



ESSAY

Stormwater Management

City of Gardens and Water

Singapore's approach to stormwater management has evolved dramatically over the years. CLC Executive Director **Khoo Teng Chye** outlines how urban planners and civil engineers have transformed concrete drains to re-naturalised streams and bioswales that have reduced flooding, improved water quality, enhanced biodiversity and brought people closer to nature. This essay is adapted from a public speech on 27 February 2015 at the "Mainstreaming the ABC Waters Programme" forum, organised by CLC.

Over 5.5 million people live in Singapore on an island of just 720 square kilometres. Despite this high density, it is considered one of the world's more liveable cities. This is due to many factors, but it is its greenery that most distinguishes Singapore from other densely populated cities.

Roadside greenery, the backbone of Singapore's City in a Garden vision, forms a pervasive green matrix, together with ample parks, nature areas, community gardens and skyscraper greenery. Over the

span of two decades from the mid-1980s, Singapore's population grew 1.7 times, and its economy 6.6 times. Yet the proportion of green cover—including roadside tree canopies, nature areas and parks—was able to grow more than 1.3 times. This suggests that Singapore's commitment to greenery was critical to helping it improve liveability and avoid the experiences of other developing cities, where quality of life and the environment are often sacrificed during periods of rapid growth.



CLC Executive Director **Khoo Teng Chye** was previously Chief Executive of PUB, Singapore's national water agency, and CEO of the Urban Redevelopment Authority, PSA Corporation and Mapletree Investments. He sits on the Jurong Lake District Steering Committee, and Advisory Committee for the new capital of Andhra Pradesh state in India.





A large part of Singapore's liveability is due to the city's extensive greenery.



What About Water?

Greenery has now been mainstreamed in Singapore. A robust ecosystem of government policies and programmes together with industry and citizen participation supports its development. I believe integrating a blue layer into Singapore’s green matrix can boost its liveability to a new level.

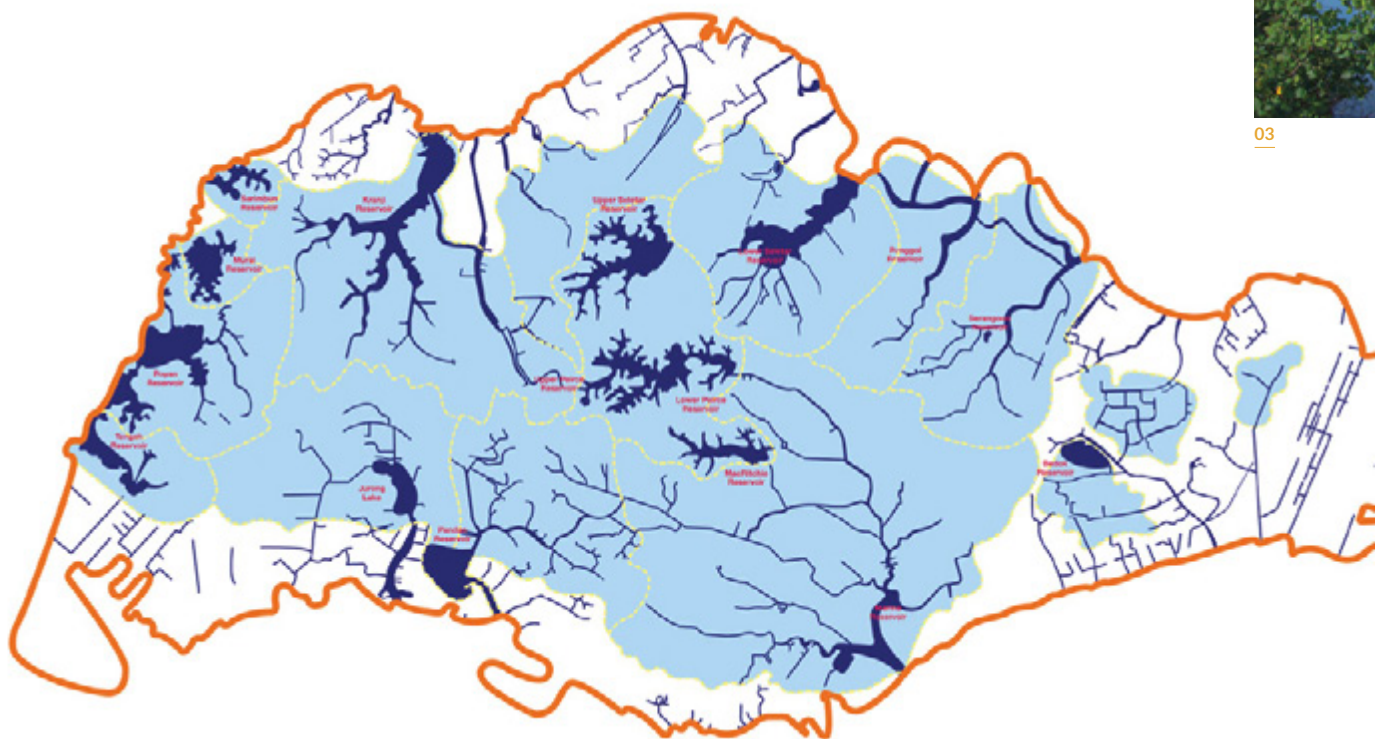
Many people are surprised by Singapore’s Blue Map of 17 reservoirs and 8,000 kilometres of waterways, inclusive of 32 rivers. In comparison, Singapore’s iconic roadside greenery lines much of the road network of just 3,500 kilometres. With such an extensive water network and 2.4 metres of annual rainfall across the island, this ought to be a Venice! But thanks to civil engineers like me, most blue areas became ugly concrete drains, canals and stormwater collection ponds.

