

WORLDSBE Conference 2017 Hong Kong
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Driving Innovations for Green Infrastructure Components

Mr. Nicholas AU
Senior Landscape Architect
Hong Kong Housing Authority



Organisers:



International Co-owners:





Nicholas H.F. AU

MA(LD), CMLI(UK), Registered Landscape Architect (HK)

Senior Landscape Architect

Hong Kong Housing Authority (HKHA)



Apart from external works design, open space project design and management of landscape contracts, Nicholas is also in charge of landscape professional and technical support to the Department's Research and Development items.



The design of the Zero Irrigation System received Merit Award (Research) under the Landscape Design Awards 2014 granted by the Hong Kong Institute of Landscape Architects and Merit Award (Research and Planning Category) under the Green Building Award 2014 granted by the Hong Kong Green Building Council.



Organisers:



International Co-owners:



Sustainable Buildings and Climate Initiative
Promoting Policies and Practices for Sustainability



Global Alliance
For Buildings and
Construction

Background

Researches

- (a) Sustainable planting system for Roof Greening
- (b) Cost effective Vertical Greening System
- (c) Rain water harvesting system with bio-retention mechanism
- (d) Root Zone Irrigation System for Ground Cover and Shrubs
- (e) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

Conclusion



Organisers:



International Co-owners:



Background



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Introduction

Hong Kong Housing Authority (HKHA) implements one of the world's largest public housing programme

Housing Estates in Hong Kong

- Adopt **functional and cost-effective design** in the Planning, Design, Construction and Management of housing projects;
- Promote **healthy living and green environment** in the work;
- Act with **caring and partnering** culture beyond baseline performance.

2,140,000 (30%) population

14,000+ workers daily

99 listed contractors

80+ active suppliers

9,000+ HA staff



756,000 flats in use



280,000 new rental & subsidized sale flats from 2017/18 to 2026/27



以人為本



Our Vision

To **help low-income** families with housing need gain access to affordable housing.

Our Mission

- To provide **affordable quality housing**, management, maintenance and other housing related services to meet the needs of our customers in a proactive and caring manner;
- To ensure **cost-effective** and **rational use of public resources** in service delivery and allocation of housing assistance in an open and equitable manner; and
- To maintain **a competent, dedicated and performance-oriented TEAM.**



International Co-owners:



Greening Mission in Housing Authority:

- To plant at **least one tree for every 15 flats** since 2000.
- Achieve overall target of **30% green coverage** for all new housing projects since 2010.

Green Infrastructure Components:

Building

- Green roofs
- Vertical greening

Water

- Rain water harvesting
- Water saving irrigation system

Landscape

- Bio-retention
- Plant Selection

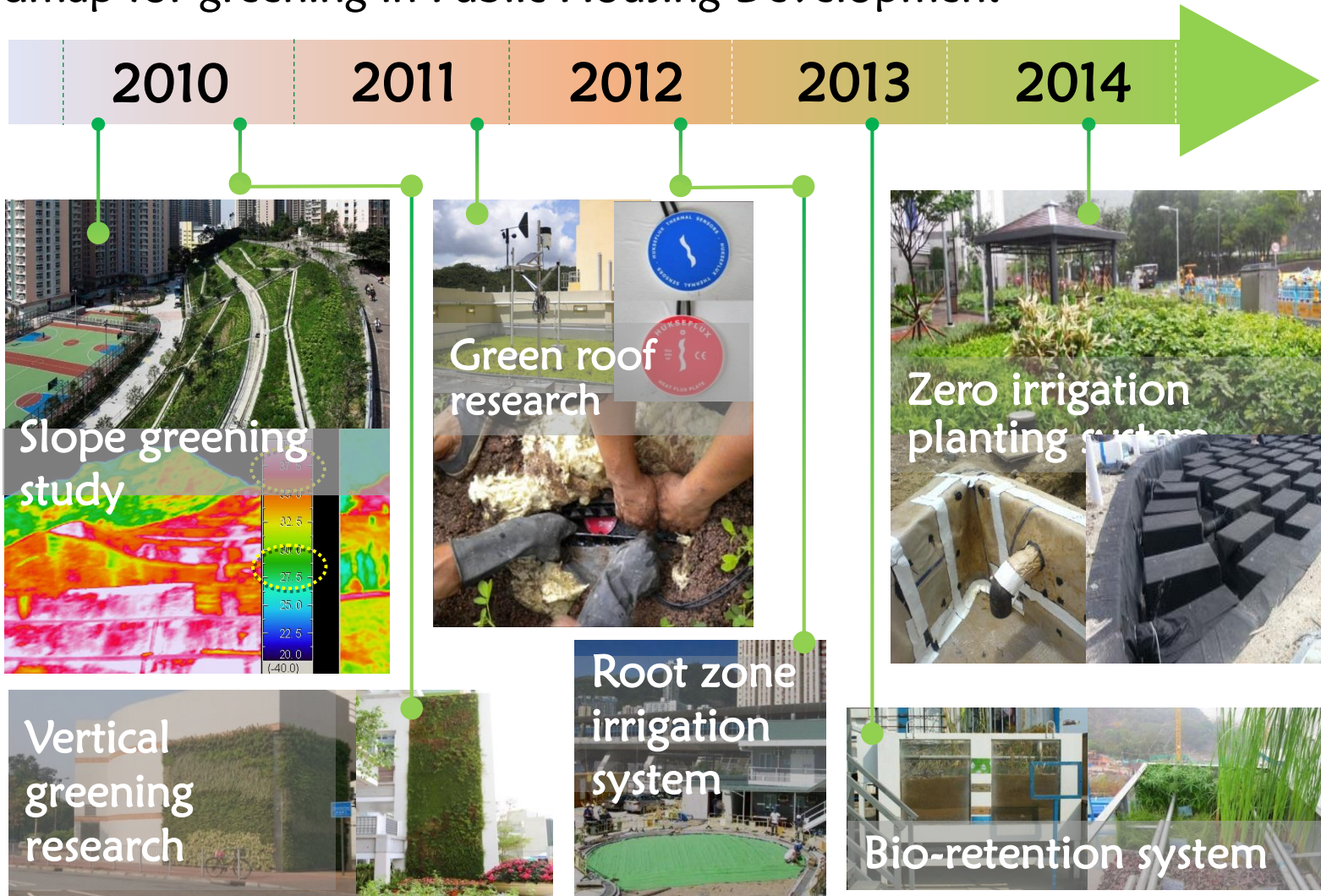
Hardscape

- Pervious pavement

30% overall green ratio achieved at Upper Ngau Tau Kok Estate Phase 2 & 3



Roadmap for greening in Public Housing Development



International Co-owners:



