Use of seawater in dual municipal water supply

Hong Kong, China

water scarcity impact

Reduced withdrawal	●
Reduced consumption	
Improved water quality	
Increased productivity	
Net basin benefit	●

volumetric impact
271 000 000 m^3/yr

capital cost
$737 000 000

estimated unit cost of water
20 ¢/m^3

Water Stress
Hong Kong, China

Arid & low water use
Low (<10%)
Low to med (10-20%)
Med to high (20-40%)
High (40-80%)
Extremely high (>80%)
No data available

Water Stress Map:
Gassert, F., M. Landis, M. Luck, P. Reig, and T. Shiao. 2013. "Aqueduct Global Maps 2.0."

Confidence level
Low Medium High

Water Scarcity Impact Key
Main Minor

Project Overview

Hong Kong has limited freshwater resources within its administrative boundaries. Its 7 million residents currently consume 951 000 000m^3 of freshwater every year, 80% of which is purchased and conveyed from Guangdong Province in China. Prior to the 1960s water purchasing agreement, shortages and rationing were very common with many instances when water was supplied for only a few hours every three or four days, which posed a significant public health risk.

The project to use seawater for flushing toilets was initiated 50 years ago to address the public health risk and to reduce demand on the limited freshwater resources. This has helped to ensure that the city is able to meet its water demands.

The system has expanded over fifty years and now comprises of forty five service reservoirs, forty pumping stations and over 1400km of pipes with corrosion protection. The fixed asset cost of the seawater infrastructure is estimated at $737m by the Water Serviced Department of Hong Kong.

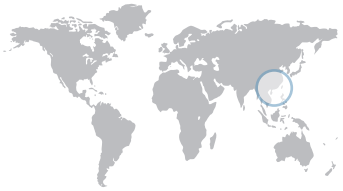
The system provides 27 000 000m^3 of seawater per year to a population of 5.5 million. However when the seawater is polluted due to red tides caused by algal blooms, the network has also conveyed freshwater to maintain supply.

Key Elements

- Dual reticulated water supply serving the majority of the city's population.
- Use of seawater for toilet flushing and evaporative cooling.
- 37% lower energy consumption of seawater supply in comparison to freshwater supply.
- Seawater is supplied free of charge to all consumers.

Key Outcomes

- 22% of the total municipal water demand is met by seawater.
- 17 million kWh lower energy use by using seawater instead of freshwater due to reduced treatment and conveyance.
- Enables freshwater use restrictions to be implemented without public health concerns in event of future water shortages.
- Estimated capital and operating cost over 60 years of $4 425m for the dual supply system. This is 40% lower than the estimated $6 143m for a single freshwater supply system.
- Saving of $160m/yr in bulk water purchases from Guangdong province.



Hong Kong, China

Intervention Features

- Dual piped water supply system
- Seawater for toilet flushing

Project Levers

The dual reticulated system provides security that the basic sanitation needs of the city can be met with seawater if the fresh water supply is diminished due to drought or external water demands.

(1) Dual reticulated network:

The 1 400km of dual reticulated system is currently the most extensive in the world. As with other reclaimed water systems, the separation of supplies enables supply of water at a lower quality thus reducing the energy and material cost of treatment.

(2) Treatment of seawater:

The seawater goes through minimal treatment as its end use has limited public health risks. The incoming water is screened to remove sizeable particles followed by disinfection with electrochlorination.

(3) Corrosion resistant fixtures and pumps:

The risk of corrosion of the pipes is reduced through use of cement lined iron pipes for the main distribution network and polyethylene (HDPE) pipes for in-building services. These measures have increased the average life expectancy of pipes in the network before renewal may be necessary.

(4) Certification programme for plumbers and installers:

To prevent misconnections and cross connections, a certification and training programme was created to train and certify plumbers and appliance installers.

(5) Use of other alternative sources for water:

The network can supply water from alternate water sources, such as reclaimed water and untreated raw freshwater. This is used when the quality of seawater has been below the approved threshold for supply. Following upgrades to the wastewater treatment plants in the city, there may be opportunity to increase the reuse of municipal reclaimed water reducing the rate of corrosion of the system and components.

Outcomes and Challenges

Seawater accounts for 22% of the total water consumption, saving 271 000 000m^3 of freshwater for other uses. It also saves the city $160m a year in purchase of a similar quantity of water from Guangdong.

A dual pipe system helps meet basic sanitation needs irrespective of freshwater constraints, such as droughts. Based on the success of the Hong Kong system, the city of Qingdao in China opened the first part of a dual piped seawater network in 2009.

Use of corrosion resistant pipes has mitigated the increased risk of corrosion from seawater. However, system components, such as pumps and valves still suffer from corrosion and have a lower life expectancy in comparison to freshwater systems. Even with the more frequent replacement, the lifetime cost of the dual reticulated system over 60 years is estimated to be $4 425m, which is 40% lower than the estimated $6 143m it would cost to operate a single freshwater supply, when cost of the water purchase is taken into account.

The public risks from cross connections have been managed through training and certification programme of installers, with only one incident of cross connection in more than 50 years.

Although originally supplied for a charge, seawater has been supplied without charge since 1972. With free seawater and low cost of fresh water, there is limited incentive to reduce consumption resulting in one of the highest per capita consumption rates of 219 litres per day (127 litres freshwater, 92 litres seawater).

Increased salinity does increase the complexity and cost of wastewater treatment and makes it more difficult to reclaim wastewater for municipal use.

Above: Hong Kong (© PHILIP ILIFF - Wikimedia Commons)