3 Practical Guidance for Construction, Operation and Maintenance of Road SUDS

CHAPTER AIMS

- Practical guidance for particular SUDS features appropriate for use in roads taking into account detailing and construction activities.
- Preparation of operational and maintenance guidelines for SUDS in roads.
- To identify key features which require to be inspected and maintained.
- To promote the use of inspections to inform the maintenance strategy.
- Provide examples through links to case studies within the guidance.

3.1 DETAILING PRACTICE

3.1.1 Whilst the available design guidance provides specific detail on the SUDS feature, it takes no account of the effects of specific detailing relating to the location of a road SUDS feature where external factors may affect its performance.

3.1.2 For example, the location of permeable paving, or a filter drain at the bottom of an earthworks slope without a verge and protection prior to the establishment of vegetation, is likely to result in siltation from soil erosion contaminating the filter media leading to a loss of capacity and water quality, as detailed in Figure 3.1. A simple dished channel at the toe of the slope would serve to trap eroded soils, prevent clogging of the gaps between block paviours and contamination of the filter media.

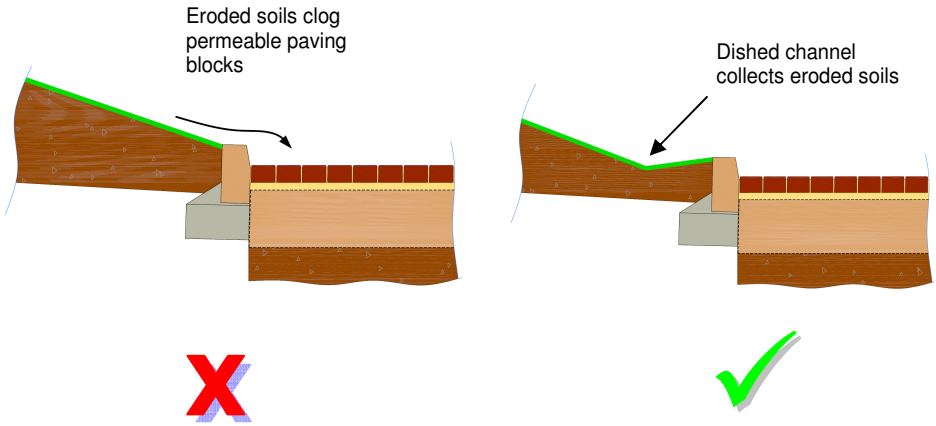


Figure 3.1 Earthworks Toe Detail

3.1.3 Other practical considerations such as the specification of grass seed mix for vegetated SUDS with slow and limited growth properties would assist in reducing the frequency of future maintenance. The use of plants requiring minimal maintenance should be explored, using the expert advice of a landscaping architect/ consultant.

3.1.4 Integration with site wide infrastructure including utilities also needs to be considered in the planning, design and detailing of SUDS within the road corridor.

3.1.5 Figures 3.2 and 3.3 show how the adoption of permeable paving can be integrated with the other functions of a road including utilities and conventional foul drainage to serve a development:

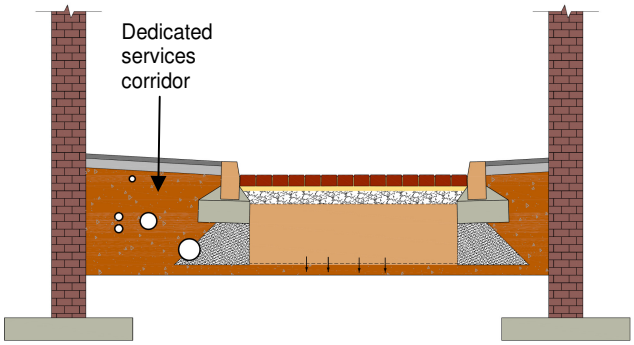
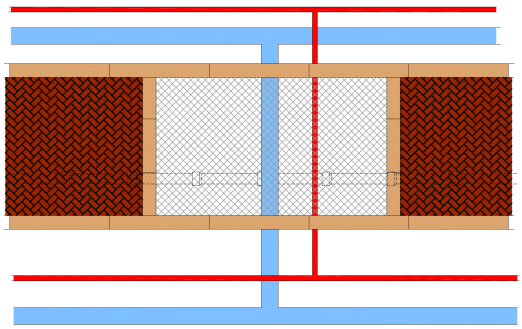
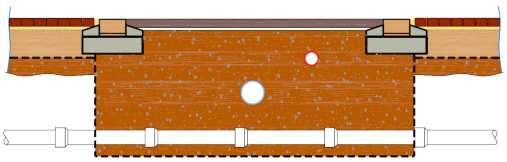


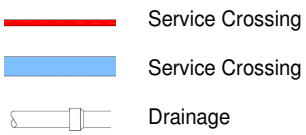
Figure 3.2 Services Corridor

3.1.6 Utilities within footways in dense urban settings allow the provision of SUDS within the road structure



Plan





Section

Figure 3.3 Delineated Utility Road Crossing

3.1.7 Where services crossings are required, these may be provided and bounded using flush kerbs and, for example changing the pattern adopted in the block paving or colour of the surfacing to define the extent of the service crossing for future maintenance access, as shown in Figure 3.3.

