BRITISH WATER

Technical Guidance

Guidance to proprietary sustainable drainage systems and components – SUDS

In partnership with

Environment Agency

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Guidance to proprietary sustainable drainage systems and components

Foreword

This guidance document was produced by the British Water Sustainable Drainage Systems Focus Group – for membership see the company logos on the last page. It has benefited from consultation and input from relevant organisations and the regulators: it is intended to supplement publications from these sources. However, the environmental regulators do not specifically endorse any particular manufacturer's product.

The requirement for the guidance stemmed from the limited amount of information available to stakeholders on the use of proprietary SUDS technology. The document covers the four principle areas of proprietary SUDS solutions including Infiltration, Flow Control, Storage/Attenuation and Treatment – each of which can be included in one of the three headings of the 'SUDS triangle' of Quality, Quantity and Amenity.

The information will be widely disseminated to promote the use of the most suitable and appropriate solution when proprietary SUDS are required. It is intended to complement the guidance that already exists on the wide range of soft SUDS solutions such as swales, ponds and infiltration trenches. This will ensure that the needs of the environment are considered during development whether they are large or small, residential, industrial or commercial.

Scope

To provide information and guidance to all stakeholders including owners, developers, regulators, consultants, contractors and planners.

It provides general guidance and comparative information on the criteria that should be assessed when considering the incorporation and selection of proprietary SUDS equipment. It is not intended as a detailed design document and sound engineering practice should be followed. Every consideration of downstream treatment conditions should be taken into account when selecting the most suitable proprietary products.

Summary of Regulations

The primary water legislation from the different UK legislatures contains general requirements for the management and discharge of surface and drainage waters. More detailed requirements are contained in the Planning Regulations, Planning Guidance information and the Building Regulations (for England & Wales in Part H, for Scotland in Part M and in the Northern Ireland Building Regulations).

There is a general expectation that a drainage system should be adequate, this applies particularly to drains created by developments subject to Building Regulations.

Adequate performance will usually be achieved if the drainage system:

- conveys the flow via a suitable network or treatment system to a suitable outfall (a soakaway, a watercourse, a surface water or combined sewer)
- minimises the risk of blockage or leakage and with good access for clearing blockages and any necessary maintenance
- has a sufficient capacity to carry or retain the expected flow at any point in the system and so does not increase the vulnerability of the development to flooding.
- provides drainage from roofs or paved areas to an adequately and suitably designed drainage system
- where necessary is adequately ventilated such that foul air does not enter any buildings

It should be noted that:

- the priority for discharge of rainwater is firstly to an adequate soakaway or infiltration system, if that is not reasonably practicable then to a watercourse, the last option is to a sewer
- discharges into the ground (where permitted) should be distributed sufficiently so that foundations of buildings or structures are not damaged

References for SUDS

Documents which give further information and guidance:

- Interim Code of Practice for Sustainable Drainage Systems: National SUDS Working Group. 2004, (available from CIRIA)
- SUDS – Design Manual for England & Wales: CIRIA C522, 2000
- SUDS – Design Manual for Scotland & Northern Ireland: CIRIA C521, 2000
- SUDS – Best practice manual: CIRIA C523, 2001
- Sustainable drainage systems – hydraulic, structural and water quality advice: CIRIA C609, 2004
- Sustainable drainage systems: an introduction: Environment Agency, Environment Heritage Services, Northern Ireland and SEPA, 2003
- Model agreements for sustainable water management systems. Model agreements for SUDS: CIRIA C625, 2004
- Infiltration drainage – Manual of good practice: CIRIA Report 156; 1996
- Policy and practice for the protection of groundwater: Environment Agency, 1998. To be replaced by The Environment Agency Groundwater Strategy during 2005
- Soakaway design: Building Research Establishment (BRE) Digest 365, 1991
- Source control using constructed pervious surfaces – hydraulic, structural and water quality performance issues: CIRIA C582; 2002
- Sewers for Adoption: 5th edition; WRc; 2001

Infiltration

Infiltration devices are the first option which should be considered for stormwater disposal. Only if infiltration is not practical should runoff be disposed of to a watercourse or sewer. Infiltration allows runoff to be dealt with at source and mimics the natural process of groundwater recharge. Being buried, the systems often require little or no additional land take.

