CIRIA C687

London, 2010

Planning for SuDS – making it happen

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Keywords		
Sustainable water management, flood risk management and surface water drainage, regeneration and contaminated land, sustainability and the built environment		
Reader interest	**Classification**	
Spatial planners, urban designers, landscape architects, drainage engineers, highway engineers, developers, sewerage undertakers, contractors and other organisations involved in the provision	AVAILABILITY	Unrestricted
	CONTENT	Technical guidance
	STATUS	Committee-guided
	USER	Spatial planers, urban designers, engineers, regulators

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CIRIA C687 RP784

© CIRIA 2010 ISBN: 978-0-86017-687-9

British Library Cataloguing in Publication Data

A catalogue record is available for this book from the British Library

Published by:

CIRIA

Classic House, 174–180 Old Street, London, EC1V 9BP

Acknowledgements

Research contractor

This publication is the outcome of CIRIA Research Project 784. The publication was prepared by MWH with support from CIRIA.

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Project funders

Campbell Reith

Environment Agency

Greater London Authority

Hepworth Drainage

Homes and Communities Agency

Hydro International

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CIRIA wishes to acknowledge the following individual who provided substantial additional information and input:

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Illustrations

The illustrations were developed by Ailsa Gunson, Celeste Morgan and Kelly Guest from Aecom.

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Figure 1.6	Environmental Services, City of Portland, Oregon
Case Study 1.2	Bob Bray, Robert Bray Associates
Figure 1.7	Paul Hargreaves, Halcrow
Chapter 2 cover (green roof and swales)	Celeste Morgan, Aecom
Chapter 4 cover	Dusty Gedge, Livingroofs.org
Figure 4.1	Celeste Morgan, Aecom
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Case Study 4.1	Celeste Morgan, Aecom
Figures 4.11 and 4.12	Bob Bray, Robert Bray Associates
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Figure 7.1	Roger Nowell, Sheffield City Council

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				What is specifically demonstrated in the case study?									
Case study ref	Page ref	Location	Development	Delivery of SuDS management train	Managing local flooding	Water quality benefit	Biodiversity and habitat benefit	Community involvement	Educational benefits	Multifunctional benefits	Adoption and maintenance issues resolved	Early and effective stakeholder engagement	Adaptability and retrofitting SuDS
		Symbols identifying specific benefits:											
1.1	7	North Hamilton, Leicester	Residential		✓		✓	✓		✓	✓		
1.2	11	Exwick Heights, Exeter	School	✓			✓		✓		✓		
1.3	12	Elvetham Heath, Hampshire	Residential	✓							✓	✓	
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Introduction

What is the guidance about?

Water is an essential part of our natural and built environment. The way we live, work and play to varying degrees are influenced by the availability and quality of water.

Increasingly we need to embrace water management as an opportunity, rather than a challenge. Successfully delivered sustainable drainage provides communities and wider society with benefits set within the context of adapting to climate change, development and improving our natural environment.

Sustainable drainage systems or SuDS are a more natural approach to managing rainfall where it falls for any site. There are many different SuDS components to suit the opportunities and constraints of a site.

SuDS are an important part of delivering sustainable communities and development, and should be considered together with established requirements for public open space, parking, transport etc. Also, efficiently delivered SuDS will unlock other sustainability benefits within the development, and contribute to ecosystems services.

Have you wondered what SuDS are, discussed their benefits with clients, planners or consultants? Have you wondered what the interactions are with the planning process, and how a good SuDS scheme can be delivered? Have you also wondered how to develop a vision for draining a development more sustainably? If the answer to any of these questions is yes, then this guidance may be of interest to you. It provides information on the planning, design and delivery of attractive and high quality SuDS schemes.

What is the scope of the guidance?

The guidance is primarily intended for use by those people involved in the planning and development process requiring independent and digestible information on the delivery of SuDS. It gives information for those familiar with sustainable drainage about the planning, master planning and development process and how they can be effectively used to deliver a more sustainable approach to drainage. These disciplines include:

- spatial planners
- architects and urban designers
- developers
- drainage engineers
- highway engineers
- landscape architects.

Why use the guidance?

Sustainable drainage offers an opportunity to deliver multiple benefits within a development, contributing to local quality of life and green infrastructure. This guidance seeks to support the delivery of high quality SuDS integrated within developments.

The guidance provides an easy to use reference for those not overly familiar with SuDS, the planning and development process or a mixture of both. It should be viewed within the wider context of surface water management.

The Flood and Water Management Act 2010 proposes a regulatory framework that places local authorities, particularly county, unitary or metropolitan authorities at the heart of SuDS delivery. They will be responsible for the approval and eventual adoption of SuDS in-line with the forthcoming National Standards for Sustainable Drainage. The guidance within this publication is based on good practice and is complementary to the National Standards that are likely to be introduced in 2011. The National Standards will help with the approval, design and construction of SuDS and should simplify the process – the design process will ultimately remain the same.

How to use the guidance

There are symbols throughout the guide to identify specific benefits in case studies and in some of the figures. These are:

Delivery of SuDS management train

Local flood risk management benefit

Water quality benefit

Biodiversity and habitat benefit

Community involvement

Educational benefit

Multifunctional benefit

Adoption and maintenance issues resolved

Early and effective stakeholder engagement

Adaptability of retrofitting SuDS

1 Why sustainable drainage systems?

This chapter will…

- explain why we should use sustainable drainage
- outline the benefits of sustainable drainage
- explain sustainable drainage
- refer to the drivers for sustainable drainage.

1 Why sustainable drainage systems?

1.1 Why change?

When imaginatively and innovatively integrated into the built environment water creates attractive places for people to live, play and work. The management of surface water runoff is an important part of this vision and the water cycle. However, traditional drainage systems were designed to collect surface water as quickly as possible and dispose of it from the built environment through underground pipes (drains and sewers).

Figure 1.1 demonstrates the changes that urbanisation can cause in terms of increasing surface water runoff. This can reduce opportunities for water to be managed naturally with the potential for pollution and localised flooding when the piped systems cannot cope with rainfall.

In many of our towns and cities we have ageing drainage systems that are struggling to cope with existing rainfall and runoff. They are unlikely to cope with further urbanisation and greater extremes in rainfall because of climate change.

Useful information *i*

SuDS mimic natural drainage patterns by:

- storing runoff and releasing it slowly (attenuation)
- allowing water to soak into the ground (infiltration)
- filtering out pollutants
- allowing sediments to settle out by controlling the flow of the water
- creating attractive environments for people and wildlife.

