education system serves as a useful platform to educate the young, especially during their impressionable years, on the importance of saving water and the need to cultivate good water saving values. The numerous activities implemented include:

- (i) Incorporating water conservation topics in school textbooks;
- (ii) Setting up water conservation centre to promote water conservation to students, the general public, community clubs, grassroots organizations;
- (iii) Conducting water conservation talks and visits to waterworks for schools; and
- (iv) Using interactive skit to play out the water conservation message in a fun and interesting manner to reach out to the lower primary school students.

3P Partnership Involvement

Community participation in water conservation is also part of our publicity and educational programme. The programme engages the institutions, large customers and grassroots organisations. They have responded well by organising activities such as distribution of save water leaflets, signing of the Save Water Pledge, organising essay and art competitions and save water exhibitions.

We have also maintained close liaison and consultation with government agencies and the various industries such as the Singapore Hotel Association, Singapore Plumbing Society and Singapore Sanitary Wares Importers & Exporters Association to promote the sharing of water conservation know-how among its members through exhibitions, conferences and seminars.

Water Efficient Homes Programme

In 2003, PUB initiated a new water conservation programme, Water Efficient Homes, to help residents conserve water and save on their water bills. Together with its 3P partnership approach involving residents and grassroots leaders and volunteers, residents are encouraged to run water efficient homes by installing water saving devices and adopt good water saving habits. In this outreach programme, do-it-yourself (DIY) water saving kits are distributed to the residents free-of-charge for self installation. Mobile exhibitions were also set up to brief and demonstrate to residents the effectiveness of the water saving devices and its installation procedure.

10-Litre Challenge

In order to encourage the public to play a part in reducing the domestic water consumption, PUB has also in 2006 embarked on a initiative called the "10 Litre Challenge" to challenge every Singaporean to save 10 Litres of water a day. Together with Singapore Environment Council (SEC),

PUB has set up a dedicated 10-Litres Challenge website to host the challenge, as well as sharing information on useful water conservation tips.

In short, the 10-Litres Challenge website is a one-stop portal for all water conservation matters, showcasing all water conservation information. Users who log in the website will be challenged to assess their individual water usage behaviour and the extent of the use of water conservation devices, as compared to the average performer. They will also be challenged to adopt the various water conservation measures and devices in the 4 main areas (showering, toilet flushing, laundry and sink/basin taps) in order to achieve a saving of 10 litres per person per day.

PUB is also working with voluntary welfare organisations and schools to form water “Water Volunteer Groups (WVGs)”. This WVG programme is another programme under the 10-Litre Challenge initiative. WVGs formed will be supported by PUB officers to conduct house-to-house visits to households to educate them on water conservation practices, and assist in the installation of water saving devices. The WVGs will also visit lower income and needy families to help them save on their water bill.

Another programme under the 10-Litre Challenge is the voluntary Water Efficiency Labelling Scheme (WELS). This scheme is jointly developed by PUB and Singapore Environment Council (SEC). It aims to label water fittings and products so that consumers can have an informed choice when purchasing them. The water fittings and products covered are taps, showerheads, dual flush low capacity flushing cisterns, urinals and washing machines. This voluntary WELS will help to raise public awareness on water conservation and encourage the infiltration of more water efficiency products in the market. The objectives of the scheme are:

- (i) facilitate consumers to make informed choices when purchasing products;
- (ii) increase public awareness on water conservation;
- (iii) encourage manufacturers/importers to bring in more water efficient products;
- (iv) promote water efficient building design; and
- (v) encourage innovation and R&D.

PUB will also mandating the WELS for all taps, urinals and dual-flush flushing cisterns in July 2009. The use of dual-flush LCFCs will help to cut down on water used for flushing toilets as it allows toilet users to use lesser amount of water (i.e. short flush) for flushing of liquid wastes.

Water Efficient Buildings Programme

On the non-domestic front, commercial/industrial customers are encouraged to run water efficient buildings by reviewing and reducing their water consumption and repairing leaking fittings promptly. They are also encouraged to recycle/reuse used water where feasible. Circulars were sent to large non-domestic customers urging them to reduce the flow rate at the wash basin taps in all their staff and public toilets within their premises to 2 litres/min and urinal flush volume to 0.5 litres/flush. They were also advised to conduct checks on water fittings in their premises to ensure the flow rates are not excessive and to adopt water efficient flow rates for the various water fittings.

Water Recycling and Substitution

All applications for water supply must be submitted to PUB for approval. In evaluating the water requirements, applicants are advised to adopt water conservation measures, including recycling of

process water and substitution of potable water with NEWater and sea water wherever feasible for their non-potable usage.

