

WATER SUPPLY AND WATER QUALITY MANAGEMENT IN SINGAPORE

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ABSTRACT

Singapore is an exemplary city-state of not only Urban water Management but this is the result of competent political leadership, bold national policies, strong institutions and an effective and clean bureaucracy. Public Utility Board (PUB), Singapore the national water agency of Singapore has closed the water cycle loop by making use of every drop of water and managing the country's water resources in an integrated manner. Used water is collected, treated, used & reused. When most of developing countries facing problems of water environment and growing urban population the Singapore government have achieved 100 % coverage in safe water, clean environment and good health to their people in sustainable way for next 100 years. The objective of the article :-

1. To introduce the water supply management in Singapore.
2. To deduce and develop the concept of sustainable urban water supply management and acknowledge the performance gaps in domestic water supply.
3. Understand the factors which govern the function of water supply utility agency.

1. INTRODUCTION

Singapore Co-operation Programme Training Awards (SCPTA) is one of the initiatives

offered directly to developing countries on a government to government basis by Ministry of Foreign Affairs collaborates with PUB, an agency under the Ministry of the Environment and Water Resources, Government of Singapore to conduct this training programme. In year 2011, 2-8 March, the programme was attended by 28 Participants. Including author there were 25 different National Identities in training at Water Hub PUB 80 Toh Guan Road East, Singapore. PUB is statutory board is Singapore's National water agency that manages water supply, water catchments and used water in an integrated way.

2. SYNOPSIS AND METHODOLOGY

The topics covered were :-

1. Management of the Catchments and water Ways.
2. Storm Water Management.
3. Water Treatment Technologies and Water Supply Plant Management.
4. PUB's Integrated Water Quality Management Programme.
5. R&D in Water Technologies.
6. Public - Private Partnership

The class room lectures, discussions and site visits were included in the course.

3. WATER SUPPLY MANAGEMENT

Singapore has been importing water from Malaysia since 1961, before getting independence from a self-governing British Colony. It was perceived well in time the importance and role of water in development by the mentor of today's Singapore who insisted use of water as scarce commodity and initiate search for the new source of water. Today Singapore is getting water from 4 National Taps :-

1. Imported water
2. Catchment water
3. NEWater
4. Desalinated water

3.1 IMPORTED WATER

Water from Malaysia is not purchased as finished product. It is collected and treated at Johor Bahru, Malaysia and carried to Singapore by PUB itself. Importing of water is maintained by years back long-term bilateral agreements signed between Malaysia and Singapore in 1961 and 1962. One agreement was up to mid 2011 and another shall continue up to year 2061 for increased quantity of water. Agreement is such that it saves the interest of both the countries. This agreement should be termed as sign of good relationship between neighbor countries for sharing of available resources for the mutual benefits.

3.2 CATCHMENT WATER

Despite 2400mm average annual rainfall, the rains were not capable to meet the water demand of Singapore because the Country had no developed catchments, natural aquifers or lakes. To maximize the use of catchment water and used water a robust catchment management is exercised which

includes land use planning, development and protection of catchments, creation of new reservoirs, effective pollution control measures, formulation and implementation of regulations etc. Decade's long tactics and efforts for erosion and sediment control including other measures brought Singapore at such level to declare their reservoirs start from drains. The used water and rains joining drains are strictly as per the norms for suspended solids and other parameters contents which make cleaner water in the drains. Routine water quality monitoring in existing reservoirs and catchments ensures clean canals & reservoirs. Singapore is one of the first in the world to tap urbanized catchments with separate networks for drainage and sewerage, rainwater is systematically harnessed from urbanized catchments via a comprehensive network of drains, canal and rivers and stored in created reservoirs.