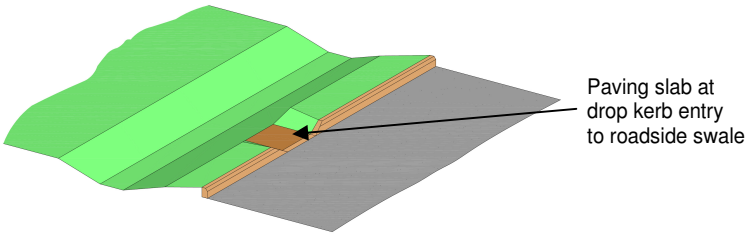


Figure 3.4 Drop Kerb Swale Inlet Detail

3.1.8 Where drop kerbs are applied to promote runoff from the road surface to swales, the introduction of a paving slab at road channel level, as shown in Figure 3.4, reduces erosion and accumulation of silt at this location.

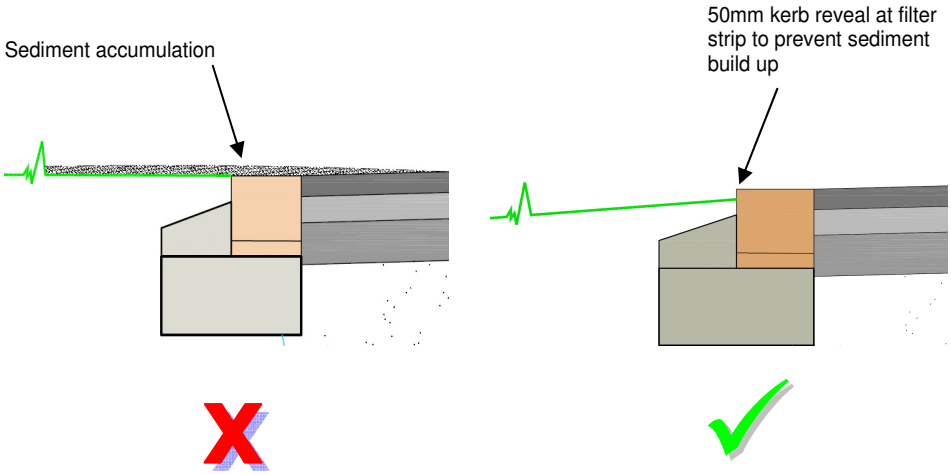


Figure 3.5 Filter Strip Roadside Edge Detail

3.1.9 Grass filter strips should be constructed 50mm below the road channel level to prevent build-up of silt at the road edge, impeding runoff of surface water from the road surface[6], as detailed in Figure 3.5.

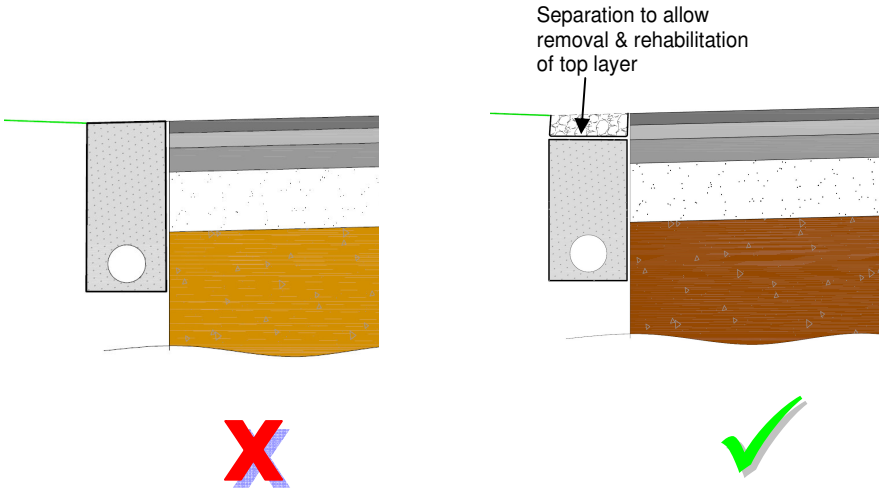


Figure 3.6 Filter Trench Detail

3.1.10 The introduction of a top layer of gravel filter media wrapped with permeable geotextile, as detailed in Figure 3.6, provides separation from the main body of gravel media and allows straightforward removal, cleaning and replacement of the contaminated top layer.

3.1.11 Where below ground SUDS features are being used, the introduction of monitoring and sampling chambers, detailed in Figure 3.7, allows the performance to be monitored and checks to be made on the presence and extent of contamination.

