Operation & Maintenance of Sustainable Drainage Infrastructure

This information sheet is summary of a report on the Operation and Maintenance of Sustainable Drainage Infrastructure (and Associated Costs). This report was prepared as part of a DTI and industry funded research project to investigate the economic incentives, social impacts and ecological benefits of sustainable drainage systems (SUDS). The report's main author was Bob Bray of Robert Bray Associates, supported by HR Wallingford as project managers and report editors.

As part of this research, a series of reports have been produced:

SR 622: An Assessment of the Social Impacts of Sustainable Drainage Systems in the UK

SR 625: Maximising the Ecological Benefits of Sustainable Drainage Schemes

SR 626: The Operation and Maintenance of Sustainable Drainage Systems (and Associated Costs)

SR 627: Whole Life Costing for Sustainable Drainage

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Introduction

SUDS comprise an approach to managing runoff from urban areas that collect, clean, store and release water slowly to the environment in as natural a manner as possible. The benefits of SUDS may be summarised as follows:

- SUDS attenuate runoff to reduce flooding and environmental damage downstream from the site;
- SUDS manage pollution by trapping silts and treating runoff;
- SUDS provide amenity benefits to the local and wider community.

However, there are concerns about their operation and maintenance in both the short and long term. SUDS ideally comprise an integrated group of techniques that manage runoff from part or all of a catchment. Each component should add to the performance of the system, rather than operating as one of a series of isolated drainage devices. The management and maintenance of such systems should therefore be inclusive of all components of the design, from the point at which rainfall reaches the development surface to the point at which water is discharged to natural drainage paths, or storm sewers.

Conventional drainage is traditionally maintained by contractors using specialist machinery to clear gullies, pipework, and storage zones of trash and sediment accumulation. Most conventional drainage infrastructure is out of sight; so the frequency of routine maintenance is generally determined by routine rather than need, and irregular maintenance activities tend to be triggered by system performance failure.

SUDS are predominantly surface features that mirror natural drainage processes. Standard landscape management techniques are therefore appropriate for application to their operation and maintenance. The features in SUDS should be highly visible and their function should therefore be easily appreciated by those charged with their maintenance. When problems occur, they are generally obvious and can be remedied simply by using standard landscaping practice. The long-term deterioration of SUDS tends to be gradual and, if the systems are properly maintained, can be managed out.

Whole Life Design Principles

One of the advantages of SUDS is that they are robust and easy to maintain. However, the effectiveness and ease of their long-term management will be dependent to a certain extent on their initial design characteristics.

Considerations that affect the design of SUDS structures, methods and components should include:

- The drainage and water quality functions they are required to perform;
- The maintenance required to ensure they continue to work as intended;
- An assessment of the future repair or replacement requirements.

Whole Life Design & Maintenance

Quantity Drivers

Design and management of attenuation structures needs to consider all of the following issues to ensure that risks to performance are minimised:

- Hydraulic design objectives of the scheme;
- Silt and vegetation accumulation processes;
- Amenity objectives;
- Ecological benefits;
- Health and safety issues, e.g.effective inlet and outlet structures that are easy to maintain.

The use of the 'management train' with open silt interceptors and discreet forebays for regular silt removal should be employed, together with early interception of inorganic silt.

Quality Drivers

A common criticism of conventional drainage is that gullies, silt traps and petrol interceptors are not maintained to an acceptable standard, and as a result contribute to pollution off-site that others are then required to manage. This situation arises in part because the structures are out of sight, but also because the consequence of failure does not have an immediate impact on the site generating the runoff.

Quality Drivers (continued)

The integration of SUDS within the development area means that water quality problems can have a rapid and significant impact on public perception and amenity functions. Appropriate silt collection and pollution control mechanisms in SUDS design can minimise these pollution risks, providing they function effectively at all times.

However, regular monitoring is required to ensure that risks to water quality can be spotted early, and acted on, avoiding system failure.