Researches



Organisers:



International Co-owners:



Sustainable Buildings and Climate Initiative
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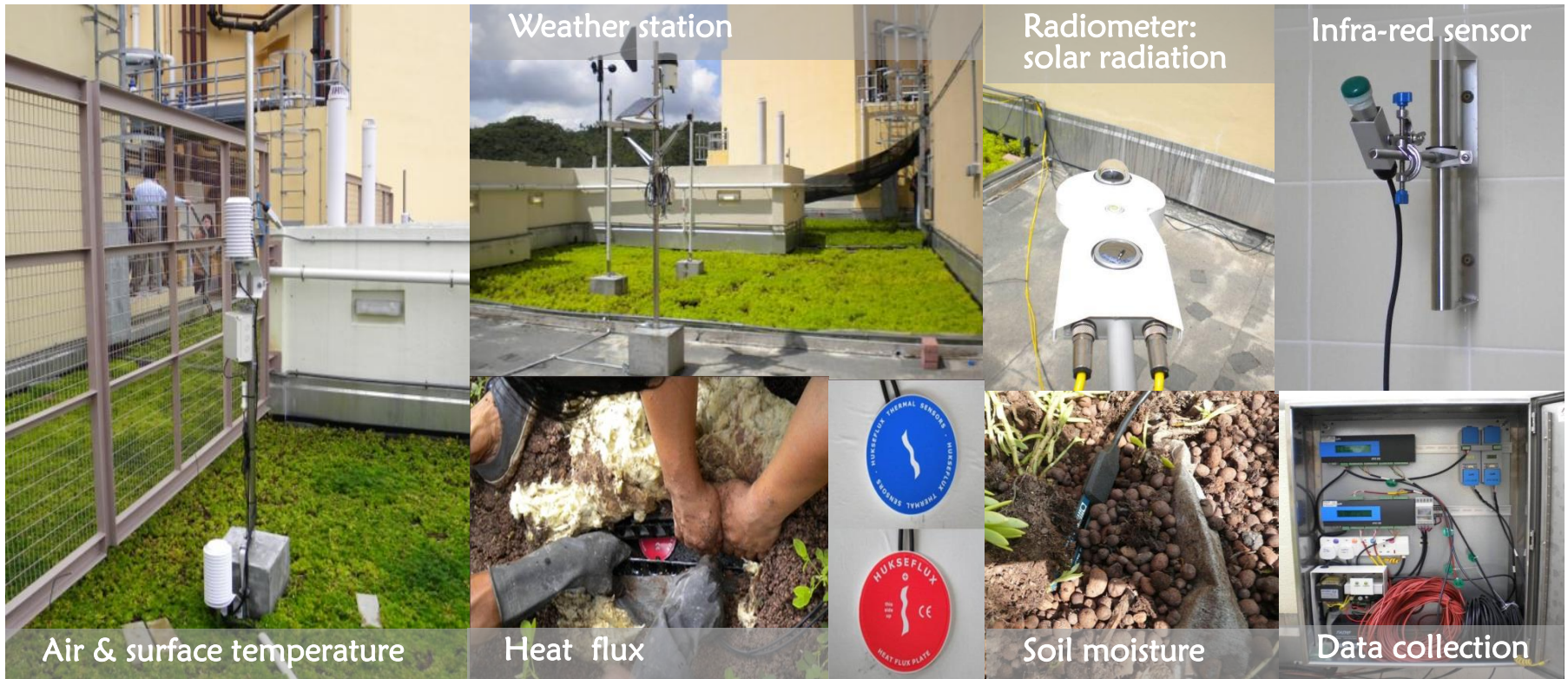


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(A) Sustainable planting system for Roof Greening

Objectives:

- To establish a low-maintenance green roof.
- Compare the growth performance of two commonly used green roof plant species (Sedum mexicanum 金葉佛甲草/ Arachis pintoii 蔓花生).
- Test the environmental performance of the green roof systems.



Organisers:



International Co-owners:



(A) Sustainable planting system for Roof Greening

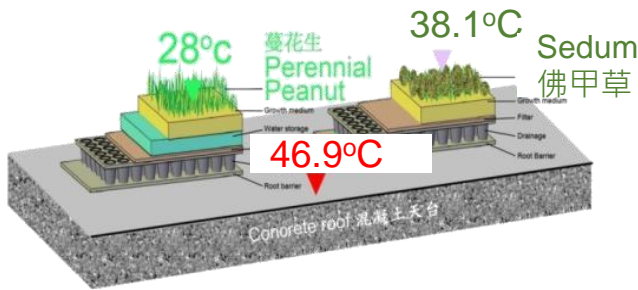
Green Roof Research Findings



Heat Reduction - the green roof surface is **18.9°C cooler** than roof surface without thermal insulation.

Plant performance –

Sedum mexicanum 金葉佛甲草 and Arachis pintoii 蔓花生 should be promoted in consideration of its long term low maintenance requirement.