There is a growing acceptance that we need to have a more sustainable approach to managing surface water. Sustainable drainage systems (SuDS) mimic natural drainage processes to reduce the effect on the quality and quantity of runoff from developments and provide amenity and biodiversity benefits.

Planning for SuDS – making it happen guides you through a relatively new approach to managing rainfall in our towns and cities, encouraging an integrated multi-disciplinary approach towards managing runoff. This guidance can help those involved in the planning system understand their involvement in sustainable drainage, how SuDS should be incorporated into the planning process and the importance of early decision making.

1.2 Benefits of sustainable drainage

A good SuDS scheme will be compatible with the landscape and can be seamlessly integrated with other urban design features within a development. Depending on the design criteria (➲ **Section 5.1**) often they provide multiple benefits, eg drainage, public open spaces, and car parking. Figure 1.2 provides an overview of some of the benefits, which can be associated with ecosystem services.

When specifying SuDS, early consideration of potential benefits and opportunities will help deliver the best schemes.

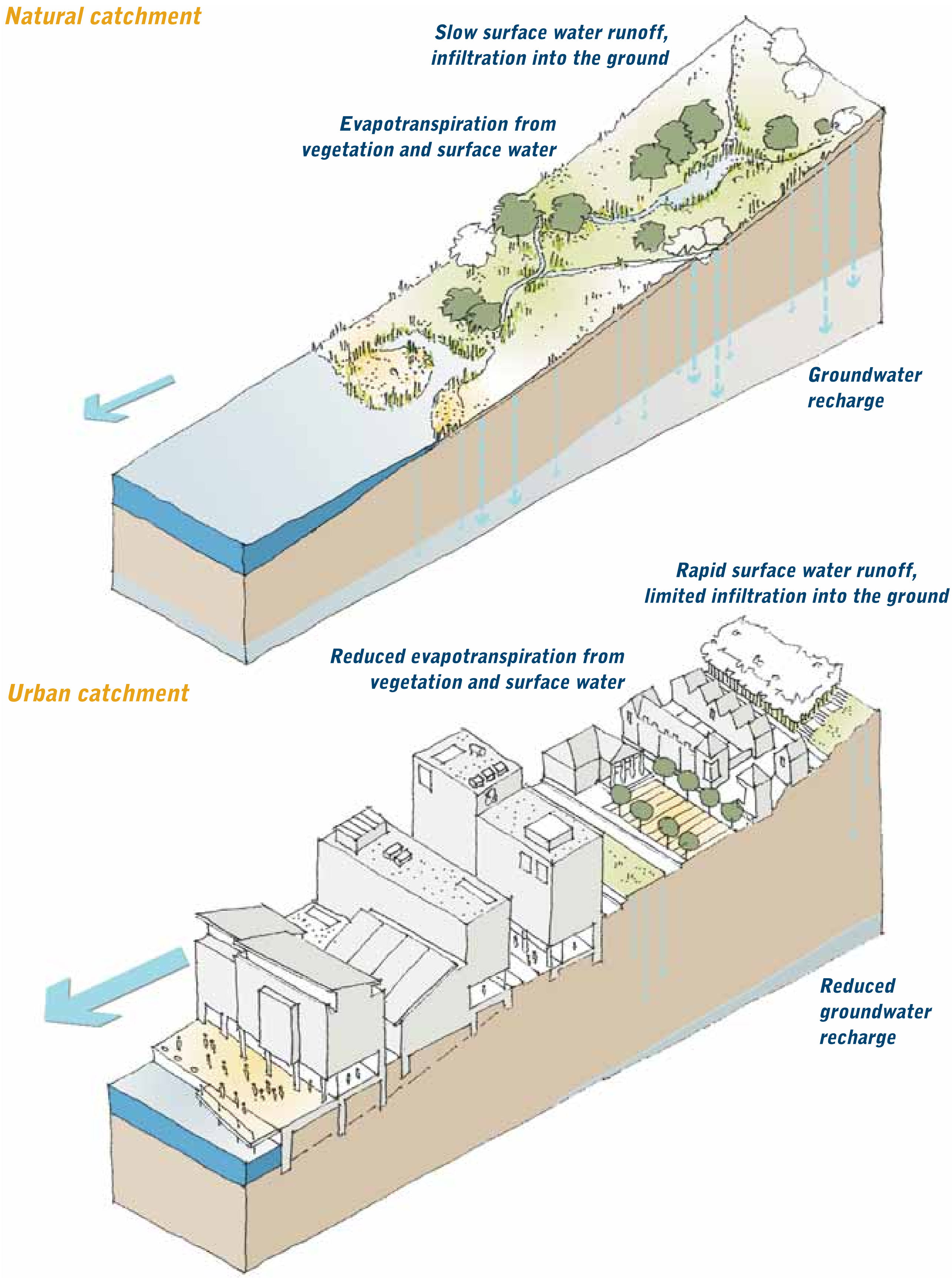


Figure 1.1 Effects of urbanisation on the water cycle

North Hamilton, Leicester (➲ **Case study 1.1**) shows how delivering SuDS has introduced several benefits to the site, such as creation of ponds with good biodiversity and open space, which has given local residents pride in their surroundings.

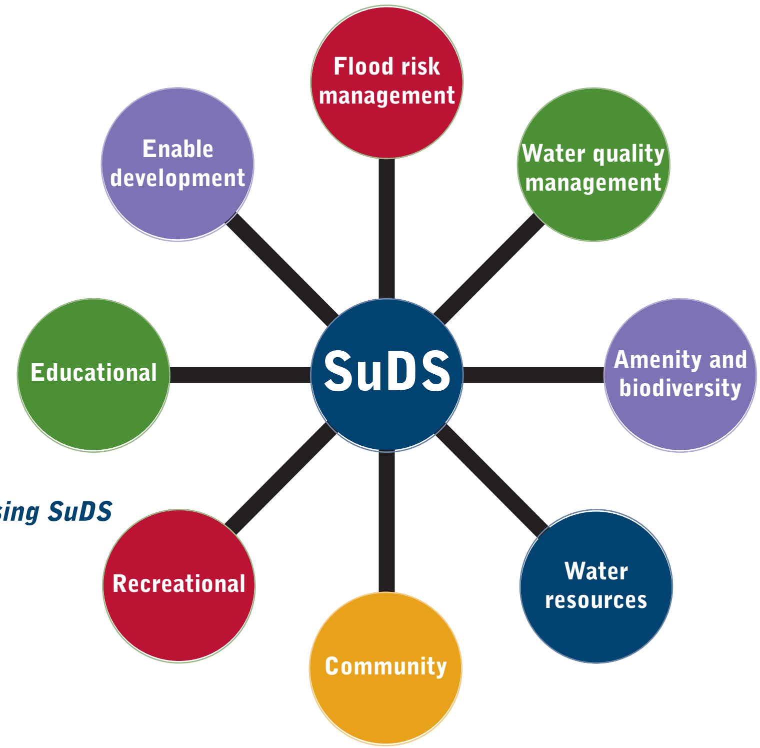


Figure 1.2

Benefits of using SuDS

Case study 1.1

Residential development, North Hamilton, Leicester

Location	North Hamilton, Leicester
Type of development	Residential
SuDS used	Swales and retention ponds

Background

This residential development is located on former agricultural grassland. The aim of the scheme was to mimic natural drainage patterns, removing the need to connect to traditional sewers, which would reduce cost. The main focus for the use of SuDS was existing flooding problems in the nearby Melton Brook.