Infiltration systems are only effective in certain soil types and groundwater levels. They should only be installed if they will not put groundwater quality and ground stability at risk. Runoff which is likely to be heavily contaminated should not be disposed of by infiltration. Land use above and around the devices may need to be restricted to allow maintenance and prevent structural damage.

The environmental regulators' groundwater protection zone and groundwater vulnerability maps must be consulted and the location of any water wells should be identified and taken into account in the design process. The proposer should discuss feasibility and design options with the environmental regulator before any designs are finalised or submitted for planning approval.

Infiltration

● Performs **very well** against this criterion relative to other devices in this table
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Device		Applications	Limitations	Installation: Time	Installation: Complexity	Installation: Space	Power Required	Ease of Commissioning	Inspection Frequency	Operation and Maintenance	Waste Mgmt Requirements	Likelihood to Block or fail	Adoptability*	Reliability
Geocellular Systems		High storage capacity, so applicable where space is constrained Also provide attenuation	Load bearing capacity Maintenance access	◑	◑	●	No			◑		●	◑	◑
Perforated Pipes		Conveyance and infiltration as part of filter drain systems	Capacity and load bearing capacity	◑	●	●	No			●		◑	◑	◑
Permeable Surfaces		Large hard surfaces such as car parks and minor roads reduces the extent of traditional surface drainage Provides preliminary treatment	Construction sequencing (site slope)	◑	○	●	No			◑		●	◑	◑
Soakaways	a.chamber	Infiltration of runoff from individual properties	Silt blockage	◑	●	◑	No			●		◑	◑	◑
	b.trench	Drainage for larger areas with linear space available	Maintenance access	◑	●	◑	No			●		◑	◑	◑
	c.granular soakaway	Drainage for larger areas		◑	●	◑	No			●		◑	◑	◑

* The relevant highways authority should be consulted if the area to be drained includes highway runoff, as this may affect the adoptability of the road itself.

Useful web addresses

Regional regulatory and guidance information can be accessed at the following websites:

Environment Agency (EA)	www.environment-agency.gov.uk
Environment and Heritage Service Northern Ireland (EHSNI)	www.ehsni.gov.uk
Scottish Environmental Protection Agency (SEPA)	www.sepa.org.uk
Office of the Deputy Prime Minister (ODPM)	www.odpm.gov.uk
Department for Environment Food and Rural Affairs (Defra)	www.defra.gov.uk
The Scottish Executive	www.scotland.gov.uk
Department of the Environment Northern Ireland	www.nics.gov.uk
Highways Agency	www.highways.gov.uk
Building Research Establishment (BRE)	www.bre.co.uk
Construction Industry Research and Information Association (CIRIA)	www.ciria.org/suds
Livingroofs.org – for information on green roofs	www.livingroofs.co.uk
UK Rainwater Harvesting Association	www.ukrha.org
Water Research Centre (WRc)	www.wrcplc.co.uk

Storage and Attenuation

In situations where infiltration is not suitable due to ground conditions attenuation storage will still allow the control of peak storm water. Storage allows surface water discharge from a developed site to mimic run off in its undeveloped state. A range of options are available and the choice will be influenced by a number of factors including drainage depth, site layout, site usage (car park or building) and space available.

All systems will still require provision of some form of flow control to mobilize the storage except where the run off restriction is not onerous or where discharge to natural ground to replenish ground waters is feasible. In all cases the site condition and constraints, as well as discharge licences stipulated by the regulating body, must be properly understood before the preferred system can be specified.

All of the systems are relatively easy to maintain, although certain modular systems and in situ tanks could allow silt to enter and may be more difficult to clean than conventional piped systems. Some systems will require very different forms of maintenance from conventional drainage maintenance techniques. For example, maintenance of green roofs will be more akin to landscape gardening and porous pavements will require highways and pavement management skills to keep them operational.