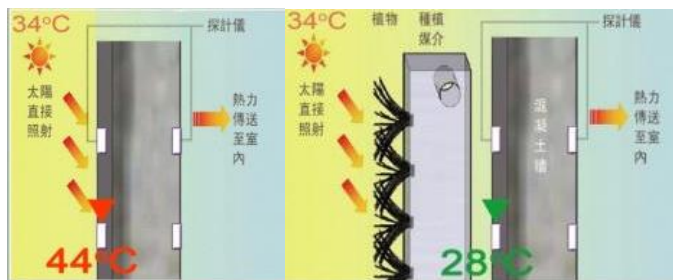
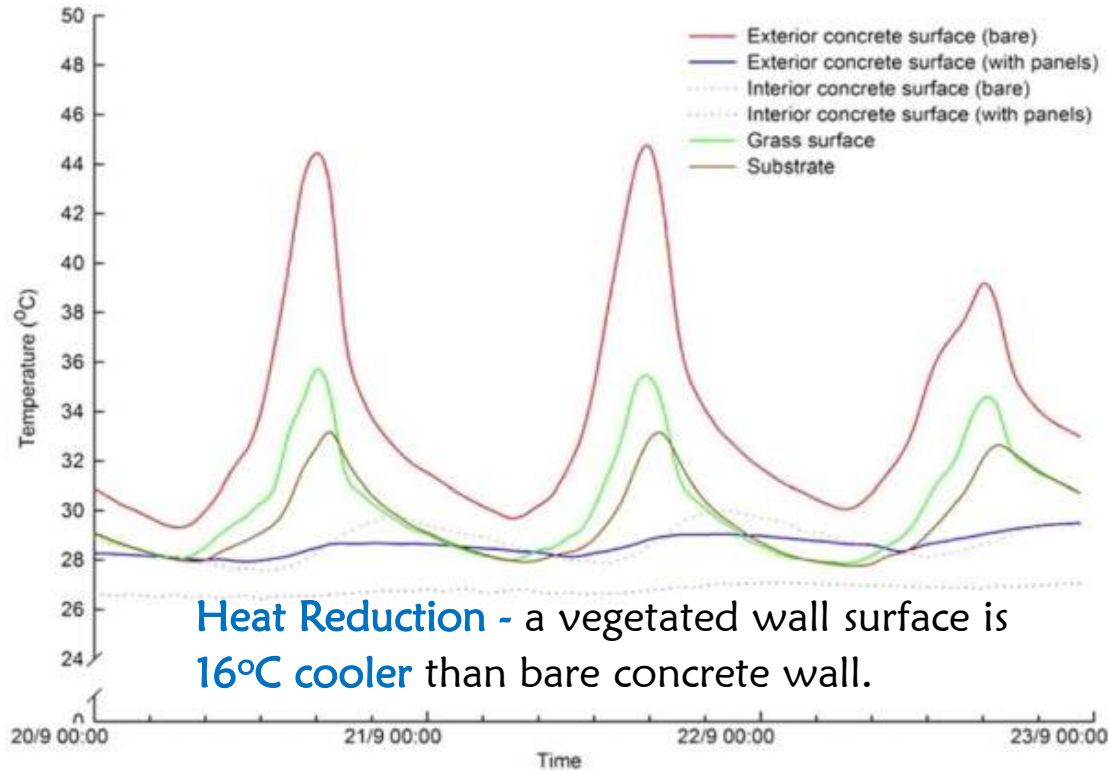
Arachis pintoii 蔓花生

Comparison of the performance of Sedum mexicanum 金葉佛甲草 and Arachis pintoii 蔓花生

(B) Cost effective Vertical Greening System

Objectives:

- To evaluate:
 - (i) heat reduction capacity,
 - (ii) water use efficiency,
 - (iii) plant performance & species selection,
 - (iv) fertility persistence and nutrient loss.



(B) Cost effective Vertical Greening System

Vertical Greening Research Findings:

WATER CONTENT

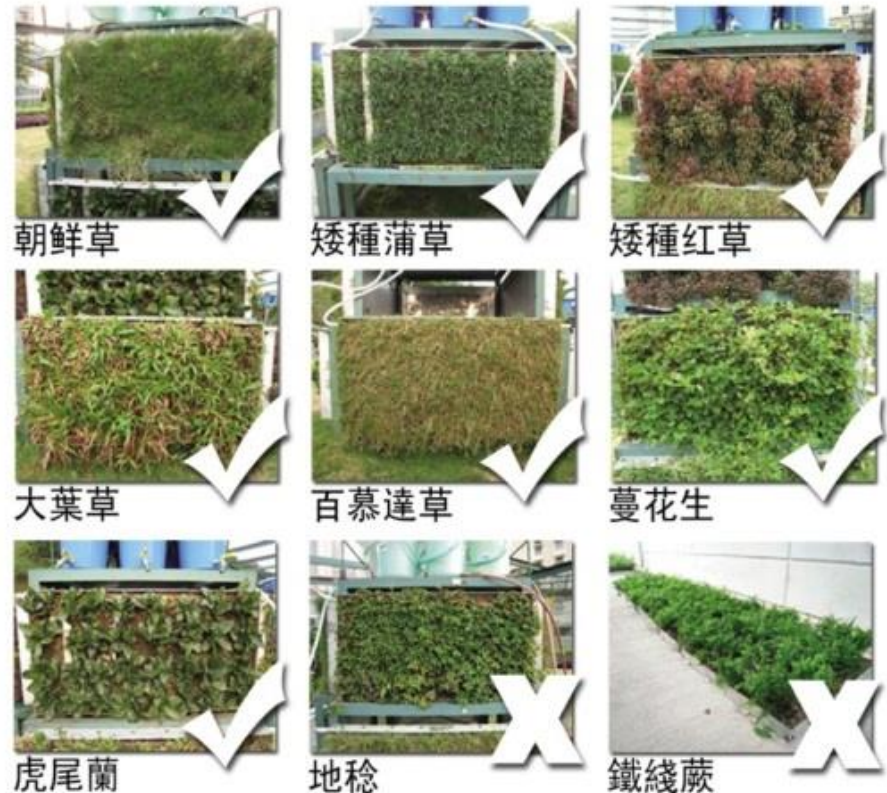
The water content of the panels should reach at least 25%. A 1m x 0.5m panel requires 1 liter of water per day.

PLANT SPECIES

The study identified the suitable plant species and their combination in terms of colors, contours and appearance to form lively and diversified patterns.