The SuDS components are an integral part of the site, which have been designed as water features.

The scheme does not include many source control components but it does include retention ponds and swales, which have been used to improve the visual landscape and local biodiversity value.

The retention ponds include open water, marginal vegetation and reedbeds within the swales that all improve the biodiversity value of the facilities. Wildlife that has been attracted to the area includes the Gadwall duck, which is a rare species.

The ponds with nearby grassland now meet the criteria for designation as a local wildlife site.

Local people take more pride in their local environment, and maintenance is undertaken by a private maintenance company

Flood risk management benefits

Development often alters natural drainage by replacing free draining ground with impermeable surfaces, gulleys, pipes, sewers and channels. Also, it can remove vegetation and compact the ground. These changes increase the total volume and flow of runoff and may make areas more susceptible to flooding locally but also exacerbate river flooding.

Our climate is changing, and recent research suggests that:

- winters may become milder and wetter with more intense rainfall events
- summers may be hotter and drier across the UK
- extreme weather events may become more frequent, eg heat waves, cold snaps and heavy rainfall.

We need to have drainage systems that can adapt to and mange the extreme events including flooding and periods of drought, while reducing our carbon emissions.

SuDS schemes can be designed to slow water down (attenuate) before it enters the watercourse, provide areas for water storage in natural contours, and can be used to allow water to soak (infiltrate) into the ground (➲ **Section 2.1**) or evaporated from surface water and transpired from vegetation (known as evapotranspiration). These benefits of SuDS have been highlighted in Defra (2008) and the Flood and Water Management Act 2010. SuDS are already the preferred approach for surface water management for most planning authorities.

Figure 1.3 Runoff flowing into a swale as part of public open space, Ipswich, England

Water quality management benefits

Our activities lead to numerous pollutants (such as oil, sediments, fertilisers, pesticides, animal waste and litter) that can cause diffuse pollution and adversely affect the environment, which is not managed by traditional piped drainage. Pollutants or contaminants can be washed into sewers and eventually watercourses through surface water runoff making it difficult to comply with water quality legislation.

Some SuDS components provide water quality improvements by reducing sediment and contaminants from runoff either through settlement or biological breakdown of pollutants.

The Water Framework Directive (WFD) (Directive 2000/60/EC) established a framework for the protection, improvement and sustainable use of all water bodies across Europe, ie all rivers, lakes, canals, estuaries, coastal waters, wetlands and groundwater.

Amenity and biodiversity benefits

There is increasing pressure on planners and developers to deliver green infrastructure. SuDS can help meet this challenge and improve a development by creating habitats that encourage biodiversity and simultaneously provide open space.

SuDS provide an array of amenity, recreational and biodiversity benefits (➲ **Case studies 1.1 and 5.1**), particularly from components like ponds and stormwater wetlands. However, they will only fulfil their ecological potential, if their design criteria consider ecology, flood risk and water quality management together (➲ **Section 5.1**).

SuDS provide opportunities to create visually attractive green (vegetated and landscaped) and blue (water) corridors in developments connecting people to water. This encourages opportunities for returning modified watercourses (culverts, engineered channels etc) to their more natural, visually and environmentally appealing state.

Figure 1.4 Wildlife benefit of SuDS

For guidance on maximising the ecological value of SuDS ponds see *Ponds, pools and lochans* (Biggs *et al* 2000)

Water resource benefits

As we adapt to climate change it is important that we consider how we can connect the water cycle. In areas that require water cycle studies, where the effects of development on the water cycle have to be managed, often SuDS are required.

Some SuDS components that soak water into the ground can recharge underground aquifers (where there is no risk of polluting the aquifer). More specifically SuDS can capture, or harvest rainwater that can be used for functions that do not require treated water from the mains (flushing toilets, irrigation etc). This may contribute to water efficiency and, depending on the scale of the system, can contribute to localised flood risk management. Also, this is a good approach to scoring highly in the *Code for Sustainable Homes* (CLG, 2006).

Community benefits

National and regional planning policies encourage the design of attractive public open space and the development of social cohesion to improve the quality of life and create better communities. Well designed SuDS can incorporate many of these aspects that create better places to live, work and play.

SuDS deliver value and benefits for the community often in highly urbanised areas improving local quality of life and our interaction with water. How? By:

- using green space to store runoff
- creating habitat for wildlife
- creating attractive areas for social and recreational activities
- using rain gardens in highways to collect and infiltrate runoff, and calm traffic.

By introducing water to the urban environment the planning process provides the opportunity to bring SuDS into the public arena, addressing the aspirations of the public for a better, cleaner and greener urban environment. Wetlands can become wildlife parks with stepping stones, boardwalks and islands. Similarly, ponds with the inclusion of footpaths, benches, picnic tables etc can be exciting social and recreational areas. Ponds and wetlands will be assets to the community, enhancing the quality of life, by providing attractive and tranquil green space within the built environment.

Figure 1.5 Stormwater wetland area, Malmo, Sweden

Recreational benefits

SuDS can deliver recreational benefits through the dual use of components and facilities such as using attenuation and storage areas and overland conveyance routes for play and/or sports areas (➲ **Figure 2.6**). Also, multifunctional use of SuDS components can have other benefits such as the incorporation of recreational open space into a development that otherwise may be deemed impracticable by a developer.

Educational benefits

In addition to improvements to the visual appearance of a development, many SuDS components have been used for recreational and educational purposes with schemes located in school grounds. Exwick Heights School, Exeter (➲ **Case study 1.2**) includes SuDS to manage surface water that also provides an invaluable learning resource about water. Within the school green roofs provide storage for dealing with runoff on site, to help mitigate surface water storage and disposal costs, as well as increasing noise and heat insulation. The scheme uses a permeable pavement, under-drained swales and feature ponds at the end of the system and further down the receiving watercourse. Rainwater is harvested by a permeable play space that collects water from roofs and other hard surfaces to be used for toilet flushing.

