Legislative Council Panel on Development
Visit to Singapore
Supplementary Information on
Water Resources in Hong Kong

1. This note is to provide information on the water resources in Hong Kong.

A. Current Water Resources in Hong Kong

2. Hong Kong currently has three water resources, namely (1) local yield, (2) raw water imported from Dongjiang (DJ) and (3) seawater (for flushing). In 2015, Hong Kong consumed a total of 1 245 million cubic metres (mcm) of water, of which around 16% is from local yield, 62% from DJ and the remaining 22% from seawater.

Local Yield

3. Hong Kong lacks fresh water resources. There are no natural lakes, rivers or substantial underground water sources. The Government coped with the increasing water demand by constructing impounding reservoirs and designating about one-third of the territory (300 km^2) as water gathering grounds. Today, Hong Kong has 17 impounding reservoirs with a total storage capacity of 586 mcm. In the past 20 years, the local yield has been fluctuating with the lowest yield of 103 mcm in 2011 to highest yield of 336 mcm in 2013, which is far from sufficient for meeting the demand in Hong Kong.

Importation of DJ Water

4. Hong Kong has been importing raw water from DJ since 1965. The annual quantity of DJ water imported has increased by more than ten folds from the 68 mcm in 1965. Since 2006, the DJ water supply agreement with the Guangdong authorities has adopted the "package deal lump sum" approach, which grants Hong Kong the water right to import DJ water as needed up to an annual ceiling quantity of 820 mcm to ensure a 99% reliability[1] of water supply in Hong Kong. The actual

[1] "99%" reliability means that water supply is maintained round-the-clock even under extreme drought condition with a return period of 1 in 100 years. "Return period" is the average number of years during which an event will occur once statistically. A longer return period means a rarer chance of occurrence.

quantity of DJ water to be imported each year is dependent on the amount of local yield, reservoir storage level and water demand. This flexible approach ensures the reliability of the water supply in Hong Kong while avoiding wastage of the precious DJ water resources as well as the pumping cost.

Seawater for Toilet Flushing

5. To save fresh water resources, an innovative scheme of using seawater for toilet flushing was implemented in the 1950s. Since then, all new buildings were required to be installed with dual plumbing systems for potable and flushing water. The seawater supply networks in Hong Kong currently cover about 80% of the population. Hong Kong is unique in the world to use seawater for toilet flushing in such a scale. The remaining 20% of population, located at areas such as Yuen Long, Tin Shui Wai, Sheung Shui, Fanling, the Peak, Southern District, Sai Kung and the outlying islands, is using fresh water for toilet flushing. Provision of seawater network for many of these areas is constrained by their remoteness from the sea, their high altitudes or their sparse and scattered population. To conserve the fresh water used for toilet flushing, the seawater supply networks would be further expanded to increase its coverage from the current 80% to 85% of the population. Infrastructure for extending seawater supply to Pokfulam and Northwest New Territories has already been constructed and these areas are being converted to seawater flushing.

Unit Costs of Water Resources

6. The unit costs of the current three water resources in 2014-15 financial year are listed below:

	Local Yield	Dongjiang water	Weighted average for fresh water	Seawater for flushing
Unit Cost (HK$/cubic metre ($m^3$))	4.2	9.1	8.4	3.7

B. Development of New Water Resources

7. Hong Kong is not immune to climate change. The Government strives not just to enhance the water security in Hong Kong, but also to build resilience by developing new water resources that are not susceptible to climate change.

Seawater Desalination

8. Seawater desalination is a resilient additional water resource for a coastal city like Hong Kong. The pilot desalination plant study completed in 2007 concluded that seawater desalination using reverse osmosis technology was technically feasible in Hong Kong. The technology of reverse osmosis has become more mature and the cost of seawater desalination has been reduced over the years, making it a right juncture for Hong Kong to develop seawater desalination.

9. Having completed the planning and investigation study on a desalination plant in Tseung Kwan O Area 137, the Water Supplies Department (WSD) engaged consultants in November 2015 to embark on the design of the desalination plant with a view to tendering for a "Design and Build" or "Design-Build-Operate" contract as early as possible. The medium-sized plant will adopt reverse osmosis technology, and will have a water production capacity of about 135 million litres per day (Mld) expandable to 270 Mld to meet 5 to 10 percent of the overall fresh water demand of Hong Kong.