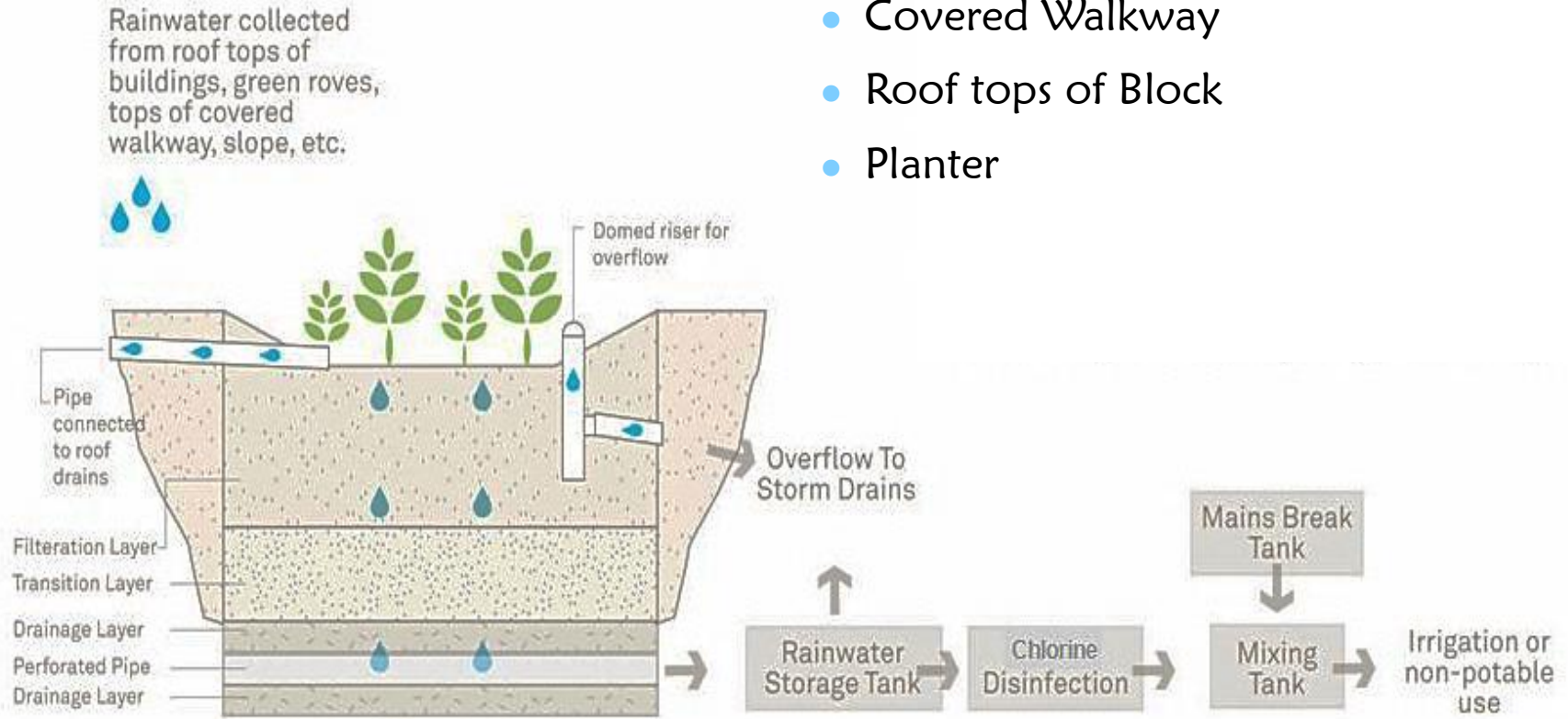
NUTRITION STRATEGY

Liquid fertilizers should be applied for a duration of six weeks in spring each year.



Rainwater Collected from :

- Green Roofs
- Covered Walkway
- Roof tops of Block
- Planter



Source: AECOM, 2014. *Mock-up of bio-retention Rainwater Harvesting System in Shui Chuen O Phase 1—Summary report for Hong Kong Housing Authority*

Trial at Shui Chuen O Estate

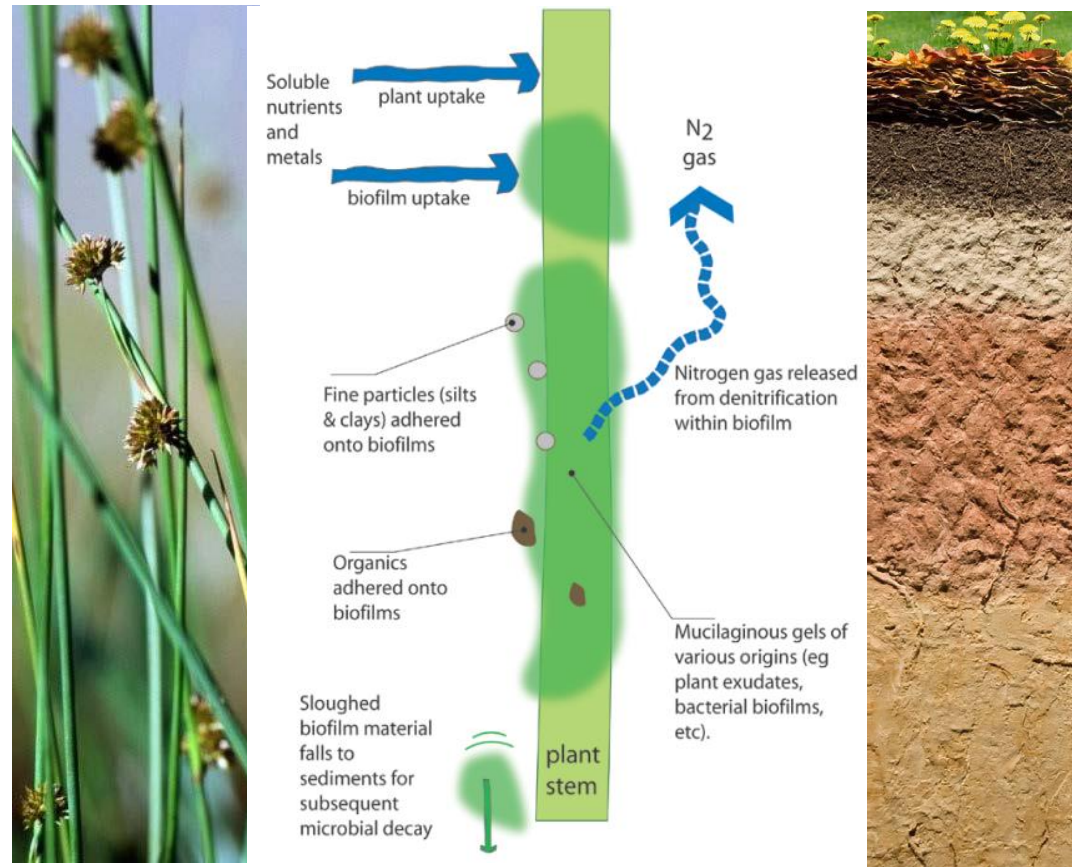


Source: AECOM, 2014. *Mock-up of bio-retention Rainwater Harvesting System in Shui Chuen O Phase 1—Summary report for Hong Kong Housing Authority*

PRINCIPLES OF WATER TREATMENT

Pollutants in water are removed through physical and biological processes, effected by soil layers, vegetation and biofilm:

- Physical filtration
- Induced sedimentation of fines
- Biodegradation with oxygen transfer through roots to soil (aerobic microbial processes)
- Nutrient and contaminant uptake by plant and microbes on biofilm as well as retention in the soil matrix
- Absorption of particles and contaminants onto biofilm

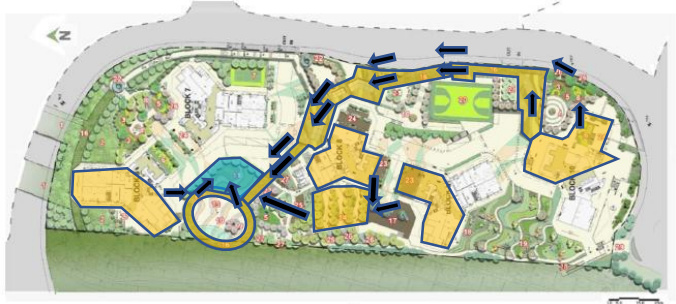


Source: AECOM, 2014. *Mock-up of bio-retention Rainwater Harvesting System in Shui Chuen O Phase 1– Summary report for Hong Kong Housing Authority*