PUB also produces NEWater and industrial water for non-potable use. NEWater is high grade reclaimed water that has undergone stringent purification and treatment process using advanced dual-membrane (microfiltration and RO) and ultraviolet technologies.

Water Audit

As part of the Board's efforts to promote water conservation, regular water auditing is carried out by PUB officers for large customers (consumption more than 5000 m³/month). The visits are part of a market-oriented programme to obtain industries' feedback on our water supply and to work with customers on the implementation of water conservation measures within their premises.

10 Percent Challenge For Non-Domestic Sector

For 2008, PUB is targeting the non-domestic customers to take up the 10% Challenge. Over the next 3 to 5 years, PUB will engage different sectors to identify how each of them can lower their water consumption. Under the 10% challenge, the initiatives being implemented are 10% Challenge, a 10% Challenge Website, Water Efficiency Manager Course, Water Efficient Building Design Guide

EFFICIENT WATER NETWORK MANAGEMENT

Since the early 1980s, PUB is conscious of the need to manage the water supply network efficiently and to account for the amount of water distributed through the network. This concern is primarily motivated by PUB's endeavors to provide high level of service to customers with reliable supply of water at affordable cost. With the strong support of the top management and the active participation of everyone in PUB, measures have been put in place in the work processes to ensure that leakage in the new networks is kept to a minimum through proper planning, design and use of good quality materials.. Losses in existing network have also been reduced through network management and leakage controls as well as to account for water distributed by full and accurate metering. Consequently, these deliberate efforts have made Singapore a city with one of the lowest UFW in the world (below 5%).

PUB adopts a holistic approach towards managing the water network and the key components of the approach are broadly categorised as :

- (i) Good quality network;
- (ii) Active leakage control;
- (ii) Full & Accurate Metering; and
- (iv) Strict legislation on illegal draw-offs.

Good Quality Network

New Network - Use of Better Quality Pipes and Fittings

The first step towards reducing UFW was to minimize the occurrence of leaks in the transmission and distribution network. This was done by introducing new and better quality corrosion-resistant materials for new pipelines, and tightening supervision of pipelaying work to ensure high quality

workmanship. The objective was to ensure that newly-laid pipelines are watertight.

Since 1980 the use of unlined cast iron and galvanized iron pipes was prohibited. More durable and corrosion-resistant piping materials such as copper/stainless steel and steel/ductile iron pipes which are internally lined with cement mortar were used. The use of such materials has helped to prevent leaks in the water distribution network.

Existing Network - Mains Replacement Programmes

PUB adopted a dynamic watermains replacement programme where computer based system was used to capture information on mains such as locations, type, size, and age of mains, details of leak and repair works. Problem areas were identified and prioritized for early replacement.

Besides the mains replacement programme, every opportunity is exploited to constantly review and upgrade the transmission and distribution system through:

- (i) Replacing old pipeline systems with new ones in areas undergoing redevelopments.
- (ii) Using better quality materials for water pipes and fittings to reduce leaks.
- (iii) Conducting regular maintenance/servicing programme for the transmission and distribution network.

Active Leakage Control

Dynamic Leak Detection Programme

A thorough leak detection programme also traces leaks, which would otherwise go unseen and undetected, like underground leaks. The programme is a dynamic one with priority given to regions which are more prone to leaks based on leaks history as well as the age of the watermains in the region. It involves detecting leaks by visual inspection along all pipeline routes and the use of leak noise localisers to quickly identify the potential areas of leakage along the distribution mains. Once the leak areas are identified, the leak detection teams will be mobilized to pinpoint the leaks using other precision leak detection equipment for follow up repair work.

Quick Response to Public Reports of Leaks and Rectification of Faults

The extent of water loss from a leaking main depends on the length of time between the occurrence of the leak and the isolation of the main. Here, public co-operation in reporting leaks is essential. To facilitate public reporting of leaks, PUB operates a 24-hour contact centre, PUB-One, where the Board's customers can contact us through the 6 multi-channel contacts namely telephone, fax, emails, SMS, web-chat and voice-over-IP. The centre is also equipped with modern data recording and retrieval systems and communication system. Some 92% of urgent complaints received were attended to within 45 minutes.

Full and Accurate Metering

In Singapore, the entire water supply system from waterworks to customers' premises is metered. The two main reasons to have 100% of the water supply system metered are to account for usage and to bill customers.

Types of Water Meters Used

The accuracy of waterworks output meters is of utmost importance as any error in registering the production output would grossly affect the water balance account. PUB has since 1985 replaced the waterworks output meters with electro-magnetic flow meters. These meters are highly reliable and accurate to within 1 % allowable error for flow rates between 0.5 to 1.0 m/s and 0.5% allowable error at flow rates above 1.0 m/sec. To ensure reliable and accurate flow measurement, the waterworks output meters are checked monthly based on volumetric measurements by using the draw-down of the clear water storage tanks in the waterworks.