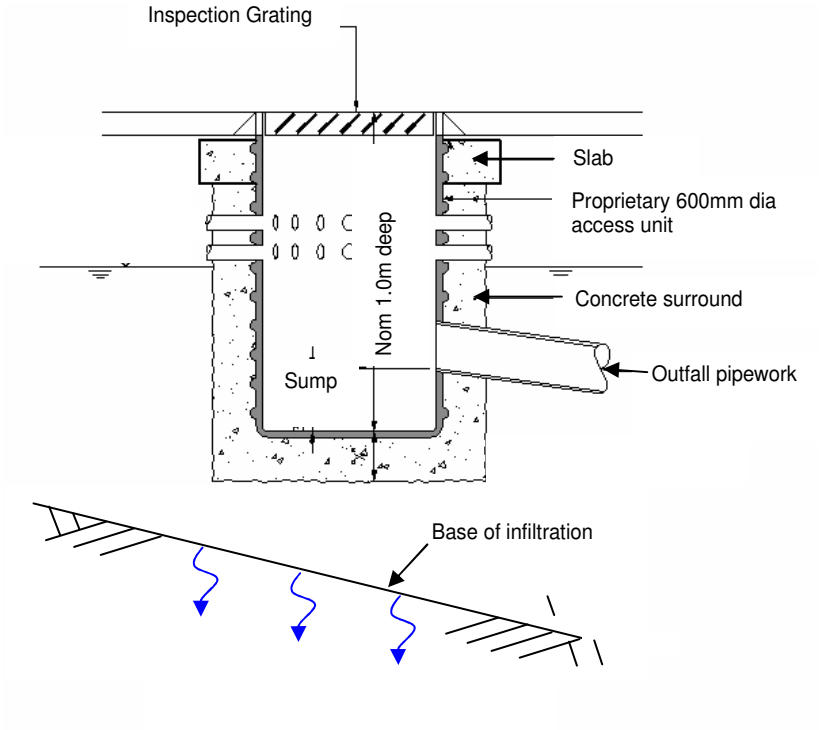


Figure 3.7 Typical Monitoring and Sampling Chamber Detail

3.2 INSTALLATION/ CONSTRUCTION GUIDELINES

SCOPE OF GUIDELINES

3.2.1 There is a statutory requirement to control the quality of surface water discharges from sites within “The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) (NB incl. amendments and corrections – 2007)”, with the control of water quantity governed by Local Authorities when discharging to a watercourse, and Scottish Water when discharging to a public sewer all of which is linked to the subsequent risk of flooding or capacity constraints.

3.2.2 The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) (NB incl. amendments and corrections – 2007) regulates activities associated with the water environment.

3.2.3 CAR has three separate tiers of authorisation with increasing levels of monitoring and control. The 3 tiers of control are *general binding rules*, *registration* and *licences*. This tiered approach allows the level of regulation to which an activity is subject to be in proportion to the environmental risk posed by the activity and minimises the regulatory burden for both SEPA and operators. Every activity regulated by CAR falls under one of following regimes:

- Pollution control
- Abstraction
- Impoundment
- Engineering

3.2.4 The type of authorisation will depend on the level of impact the activity may cause, such as the following:

- A low risk activity will be granted a general binding rule (GBR)
- Low risk activities that cumulatively pose a risk to the water environment will need to be registered
- Activities that require site-specific controls will need a licence

PRE AND POST CONSTRUCTION EROSION AND SEDIMENT CONTROL

3.2.5 Erosion and subsequent sediment release into the water environment is one of the most common forms of waterborne pollution resulting from construction sites.

3.2.6 The risk of pollution and control of sediment release through construction works therefore needs to be considered at the outset prior to the commencement of the works with a site management plan prepared identifying the location and type of any temporary construction SUDS including their integration/association with permanent SUDS. The management plan should also include/address the need for the inspection and maintenance of the temporary SUDS including water quality monitoring/testing as appropriate and agreed with the relevant statutory authority.

3.2.7 Relevant guidance includes:

- CIRIA C698 - Site Handbook for the Construction of SUDS
- CIRIA C532 - Control of Water from Construction Sites – Guidance for Consultants and Contractors
- CIRIA C648 - Control of Water pollution from Linear Construction Projects: Site Guide
- PPG5 - Works and Maintenance in or near Water

3.3 CONSTRUCTION AND SITE HANDOVER INSPECTION

3.3.1 A consistent approach to inspection of constructed roads incorporating SUDS by using a construction and handover checklist is recommended. An example checklist is presented in Table 3.1:-

Phase and inspection description	Inspection date	Acceptability (✓ / X or N/A)	Date completed	Remarks
ROADS				
Formation				
Correct levels and grades				
Compaction in accordance with specification				
CBR in accordance with specification				
Infiltration Coefficient meets design criteria				
Sub – base / Capping				
Correct levels and grades				
Materials in accordance with the specification and testing				
Compaction in accordance with specification				
CBR in accordance with specification				
Density in accordance with specification				
Pavement				
Correct levels and grades				
Pavement thicknesses in accordance with design				
Compaction in accordance with specification				
Materials used in accordance with specification and testing				
Drainage				
Gullies clean, set at correct level				
Silt traps clear, set at correct level				
CCTV survey of pipework				