Treatment System 1



Treatment System 2



Treatment System 3



Bio-retention System at Shui Chuen O Estate

 Bio-retention

 Catchment Area

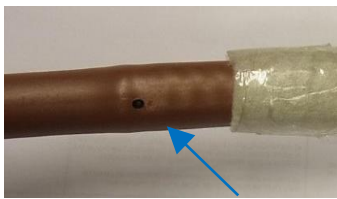
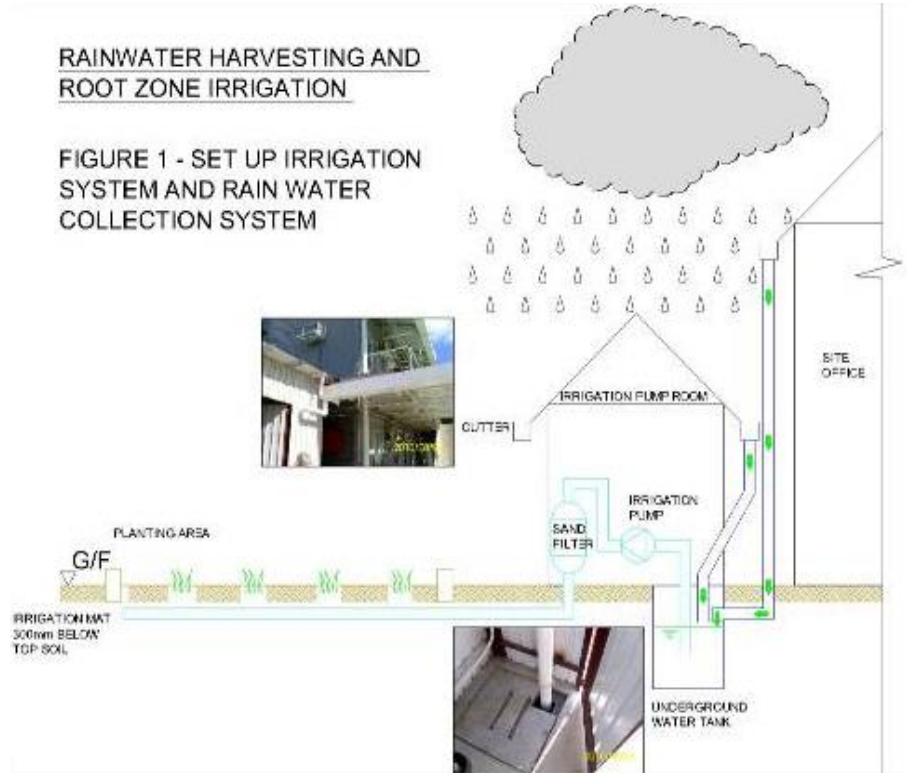
Plant Selection for Bio-retention



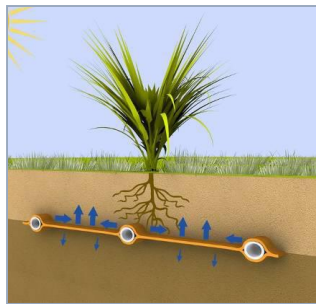
(D) Root Zone Irrigation System for Ground Cover and Shrub

ROOT ZONE IRRIGATION SYSTEM

- Supplies water directly to plant roots to minimized evaporation and reduce the amount of irrigation.
- Major components:
 - Polyethylene drip pipes wrapped in special fleece.
 - Irrigation mat enables even distribution of water.
 - Water migrates by capillary effect Mat is installed about 10 to 20 cm below soil surface.

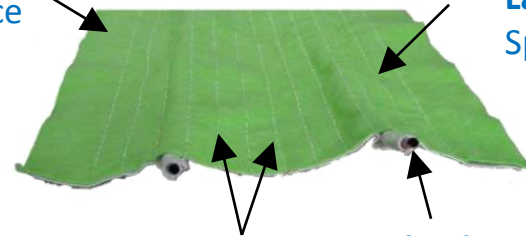


Drip hole



Layer 2:
fleece

Layer 1:
Special fleece



Seam: PP thread

Drip pipe:
Wrapped in Special fleece



Organisers:



International Co-owners:



(D) Root Zone Irrigation System for Ground Cover and Shrub

Research findings at Tak Long Estate:

- **Water saving** potential is approximately **38%**
 - Plot provided with root zone irrigation system – **1.54 litre/m²/day**
 - Plot provided with manual irrigation – 2.5 litre/m²/day

Maintenance:

- **No breakdown** throughout monitoring period.
- Sand filter had been cleaned 2 times within a 15 months period.
- **No particular maintenance** was required for irrigation mat.

Limitation:

- Suitable for small vegetation since the mat cannot be installed more than 400mm below soil surface.



(E) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees



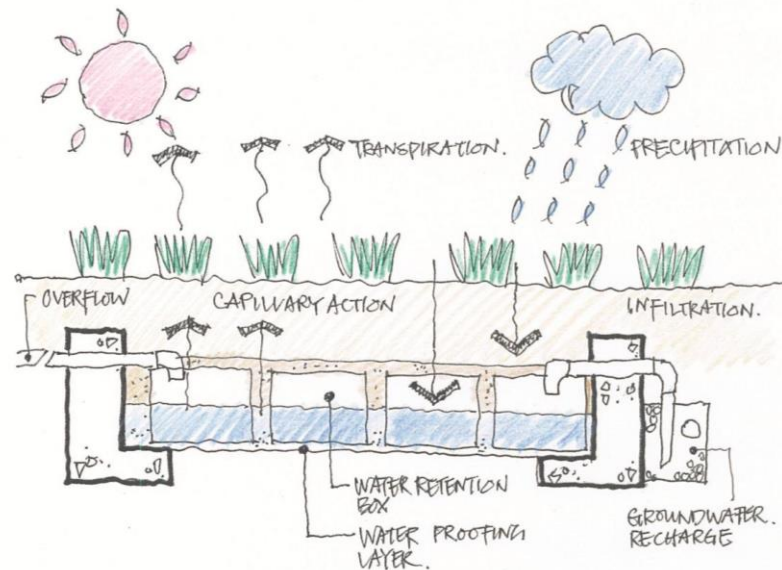
ZIS includes two main mechanisms:

1. Sustainable Urban Drainage System (SUDS)

- Decentralized network of site-specific storm water management techniques.
- To reduce / defer the volume of storm water runoff entering the sewer system
- Restoring the natural hydrologic cycle (water recharge)

2. Sub Soil Irrigation System

- The sub-irrigation system comprises a wicking mechanism which is a self-sustained and passive design to deliver the storm water stored in water retention cells to the vegetation and to minimize topsoil evaporation through capillary action.