Dynamic Meter Replacement Programme

PUB installs only good quality and accurate meters. Household (15 mm diameter) meters are volumetric type which performs better than velocity type at low flow rates. Large meters (up to 150mm in diameter) used for large non-domestic consumers are of the compound meter type. These meters have a main meter to measure large flows and a by-pass meter to register small flows. To maintain the accuracy of the meters in service, a dynamic meter replacement programme is in place whereby meters in domestic premises are replaced when the meters register above 4,000 cu m or are more than 15 years. For non domestic meters, the meters are replaced once every 7 years and for our high end large customers, the meters are replaced annually.

Meter Maintenance and Replacement Programmes

PUB operates a meter workshop for maintaining and testing meters. Since 1985, in-service testing of meters has been carried out periodically to check the accuracy of the various meters in service. A random selection of meters according to model, size, period in service and location are returned to the meter workshop for accuracy testing. The results obtained are useful in checking the effectiveness of particular meter models and deciding on the replacement or bulk-changing intervals and frequencies.

Computerized Billing System

A computerized billing system which incorporates a check programme is used to verify readings taken off meters. Any abnormally high or low consumption is automatically detected by the computer during the billing process and singled out for further investigation. This enables defective meters and leaks in the customers' reticulation systems to be identified and rectified early.

Strict Legislation on Illegal Draw-offs

There have been very few cases of illegal or unauthorized draw-offs in Singapore. This can be attributed to legislation and stringent enforcement on illegal draw-offs. As a deterrent, anyone found responsible for carrying out an illegal draw-off is prosecuted in court under the Public Utilities Act.

CONCLUSION

Singapore has put in place a comprehensive water demand management programme to promote the efficient use of water by both the domestic and non-domestic sector; and to ensure efficient network management for providing reliable and good quality water to our customers. The water

conservation message has been successfully driven home and resulted in a reduction of per capita domestic water consumption from 172 litres/day in 1995 to 157 litres/day in 2007. Industries are encouraged to substitute potable water with NEWater and run Water Efficient Buildings. Consequently, these deliberate efforts have made Singapore a city with one of the lowest UFW in the world (below 5%).

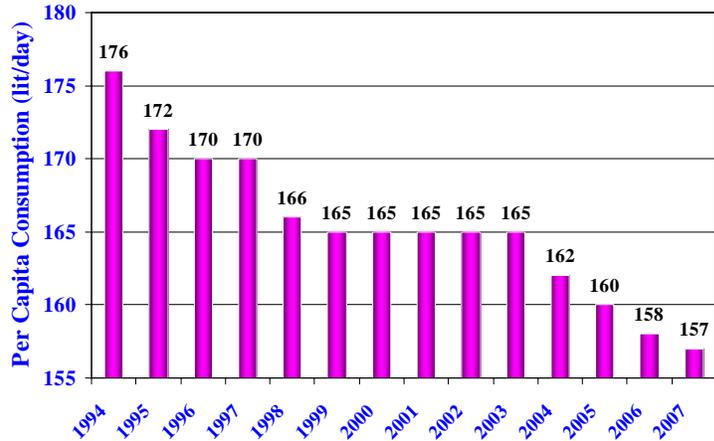


Figure 2 : Per Capita Consumption

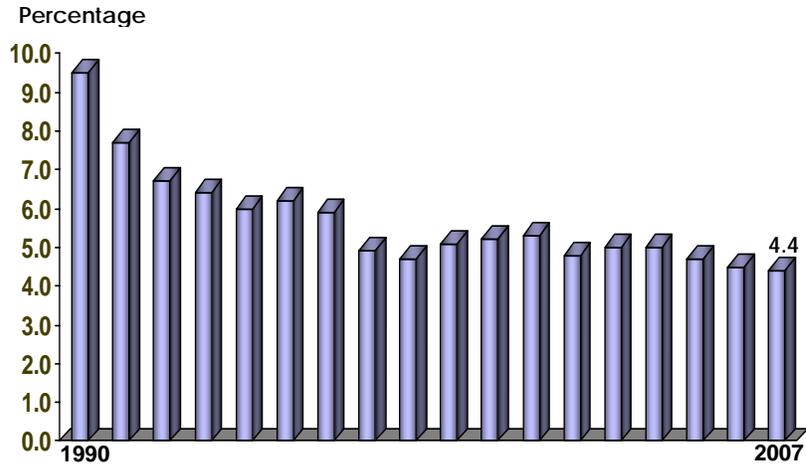


Figure 3 : Per Capita Consumption