10. Based on the planning and investigation study, the unit water production cost of the proposed desalination plant is estimated to be about HK$12.6/m^3 (at 2013-14 price level) with breakdown as below:

	HK$/m^3	**HK$/m^3**
(i) Energy Cost	3.6	
(ii) Capital Cost	4.6	
(iii) Treatment Cost (excluding Energy Cost)	1.9	
Unit Production Cost ***(excluding distribution and customer services)***		**10.1**
(iv) Distribution Cost	1.9	
(v) Customer Services Cost	0.6	
Unit Production Cost ***(including distribution and customer services)***		**12.6**

11. The estimated unit water production cost of the proposed desalination plant is in comparable order with those of the overseas plants using reverse osmosis technology which range from HK$3.2 to HK$46.2 per m^3 (at 2015 price level) according to the International Desalination Association[2]. However, it should be

[2] Unit water production costs from International Desalination Association exclude distribution and customer services costs.

noted that the unit water production costs in Hong Kong and other countries cannot be compared directly as they are affected by various factors such as the energy cost which is a major component of the operating cost of a desalination plant, the seawater quality and temperature, intake arrangement, environmental measures, financing details, and specific details of the water purchase agreement, etc.

12. Taking the Tuaspring plant in Singapore as an example, the published unit water production cost of S$0.45/$m^3$ (HK$2.79/$m^3$) was a first-year price for desalinated water sold to the Public Utilities Board of Singapore but there is little information available on how such price was set as well as the water prices in the subsequent years. It is understood that under the water purchase agreement, the contractor would build the desalination plant together with a power plant side by side for enhancing efficiency through an integrated design. Besides, the power supply surplus to the requirement of the desalination plant would be sold to the grid[3], thereby resulting in significant cost savings[4]. It is also uncertain whether the unit water production cost covers all the cost components used in the derivation of the unit water production cost of the proposed desalination plant in Hong Kong as described in paragraph 10 above. Therefore, a direct comparison of the unit water production costs of the two plants would not be meaningful. A more reasonable comparison on the other hand would be the energy consumption for production of each unit of desalinated water. The preliminarily estimated energy consumption for the proposed desalination plant in Tseung Kwan O Area 137 is about 4.4 kWh/m^3, which is indeed comparable with that of the Tuaspring plant (4.0 kWh/m^3).

Reclaimed Water

13. As mentioned in paragraph 5 above, Sheung Shui and Fanling are using fresh water for toilet flushing as it is not cost effective to construct and operate a seawater supply system due to their long distance from the seashore. With the proposed expansion and upgrading of the Shek Wu Hui Sewage Treatment Works to tertiary treatment for meeting the requirement of "no net increase in pollution load in Deep Bay", WSD conducted an economic assessment in 2012 which indicated that the supply of reclaimed water produced from tertiary treated sewage effluent of the Shek Wu Hui Sewage Treatment Works for toilet flushing in Sheung Shui and Fanling was a cost effective option. The preliminary estimate of the unit production

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[3] Source: WaterWorld.com, "Singapore's second desalination facility set to open with combined power plant", 14 September 2013, internet link below: http://www.waterworld.com/articles/2013/09/singapore-s-second-desalination-facility-set-to-open-with-combined-power-plant.html

[4] Source: Internet article "Hyflux Tuaspring Desalination", internet link below: http://www.indobara.co.id/2013/hyflux-tuaspring-desalination/

cost of the reclaimed water was about $3.8/m^3 [5] as compared with $5.6/m^3 and $10.4/m^3 for fresh water and seawater[6].

14. To effect the supply of reclaimed water to north-eastern part of New Territories progressively starting from 2022, WSD has commenced the design of infrastructure and the construction works are targeted to commence in stages from end 2016. Concurrently, WSD is studying the financial and legal aspects of supplying reclaimed water to the public. The estimated amount of fresh water that can be saved by supplying reclaimed water to the north-eastern part of New Territories for toilet flushing and other non-potable uses is about 21 mcm per year after full commissioning. By then, the seawater and reclaimed water supply networks will cover approximately 90% of the population in Hong Kong.

Grey Water Reuse and Rainwater Harvesting

15. The Government is also promoting the wider use of grey water[7] recycling and rainwater harvesting systems by installation of such systems in suitable new government projects. WSD has established corresponding technical and water quality standards and provided detailed guidelines on the use of recycled grey water and rainwater in government premises.