3.3 NEWATER

NEWater is high grade reclaimed water produced from treated used water through advanced membrane technology, making the water ultraclean. Reuse of water has become a viable solution to face the water scarcity; it has proved true in Singapore. PUB claims tests and has passed more than 65000 scientific tests and has surpassed WHO standards. Newater is produced by stringent purification and treatment processes using advanced dual membrane (microfiltration and reverse osmosis) and ultraviolet technologies. Newater is being produced since year 2002 and by 2011 it was targeted to meet about 30% of Singapore's daily demand from NEWater. Newater is mainly supplied to industrial and commercial customers; some amount is blended

with raw catchment waters for domestic supplies. Newater has freed the use of potable water for other purposes.

3.4 DESALINATED WATER

In year 2005, 30 MGD plant started to desalinate the sea water under PUB's first Public Private Partnership project. Opening of 2nd desalination plant of 70 MGD under DBOO (Design, Built, Own and operate) arrangement was to be opened by 2013. Like Newater desalinated water can further enhance the drought resilience. Through R & D project search of more cost efficient desalinated water production is under way by the Environment and Water Industry Programme office.

To achieve today's level of water supply management Singapore has traversed a long way of plans, formulation of water related policies, implementation of the new regulations, community awareness-community driven programme, heavy investments in desalination and extended reuse of used water, high investment in Research and development activities and many other ancillary activities. Today through an integrated management of the water loop, PUB claims the water supply of Singapore is not only diversified and robust, but sustainable for generations to come.

4. DEMAND MANAGEMENT

Attaining sustainability in water by tapping 4 Tap systems, the PUB invokes people to conserve value and enjoy the waters through their A B C (Active - Beautiful-Clean) Projects. It is the right time to pass on message towards new generation to understand their role to continue reducing needless usage and contribute to demand management by wise use of this scarce re-

source maintained available by hardship of good governance.

To perform effectively the PUB has divided the entire water supply management work among various Directors. Separate Directors are assigned for the catchment & water ways, water supply plants, Technology and water quality, corporate developments, 3P Network, water reclamation plants, policy and planning, Human Resource management, etc. The responsibilities are further delegated to different segment of works to different works Manager. The management system is constantly reviewed for improvement and the board has successfully attained various ISO certificates regarding operation and management of waterworks.

The control in demand of water was not possible without peoples's involvement and changing their attitude regarding conservation of water. To change the water using habits requires a lot of effort and time. Some initiatives taken are briefed in following para.

5. IMPORTANT INITIATIVE TAKEN TO CONTROL WATER DEMAND

5.1 IN DOMESTIC USE

1. Restructuring water tariff and impose of Water Conservation Tax.
2. Use of dual flush low capacity flushing cisterns installations made mandatory, which consumes considerable less water than traditional water closet.
3. Start of water conservation assistance program with water efficient homes concept.
4. Launching of Web site portals to educate and assist the people.
5. Use of water volunteer groups

6. Use of water efficiency labeling on appliance to promote water efficient appliances

5.2 CONTROL AND INITIATIVES IN NON DOMESTIC USE

1. 10% challenge, a 10% curtail in their monthly water consumption for institutions, hotels, schools, commercial buildings and government offices.
2. Water efficiency Manager course
3. Water efficiency building design guide
4. Promoting water recycling.

Water pricing has direct impact on consumption water in domestic use. This has been proved in Singapore. When the water tariff rose people used water more consciously. It is the result of water saving campaign and strong water tariff which made possible to bring down the per capita consumption of water from 174 litres in year 1994 to 164 litres in year 2000. Introducing some more water conservation measures water consumption was reduced to 154 liters by year 2009. (See Figure 1)

PUB has a high level of autonomy and solid political support which have allowed it to increase the water tariffs in progressive steps during the years 1997 to 2000. This increase in tariff and other demand control measures not only reduced the average monthly household water demand but also increased the income of PUB, which enabled PUB to generate funds not only for good and timely operation and maintenance of the existing system but also for investments for newer amenities. Since year 2000 the water tariffs were unchanged till 2011.

6. WATER QUALITY MANAGEMENT SYSTEM :-

The PUB has remained successful to get the credibility of services provided by his ethics of honest working. The Credibility is proved by the guarantee of quality of Tap water supplied. The board carries water quality management in an intergrated way. The objectives and process employed may be briefed as follows :-

6.1 OBJECTIVES :-

1. Ensure all collected water be treated for drinking.
2. Maintain high level of Public confidence in drinking water.
3. Achieve key performance Index.

