CRC for Water Sensitive Cities

Fact Sheet: Biofilter Construction Checks

Table 2. Identifying risks, pitfalls and tips during the construction process

Critical stages	Risks / common pitfalls	Useful tips
Pre-construction		
Underground services check	Damage to unexpected **underground services** during excavation can be highly expensive, dangerous and may require costly late-stage design modification.	Use the Dial-Before-You-Dig service during initial design phase (service locations may influence siting and depth). Before construction commission an underground services expert to prove service locations and depth. Mark out services at the site and map locations and depths on site plan. Inform all site personnel at pre-site meeting.
Ordering plant stock	If **plant stock** is not pre-ordered in sufficient time they may not be available at the desired planting time (especially for large projects).	Communicate well ahead of construction with the nursery, ideally during plant selection in the design phase.
Sourcing filter media	**Media composition** is critical to pollutant retention and infiltration rate. Poor media selection can lead to nutrient leaching, clogging, a system that is too dry or wet, and the washout of fine particles.	Ensure the media has been tested to comply with specifications in the Guidelines for Filter Media in Biofiltration Systems (Appendix C). Ensure fine aggregate for drainage layer material has been sufficiently washed to remove fine particles.
Sediment management	**Sediment management** is critical in catchments undergoing development and during construction of the biofilter itself. This is a critical risk to long-term performance. Unless protected, a high sediment load will rapidly overwhelm and clog the biofilter, requiring an expensive re-set. Problematic if the biofilter is commissioned too early in the development process.	During construction activities the system must be protected using temporary measures such as flow diversions, use of bunding and/or geofabric, sediment traps, and planted with a temporary turf layer. Develop a management plan before construction commences and leave measures in place until construction activities cease and soil surfaces are stabilised. Refer to Water by Design (2009) for detailed guidance on sediment management.
Runoff management plans	**Drainage and runoff management plans** are essential during construction when soils are exposed. Rainfall events during construction can wash substantial volumes of soil into the biofilter excavation or any laid media layers. If left, these sediments will severely compromise the infiltration and pollutant removal performance of the biofilter.	To the extent possible, biofilter construction should be conducted in a dry weather period. Flow diversions need to be set up, and this will be particularly challenging for online systems (these are not recommended except for small catchments). Any sediment that is washed into the system during construction must be removed (including any media mixed with sediment). Refer to Water by Design (2009) for further guidance on managing runoff during construction.

For full details please refer to the Adoption Guidelines for Stormwater Biofiltration (CRC for Water Sensitive Cities, 2015)

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Table 2. Continued

Critical stages	Risks / common pitfalls	Useful tips
Timing of construction and commissioning stages	The coordinated **timing of biofilter construction** with development in the catchment is critical for long-term success. Failure to protect the new system from construction works may lead to a complete re-set before its official commissioning.	Stages of works must be carefully planned in coordination with development in the surrounding catchment. Sediment management, temporary protection measures for the biofilter, and delayed planting and commissioning of the biofilter, are all vital. Refer to Water by Design (2009) for step-by-step requirements for each phase of works (including on-site fact sheets).
Construction		
Roles and responsibilities **Communication between Stakeholders**	Poor **communication and division of responsibility** between parties can lead to poor oversight of the project and lack of quality control. Projects require cooperation between multiple disciplines and authorities. A common problem is poor coordination between the construction and landscape teams, and a lack of understanding of the system function and objectives.	Ensure **roles and responsibilities** are clearly assigned for each phase, with clear, frequent communication between all parties and across all project stages. Take particular care to ensure communication between designers, the construction team and landscaping/ maintenance teams. All parties should understand the project objectives, function of the system, and key risks to success. Refer to Water by Design (2009) for a discussion of roles, responsibilities for ownership and maintenance, contract requirements and handover.
Excavation & earth works	Traditional **excavation techniques** create a smooth and compacted base, which can reduce infiltration. **Accurate levels and slopes** are critical for effective system function, particularly flow control structures (inflow, overflow) and drainage. Incorrect levels will lead to hydraulic malfunction, plant death and poor treatment, either from flow bypass or flooding. In particular, it is vital that the ponding depth is achieved and the slope of the surface allows even flow and widespread distribution.	If infiltration is an objective (system is unlined) and clay soils are present, excavate using a bucket with 'teeth' to loosen and roughen the base. Levels must be carefully constructed and surveyed once complete. Once commissioned, water levels and flow hydraulics should be checked against the design during significant inflow events.
Liner installation (if present)	Puncture of the liner or ineffective sealing of the system will lead to leakages which may i.) compromise nearby sensitive structures (if present), ii.) reduce yield for stormwater harvesting schemes, and iii.) lead to system failure	Place liner onto surfaces free of rocks, roots or other sharp objects that may cause puncture. Use a reliable and experienced contractor.