In the city of Portland, USA many of the playgrounds are designed to educate pupils in surface water management. Mt Tabor Middle School is a good example of this approach. Previously, the area had experienced sewer flooding. A rain garden was retrofitted into a playground and a car park to capture runoff from impermeable surfaces on the roof and asphalt. This reduces runoff entering the sewer system and encourages infiltration. Fencing and barrier planting of shrubs controls access to the garden, with viewing areas provided to allow the area to be observed.

***Figure 1.6** Rain garden constructed on a school playground, Portland, USA*

Benefits for developers

Delivery of SuDS can enable the granting of planning permission as sustainable drainage is encouraged through national planning policy. The Environment Agency expects SuDS to be incorporated into new developments.

SuDS can provide savings on the overall construction and maintenance of drainage schemes. The SuDS scheme at Lamb Drove, Cambourne and Cambridgeshire gave a 10% saving on design and capital costs to traditional drainage. This saving could have increased with effective pre-application discussions.

The use of SuDS and resultant improvements in visual attractiveness of a development has been proven to increase house values by 10% to 20% (➲ **Case study 1.3**).

Also, sustainable drainage can be integrated into strategies for public open space and green infrastructure within developments. This will link urban areas through the development of blue/green corridors, such as the proposals set out in the Camborne Pool Redruth surface water management plan (SWMP) and drainage implementation strategy (DIS) (➲ **Figure 1.7**).

Case study 1.2

Location	Exwick Heights, Exeter
Type of development	School
SuDS used	Swales, permeable paving, rainwater harvesting, green roofs, filter drains, detention basins and stormwater wetlands

Background

The Exwick Heights Secondary School is located on a steeply sloping site. The access road, school building and play spaces are positioned at the top of the site on two terraces with a multi-use games area (MUGA) and sports pitch mid-way.

The car park is drained using permeable pavement with runoff passing through concrete blocks into voided stone to provide full storage and release of water at greenfield rate of runoff to adjacent grass basins that collect road runoff.

Runoff from the entrance road and paths flows directly to a detention basin or roadside swale with storage of first flush runoff to allow silt and spillage management but allowing large storm events to bypass to wetland attenuation lower down the site.

Runoff from the access road and play surface behind the school is stored within the road construction beneath the impermeable tarmac road surface flowing via a control chamber to low flow grass channels. By removing the requirement for silt traps, storage structures and deep excavation, flows are at greenfield rate of runoff. Where flows cross the contour, they drop down in stone filled baskets to prevent erosion before entering the biodiversity pond at the bottom of the site. Runoff from the school roof is attenuated and cleaned by a green roof.

The upper terrace and school entrance drive generally drain to the roadside swale. The runoff from the lower terrace is collected in the filter drain and stored in the play area. This then discharges directly to a low flow channel beyond the gabion wall to the wetland and pond feature lower down the site.

The MUGA hard play has a permeable asphalt surface over voided stone construction and acts as a collector for both the play surface and nearby hard areas.

Case study 1.3

SuDS integrated at a residential development, Elvetham Heath, Fleet, Hampshire

Location	Elvetham Heath, Hampshire
Type of development	Residential
SuDS used	Soakaways, detention basins, a pond and swales

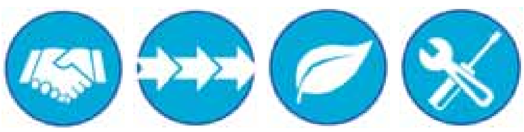
Background

Elvetham Heath is a residential development in Hampshire that integrated SuDS. The main reason for using SuDS was because the development was close to a site of special scientific interest (SSSI) immediately downstream.

The drainage strategy was to use soakaways to drain areas of high ground, swales for conveyance in the flattest areas and shallow detention basins for attenuation and to encourage infiltration to reduce the amount of runoff. A retention pond is used as a regional control immediately upstream of the nature reserve, and it also incorporates several proprietary SuDS engineering components.

Thames Water adopted the drainage system but Hart District Council carries out operation and maintenance of all landscaped SuDS schemes as well as other public area landscaping, based on a commuted sum paid by the developers.

Research into the residents responses at the site suggest that the local community has high regard for the scheme, which is reflected in the positive values of properties close to open water.