Amenity Drivers

Unlike conventional drainage, SUDS are surface features generally charged with providing amenity benefits. This requirement drives the need for a level of operation and maintenance that ensures public acceptability in terms of visual aesthetics, as well as retaining the required technical performance standards.

Whole Life Design Criteria

The full report provides tables for the complete range of SUDS components highlighting design issues that are likely to influence their long-term performance, and that may impact on the feasibility of important operation and maintenance activities. These do not provide a comprehensive list of design criteria and objectives, but do highlight important considerations for the planning of any system.

The report also discusses whole life design criteria for associated features and structures that service the main control methods. These include inlets, outlets, storage structures, silt traps, flow control devices, headwalls, low flow channels, and overland flood routes. The table below shows an example for filter strips and swales.

Component	Function	Design Criteria	Comments
Filter Strips	To transport runoff via vegetated surfaces that trap silt & pollutants Usually located upstream of storage or infiltration areas	• Well-maintained grass or other vegetation able to trap pollutants • A gently sloping site to ensure an even distribution of overland flow • An even fall across the filter strip to minimise the possibility of erosion & gullying occurring • A flush edge to the impervious hard surface collector	• Use of a gravel strip along the edge of the pavement is recommended to arrest & distribute flow evenly across the length of the filter strip
Swales	To store & convey surface water via linear grassed areas (can allow infiltration)	• Infiltration areas to retain runoff • Stilling areas to arrest or redirect flows • Inlet/inflow structures that ensure sheet flow in the swale • Check dams & erosion control to maintain falls below 1 in 50 & prevent gullying • Outlet/outfall structures that facilitate long-term maintenance & are resistant to blockage	• The use of coir blanket should be specified to ensure erosion does not take place during the early stages of grass growth • If the swale is likely to be water logged for serveral months in the year, this may prevent regular mowing, particularly during winter & may encourage a wetland flora to develop

Principles & Practice of Landscape Maintenance

A key feature of SUDS is their integration within the local landscape and their amenity contribution, and it is appropriate therefore that landscape maintenance practice is applied to their management. An advantage of using site managers and landscape contractors to maintain SUDS is that they are likely to have an intimate knowledge of the development and already visit the site on a regular basis to undertake routine care such as grass cutting, sweeping and litter picking. This attendance should ensure regular monitoring of the drainage system, a rapid response to maintenance needs, and a feeling of ownership of the SUDS features.

The principles of landscape maintenance have been established for some time and designers of SUDS have an opportunity to use existing management techniques to develop management plans and maintenance contracts. For large complex sites, the following landscape maintenance procedures are usually applied. These can be simplified for smaller development areas:

- **Management Plan** - describing the management objectives for a site over time, and the management strategies that will be employed to both realise these objectives and reconcile any potential conflicts that may arise.
- **Specification** - detailing the conditions under which the work will be done, the materials to be used and the standard of work required.
- **Schedule of Work** – itemising the tasks to be undertaken and the frequency at which they will be performed.

Maintenance Requirements of Sustainable Drainage Components

The full report contains detailed maintenance specifications for each component, for use in designing and implementing a SUDS management plan. An example summary table is shown below for filter strips and swales.