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Table 2. Continued

Critical stages	Risks / common pitfalls	Useful tips
Sealing hydraulic components	Effective **water-tight sealing on hydraulic structures** is essential to prevent short-circuiting, erosion and potential collapse and failure of the system, particularly at steep sites. It also reduces the opportunity for invasion of pipes and structures by plant roots. Problems can arise during sealing and preventing preferential flows at the interfaces of inlet points, inlet/outlet collection pits, sediment forebays, drainage pipes, basin walls and bunds between cells. Points where pipes enter walls/bunds are particularly sensitive failure points. In addition, preferential flow paths can develop down the sides of the inlet pit and sediment forebay, bypassing the surface filter media.	Take great care to water-proof seals at connection points. Use collars on outlet pipes at the point where it traverses the wall. This can be tricky, especially to achieve compaction around the seal. Alternatively it is feasible to use shockcrete to create a large collar extended across the basin surface. (Note techniques developed by Hornsby Shire Council) A filter fabric can be used around the top of inlet pits and underneath inlets and sediment forebays to prevent preferential flows underneath and down the sides, where the structures are embedded below the filter media surface.
Laying down drainage pipe (if present)	Damage to **underdrain** during construction, compromising its function.	Lay pipe above a fine aggregate bed, with sufficient covering with aggregate. Do not use heavy equipment.
Receiving media on-site	Media can be **contaminated with on-site soils** (e.g. clay) upon delivery and earthmoving works. This will significantly reduce infiltration and pollutant removal capacity.	Ensure soils are either delivered straight into the biofilter pit, or tipped onto a hard concrete surface. This prevents the excavator bucket from digging down into in-situ site soils.
Laying down media layers	Appropriate **media layering** (mixing, depth) is a vital characteristic of biofilter function. A high degree of mixing or depths differing from design will compromise pollutant removal.	Lay media sequentially and carefully adhere to the design, including depths of the layers. Conduct quality control checks during media placement. Complete in stages with care to avoid mixing. Additions, such as material providing a carbon source or soil ameliorants, should be thoroughly mixed before placement in the system. When placing layers above the underdrain, avoid dropping large volumes from a height.
	Excessive **compaction** will impede infiltration, thereby severely compromising the treatment capacity of the biofilter	Do not use construction techniques or equipment that leads to high compaction. Light compaction can be applied. Where possible machinery should be located outside and alongside the system, with only lightweight machinery used within the system. Refer to Water by Design (2009) for further details of construction techniques, including specifics for large systems. Where compaction was unavoidable, use scarifying to loosen the media.
Quality control	Ensuring the **construction meets design**, and the **design operates as intended** are vital checks that should be conducted throughout the project. Timely **quality control** will likely allow straightforward rectification, whereas belated discovery of errors will require far greater expense.	A number of hold points should be defined for inspection checks. For example, the drainage system should be checked before it is overlaid with media; checks should be made as the media are laid and also upon completion. Undertake as-constructed cross checks with the design drawings. Confirm levels using survey or measurements. Refer to Water by Design (2009) for survey methods and recommended tolerances.