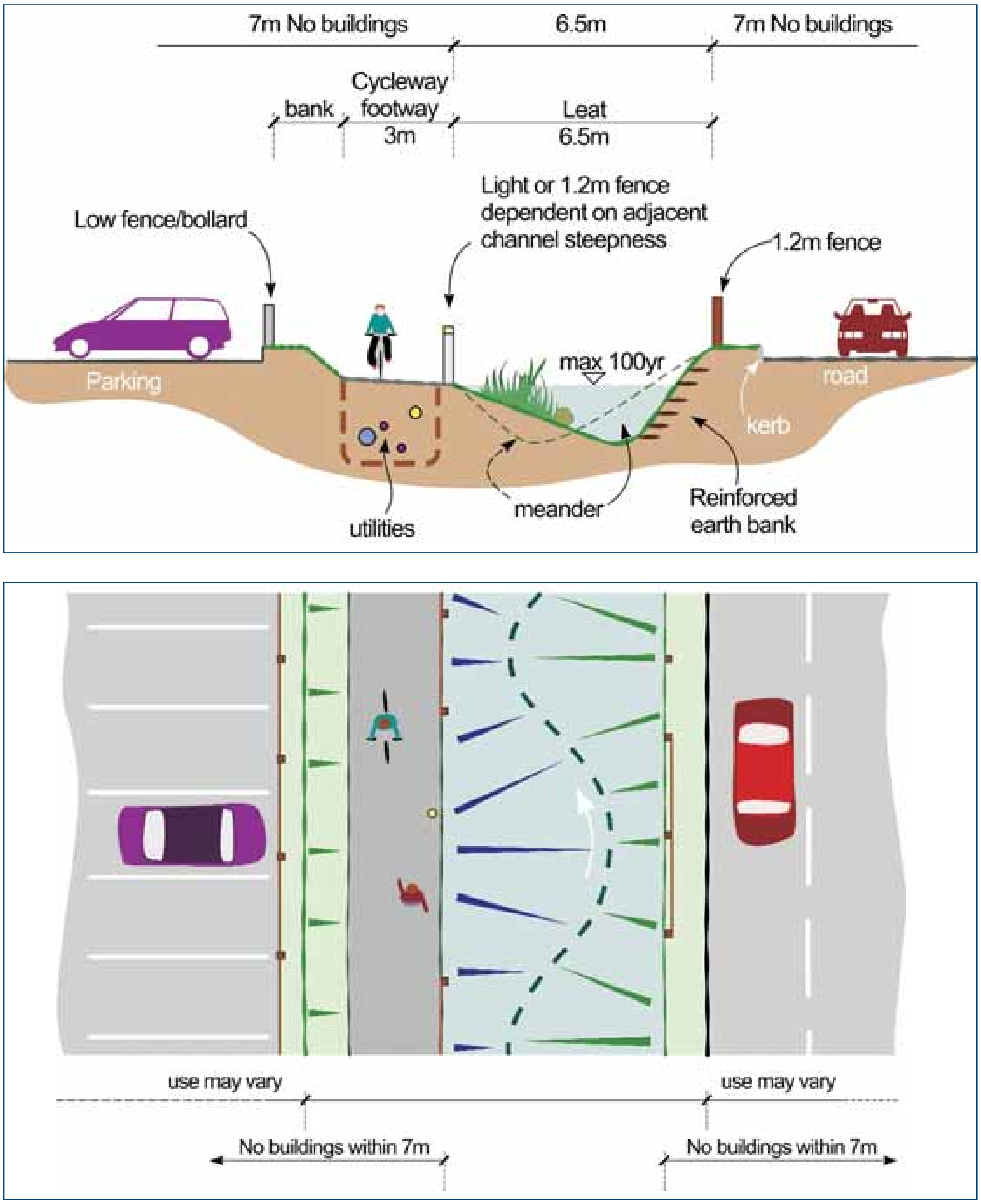


Figure 1.7 Camborne Pool and Redruth SWMP and drainage implementation strategy

1.3 Sustainable drainage explained

SuDS are becoming the preferred approach for managing surface water runoff. This more natural approach to managing water as close to its source (where it falls) helps manage flood risk, water pollution as well as contributing amenity and biodiversity. The SuDS triangle (Figure 1.8) presents the primary benefits of sustainable drainage. The extent to which these benefits can be realised will depend on the opportunities and constraints of the site.

Sustainable drainage uses both landscaped features and harder engineering. Landscape features include green roofs, and more natural features such as ponds, wetlands and shallow vegetated channels called swales. Harder engineered SuDS components, such as permeable paving, and soakaways can be used and often are incorporated into high density developments.

SuDS components are described in further detail in Chapter 2 (➲ **Section 2.2**). Figure 1.9 is an illustration of how different SuDS components can be integrated into a development. The SuDS management train (➲ **Section 2.3**) is an important concept in delivering sustainable drainage and maximising benefits. This is where SuDS components (described in Section 2.2) are used in sequence to provide an integrated and balanced approach to managing surface water. This approach helps to imitate the natural drainage system by focusing on managing surface water as close to where it falls as possible. In Figure 1.9 SuDS components like permeable paving, green roofs and bioretention help manage water close to the source of runoff, with it then being conveyed to ponds and wetlands further downstream.

Sustainable drainage requires a new approach to surface water management, moving away from traditional piped drainage systems promoting wider environmental objectives and meeting the requirements of new legislation. Sustainable drainage is different to traditional drainage because:

- it delivers a higher environmental performance expected by society
- it is often visible above ground, enabling easier inspection and management
- it is often easier to manage
- it is often multi-purpose, eg providing drainage and public open space, or car parking, etc
- it reduces the rate and volume of runoff from development with more natural approaches
- it can remove pollutants from runoff
- it is easier to adapt to climate change and developmental pressures.

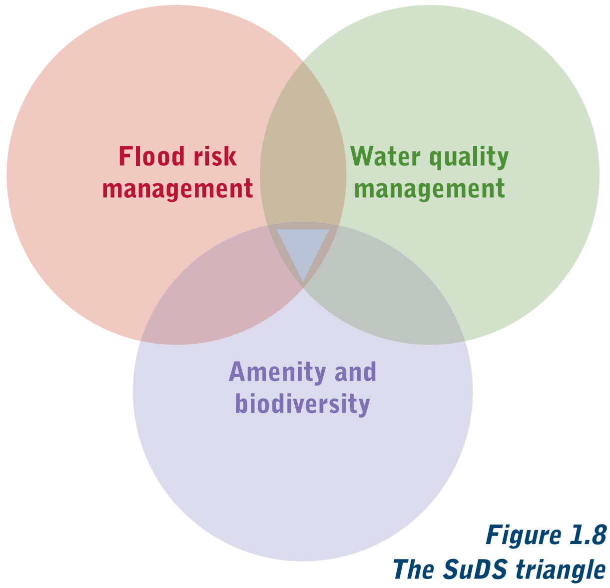


Figure 1.8 The SuDS triangle

1.4 Policy and regulatory drivers

The Flood and Water Management Act 2010 introduces a legal requirement for sustainable drainage in new developments and redevelopments. SuDS will become the norm and the use of traditional drainage systems will become the exception. This will be supported by the forthcoming National Standards for Sustainable Drainage that will help developers, builders and local authorities meet these new legal requirements. Chapter 3 explains the regulatory aims and approaches to work with the planning and development process in lieu of the National Standards being introduced.

Sustainable drainage should be seen in the context of other surface water management approaches, including flood routing, the management of extreme events where the rainfall exceeds the capacity of the drainage system (drainage exceedance) and the opening of urban channelised watercourses (culverts). These approaches help manage flood risk, the compliance with the Water Framework Directive (WFD) and a connection with water and the environment.

1 Urban square with permeable paving
2 Retention pond with integrated seating
3 Rill within pedestrianised shopping street
4 Brown roofs within town centre
5 Planted road-side bioretention strips
6 Detention basin/infiltration trench
7 Green roofs
8 Segmented micro-wetland within courtyard
9 Filter strip and retention pond within residential square
10 Permeable paving within residential street/ mews
11 Road-side bioretention tree pits
12 Large, naturalised swale within green space
13 Wetland areas
14 Natural waterway
15 Rainwater butt

Figure 1.9 Integration of SuDS into a development

1.5 Key learning points

What are the benefits of using SuDS?

Managing flood risk

- less surface water entering sewers (freeing capacity and reducing flood risk)
- flow control and dealing with surface water at a catchment level helps manage flood risk
- allows adaptation to a changing climate
- making space for SuDS allows overland flow routing and management of flooding from extreme events (drainage exceedance).