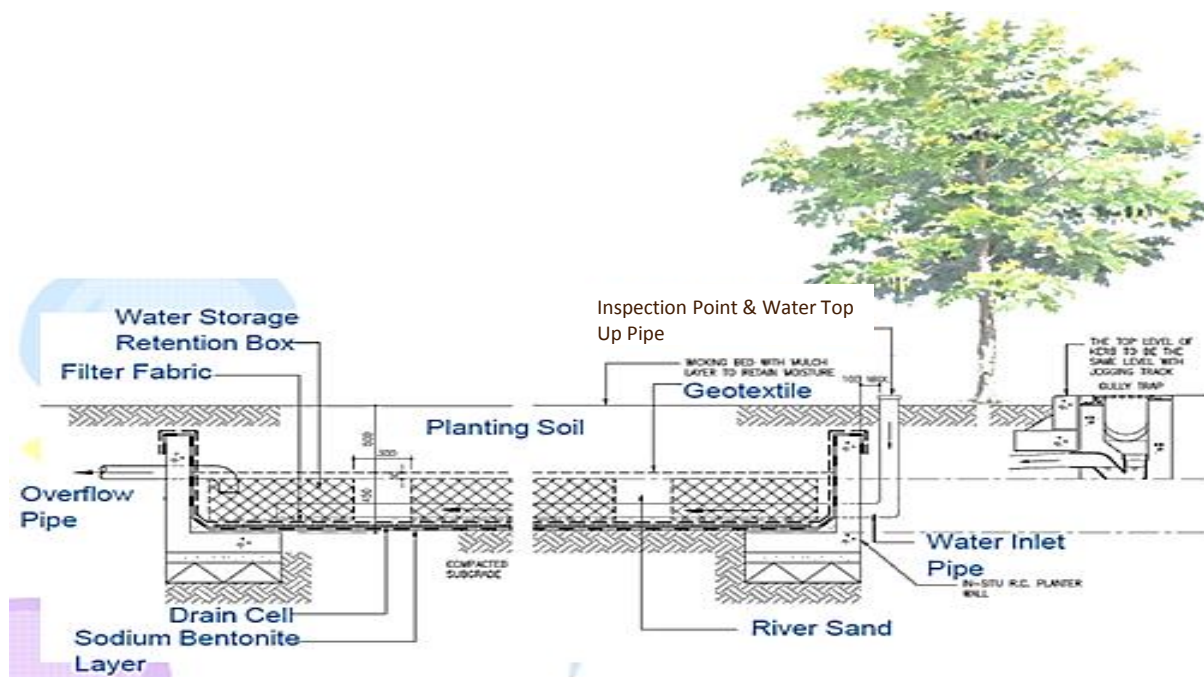


(E) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees



ZIS trial at Tuen Mun:

1. Minimize Manual Irrigation Operation and Long Term Maintenance Cost
2. Reduce the Storm Water Runoff Loading + Ground Water Recharge