Table 2. Continued

Critical stages	Risks / common pitfalls	Useful tips
Planting and establishment		
Timing of planting	Poor **seasonal timing of planting** can lead to low plant growth, a prolonged establishment period and reduced survival if conditions are challenging. Planting is sometimes dictated by external factors (e.g. need for early landscaping in new developments)	Ideally aim to plant in early spring or autumn for temperate climates, but in tropical and sub-tropical climates there may be a wider planting window, possibly in the cooler season if enough rainfall is available. If non-ideal planting season cannot be avoided, implement careful seedling establishment (see below), including irrigation as required.
Plant establishment	**Establishment of healthy plant cover** across the biofilter is vital for effective long-term function. The period of seedling establishment and early growth is a vulnerable time. Common problem is to 'plant and forget', but careful management during establishment will avoid increased replanting and maintenance costs (e.g. repair of erosion).	Aim to rapidly achieve high plant cover to limit erosion and weed ingress and enhance system performance. Closely monitor vegetation health during seedling establishment. Water frequently as required, particularly immediately following transplant and during long dry periods. More frequent watering will initially be required for smaller seed stock, but can be reduced as plants grow. Plan to provide watering support, particularly during long dry periods, for the first 2-3 years. Some designs allow the temporary raising of the submerged zone and lowering again as plant roots establish. Protect seedlings from erosion - some flow diversions may need to temporarily remain in place from the construction phase if planting occurs during a season of high inflows. Replace dead plants immediately and avoid use of pesticides or herbicides, and fertilisers (beyond an initial once-off). Detailed advice on plant procurement, pre-planting preparations, planting procedures, establishment and assessment are provided in Water by Design (2009).
Maintenance during establishment	**Timely maintenance during establishment** can prevent problems growing into large issues that require costly rectification works (and possible system re-setting). During initial operation, biofilters are particularly vulnerable and errors in construction and design can become apparent. A common problem is insufficient budget to implement the necessary early-life maintenance program, but without this, costs can multiply.	Carefully plan and implement a maintenance schedule specific to the establishment period (initial 2 years of operation). This needs to be conducted at higher frequency with more thorough checks than for mature systems. Ensure adequate budget is available for this maintenance (must be set aside in budget planned during design).
Handover (if relevant)		
Asset handover	**Handover** is a key opportunity for rectification of problems that may compromise long-term system performance e.g. poor plant health, bare zones, inappropriate hydraulics, excessive sediment accumulation.	Inspection is required before handover, and any issues should be rectified before the handover is signed off. Detailed asset handover checks, sign-off documentation and protocols are provided by Water by Design (2009).

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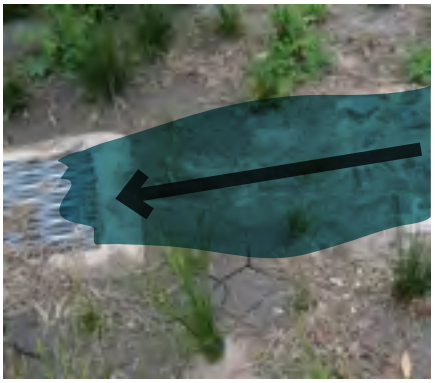
Sediment management: high risk of sediment washing into biofilter during construction in catchment

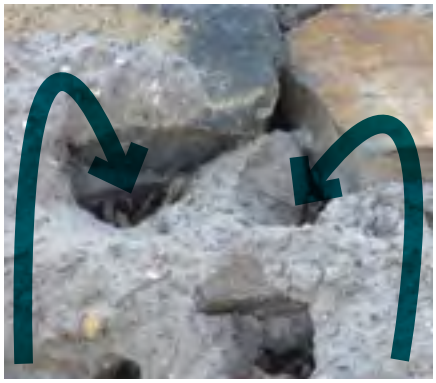
Surface of biofilter not flat, slope follows fall of road – poor distribution of flow

No step down into biofilter: flow cannot easily enter

Overfilling with media or mulch – reduces or prevents ponding, reducing treatment capacity



Level of overflow designed or constructed too low, overfilling with media or uneven biofilter surface: these reduce ponding & flow distribution, allowing flows to bypass



Good hydraulic design and flow management during construction & establishment required to prevent erosion and short-circuiting