Table 3.1 Example Construction and Handover Checklist. Continued overleaf

SUDS				
Excavation				
Runoff from bare soil and contaminated areas diverted to temporary SUDS				
Soil not overly compacted to reduce permeability				
Excavation to required size and depth and correct location				
Side slopes are correct				
Debris and roots removed from base of feature				
No groundwater seepage in base of feature				
Construction				
Earthworks in accordance with specification				
Filter materials in accordance with specification and testing				
Compaction in accordance with specification				
Inlets, outlets and control structures in accordance with specification and drawings				
Construction to line and level as drawings				
Planting				
Planting in accordance with specification				
Planting condition and established				
Handover inspection				
No silting from construction				
No erosion or bare areas of planting				
All litter removed				
All inlets, outlets and control structures operating correctly				

Table 3.1 Example Construction and Handover Checklist

CONSTRUCTION PERIOD INSPECTIONS

3.3.2 During the construction period of the site, permanent & temporary SUDS used for treatment of construction runoff should be regularly inspected to ensure that runoff is being successfully managed across the site and that water quality within the downstream receiving watercourse or receiving sewer is not detrimentally affected.

3.3.3 It is recommended that SUDS used during the construction period, and general site conditions, are inspected on a regular basis (Dependant on complexity/size of scheme and techniques used) by a suitably experienced inspector. Control devices e.g. headwalls, orifices, hydro-brakes, etc should be observed on a regular basis during the construction period, and after periods of heavy rainfall, as these represent the highest risk of flooding due to blockages by construction debris.

The suitable experienced inspector indicated above must have completed a recognised training module on SUDS inspection or be able to demonstrate through their experience an acceptable understanding of the required standards.

SITE HANDOVER INSPECTIONS

3.3.4 Following construction of the scheme and associated SUDS, a joint inspection should be undertaken to identify any defects and subsequent remedial works required to reinstate the SUDS feature to its intended design layout. This inspection should be attended by a representative of the contractor, the design team and a representative of the adopting/maintaining authority. Remedial measures should be agreed and recorded on a checklist, as outlined in Table 3.1, which will form the basis of a formal inspection report. The inspection report should be retained and include details of identified remedial measures including their satisfactory completion. This report will form the basis of future routine inspections undertaken by the adopting/maintaining authority providing a complete maintenance/performance history from inception.

3.3.5 It is anticipated that inspections will usually be visual only. Any necessary remedial or maintenance works should be identified and recorded on the inspection report at the time of the inspection with remedial works arranged by the appropriate person.

3.4 MAINTENANCE GUIDELINES

OVERVIEW

3.4.1 In this section, guidance is given in the development of a sustainable strategy for the maintenance of a completed SUDS feature or series of features associated with new roads.

3.4.2 The need for maintenance of the road is driven by three core principles:

- Safety – to comply with statutory obligations
- Serviceability – to ensure that the requirements for the road integrity and quality are met
- Sustainability – maximising value of the road network to the community and minimising costs over time

3.4.3 The guidance in this document does not provide prescriptive maintenance procedures, but directs that a series of inspections should inform the maintenance strategy. The guidance indicates when inspections should be carried out and identifies events which would be a reason for a further inspection.

3.4.4 Some design considerations are highlighted which can assist in lessening the long-term maintenance requirements, as well as some of the maintenance issues peculiar to specific SUDS features. Items which should be included in inspections are listed.

3.4.5 In most cases the maintenance tasks necessary for SUDS are already being undertaken by local authorities in the inspection and maintenance of streets, parks and watercourses within their boundary. Typically, the following traditional road features require regular inspections and repairs as appropriate:

- Carriageway defects
- Footways and cycle tracks
- Manhole and gulley covers, gratings and frames
- Gullies, catchpits and interceptors
- Kerbs
- Culverts
- Verges
- Landscaped areas
- Ponds with outflow controls
- Ancillary drainage items – headwalls, screens, aprons, valves, tidal flaps

3.4.6 Further details on routine maintenance management may be found within The Trunk Road Maintenance Manual: Volume 2 – Routine and Winter Maintenance Code [7].

3.4.7 Roads Asset Management Plan (RAMP), prepared by roads authorities comprise of a detailed statement / inventory of the assets owned by a roads authority, which enables the authority to gain a better understanding of, and make informed plans for, the future maintenance requirements and disposal of these assets, as well as the acquisition of new assets. A RAMP is a life cycle planning tool to enable informed decisions to be made about these assets, relating to expected life, maintenance requirements and regimes, renewal or replacement frequencies etc. based on the details it contains, and therefore it enables authorities to move from short term annual budgeting to long term financial planning.

THE NEED TO MAINTAIN

3.4.8 Un-maintained SUDS features may eventually fail operationally[1]. For example, experience shows that the useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely[2].

3.4.9 Where roads are constructed by a local authority, a robust maintenance regime serves to protect the investment made in roads assets[3]. In cases where assets are constructed by a third party and later vested with a local authority, a well-developed maintenance strategy prevents premature failure of the assets, and the resultant expenditure to the local authority.

3.4.10 Where SUDS features are not maintained they can become unsightly, and any amenity benefits which were intended during design may be lost. Similarly, while wildlife will investigate and annex new habitats, certain animal species may abandon or fail to survive in unmaintained areas.

