Track 7: Innovative Practices for Transforming SBE

Session 1.10: Green Infrastructure in SBE - Hong Kong Cases

Implementing the Beautification and Sustainable Designs for the Harbour Area Treatment Scheme (HATS) Stage 2A

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ABSTRACT

Drainage Services Department (DSD) and the Consultant collaborated on the conceptual design and implementation for beautifying Stonecutters Island Sewage Treatment Works (SCISTW) and demonstrated various sustainable features under Harbour Area Treatment Scheme (HATS) Stage 2A project. Such designs echo the policy initiatives in promoting sustainable built environments for Government facilities.

Upgrading works in expanding the treatment capacity at SCISTW include architectural and aesthetic designs of buildings and treatment facilities, both for existing and new ones. These include building facade with elevational treatment, grasscrete and porous paving, green roofs, as well as boundary and landscape planting. Beautification features specifically for future visitors at SCISTW include:

- Careful planning of visitor path with landscape enhancement works to balance visitor safety and experience in showcasing the basics of SCISTW operation, while minimising operation disturbance;
- Greeting visitors by water wall at sedimentation tank area, facing the main entrance. The water is replenished with recycled rainwater, a real-life application of rainwater harvesting; and
- Adopting sustainable materials including recycled glass-paving blocks and grasscretes at the new Main Pumping Station (MPS2) building.

Sustainable features include sustainable urban drainage systems (SUDS), for which multiple locations have been studied for pilot-testing. These include vegetated bioswales, permeable pavements, rain gardens, bioretention planters and rainwater harvesting. These SUDS will be evaluated with reference to overseas (USA and Singapore) SUDS experiences and manuals. Permeable pavers, one bioswale and one rain garden are currently undergoing test trial at the SCISTW and Chamber 15 sites. Localised design performance in reducing stormwater peak flow, runoff volume and pollutant loading will be evaluated through these installations.

Project-specific beautification design and detailed evaluation methodology and on-site performances of these sustainable designs in HATS Stage 2A project, and recommendations on their possible implementation in other similar built environments, will be presented in the full paper.

Keywords: *green infrastructure, water management*

1. INTRODUCTION

Since 2004, Drainage Services Department (DSD) of the Government of the Hong Kong Special Administrative Region has incorporated "integrating sustainability considerations into the design, construction and operation of our facilities" into their environmental policy. (Drainage Services Department of the Government of the Hong Kong Special Administrative Region, 2004). In the Hong Kong Climate Change Report 2015, the Government further prioritized the exploration for blue-green infrastructures as a major mitigation measure to climate change. In a congested city like Hong Kong, however, implementing such sustainable features has always been a challenge, and such challenge becomes more prominent when the development is not a greenfield site. In consideration of the beautification and sustainable designs at the Stonecutters Island Sewage Treatment Works (SCISTW) under the Harbour Area Treatment Scheme (HATS) Stage 2A project, a good balance has been strived among the user convenience, site constraints and sustainability.

2. CONCEPT DESIGN CONSIDERATIONS

2.1 Planning principles

The introduction of beautification and sustainable urban drainage systems (SUDS) to HATS was first inspired by the Active, Beautiful, Clean Waters Programme implemented in Singapore starting from 2006, which aims to seamlessly integrate the environment, water bodies, as well as the community to create new community spaces and to encourage lifestyle activities to flourish in and around the waters (Public Utilities Board, Singapore, 2014). As the climate in Singapore is different from that in Hong Kong, localisation of the experience was crucial to the success. Three fundamental principles were derived to assess the design options for HATS, namely:

- During the construction stage, sustainable materials shall be selected to minimise the carbon footprint;
- During the operation stage, water and energy saving shall be achieved to enhance operation efficiency; and
- The sustainable features shall be hospitable towards visitors so as to establish a case to promote sustainability.

With these principles in mind, as well as the knowledge for the best practice both locally and internationally, the concept for water feature wall, landscaping visitor route, and SUDS to HATS has been proposed.

2.2 Design concept of water feature wall

To echo the client's identity and to grab the visitor's attention on arrival, a water wall of recycled rainwater will be positioned outside the chemically enhanced primary treatment (CEPT) tank facing the site entrance. Renewable energy installations such as solar panels and wind turbines would also be explored, in order to enhance the eco-friendliness of the water wall as well as to reduce the operation cost. As the first feature to greet the visitors, the running water and the sustainable thoughts behind it shall inspire the visitor's thoughts about the use of recycled water.