Figure 2. Hydraulic and sediment management issues

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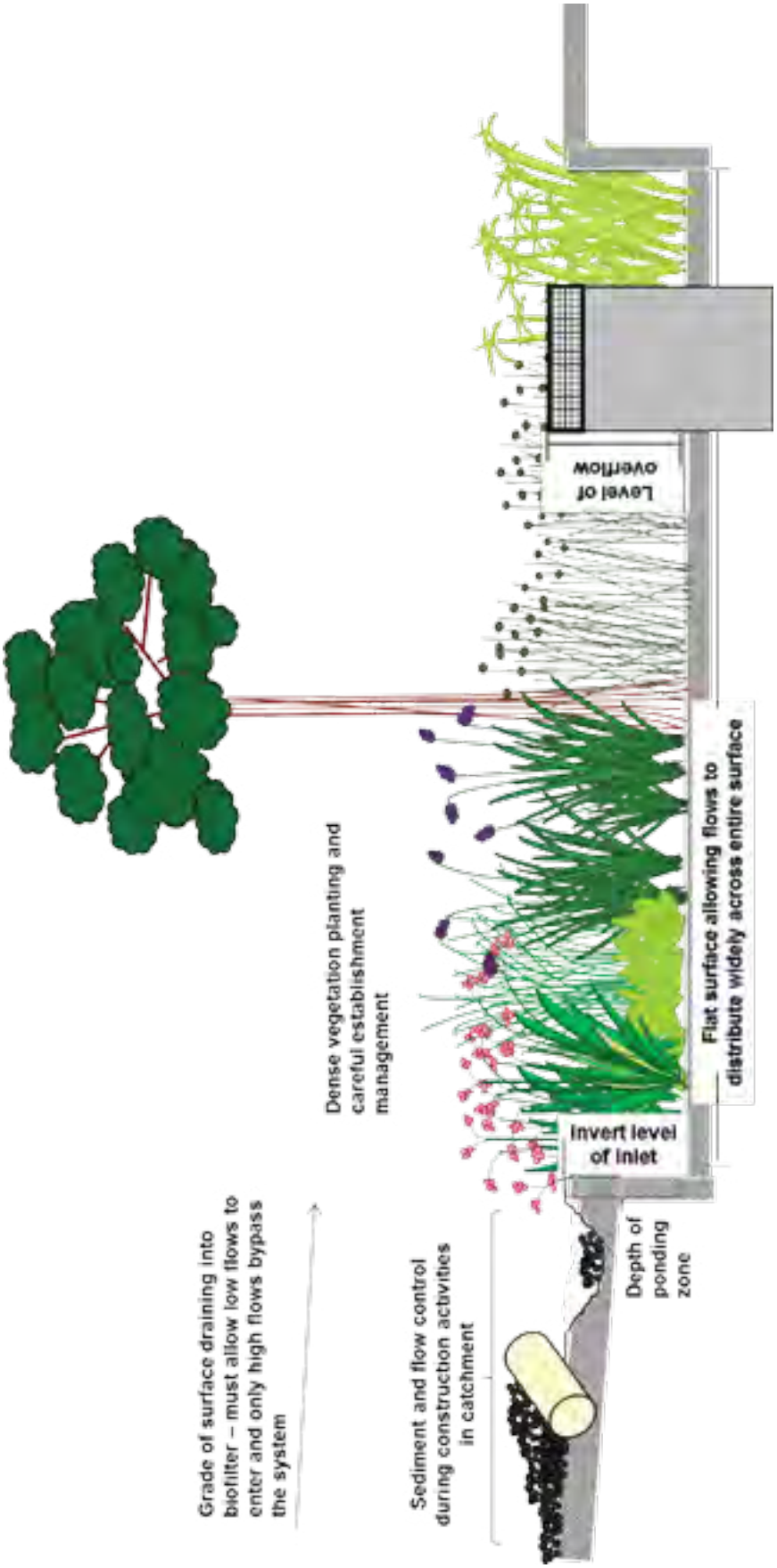

Figure 1. Critical quality control checks during and following construction