3.4.11 Within the suite of SUDS features available there are systems which not only improve water quality, but aid mimicking the pre-development hydrograph. Any flood risk mitigation characteristics a system may possess will be lost in time where the system is not suitably maintained.

MAINTENANCE – WHEN?

3.4.12 Following practical completion of road construction, a one year defects liability period is entered into, during which maintenance and defect repairs are undertaken by the owner, prior to adoption by the roads authority.

3.4.13 During the defects liability period and following adoption, inspections of the roads SUDS should be carried out on a monthly basis, or after a severe rainfall event as part of a tailored monitoring framework. These will enable the owner to:

- Become familiar with the operation and performance of the system
- Address any construction or emerging defects, and
- Identify any initial maintenance that is required

3.4.14 A tailored monitoring framework should be sufficiently flexible to allow inspections to take place during inclement weather when the real-time performance of a system may be evaluated.

3.4.15 After an initial period, the long term schedule for visits for maintenance should be established based on the outcomes of previous inspections and maintenance. Consider two illustrative scenarios:

- A particular system may be prone to accumulating litter. If remedial measures cannot address this issue, inspection and maintenance will require to be more frequent to ensure the system performs satisfactorily.
- Another system is found to be performing well, with little sediment discharging into the feature and well established species of grass and planting with a slow rate of growth. In this case the interval between visits may be extended progressively.

3.4.16 Where tried and tested SUDS solutions are constructed, the monitoring framework developed for previous schemes may be used as a basis for monitoring new installations.

3.4.17 The Figure 3.9 flowchart indicates in outline how a tailored maintenance schedule may be developed.

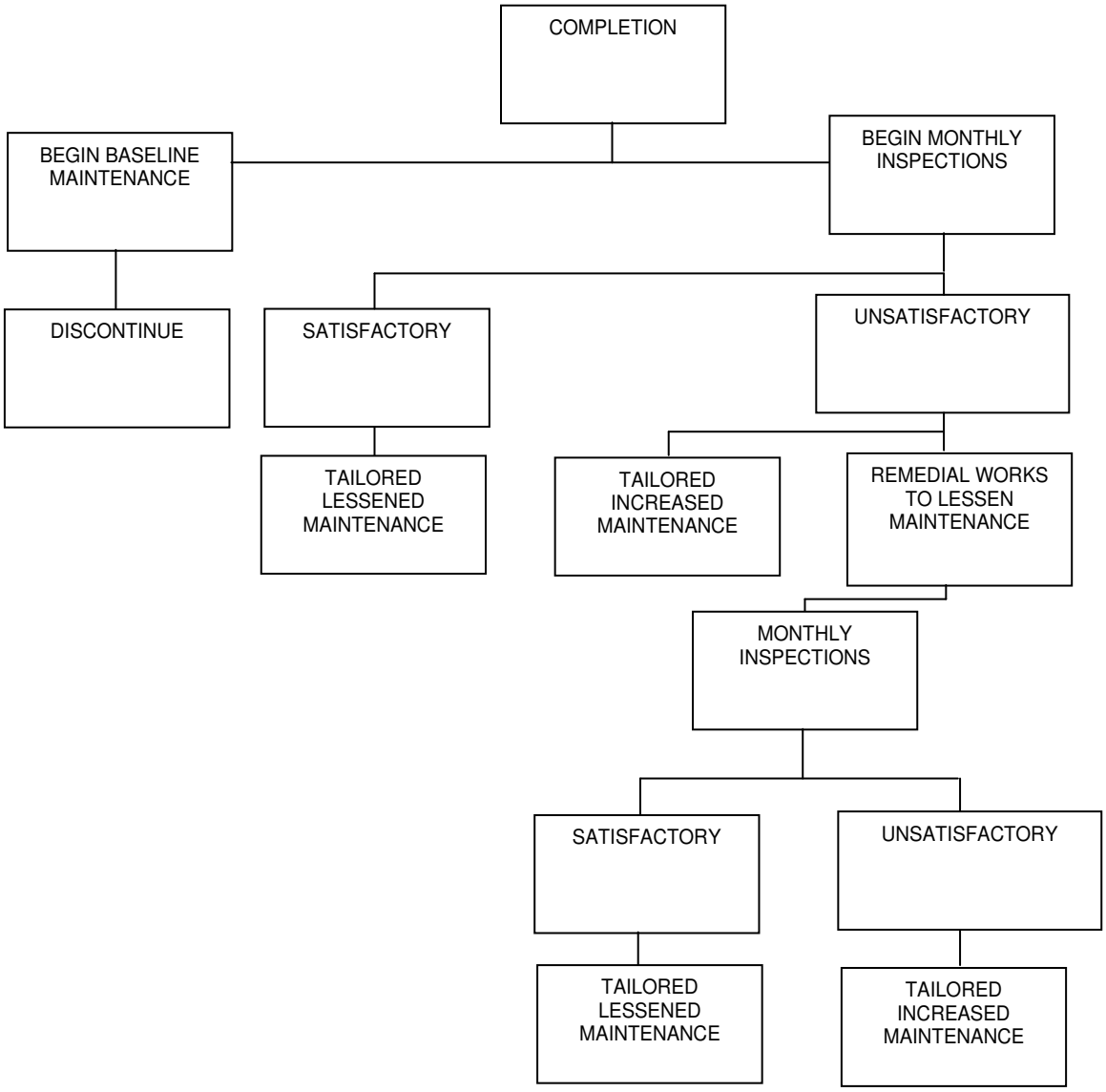


Figure 3.9 Tailored Maintenance Flowchart

3.4.18 At any time during the lifespan of a drainage system events may occur which would trigger an additional inspection. Any event with significant potential to adversely affect water quality or the integrity of the system will be a trigger for an additional inspection. Examples include:

- Immediately following a serious road traffic accident
- Immediately following the spillage of chemicals or fuels, or the use of fire fighting foams
- Immediately after collision or impact with the elements of the drainage system

3.4.19 The Figure 3.10 flowchart illustrates the sequence of events associated with an additional inspection.

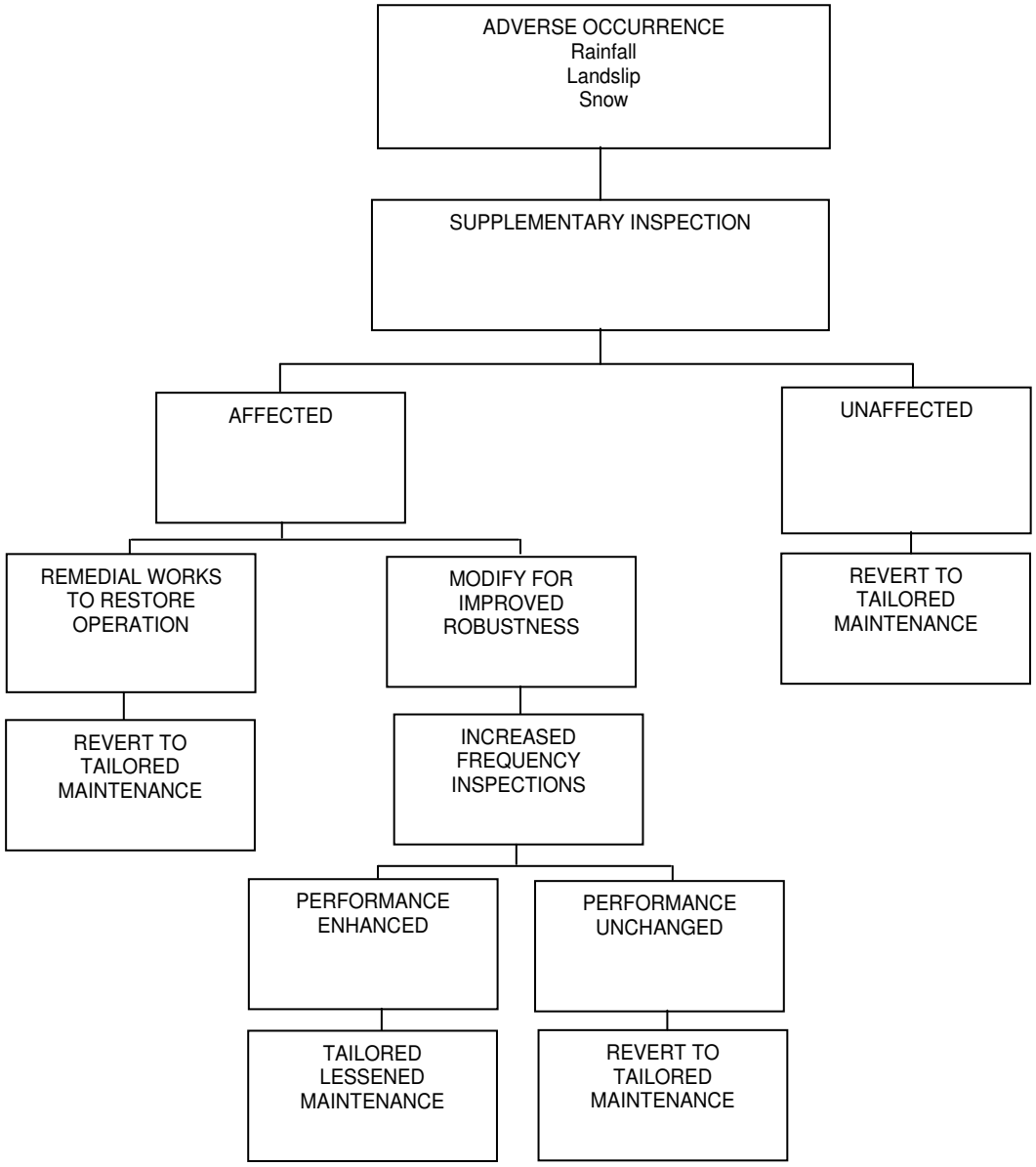


Figure 3.10 Sequence of Events Associated with an Additional Inspection

3.4.20 During the summer months, when water levels may be below designed levels ponds, wetlands and swales should be monitored to determine if irrigation or watering of plants is necessary.