Managing water quality

- water quality will be managed to reduce the amount of pollution in runoff
- assists with compliance with the Water Framework Directive.

Amenity and biodiversity

- the use of SuDS can contribute to the quality of the place
- provides opportunities for multifunctional areas (play areas in detention basins)
- provides wildlife habitat and ecological benefit.

Water resources

- some components can recharge underground aquifers
- harvested rainwater can be used for toilet flushing, garden irrigation etc.

Community and recreation

- SuDS can improve local quality of life
- promotes attractive surroundings to socialise and undertake recreation.

Education

- enables children to improve their understanding of the water and natural environment
- provides attractive environments for education.

Developers

- reduced construction costs
- reduced maintenance costs compared to many traditional drainage methods when carried with landscape maintenance
- increased property values.

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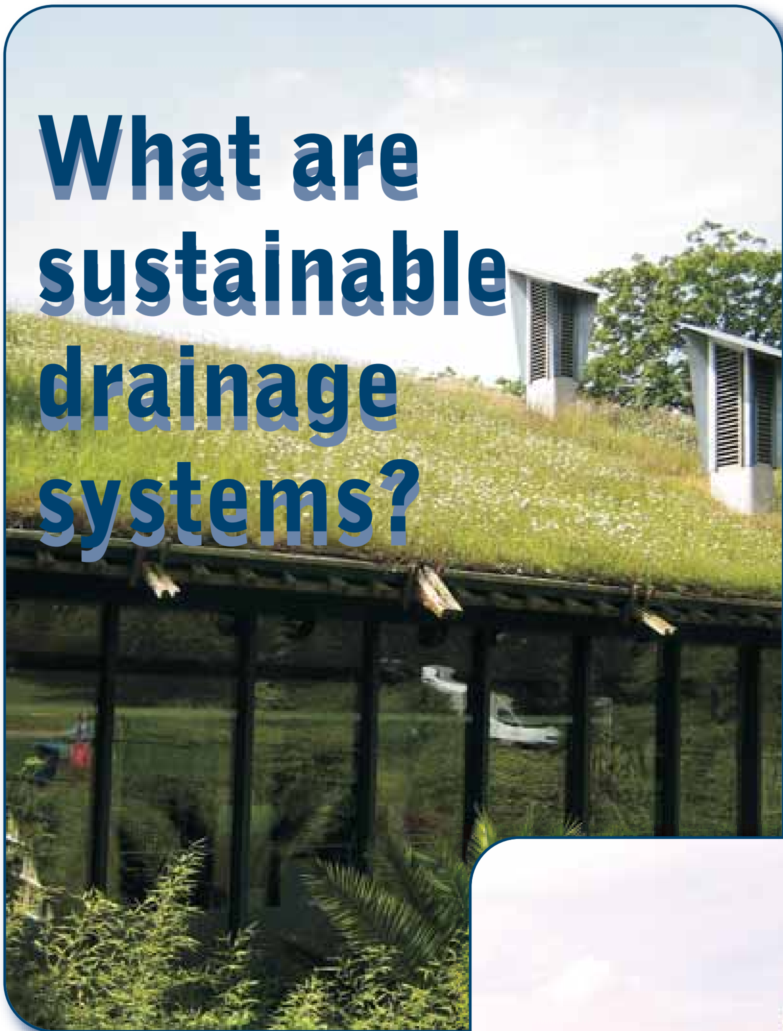
Statutes

Flood and Water Management Act 2010

2

What are sustainable drainage systems?



This chapter will…

- describe the SuDS approach
- introduce the SuDS components
- describe the SuDS management train
- explain the importance of the management train
- discuss where SuDS can be used.

2 What are sustainable drainage systems?

2.1 Sustainable drainage approaches

SuDS include a wide range of different components that can be designed to cope with flows from a variety of developments and sites. SuDS components work in several ways: they can infiltrate (soak) into the ground, convey (flow) into a watercourse (or if necessary a sewer), they can also provide storage on site and attenuate (slow down) the flows of water. Often SuDS schemes use a combination of these processes. More detailed information on the design and technical specification of sustainable drainage can be found in *The SUDS Manual* (Woods-Ballard *et al*, 2007a). The design of the scheme will depend on the site and the design criteria used (➲ **Section 5.1**).

Useful information *i*

The SuDS approach

- mimic natural drainage – the collection of rainfall in components or features that slow, store or filter water at the surface
- control water at its source – manage rainfall as close to is source as possible
- use the SuDS management train – uses a sequence of SuDS components to help manage the flow and volume of water. It also provides incremental improvements in water quality.

Generally, water is an attractive feature that people enjoy. SuDS improves water in the landscape and provides a focal point for developments.

Section 1.2 discuses the benefits of SuDS in detail. Some simple components can be incorporated into schemes to promote their ecological value, such as providing native planting or a series of shallow pools. Maximising the ecological value of SuDS gives an important contribution to urban areas. Also, good ecology is linked to high quality attractive environments that have a wide public appeal.

Figure 2.1 ***SuDS scheme providing amenity and biodiversity***

Figure 2.2 **Wetlands providing habitat, biodiversity and green corridors, Elvetham Heath, England**

Figure 2.3 **Wetland managing pollution by controlling discharge into the watercourse**

Figure 2.4 **Regional pond providing biodiversity, Elvetham Heath, England**

Well designed SuDS schemes can drain:

- permeable and impermeable sites
- sites with clay soil
- steep and flat sites
- large open spaces
- small constrained sites
- high density developments
- sites with contamination.

✓

2.2 SuDS components

A diverse range of SuDS components are available, each suited to different site opportunities and constraints. In most cases, a combination of components is required to provide the best results. With this in mind, and with careful consideration and selection, sustainable drainage can be used on most, if not all sites.

SuDS are not just traditional soakaways, ponds or wetlands, but are a suite of measures working in different ways that can be used to drain a variety of sites. Table 2.1 provides an overview of different SuDS components and their suitability. The level of operation and maintenance will vary depending on the type of SuDS component and scheme, and site considerations. Further information can be found in *The SUDS Manual* (Woods-Ballard *et al*, 2007a).

Dealing with water when and where it falls (source control) may be the preferred, cheaper and easier option for many developments. Source control is more appropriate in urbanised areas where space may be at a premium and less readily available (➲ **Case study 4.3**). By dealing with runoff at the source the volume of water and the potential amount of contamination is less, which requires smaller SuDS components further downstream. Often source control components are within the curtilage of properties and maintained by the property owner or manager and can include green roofs, permeable surfaces, rainwater harvesting etc.