CONSTRUCTION PROCESS

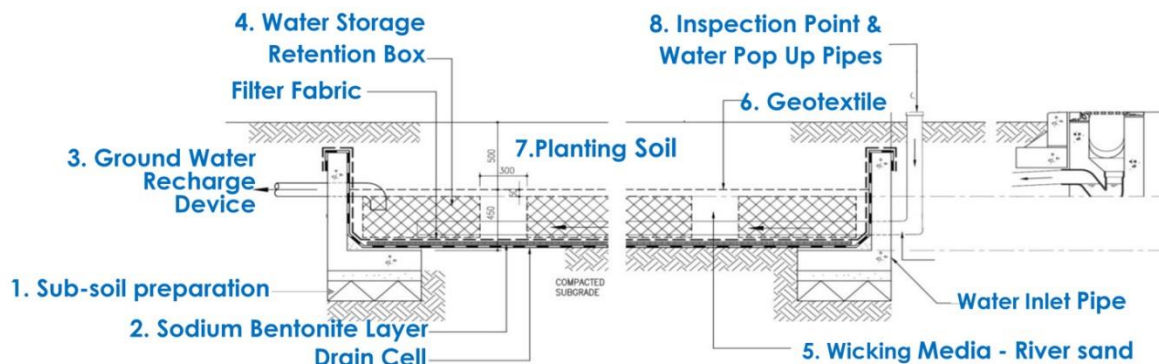


1. Sub-soil Preparation

2. Water-proofing Layer – Sodium Bentonite Layer

3. Ground water recharge device

4. Water retention cell



ZIS Section



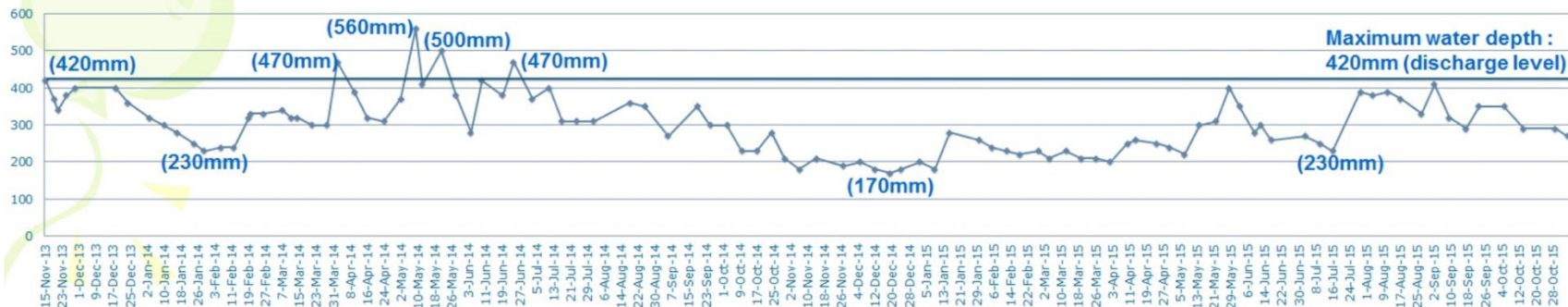
5. Wicking Media – River sand

6. Geo-textile between growing media and river sand

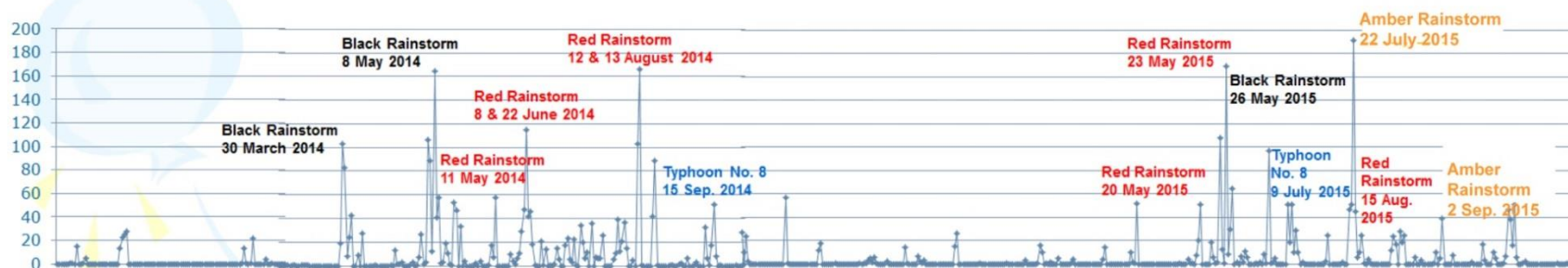
7. Growing Media

8. Inspection Point and Water Top-up Pipe

Records - Water Consumption & Rainfall (15 Nov 2013 – 4 Oct 2015)



Water Depth of ZIS (24 months)



Rainfall Records (24 months)

Yearly Water Consumption

1st Water Consumption = 2.6 L/m²/day

2nd Water Consumption = 1.8 L/m²/day

Observation

2.2L/m²/day



Organisers:



International Co-owners:



Summary of findings and observations:

- **No manual watering operation and potable water are required.**
- Average daily water consumption is **less than 2.21L / m² / day.**
- **Increase** water storage capacity of soil & minimize water loss through evaporation
- **No flooding** even under black rainstorm warning
- **5 out of 6 species of plants were well established**
- **No odor** or any unpleasant smell were detected.
- **No particular maintenance** is required for components
- Limitation: Tree planting at pre-designated locations in the planter



(E) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees



Condition of Plant Species - chosen for this trial (Up to May 2014)



Cordyline terminalis 'Tricolor'
(三色鐵樹)

Drought Tolerant		
High	Medium	Low
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



Duranta erecta 'Variegata'
(花葉假連翹)

Drought Tolerant		
High	Medium	Low
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



Drejerella guttata
(鴨咀花)

Drought Tolerant		
High	Medium	Low
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



Nephrolepis exaltata 'Bostoniensis'
(波斯頓蕨)

Drought Tolerant		
High	Medium	Low
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>



Schefflera arboricola 'Variegata'
(花葉鴨腳木)

Drought Tolerant		
High	Medium	Low
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>



Sansevieria trifasciata 'Golden Laurentii'
(金邊短葉虎尾蘭)

Drought Tolerant		
High	Medium	Low
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(E) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees



Tree performance at tree corridor along ZIS

- In November 2013, trial on shrub planting with ZIS was installed.
- In September 2014 onwards, no more manual watering was carried out for tree corridor adopting ZIS planted with 4 nos. heavy standard tree.
- In November 2015, the project had been handed over to Housing Management Office as scheduled.

Observations

- The growth of all trees adopting ZIS was in good condition.
- There was no sign of suffering due to lack of water.
- No flooding was observed.



Photo showing project handed over to Housing Management Office



Organisers:



International Co-owners:



Way forward



Organisers:



International Co-owners:

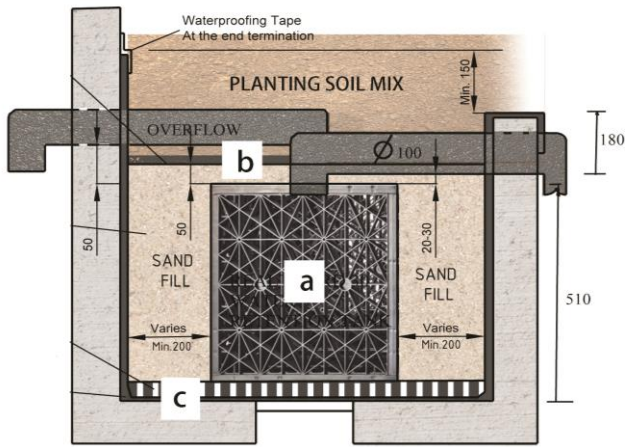


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Promoting Policies and Practices for Sustainability

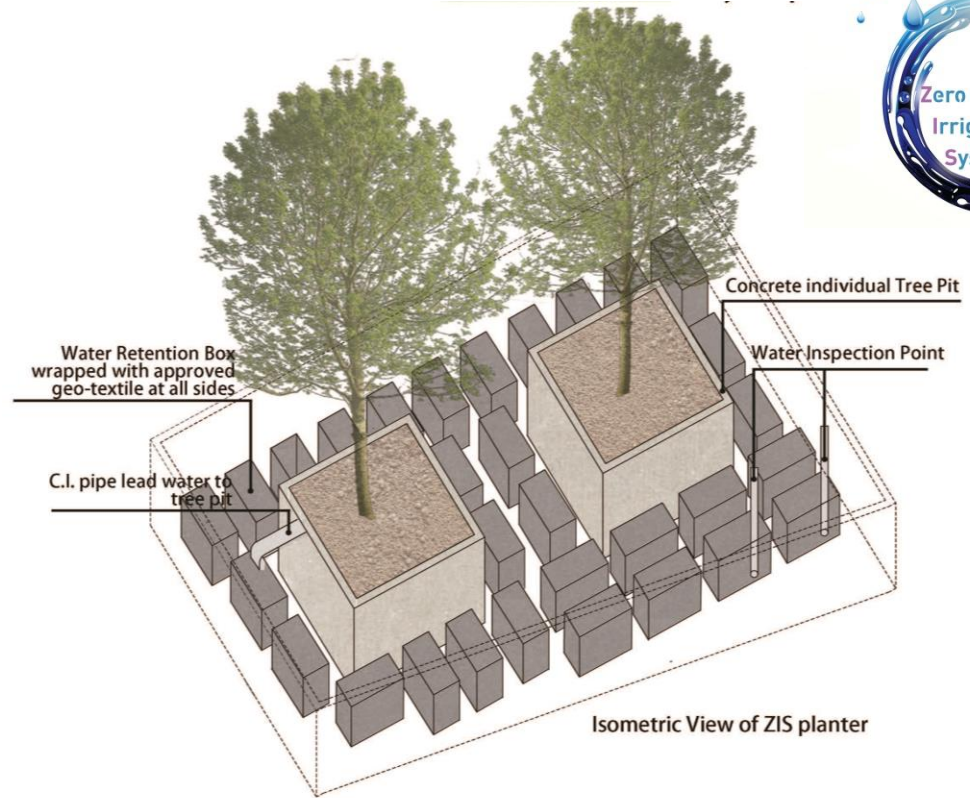


(D) Way Forward

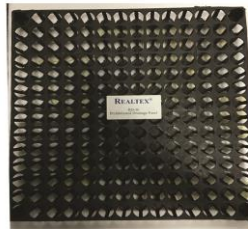
ZIS detail with Tree Planting



Typical Section of ZIS planter



Isometric View of ZIS planter



a. Water Retention Box



b. Geo-textile



c. Sodium Bentonite



Organisers:



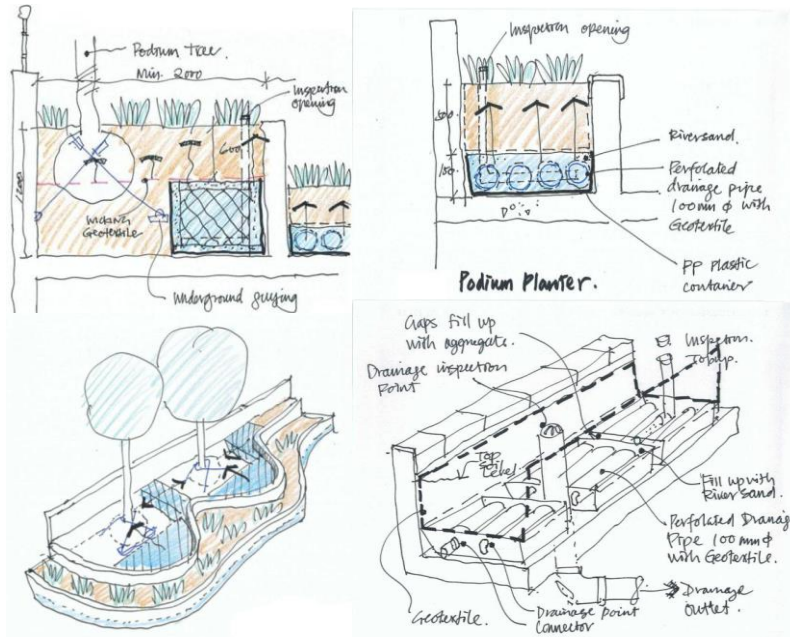
International Co-owners:



(D) Way Forward

- Conduct further study and explore more economical material to refine the system, particularly modular type ZIS, to achieve a more cost effective design and to reduce the capital cost as far as practicable
- Collaborate with academia to optimise ZIS design
- Design ZIS with tree pits to facilitate tree planting

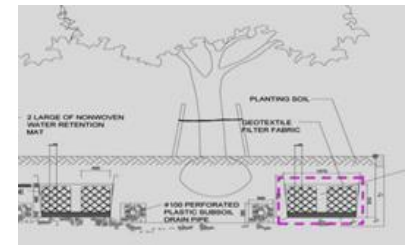
ZIS with tree planting



Trial on Modular ZIS



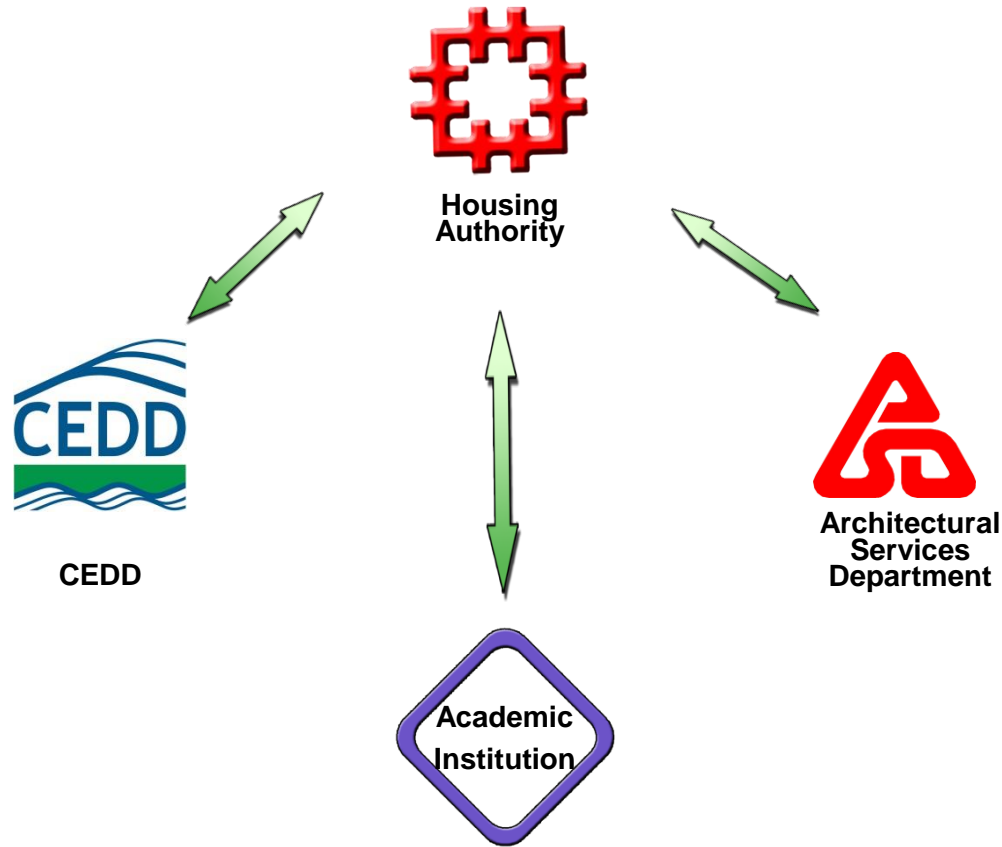
ZIS with tree planting



(D) Way forward



Sharing with the industry:



Organisers:



International Co-owners:



Researches and innovations are the key to improving our planning, design and delivery of public housing. These are carried out both in-house and in collaboration with academia, industry specialists, business partners and other related stakeholders.

Our ultimate goal is to integrate all these knowledge and technologies in public housing development and for the benefit of the society.

Website for sharing with the society www.housingauthority.gov.hk



Organisers:



International Co-owners:



Thank you

For details of Hong Kong Housing Authority's Sustainability Initiatives, please visit –

English Version

http://www.housingauthority.gov.hk/hdw/video/videoshell_Environmental_corporate_Eng.html

Putonghua Version

http://www.housingauthority.gov.hk/hdw/video/videoshell_Environmental_corporate_Mand.html

Cantonese Version

http://www.housingauthority.gov.hk/hdw/video/videoshell_Environmental_corporate_Cant.html



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