3.4.21 Where construction is due to commence within the catchment of a SUDS feature, an inspection of the condition of the system should be undertaken. Similarly, where construction traffic is anticipated to exit a site onto a road draining to SUDS, the condition of the system should be recorded in advance.

3.4.22 Where the tailored inspection and maintenance regime indicates that long intervals may elapse between visits, the visits should be timed to take place shortly in advance of autumn.

3.4.23 Innovative solutions may require higher levels of monitoring and maintenance to comply with the manufacturer's specification. Even where a manufacturer makes specific recommendations, a tailored maintenance and monitoring framework should be developed. This will require continued dialogue with the manufacturer, and will be especially necessary where a system is warranted.

MAINTENANCE – WHO?

3.4.24 It will be the responsibility of the owner of the system to demonstrate that inspections, and maintenance, are being performed. This could be demonstrated by submission of a brief report after each inspection. The report should indicate the date of the inspection, its findings (including dated photographs), details of any maintenance performed, and the rationale for future variation of the monitoring framework.

3.4.25 Where there are doubts over ownership a lack of maintenance will often result. Ownership of the road SUDS features should be agreed during the evaluation stage of SUDS selection.

3.4.26 Adopting authorities should, wherever possible, share SUDS maintenance resources which will increase cost efficiencies and increase the knowledge base, and experience.

3.4.27 Further information on adoption responsibilities is provided in Chapter 4 Strategy for Adoption.

TYPICAL INSPECTION CHECKLIST

3.4.28 In this section a non-exhaustive list of inspection items are identified. This may be used and expanded by owners to develop bespoke checklists for specific installations, enabling the efficiency and general health of a SUDS feature to be assessed.

3.4.29 Inspect for:

- Blockages to outlets, filters and screens; manually wash filters periodically
- Invasive species of weed; arrange for removal and replacement with intended flora
- Balding spots within grass cover; renew grass and protect until established, consider the cause of the balding
- Erosion of side slopes and base; renew profile and revegetate immediately, consider stabilisation with erosion control mulch or biodegradable matting
- Signs of soil slumping; renew profile and ensure proper compaction of suitable sub soils, re-vegetate immediately
- Signs of burrows; record, consider whether damage to liners, etc may be occurring
- Signs of leaks; consider effect and remediate if necessary
- Disrupted or missing rock lining or rip-rap; replace, consider cause of disruption
- Sedimentation indicative of ponding on permeable block pavers; monitor, clean and restore permeability
- Deterioration of emergent and perimeter shoreline vegetation; treat and revegetate, consider choice of species
- Debris and accumulated litter; remove at each inspection and prior to mowing.
- Woody and overtaking vegetation; trim and prune all vegetation, including grass
- Excess sediment; remove accumulations, in particular near to culverts and channels
- Structural integrity of headwalls, chambers, grilles, etc; maintain urgently and immediately where a risk to Health & Safety exists

A well designed SUDS feature, which receives tailored maintenance and monitoring may be expected to be as durable as a traditional system of roads and drainage.

MAINTENANCE TO SPECIFIC SUDS FEATURES

3.4.30 Surface courses formed using permeable block paving require periodic maintenance to restore the permeability of the surface. The intervals for carrying this out will be determined through regular inspections but can be expected to be in excess of 10 years. In some places systems have been seen to operate for more than 20 years[4].

3.4.31 Research has shown that the performance of permeable block paving is influenced by its age through clogging of the joints and openings. Figure 3.11 presents the service life of permeable block paving over a 10 year period. The graph indicates that over a ten year period the infiltration rate reduces to approximately 25%, from an initial rate of 5000 l/s/ha to approximately 1300 l/s/ha.

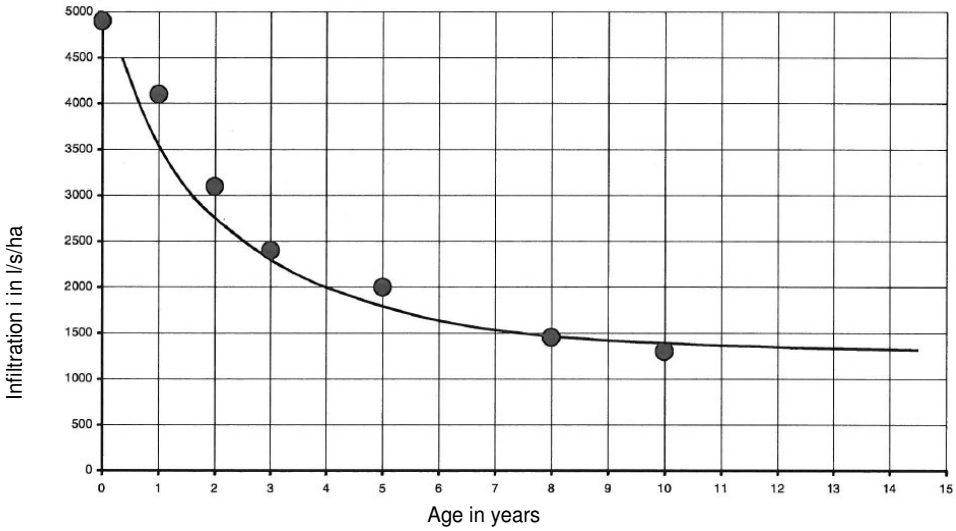


Figure 3.11 Infiltration Performance of Permeable Block Paving[8]

3.4.32 American and German experience recommends that the design infiltration rate through the surface of permeable block paving should be 10% of the initial design rate, typically 4000 mm/hour, to take account of the clogging effect over a 20 year design life[9], to reduce maintenance requirements.