Figure 1: Water feature wall (Photomontage)

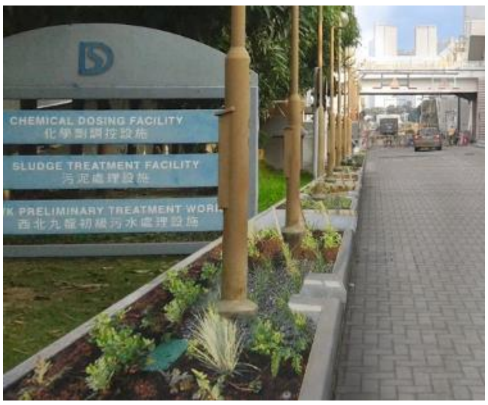

Figure 2: Flow-through planter (Photomontage)

2.3 Design concept of landscaping visitor route

The visitor route is designed such that the interference of visitors with daily operations of the plant is minimised while the places of interests can be seen along the designated visitor route. This arrangement provides a safe route for visitors. Exhibition boards could also be displayed alongside the route to fulfil the needs of visitors who may have interests for more technical information. Along the route, the use of sustainable materials will also be demonstrated, such as the recycled glass-paving blocks and grasscretes at the new Main Pumping Station (MPS2) building. Sub-routes are also developed to cater for visitors with different backgrounds, appealing to both the general public and professionals.

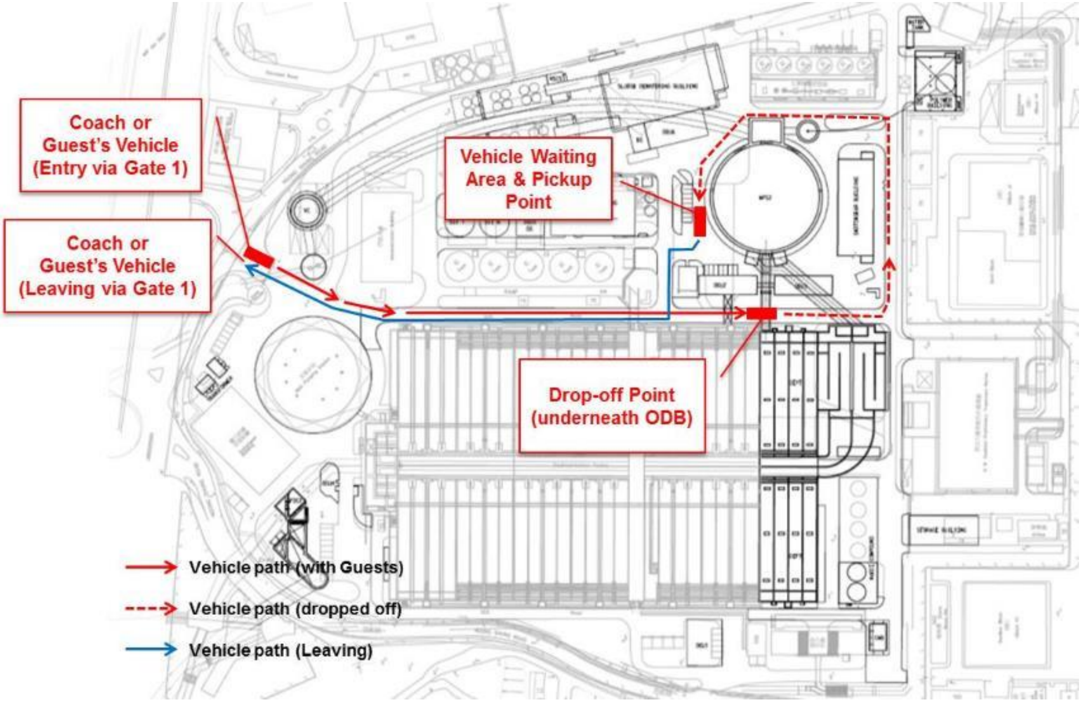

Figure 3: Visitor route for HATS: Vehicle circulation

2.4 Design concept of SUDS

SUDS refers to any stormwater greening technique, measure or device designed to retain and treat stormwater near the source of rainfall, thereby reducing the rate and volume of runoff discharged from the site and preventing pollutants from entering the drainage network and downstream water bodies. The reduced runoff could be further harvested to offset demands on the potable grid. Common SUDS measures include:

- Bioswale: A bioswale is a vegetated open channel used to treat and convey stormwater flows. Treatment action occurs along the surface of the swale by filtration through dense vegetation as well as by infiltration through the soil matrix and into the native soil.
- Rain garden: A rain garden is a shallow vegetated impoundment used to store and infiltrate stormwater runoff. Treatment occurs by infiltration through the soil matrix where pollutants are filtered out. Treated stormwater would infiltrate into the native soil or discharged via perforated subdrain.
- Flow-through planter: A flow-through planter is similar to rain gardens except it is contained within a walled container either as a raised planter box or in the ground. As with rain gardens, runoff is directed into an impoundment within the planter, stored and slowly infiltrated through the soil.
- Permeable pavement: Permeable pavement is a load-bearing surface used to allow infiltration of runoff through the pavement surface and into the soil below. Permeable pavements come in many forms including permeable “block” pavers, porous asphalt, porous concrete and grasscrete.

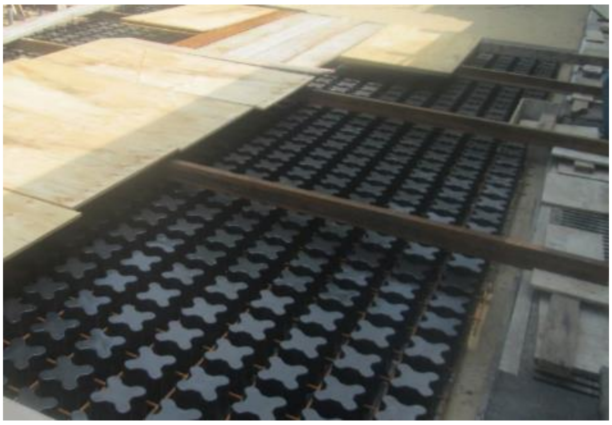

Figure 4: Grasscrete under Construction (1)

Figure 5: Grasscrete under Construction (2)

- Rain harvesting: Rain harvesting is a stormwater management technique that diverts stormwater from relatively clean surfaces such as roof and pedestrian paved areas into a temporary storage tank for reuse.

These options have been evaluated against several criteria as detailed in Table 1. It was concluded that the rain garden and the bioswale are most suitable for HATS, as they generally carry smaller footprints, have lower installation and maintenance costs, and are expected to improve the local biodiversity with the appropriate selection of plants.

SUDS Measures	**Aesthetic Value**	**Maintenance Requirement**	**Installation Cost**	**Required Footprint**	**Ability to Improve Biodiversity**	**Qualitative Score (Max 45)**
Priority Weighting	**5**	**4**	**3**	**2**	**1**	
Rain Garden	3	1	3	1	3	**33**
Bioswale	3	1	3	1	3	**33**
Flow-Through Planter	3	1	2	2	2	**31**
Rainwater Harvesting	1	2	1	1	0	**18**
Permeable Pavements	2	0	0	3	0	**16**

Performance Indicators:	**Aesthetic Value**	**Maintenance Requirement**	**Installation Cost**	**Required Footprint**	**Ability to Improve Biodiversity**	**Score**
	OK	Significant	Significant	Significant	Minimal	**0**
	Good	Moderate	Moderate	Moderate	Good	**1**
	Better	Minimal	Minimal	Minimal	Better	**2**
	Best	No Impact	No Impact	No Impact	Best	**3**

Table 1: Qualitative evaluation of SUDS options

3. DESIGN WITH SITE CONSTRAINTS AND NEW CONCEPTS

As HATS is not a greenfield development and the operation efficiency of the sewage treatment cannot be compromised, the implementation of the designed features faced challenges from unknown ground utilities, congested on-site traffic and the need for by-stage constructions to accommodate the critical construction activities. For SUDS, in particular, challenges also arose as there had been no previous use of such measures in Hong Kong. It therefore calls for by-stage constructions for better localisation of the SUDS design. Details of individual challenges are elaborated as below and illustrated how they are factored into the concept design.