C. Water Conservation

16. Excluding flushing water, the daily per capita domestic fresh water consumption in Hong Kong stands at about 130 litres per head per day (L/h/d). As the first step for a progressive reduction towards the world average of 110L/h/d, WSD launched the "Let's Save 10L" Campaign in 2014 to promote the saving of 10L of fresh water consumption each day by each member of the public. Under the Campaign, complimentary flow controllers have been distributed to participating households.

17. WSD has also been implementing other initiatives to promote water

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5 The unit production cost of reclaimed water is dependent on the level of treated effluent (i.e. primary, secondary or tertiary treated effluent) used for production of reclaimed water. The unit production cost will be higher if the level of treated effluent is lower.

6 Unit cost of fresh water was calculated based on the marginal cost and quantity of supplying fresh water for flushing in Sheung Shui and Fanling. The high unit cost of seawater was due to the long distance in pumping seawater from the sea to the service areas in Sheung Shui and Fanling.

7 "Grey water" means the water from a bath, shower, lavatory basin, sink, etc. but excludes water from a slop sink, toilets or urinals.

conservation. In the school year of 2015-16, WSD has launched the Cherish Water Campus Integrated Education Programme with participation by over 160 primary schools. In addition, WSD has been installing flow controllers at public rental housing estates, government buildings and schools. WSD has also been developing best practice guidelines for the high water-consuming commercial trades in the non-domestic sector. Moreover, WSD plans to mandate the use of water saving devices registered under the Water Efficiency Labelling Scheme (WELS) in new developments and major renovation of buildings.

18. The measures taken by Hong Kong are similarly adopted overseas such as the "10 Litre Challenge" of Singapore and distribution or installation of water-saving thimbles/flow controllers free-of-charge in Singapore and Taiwan. Currently, the WELS in Hong Kong is a voluntary scheme while Singapore has already implemented mandatory WELS in 2009[8].

D. Water Loss Management

19. Hong Kong has a hilly terrain. To supply water to developments at high altitudes with sufficient pressure, water mains at lower altitudes in the water supply system will have to operate at a relatively high water pressure. Coupled with traffic load and disturbance caused by laying and repair of other utilities in the congested underground space, the water distribution network in Hong Kong is prone to a higher rate of leakage and burst.

20. Despite such challenge, WSD has brought the leakage rate down from the peak of over 25% to the current level of 15%. This has been achieved through the substantial completion of the 15-year replacement and rehabilitation programme for aged water mains in 2015, backed with measures like active leakage control and speedy repairs.

21. With the advancement on sensing equipment and analytical technology, WSD is progressively establishing the Water Intelligent Network (WIN) to bring network management into a new era. Through the setting up of District Metering Areas (DMAs) and installation of monitoring and sensing equipment in the network,

[8] Singapore introduced the mandatory water efficiency labelling scheme in 2009 as a follow-up from its voluntary water efficiency labelling scheme which was introduced in 2006. However, a longer time is expected for Hong Kong to migrate from a voluntary labelling scheme to a mandatory scheme based on the experience in the Energy Efficiency Labelling Scheme. Hong Kong had been operating a Voluntary Energy Efficiency Labelling Scheme since 1995, but the Mandatory Energy Efficiency Labelling Scheme was only introduced in 2009.

data can be collected and analysed to continuously monitor network healthiness for timely and appropriate actions. In addition, associated analytical tools such as the use of data-mining technique to predict pipe failure will be developed to enhance the function of WIN.

22. The approach of WIN is comparable to overseas practices, with establishment of DMAs seen in cities like Taipei, Lisbon, Manila and Beijing. Singapore is also developing a Smart Water Grid with similar installation of monitoring and sensing equipment in their network.

E. The Outlook of the Future

23. The progressive transformation of the current three-pronged supply (local yield, importation of DJ water and seawater for toilet flushing) into a six-pronged supply (through the development of seawater desalination, reclaimed water and grey water reuse and rainwater harvesting) will enhance the water security and resilience of Hong Kong. WSD will also continue driving water conservation to achieve efficient and sustainable use of water resources, while ensuring quality network management through the establishment of WIN.

24. The ultimate vision is to develop a model of “Smart City” for water. The model is fundamentally characterised by the use of sustainable water resources and the implementation of WIN. In addition, smart water meters with automatic meter reading functions will be installed at the consumer end to provide real-time water consumption data and alerts to consumers, hence facilitating water conservation and reducing water loss within their premises.

Water Supplies Department
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