From the 1960s, national water agency PUB focused on critical challenges like droughts, floods and pollution. PUB improved water security by diversifying our sources via the four national taps: domestic catchment, imported, recycled and desalinated water. The Singapore River and other waterways were cleaned up, while projects like the Marina Barrage drastically reduced flooding. But much more can be done to tap water’s potential as an urban asset.

In the 1980s, the Urban Redevelopment Authority (URA) developed a vision to re-naturalise our engineered waterways. The idea came from Mr Lim Hng Kiang, then a Deputy Secretary in the Ministry of National Development (MND). I helped him set up a Waterbodies Design Panel, chaired by Dr Liu Thai Ker. It was

Blue Map of Singapore

● Water Catchment





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a whole-of-government effort, involving the Ministry of Environment, URA, Housing and Development Board (HDB), and others.

The Waterbodies Design Panel created some outstanding projects. Amidst the high rise public housing of Pasir Ris town, Sungei Api Api became a scenic river lined with lush mangroves, instead of becoming a typical monsoon canal. In another town, Bukit Panjang, what might have become a bare stormwater

pond became an attractive wooded lake. Based on this approach, URA then drew up a Parks and Water Bodies Plan.

But years later, when I had the good fortune to head PUB, I discovered to my horror that implementation had petered out. Inspired by the success of NParks' Park Connector Network, we then started the Active, Beautiful, Clean (ABC) Waters programme in 2006.

- 01 The Blue Map of Singapore shows Singapore's extensive water catchment areas and waterways.
- 02 A typical utilitarian stormwater pond in the Bedok neighbourhood.
- 03 & 04 The Sungei Api Api river in Pasir Ris town and the stormwater pond in Bukit Panjang are some of the projects undertaken by the Waterbodies Design Panel in the 1980s.



A Decade of ABC Waters

We developed the ABC Waters Master Plan based on Singapore's Blue Map. This plan identified some 100 projects that could be undertaken over 20 years, involving public agencies, the private sector and community. We were fortunate the government, particularly the Ministry of Finance, agreed it was a worthwhile programme to support.

PUB began with three demonstration sites in Bedok and MacRitchie reservoirs and Kallang River, consulting the community to improve the designs. These showed the viability of ABC Waters to other agencies as well as the general public other proof-of-concept pilots were also conducted to test specific ideas, such as the rain garden at Balam Estate, now Balam Gardens—land depressions designed to cleanse rainwater runoff by filtering it through vegetation and soil.

We also cultivated the industry. To incentivise the private sector, a certification scheme was launched to let developers who incorporated ABC Waters design features promote “certified” ABC Waters projects. Design guidelines and engineering procedures were published

to establish technical standards. PUB also conducted many seminars and talks to develop capabilities. It partnered the Institution of Engineers Singapore to run an ABC Waters Professional Programme to train and certify professionals, while universities and polytechnics introduced related modules and courses.

We are now 10 years into the ABC Waters programme. PUB has completed some 30 projects so far, like Bishan-Ang Mo Kio Park and Alexandra Canal. Overall, we can look forward to more than 100 ABC Waters projects currently being carried out by PUB, other public agencies and even the private sector such as JTC Corporation's CleanTech Park, Khoo Teck Puat Hospital at Yishun Pond, and City Developments Limited's H₂O Residences.

Momentum is growing, as people start to see the value of these projects. When he toured the ABC Waters Exhibition in 2007, Mr Lee Kuan Yew said “people will support this programme as they will very soon realise that their property value will increase if there is an ABC Waters project next to their home.” Anecdotal evidence indicates he was quite right.