Storage / Attenuation

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Device	Type	Applications	Limitations	Installation: Time	Installation: Complexity	Installation: Space	Power Required	Ease of Commissioning	Inspection Frequency	Operation and Maintenance	Waste Mgmt Requirements	Likelihood to Block or fail	Adoptability	Reliability
Deep shafts		Small footprint off line storage situations	Only suitable where flows can be pumped out to a receiving system, thus requiring substantial M&E installation. Major civil engineering requirements	◑	○	●	Yes	○	○	○	◑	◑	●	◑
Geocellular Systems	Modular block systems – various grades / strengths available for trafficked situations	Can provide large storage capacity with efficient use of space	Depth limitations with some systems. Require access chambers upstream and downstream. Check with manufacturer for strength and suitability for trafficked situations	●	●	◑	No	●	●	●	●	●	○	●
Green Roofs	Composite prefabricates and in situ construction	Most suitable for public and institutional buildings with good maintenance facilities and support	Specialist maintenance	◑	◑	◑	No	◑	◑	◑	◑	●	○	◑
Permeable Pavements	Block pavior patented systems	Appropriate only where the paving system integrates into the overall paving regime	Appropriate only where adopting entity is willing	●	◑	◑	No	●	●	●	◑	●	◑	●
Pipes – large diameter	Concrete	On line and off line storage	Very heavy. Transportation and installation can be difficult	◑	●	◑	No	●	●	●	●	●	●	●
	GRP		Relatively lightweight. Easier to install than concrete but easily damaged on site	●	●	◑	No	●	●	●	●	●	●	●
	Plastic		Lightweight. Easy to install	●	●	◑	No	●	●	●	●	●	●	●
	Steel		Heavy but offer opportunity for more bespoke construction to suit site limitations	◑	●	◑	No	●	◑	●	●	●	●	●
Rainwater Harvesting	Packaged systems	Provide rainwater storage to re-use for WC flushing, washing machines, car washing and garden	Will not provide total storage/ flood protection provision as storage will generally be partially full prior to storm events	◑	◑	◑	Yes	◑	◑	◑	●	◑	◑	◑
Tanks	Concrete (precast culvert units and cast in situ), Plastic, GRP	Tank sizing must be based on sound hydrological assessment	Design must be accurate to ensure the tank meets application requirements	●	◑	◑	No	●	●	●	◑	●	●	●

Flow Control

Flow controls are generally provided to retain or divert flows within surface water networks in order to create various forms of storage. For example, wet ponds as aesthetic/treatment facilities, attenuation storage to reduce the risk of downstream flooding caused by uncontrolled rates of runoff or to meet controlled outflow rates agreed with the environmental regulators and drainage authorities.

Due to the fact that all flow controls are generally a physical restriction of some sort they are often susceptible to blockage and would normally require an overflow or backup to prevent flooding during these occurrences or when events greater than the design storm occur. Downstream conditions need to be taken into account.

Flow Control

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Device	Applications	Limitations	Installation: Time	Installation: Complexity	Installation: Space	Power Required	Ease of Commissioning	Inspection Frequency	Operation and Maintenance	Waste Mgmt Requirements	Likelihood to Block or fail	Adoptability	Reliability
Float Operated Control	Limitation of pass forward flows to constant rate	Purpose built chamber often required	●	●	◑	No	●	◑	●		●	●	●
Orifice Plate	Limitation of pass forward flows	Inaccurate with varying heads. Cannot control low flows	●	●	●	No	●	○	○		○	●	○
Penstock Actuated	Limitation of pass forward flows. Variable settings for both flow and level	Purpose built chamber, power and level control detectors required	◑	◑	◑	Yes	◑	○	○		●	○	◑
Penstock Manual	Limitation of pass forward flows. Variable settings for both flow, isolation (pollution control) and level	Purpose built chamber	◑	●	◑	No	◑	○	○		●	○	◑
Pumps	Limitation of pass forward flows, facilitates variable settings for level	Purpose built chamber, power and level control detectors required	○	○	○	Yes	◑	○	○		●	○	◑
Throttle Pipe	Limitation of pass forward flows – can be installed as part of network	Inaccurate with varying heads. Cannot control low flows	●	●	●	No	●	○	○		○	●	○
Vortex Flow Control	Limitation of pass forward flows. Will operate with surcharge	Purpose built chamber often required	●	●	◑	No	●	◑	●		●	●	●
Weirs	Limitation of water levels and allow excess flows to outfall	Head must increase to increase flows	●	●	●	No	◑	●	●		●	●	●

Treatment

Impermeable surfaces collect pollutants from a wide variety of sources during rainfall events offering difficult challenges to successful SUDS design. Failure to deal with these pollutants (such as silt/sediment, hydrocarbons, litter, nutrients, metals, pesticides, organics, etc.) can lead to contamination of streams, rivers, ground water and other surface waters.

