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Maintenance Requirements for Bioretention Systems in the Tropics

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Introduction

Bioretention systems, also termed biofiltration and rain gardens, are becoming more popular in Singapore. Bioretention installations are almost always expected to look manicured, as they are often installed at publicly visible locations. Examples of bioretention systems in Singapore are shown in Fig 1.

Much of the maintenance requirements of bioretention systems are aesthetic related. Considering that they are often used in lieu of standard medians in car parks (Fig 1A) or in place other landscape features, the maintenance cost per hectare, though higher than wet ponds and constructed stormwater wetlands, are in fact similar to standard landscape maintenance costs. The maintenance regime though primarily aesthetic, also improves safety, hydrologic and water quality performance.

Fig 1. Various bioretention systems located in (A) a car park, (B) a residential community area, (C) a streetscape, and (D) Admiralty Park.

General Maintenance Tasks

Like any landscape features, bioretention systems require regular maintenance. The tasks include pruning and initial mulching (Fig 2). Some bioretention systems are installed with turfgrass and these require mowing. Because vegetation is essential to the aesthetic appeal of bioretention systems, it needs to be established as quickly as possible. Fortunately, due to Singapore's optimal climate for plant growth warm - temperatures and ample precipitation, vegetation is expected to establish very quickly.

Fig 2. (A) Pruning for Bioretention systems should carried out annually to biannually, (B) bioretention systems are designed to be ponded for just 1 - 2 hours after each rain event.

Typically, bioretention systems in Singapore are designed to be inundated for only 1 - 2 hours. Water in the bioretention systems will be discharged completely from the systems 6 hours after a rain event. If surface water continues to be present 1 day after rainfall, one of the likely causes could be an improper of filter media has been used. When an inappropriate filter media is installed (e.g. it contains high levels of fine silt and clay materials) it may result in compaction or even structural collapse. This leads to a substantial reduction in the soil infiltrability (hydraulic conductivity). Hence, water will not infiltrate through the media but pond on the surface instead. If this happens, in-situ soil hydraulic conductivity test needs to be performed.

Vegetation may require spot-fertilization to ensure its rapid growth. If plant establishment occurs during dry spells, watering the plants every two to three days until a rainy period recommences is recommended. The frequency of these tasks varies, depending on the age of the bioretention systems. Newer bioretention systems require more frequent maintenance (weekly), while systems with well-established vegetation may only require monthly regimes.

Bioretention outlets are prone to clogging, but monthly inspection and maintenance will help address this concern. It is imperative that outlets are checked monthly to ensure that they are free of litter and debris (Fig 3). This is particularly important if a grate is used on the highflow bypass structure. Nearly every bioretention system has an overflow, so if the outlets cannot be located, the engineering design plans have to be checked. A summary table of the most likely maintenance needs and their triggers is found in Table 1.

Fig 3. (A) The debris accumulated needs to be removed. (B) This outlet grate is not clogged, but vegetation and rubbish may continue to collect on the grate, causing water to spill into surroundings.

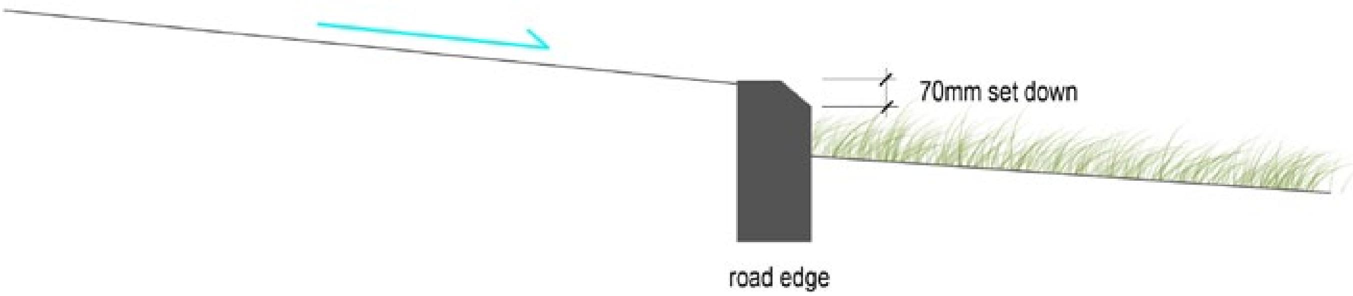

Fig 4. This photo shows leaf litter accumulating at water entry point where the grass is the same level as the road. To avoid this accumulation, a tapered flush kerb must be used that sets the top of the vegetation 70mm (as shown in the cross section), which requires the top of the ground surface (before turf is placed) to be approximately 100mm below the road surface.

Table 1. Common Maintenance Needs and Triggers for Bioretention Systems

Defects	Likely Cause/s	Required Maintenance
Surface Water present after at least 1 day since rainfall	Sediment accumulation in media is restricting flow	Remove collected sediment, typically to a depth of 75-150 mm
	Media itself is not sufficiently permeable	Test in-situ permeability of soil media. Media may need to be replaced
Vegetation is Dying	Bioretention is too wet, and not draining sufficiently fast	See maintenance tasks suggested above.
		Consider replanting with wetland vegetation
	Bioretention is too dry, and not receiving enough runoff	Adjust catchment to increase runoff volumes (if possible)
		See if outlet device has leaks, leading to prematurely drainage
		Consider replanting with more drought-tolerant vegetation
	Soil media is too sterile	Take soil test. Add alkalinity if needed, spot fertilize vegetation
Mosquitoes are present in bioretention system	Water is present for too long at surface	See related maintenance tasks above
	Litter is harboring mosquitoes	Remove rubbish
Water is overflowing the bioretention system regularly	Outlet structure is too close to the soil surface	Consider raising outlet structure, but designers MUST be contacted
	Outlet structure is clogged, causing overflow in undesired locations	Remove vegetation or debris and rubbish from overflow grate

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