3.4.33 There are no known examples where porous asphalt has been adopted by roads authorities in Scotland. Overseas experience shows that unclogging of porous road surfaces requires a combination of both high-pressure water cleaning and vacuum sweeping to restore drainage capacity, with a recommended frequency of a minimum of four times annually.[10]

3.4.34 Filter drains require frequent maintenance and offer only limited attenuation[5]. Where the inlet to a filter drain is an exposed surface at ground level, the surface material must be kept loose and clear of debris and sediment. It will not be sufficient simply to rake and loosen material inundated with sediment as this will allow sediment to penetrate further into the filter media, and lessen water quality.

3.4.35 Bioretention areas require frequent maintenance initially. However, over time their need for maintenance reduces to a level similar to the routine periodic maintenance required of any landscaped area. This will maintain the appearance of the treatment area and its ability to infiltrate surface water, and will include (1) pruning of trees and shrubs, (2) weeding, and (3) mulch replacement.

3.4.36 The harvesting of plants from wetlands should occur before the plants begin to transfer phosphorus from their foliage to below ground roots, or begin to lose metals that desorb during plant die-off. Vegetation should be cropped near to the end of each growth season to capture the nutrients and pollutants removed by the wetland vegetation[10].

3.4.37 The maintenance objectives for vegetated swales include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover. Grass height and mowing frequency may not have a large impact on pollutant removal[11]. Consequently, maintenance for hydraulic purposes may only be necessary once or twice a year however maintenance for safety or aesthetics or to suppress weeds and woody vegetation may be more frequent.

3.5 REINSTATEMENT GUIDELINES/ REMEDIAL MAINTENANCE

3.5.1 Over time there is likely to be a requirement to undertake remedial maintenance to the road and its drainage. The remedial maintenance measures associated with conventional roads and drainage typically include:

- Replacement of surface course
- Replacement of damaged kerbs
- Replace damaged drainage covers
- Landscape replacement
- Repairs to potholes
- Re-set displaced kerbs
- Clean blocked drainage features
- Repairs to road markings and street furniture

3.5.2 Equally, there will also be a requirement to undertake remedial maintenance to SUDS components associated with road drainage. These will typically be required between 10 and 25 years depending on specific site factors such as sediment load. With the exception of removal of sediments and hydrocarbons, the majority of the remedial maintenance measures are linked to landscape management/ replacement.

3.5.3 From time to time some partial reinstatement of the SUDS may also be required. For example, it may be necessary to lift and replace or relay permeable block paving on rare occasions when, even following regular maintenance, the bedding media may become excessively congested with sediment.

3.5.4 When replacement of filter drain media is required, the replaced media should be recycled. In addition, the permeability of the surrounding soils may be recovered by increasing the size of the trench by 50mm in each available direction.

3.5.5 The remedial maintenance associated with the SUDS components described in Chapter 2 is outlined in Table 3.2.

SUDS components	Remedial maintenance
Filter Strips	■ Repair Eroded areas ■ Re-level/ reinstate design levels ■ Remove build up of sediment ■ Remove hydrocarbon residues
Pervious Pavements – Permeable block	■ Rehabilitate surface and filter media ■ Repairs to depressions and rutted areas ■ Remediate landscaping to prevent eroded soils clogging pavement
Swales	■ Repair Eroded areas ■ Re-level/ reinstate design levels ■ Remove build up of sediment ■ Remove hydrocarbon residues
Filter drain/ infiltration trench	■ Clear pipework blockages ■ Replace geotextile ■ Rehabilitate filter media ■ Repairs to inlets and outlets
Bioretention	■ Replacement of vegetation damaged or covered with silt ■ Repair eroded areas ■ Replace damaged or diseased landscaping ■ Remove silt accumulations
Ponds	■ Repair eroded areas ■ Repair inlets, outlets and overflows ■ Replacement landscaping
Basins	■ Repair eroded areas ■ Repair inlets, outlets and overflows ■ Re-level/ reinstate design levels
Infiltration basins	■ Repair eroded areas ■ Repair inlets, outlets and overflows ■ Re-level/ reinstate design levels ■ Rehabilitate infiltration by scarifying/ spiking
Wetlands	■ Repair eroded areas ■ Repair inlets, outlets and overflows ■ Supplement plants
Sand filter	■ Repair of eroded areas ■ Replace clogged filter bed ■ Repairs to inlets and outlets

Table 3.2 SUDS Components Remedial Maintenance

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