6.2 PROCESS :-

- 2.1 Water Safety Plan, develop system, verify and implement
- 2.2 Quality safeguard of source water
 - By pollution control measures - Providing infrastructure for water, sewerage and drainage.
 - By land use planning - demarcate land area for various development purposes in country.
 - By legislation - enforcement of code of practice to regulate water supply to the customers, deployment of rangers.
 - Multiple barrier concept of water Treatment.
 - Maintenance of water quality in distribution net work - in installations, mandatory annual inspection and certification. conduct water service week.
 - Safety and Security - Security of the WTP premises, service reservoirs and

other important buildings by early warning and security alarm using Fence Intrusion Detection system FIDMS, CCTVs and card Access System for critical buildings.

6.3 WATER SAMPLING PLAN

1. Routine sampling Inventory sampling and sampling on special events.
2. Use of SCADA System, on line monitoring for Surrogate Parameters (pH Total residual chlorine, conductivity). Monitoring of toxicity at all inlet and outlets of service reservoirs.
3. Water quality data management system.

6.4 WATER TESTING PARAMETERS.

In all about 300 parameters are tested for drinking water quality assessment. Other than physical and chemical parameters the remaining parameters includes 26 no. organic disinfectants by product, 63no. organic compounds, 11no. Wastewater signature compounds, 4no. synthetic and natural Hormones, 26no. Dioxins and Furans, 6no. Radiological quality etc.

6.5 AUDITING OF QUALITY MANAGEMENT.

The PUB employs independent water quality Audit every six months.

1. Internal Audit Panel - Chaired by University expert.
2. External Audit Panel - comprises of foreign and local experts.

The Water Quality Audit Experts are sorted from the field of Microbiology, Environmental Engineering, Water Chemistry, Water Quality monitoring, Human Health and Toxicology etc. The PUB has obtained various

ISO certification ISO-9001 to ISO 14001 for Quality Management System to Environmental Management System.

6.6 RESEARCH AND DEVELOPMENT ACTIVITIES :-

The Board is engaged in following types of research and development activities.

1. In Transmission - For pumping main, service Reservoirs.
2. Study about water quality affecting factors of materials by seasonal variation, pattern of services etc.
3. Development and use of water quality sensors, Wireless online transmission of water quality monitoring system.
4. Partners is new R&D ideas - Local Academic institutions, Universities, Local water companies, overseas institutions and global water players & utilities.
5. Long term goals are fixed to conserve water and energy saving in water supply.
6. The aforesaid whole Water Quality Management activities are under the control of Director Technology. The task is further distributed to various Chief Technologists who perform the Quality check and R & D activities with different segment of system of water production and distribution.

7. SOME ACHIEVEMENT CAN BE LISTED UP AS FOLLOWS

1. Singapore has 24X7 water supplies to all.
2. All water connections are metered and watch over 100% accurate metering and periodic replacement.

3. The country is fully covered by sewer line .
4. Separate drainage and sewerage system to facilitates waste water reuse on an extensive scale.
5. Construction of storm water collection pond for flood control as well to make use of storm water.
6. UFW less than 5%, least in comparison to many developed countries. (See Table 1)
7. Minimum Bottled water consumption as compared to other countries.
8. Foul odor is treated by bacterial scrubber.
9. A high level customer care is maintained by PUB there are 24x7 contact operation centre in the country.
10. Response to public feedback is 99%, every call answered within 10 seconds.
11. IN 99% cases supply interruptions are restored within six hours.

8. WHY SINGAPORE HAS BEEN VERY SUCCESSFUL

To understand the success story of Singapore water supply the excerpts from Tortajada, C. (2006) Water Management in Singapore; prepared for the 2006 Human Development Report is being reproduced as follows:

An institute can only be as efficient as its management and the staff that work for it and the overall social, political and legal environment within it operates.