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- 01 The rain garden in Balam Gardens not only prevents flooding, but also injects beauty in the neighbourhood.
- 02 H₂O Residences was the first private estate to obtain the ABC Waters certification by PUB.
- 03 The Alexandra Canal, one of the completed ABC Waters Projects.



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Beyond monetary value, the community can now get much closer to water and appreciate the beauty and nature that comes with it. Unlike monsoon drains, the re-naturalised canals allow children to walk up to the stream, get their feet wet, catch fishes and see all sorts of wildlife, like egrets and otters. They can enjoy the same pleasures their grandparents did in rural streams, but which their parents' generation—like most other city dwellers—rarely experienced. Water sports like sailing and rowing are also enjoying a revival in Marina Bay and other reservoirs.

Indeed, we see many benefits from ABC Waters projects, such as better stormwater management. Conventional drainage engineering generates high peak flows, and lots of land pollutants that wash into canals. ABC Waters design features can slow down and treat the water, making it safer and cleaner. In terms of land use, it is more efficient for traditionally mono-functional water infrastructure to perform multiple roles in a land-scarce city, like combining recreation with water

storage. Importantly for Singapore as the population grows, enhancing surrounding views and amenities and providing green and blue relief areas make high-density living more tolerable, even enjoyable. Finally, ABC Waters sites also tend to be rich nodes of plant and animal life and contribute to biodiversity.

What's Next?

After a decade, the ABC Waters projects are still seen as a special feature that's not routinely incorporated in the work of planners, architects and engineers. For example, PUB itself originally designed Marina Barrage as a utilitarian facility, ugly and inaccessible to the public. But URA told PUB this would not do in the heart of our city. With URA's help, PUB redesigned the Barrage with a sweeping green roof, and opened it to the community. It has now become a well-loved destination for picnics and kite flying. With 100 upcoming ABC Waters projects, PUB is going further. Can this be done for all water infrastructure?

01 The green roof at the Marina Barrage has become a popular place for kite-flying and picnicking.

02 The appearance of otters at the Kallang River has drawn people to the Bishan-Ang Mo Kio Park.



“ Unlike monsoon drains, the re-naturalised canals allow children to walk up to the stream, get their feet wet, catch fishes and see all sorts of wildlife, like egrets and otters...”



Another idea is from Kansas City, which has an initiative to build 10,000 rain gardens. Kansas City is comparatively small, so Singapore should aim to have 100,000 rain gardens! As engineers like me tend to worry if all this landscaping can channel water away quickly, we did many experiments. For instance, the rain garden in HDB's Balam Gardens, demonstrated that we could slow down rainwater while treating it. Since then, HDB has done much more. The scenic Punggol Waterway linking two reservoirs is a landmark project at the doorsteps of thousands of families. HDB is also creating an ABC Waters precinct, Waterway Ridges, in Punggol town. Can all HDB towns be designed based on ABC Waters principles?

Turning to private housing estates, why not turn conventional drains into something different using ABC Waters? PUB is piloting this in Windsor Park, one of the first projects of its kind under MND's Estate Upgrading Programme. It introduced features like vegetated swales, retention basins, little wetlands and not-so-wet rain gardens on top of the drains, so you see landscaping instead of concrete drains. Can all residential areas be designed with such principles? Similarly, all roads can be designed with bioswales, instead of concrete drains. We have experimented with it, and PUB is working with the Land Transport Authority to do more.



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- 01 The Punggol Waterway links two of Singapore's reservoirs together, and provides a scenic waterfront for the residents in the Punggol neighbourhood.
 - 02 Proposed ABC Waters elements in Windsor Park, an upcoming private housing estate.
 - 03 The Kranji Marshes, located between the discharge points of PUB canals and the Kranji Reservoir, serves as a natural filter for water entering Kranji Reservoir. It was adopted by the Nature Society of Singapore under the ABC Waters Programme.



Mainstreaming the ABC Waters

Notwithstanding the success of the ABC Waters Programme, some building and planning professionals remain content with conventional drains, canals, stormwater ponds and other water infrastructure. As a result, great opportunities to develop a more beautiful, biodiverse and vibrant city are missed. In contrast, most Singapore planners and even the public expect landscaped areas alongside roads and buildings as a matter of course, instead of the unremitting concrete that other cities consider normal. Developers and designers are also highly aware of the value of incorporating greenery in

buildings, although it often incurs additional costs.

Prime Minister Lee Hsien Loong coined the inspirational phrase “a City of Gardens and Water” when he launched the ABC Waters Exhibition in 2007; he thought more should be done in this area. To realise the exciting potential of ABC Waters, we should mainstream it in our vision for the future. Much has been achieved already. The challenge now is to take it to a new level, creating a much more liveable and sustainable City of Gardens and Water for all to enjoy. 