3.1 Unknown ground utilities

Underground utilities are always key constraints to works at an existing development. Apart from the common utilities, such as stormwater drainage, sewerage, power cables and water supply system, there are numerous utilities that are specific for sewage treatment process, such as the centrate system, sewage culvert, signal cables, chemical pipe, etc.

Such constraints would impact on the design of the water feature wall, as its grey water recycling system needed to fit with the existing utilities. Surface runoff and roof drainage would be diverted to an underground grey water storage tank for screening and disinfection. The tentative alignment of the connection pipeworks has to avoid the conflicts with the existing utilities.

3.2 Congested on-site traffic

SCISTW is a centralised sewage treatment works for the CEPT treatment of the sewage generated from 17 preliminary treatment works. The frequency of the operational vehicles, such as chemical dosing trucks, sludge container trucks and other maintenance vehicles, are particular high. Coordination with the plant operator was required to obtain a thorough understanding of the logistics. Such understanding is necessary to avoid intrusion into the operating space and ensure that the maintenance requirement can be reasonably satisfied.

For example, one of the options for the visitor route proposed at an early stage was to make use of the road between sludge tanks with additional pot planters at the sides. Having learnt that the road would need to be cleared for occasional major maintenance, it was concluded that pot planters would be inconvenient during those occasions and the routing was reconsidered.

3.3 Need for by-stage construction

As a number of contracts were concurrently carried out at the SCISTW for achieving the full operation of the facilities of HATS Stage 2A, the construction of the planned beautification and SUDS works shall not affect the progress of the main works. To minimise the interface required, the construction of beautification works would be scheduled towards the end of the project, together with other landscaping works. SUDS was agreed to be implemented by stages, starting from a site trial at a nearby ancillary site called Chamber 15A. The by-stage construction also helped accrue knowledge and experience on the construction and performance of SUDS, as it is their first application in Hong Kong.

Since the rain garden and bioswale have been considered most suitable for the HATS project, they were selected to be the first ones for the site trial and were scheduled for construction in late 2016. It is anticipated that testing results will be published in early 2018 after the 12-month monitoring phase. The success of the site trial relied on the following aspects:

- Suitability of the selected location: The ideal locations of the site trial should not only minimise their impacts to the main works, but also be able to receive sufficient runoffs for meaningful test results. Careful studies on the contractor programme, site topography and utilities alignments were needed before deciding on the locations.
- Ease of sample taking: As water samples need to be collected over months, easy access to the samples should be planned at the design stage. Inspection manholes have been added to both inlets and outlets of the proposed rain garden and bioswale to facilitate the sample taking.

- Reliability of the test results: A detailed testing monitoring manual was issued to the Contractor to ensure the quality of sampling works. The manual has specified the requirement for regular maintenance, frequency of the sampling works, lists of equipment needed and the standard procedures. The pollutants proposed for testing included pH, temperature, conductivity, total dissolved solids, total suspended solids, nitrates/ nitrites, phosphorous, biological oxygen demand, chemical oxygen demand, copper, lead, zinc, oil/ grease, and faecal coliform.

4. VISION FOR FUTURE SUSTAINABLE DESIGNS

The experience gained from the design process would be beneficial to future sustainable designs in Hong Kong, as it represented the common challenges in most of the Hong Kong projects.

For the application of SUDS, in particular, the test results from the site trial would provide quantitative information for future cost-benefit analysis of similar facilities. At this moment without those test results, it is natural for clients and the public to view SUDS as white elephants since they are apparently considered more expensive with the need for frequent maintenance. In the case of the rain garden and bioswale, for example, monthly inspection and maintenance shall be carried out to clear the debris, prune and weed the vegetation, ensure the functioning of irrigation system, as well as to eliminate areas of stagnant water. However, the benefits of these facilities to the reduction of peak flows and pollutants into the municipal drainage systems are not intuitive. The site trials of SUDS carried out in HATS would bridge this gap for the clients and the public, allowing them to make more informed decisions for adopting sustainable designs in the future.

5. CONCLUSIONS

The design and implementation of beautification and sustainable initiatives in the HATS Stage 2A project face challenges common to most of the other Hong Kong projects. They would not have been solved without advanced knowledge of design requirements, thorough understanding of site constraints, and sufficient communications among stakeholders. The scientific data from the SUDS site trials as well as the project management experience would be beneficial to future sustainable developments in Hong Kong.

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