Component	Regular Maintenance Activities	Occasional Maintenance	Remedial Maintenance	Monitoring
Filter Strips & Swales	• Regular grass cutting • Litter removal • Inlet & outlet cleaning (if present)	• Periodic removal of excess silt • In the event of reduced permeability (infiltration swales only), a number of techniques can be used to open the surface to encourage infiltration: – Scarifying to remove 'thatch'; – Aeration equipment to encourage water percolation; – Chisel or slitting tines, solid tines (spikes), hollow tines, and vibratory tines; – Remove and replace grass and top soil (last resort). • If silt accumulation is a problem: – Remove (reuse or compost) turf – Remove accumulated silt (subject to toxicity test) and land apply or dispose of to tip – Cultivate remaining topsoil to levels – Reuse or re-turf area to agreed levels.	The following items can often be managed out through good design. Where they are found to be necessary, this is likely due to site-specific characteristics or unforeseen events, and as such their frequency is difficult to predict: • Reinstatement of edgings to hard surfaces • Repair or relocation of damaged barriers • Reinstatement of levels & turf due to erosion by rills or gullies • Lifting turf, disposal of silt accumulation & reinstatement with new re-cycled topsoil & turf • Realignment of rip-rap or other erosion controls • Repair/rehabilitation of inlets, outlets & overflows • System rehabilitation following high silt loads discharged during a single event (see procedure in occasional maintenance).	• Regular inspections should be undertaken, particularly during the vegetation establishment period & after significant storm events to: – identify areas of erosion, scour or gullies – identify locations of silt deposits – determine the health of the vegetation & soil – identify areas of excessive waterlogging or other damage • Filter strips and swales accumulate silt naturally due to their primary position in the SUDS 'management train' sequence. The accumulation of silt occurs slowly, unless there is an unforeseen incident or badly managed construction site • In the event that swales develop a 'wet' swale character, then manage as wetland vegetation.

Frequency of Maintenance Tasks

As landscape maintenance contract periods are usually 1 or 3 years duration, this is a convenient starting point for SUDS maintenance contracts. The frequency of regular maintenance tasks in a contract period can theoretically range from daily to once in the contract period. In practice most site tasks are based on monthly or fortnightly site visits, except where grass or weed growth requires a higher frequency of work. In many cases a performance specification is used with terms such as "beds will be maintained weed-free" or "grass will be cut at 50mm with a minimum height of 25mm and a maximum height of 100mm" to obtain the required standards.

Frequency can be specified within the schedule to include irregular items such as 'meadow grass'… cut 2 times annually in July and September at 50mm, all arisings raked off and removed to wildlife features compost facility or to tip" which provides flexibility for work that is not critical to the management of the site.

Maintenance tasks which suit a performance approach commonly include plant growth, grass cutting, pruning and tree maintenance. However, work tasks such as sweeping paths, regular litter collection and cleaning road surfaces will require work at an agreed frequency with a more specific timing such as weekly, monthly or annually. Where the frequency and timing of tasks is critical then a mixture of performance and frequency specification is necessary to ensure effective maintenance. This type of specification is useful where SUDS features require regular attention.

SUDS maintenance tends towards a frequency requirement to ensure a predictable standard of care which can be recorded on site and which provides a reasonable basis for pricing work. A convenient frequency for many tasks is at a monthly inspection as this is the usual minimum site attendance required in a landscape specification. The monthly frequency provides for an inspection of all SUDS features and checking of all inlets and outlets.

Certain SUDS maintenance tasks however fall outside this monthly cycle and need to be accommodated in the contract period. The two most obvious are:

- wetland vegetation maintenance;
- silt management.

There are other tasks associated with ensuring the long-term performance of the systems that may be more difficult to predict, and may even fall outside any contract period. It may therefore be more appropriate to review requirements for e.g. system rehabilitation at interim periods, when contracts are due for renewal.

Costs of Maintenance

The cost of maintenance is often significant compared with capital construction costs of sustainable drainage systems. It is therefore vital that the cost of implementing long-term management agreements is accounted for during the planning stages. As SUDS techniques are new for most contractors, it will take time before the landscape management of SUDS is commonplace, and costs can be predicted with confidence.

To give an idea of the likely costs of maintenance of SUDS components, the full report presents case studies containing cost reviews of SUDS maintenance activities at two motorway service areas (MSAs) containing a range of SUDS for surface drainage. Further information is also presented from tenders received for ongoing maintenance activities at the sites.

The quotations given were for maintenance of the whole sites and ranged considerably. For annual whole site maintenance of Oxford MSA the quotations ranged from £20k to nearly £40k, and for Hopwood MSA from under £10k to £37k. Activities specifically associated with SUDS were subject to particularly large differences. This indicates the uncertainty of contractors in their understanding of the needs of these systems, and the resulting variability that might currently be expected for landscape maintenance including SUDS components, even when a clear specification and schedule is provided for pricing purposes.