Figure 2.5

Source control: rain garden and green roof, Malmo, Sweden

Runoff is then conveyed to site or regional controls. Site control is runoff and is managed from several local sources. Typically it includes, swales, detention basins etc.

Regional control components manage runoff from sources locally and across the site and often include, basins, ponds, wetlands.

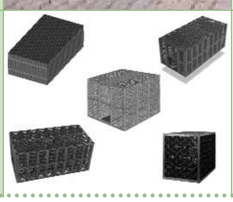
Usually, site and regional controls require more space to deal with bigger volumes of water and contamination. However, they have greater potential to provide habitat, amenity and flood risk management opportunities, by dealing with larger volumes from multiple sources. Also, they are found in the public realm and early consideration of adoption or long-term management is required.

The SuDS management train requires the use of components in sequence that work together to manage the flows, volumes and pollution. Prevention initiates the sequence where runoff and/or pollution is reduced and this follows on to source control, then site and regional controls providing benefits further downstream (➲ **Figure 2.7**).

Integrated planning unlocks multiple benefits from SuDS components when innovatively designed into open space, and can help deliver the SuDS management train. Figure 2.6 shows a play area in public open space, overlooked by residential properties in Malmo, Sweden. This attractive design uses the available space and creates a sustainable drainage feature in the development, further improving the urban form.

Figure 2.6 Play areas incorporating attenuation, Malmo, Sweden

Table 2.1 SuDS components

		What	Why	Where	Flood risk management benefits	Water quality management benefits	Amenity and biodiversity benefits
Green roofs		The roof of a building that is partially or completely covered with vegetation or another growing medium.	To control runoff as close to source. Store water and filter out pollutants. Can provide other benefits.	Private in curtilage (source control).	☆☆☆	☆☆	☆☆☆
Soakaways		Excavation or trench that can be filled with filter material. Can be made of pre-cast concrete or polyethylene rings/ perforated storage structures that are then backfilled with granular material. Allows water to soak away into the ground.	To store runoff, filter out pollutants and recharge groundwater.	Private in curtilage (source control). Also next to roads. Can be easily retrofitted.	☆☆☆	☆☆☆	☆
Rainwater harvesting		System to collect water from impermeable surfaces for use in non-potable water situations.	Reduce the amount of potable water use.	Private in curtilage (source control).	☆☆☆	☆☆	☆
Permeable pavements		Surfaces that allow water to soak into the ground or a gravel-filled base. Porous surface replaces traditional hard (impermeable) surfaces.	Water is stored in the base and released gradually. Also, it can treat runoff and remove pollutants. Can be used in permeable and impermeable ground conditions (it incorporates some form of outflow and overflow component).	Private in curtilage (source control), car parks and some roads.	☆☆☆	☆☆☆	☆
Geocellular /modular systems		Modular plastic systems that can be used to create below ground infiltration or storage.	Can both store and allow infiltration of water. Flexible systems that can be used on most sites.	Driveways, car parks, next to roads.	☆☆☆	☆	☆

Key

Good contribution ☆☆☆
Medium contribution ☆☆
Low contribution ☆

Table 2.1 SuDS components (continued)

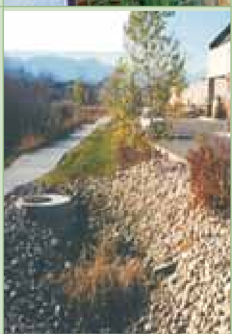
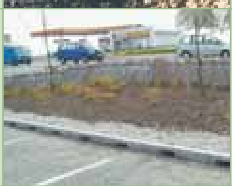
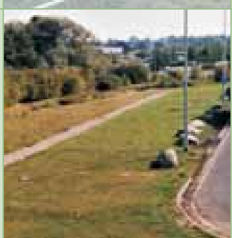
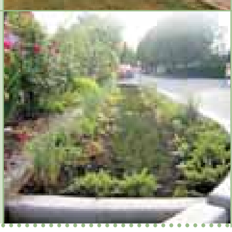
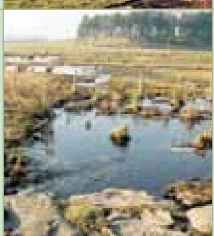
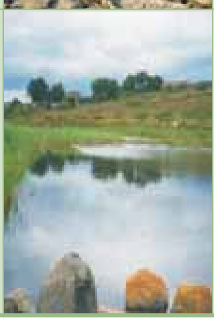
		What	Why	Where	Flood risk management benefits	Water quality management benefits	Amenity and biodiversity benefits
Channels and rills		Open landscaped channels which can be vegetated, used to convey water from one SuDS component to another.	Used to convey water and can provide some storage.	In curtilage, in open space.	☆☆	☆☆☆	☆☆☆
Bioretention		Depressions backfilled with a sand/soil mixture and planted with vegetation. Water enters through a vegetated surface and then trickles via a filter layer entering a perforated pipe at the bottom before being carefully transported downstream.	To store water and release it gradually. Some water quality improvement is provided by a filter layer.	Private in curtilage SuDS (source control), in open space, next to roads and car parking.	☆☆☆	☆☆☆	☆☆☆
Infiltration trench		Stone-filled trenches that allow water to soak into the ground, as close to where the rain lands as possible.	To control the amount of runoff and provide storage. Needs permeable ground conditions.	Open space next to roads (if preceded by filter strip) and car parks.	☆☆☆	☆☆	☆☆☆
Filter strips		A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and filter out silt and other material.	To filter out pollutants, especially sediment, before runoff entering another SuDS component or watercourse.	Open space, next to roads and car parks.	☆☆	☆☆☆	☆☆
Rain garden		Vegetated area into which runoff is drained, attenuated and stored. Water infiltrates into the ground or is taken up by plants.	To store runoff, filter out pollutants and recharge groundwater.	Next to roads, in residential developments and throughout urban areas.	☆☆☆	☆☆☆	☆☆☆

Table 2.1 SuDS components (continued)