Proprietary devices can be particularly effective at removing pollutants and selection should be carefully considered to ensure the correct systems are selected. All such systems generally require future maintenance/inspection regimes to be put in place and manufacturer's guidance and instructions should be followed closely.

Treatment

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Device		Applications	Limitations	Installation: Time	Installation: Complexity	Installation: Space	Power Required	Ease of Commissioning	Inspection Frequency	Operation and Maintenance	Waste Mgmt Requirements	Likelihood to Block or fail	Adoptability	Reliability
Filter Media		SS removal and absorption	Capacity/Life/Availability	○	○	●	*	◑	◑	◑	●	◑	◑	◑
Hydrocarbon removal	a. Separators	Removal of oil, petrol and silt from Surface Water Run-off	Footprint	●	◑	●	No	●	◑	◑	○	◑	◑	●
	b. Absorbers	Polishing of surface water run-off	Size, weight and maintenance	●	◑	●	No	●	◑	◑	○	◑	◑	○
Packaged Reed Beds		Pollutant removal	Space	●	◑	○	No	●	◑	◑	◑	●	◑	●
Sediment, Solids / Liquid Separators	a. Conventional Tank	Roughing Treatment	Footprint and dig depth	◑	◑	●	No	●	○	◑	○	○	◑	◑
	b. Vortex	Removal of silt, sediments from surface water run-off	Limited hydrocarbon removal efficiency	●	◑	●	No	●	◑	◑	○	◑	◑	◑
	c. Screens	Preliminary treatment	Maintenance	◑	◑	●	*	●	○	◑	○	○	◑	◑

*Powered and non-powered versions available

Glossary

SUDS – Sustainable drainage systems or sustainable (urban) drainage systems: a sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques: they are design philosophies rather than defined process solutions.

Attenuation: Reduction of peak flow and increased duration of a flow event.

Catchment: The area contributing surface water flow to a point on a drainage or river system.

Diffuse pollution: Pollution arising from land-use activities (urban and rural) that is dispersed across a catchment and does not arise as a process effluent, municipal sewage effluent, or an effluent discharge from farm buildings.

Evapotranspiration: The process by which the Earth's surface (water and soil) loses moisture by evaporation of water and by uptake and then transpiration (water loss) from plants.

Filter drain (infiltration trench): Linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base to assist drainage, to store and conduct water, may also permit infiltration.

Flow control device: Device to manage the movement of surface water into and out of an attenuation facility.

Geocellular system: Modular plastic structure which provides for underground water storage or infiltration with variable complexity of internal structure, including load bearing supports.

Green roof: Roof with specific plants growing on its surface providing a degree of retention, attenuation and treatment of rainwater, it also promotes evapotranspiration.

Impermeable surface: An artificial non-porous surface that generates a surface water runoff after rainfall.

Infiltration device: Device designed to aid infiltration of surface water into the ground.

Orifice plate: Structure with a fixed aperture to control the flow of water.

Penstock: A sliding plate which moves vertically to vary the size of an aperture.

Permeable surface: Surface formed of material that is impervious to water but with voids in the surface which allows infiltration of water to the sub-base, eg concrete block paving.

Pervious surface: Surface that allows inflow of surface water into the underlying construction or soil.

Rainwater harvesting: Process to collect rainwater where it falls, eg roofs, rather than allowing it to drain away.

Reed bed: System using reeds to reduce pollutants in surface water.

Soakaway: Subsurface structure into which surface water flows to allow infiltration into the ground.

Source control: Control of runoff at or near its source, eg rainfall on a car park.

Suspended solids (SS): Undissolved particles in a liquid.

Throttle pipe: Pipe with a gradually reducing diameter in the direction of flow.

Weir: Horizontal structure of predetermined height to control flow.

Vortex flow control: The induction of a spiral/vortex flow of water in a chamber to control or restrict the flow.

SUDS management train diagram on front cover with kind permission of CIRIA

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