The most of Asian water utilities are rife with following types of problems :

1. Staff including senior managers is often selected because of their political connections that fulfill the political requirements rather than their management abilities or technical skills.
2. Absence of Autonomy is one of the most fundamental problems that affect most utilities of the Asian developing countries. This in turn creates a series of second order problems and constraints that further erode the efficiency of the utilities to perform their tasks efficiently and in a timely manner.
3. Managers and head of offices often do not have the skill or don't have pro development attitude to manage, even if they had autonomy and authority to manage.
4. Corruption - corruption is rife in nearly all levels has become endemic in most of Asian utilities. Corruption had changed the better performance criteria.
5. Water utilities are overstaffed, primarily because of political interference and nepotism; unions are very strong and generally well connected politically.
6. Poor management, overstaffing and promotions because of seniority or political connections ensure that it is equally difficult to sustain support to good workers because of poor working of surrounding institutions and absence of incentives for good performer.

PUB has overcome the above and other constraints through competitive remuneration, incentives and benefits package. Salary and

benefit packages are generally benchmarked against the civil service, which in turn benchmarked against the prevailing market. In addition, PUB's pro family policies and commitment to train its staff for their profession and rewarding good performers ensure good organizational performance and development makes PUB one of the best public utility organizations in the world.

Corruption is strictly controlled in Singapore, over 95% corruption cases brought before the court lead to convictions; of all cases public officer account for only 10% and the rest are private person.

9. SUMMARY AND CONCLUSION

The effectiveness of Singapore Government confirms by Singapore's consistently high ranking by the World Bank, which defines the government effectiveness as the quality of Public service provision, the quality of the bureaucracy, the competency of civil servants, the independence of the civil service from political pressure and the credibility of the government's commitment to policies.

The main reason behind the efficiency of PUB in managing its water and wastewater is its long term concurrent emphasis on supply and demand management, wastewater and storm water management, institution effectiveness and creating an enabling environment, which includes a strong political will of the state, effective legal and regulatory frameworks and an experienced workforce. The water management institution in a country can only be as efficient as other development sectors are managed. It is unrealistic to expect the existence of an efficient water management institution in a country, in the midst of other mediocre managed institutions which affect the func-

tion of water management. The other institutions may be they for Human resource, Energy, Agriculture, Water resources, Police or Judiciary etc.

The training programme arranged by PUB is quite enough to enable participants to have better understanding of the sources of water supply and the management of good water quality in Singapore.

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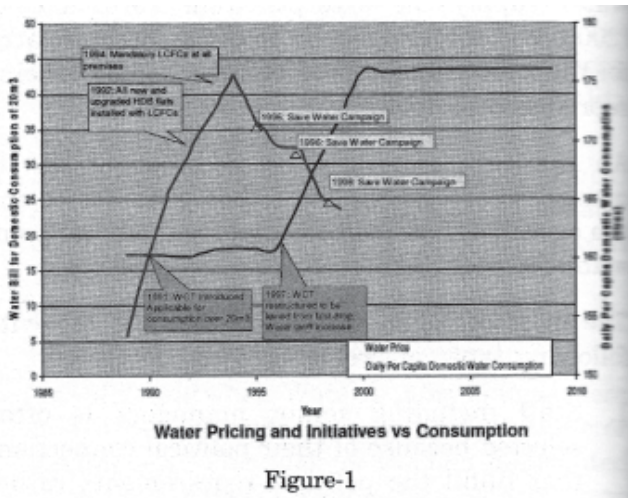


Figure-1

PARTICULARS	YEARS									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Unaccounted for water (%)	5.2	5.3	4.8	5	5.2	4.7	4.5	4.4	4.4	4.6
2. Domestic water consumption (liters per capita per day)	165	165	165	165	162	160	158	157	156	155
3. No. of leaks per 100 km of Potable Water Pipe line	16	14	11	11	10	8	7	7	7	7.1
4. No. of sewerage service disruption per 1000 km of sewer maintained	68	64	47	35	29	24	21	19	17	17

Table - 1 Performance Indicators of PUB - Period 2000 to 2009