		What	Why	Where	Flood risk management benefits	Water quality management benefits	Amenity and biodiversity benefits
Filter drain		They are gravel filled trenches with a pipe with small holes installed in the bottom.	The gravel slows the flow by storing water and releasing it gradually. Can be used in permeable or impermeable conditions. May need periodic maintenance to prevent siltation.	In open space, next to roads and car parks.	☆☆☆	☆☆	☆
Swales		Shallow vegetated swales that can run parallel to hard surfaces, allowing runoff to trickle down the side slopes and into the base of the component. Water is then transported in a controlled manner to another SuDS component or to a stream or river downstream.	To treat and attenuate runoff. Can be used in permeable or impermeable ground conditions (if under-drained).	In open space, next to roads and car parks.	☆☆☆	☆☆☆	☆☆
Trench troughs		Open landscaped channels which can be vegetated, over filter medium and under-drained. Used to convey, attenuate and improve water quality.	Used to convey water. Will provide some storage and attenuation.	In open space.	☆☆☆	☆☆☆	☆☆☆
Detention basin		Shallow vegetated depressions to control the amount and rate of runoff and some water quality improvement.	To store water during large storms, and release it gradually.	In open space.	☆☆	☆☆☆	☆☆
Wetland		Retention ponds with more emergent aquatic vegetation and a smaller open water area.	The wetlands store water and release it slowly. Sediment removal also takes place through settlement and biological treatment occurs due to the vegetation.	In open space, next to roads and car parks.	☆☆☆	☆☆☆	☆☆☆
Retention ponds		Artificial ponds with an open water area and marginal wetland around the edge. Also, should incorporate a stilling/settlement area at the inlet to allow for some treatment and calming of storm flows to prevent shock loading of the main water body.	Ponds store water and release it slowly, allowing sediment to settle in the pond in a designated basin at the inlet, while the vegetation provides biological treatment. Can be hard engineered.	In open space.	☆☆☆	☆☆☆	☆☆☆

2.3 The SuDS management train

For SuDS to best mimic natural drainage, a management train approach should be adopted. This is fundamental in achieving a successful SuDS scheme, as it uses drainage components in sequence to incrementally manage pollution, flow rates and volumes. Figure 2.7 shows the SuDS management train.

> ***Useful information*** *(i)*
>
> Good planning of a site involves consideration of surface water from the start. Delivery of SuDS is easier if they are planned and designed to be fully integrated into the urban environment.

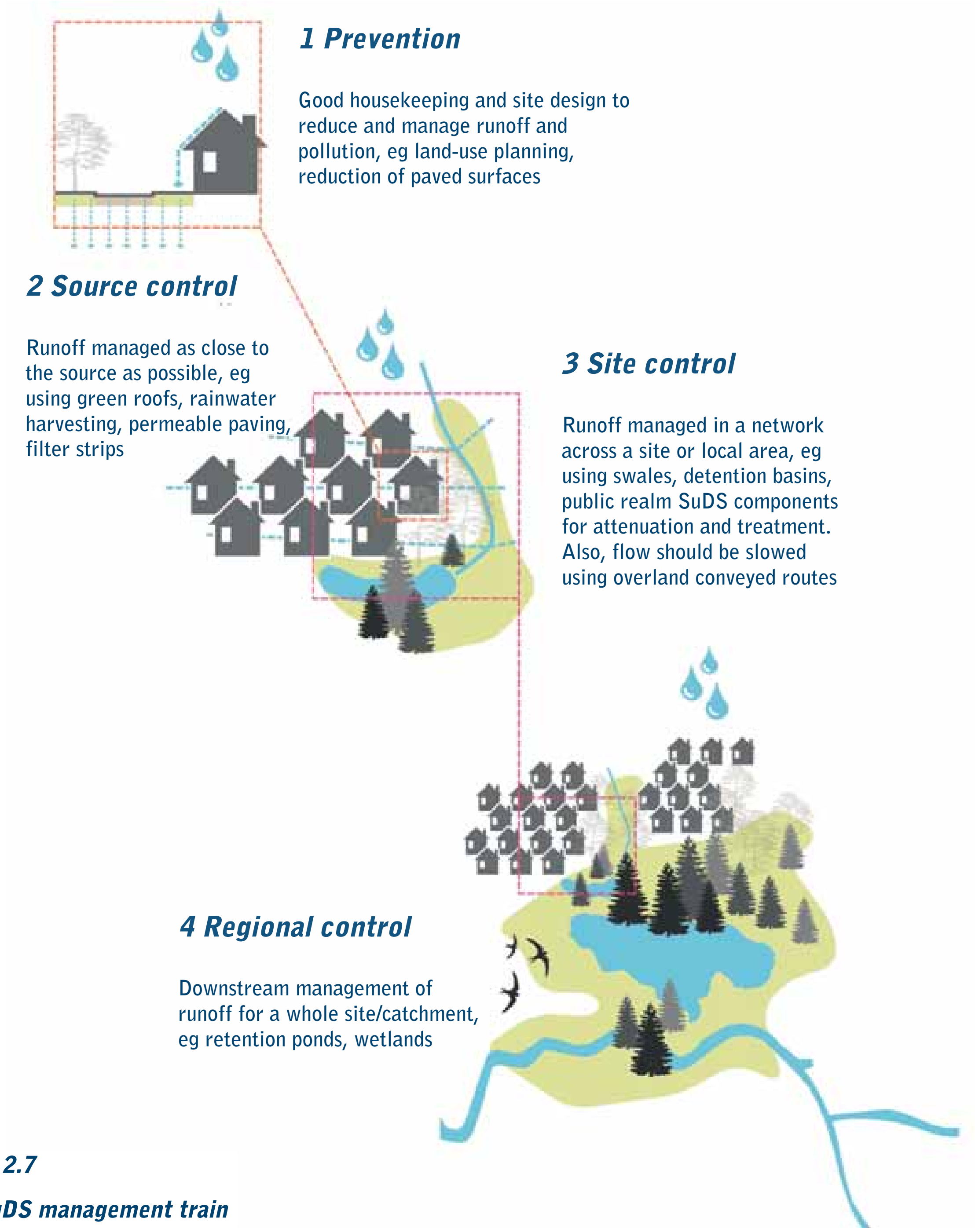


Figure 2.7

The SuDS management train

Case study 2.1

Location	Hopwood M42, Worcestershire
Type of development	Motorway service area
SuDS used	Filter trenches, filter strip, swale, wetland and pond

Background

The motorway service area (MSA) comprises a building surrounded by coach and car parking and a dedicated HGV park with a centrally located fuel filling area. The MSA is enclosed in a series of planted banks and falls northwards to the Hopwood Stream, which eventually flows to the River Arrow.

The site comprises 34 hectares, of which 25 are wildlife reserve. A stormwater ditch draining the A441 divides the MSA into two sub-catchments, the HGV park and the remainder of the MSA.

Runoff from the HGV park is directed to a tributary of the Hopwood Stream via the wildlife reserve to enhance a pre-existing wetland and help sustain base flow in the watercourse.

Open wetland systems are protected by pre-treatment components including filter strips, treatment trenches or separators to reduce pollution or silt loading and prevent catastrophic damage in the event of spillage.

The site is above naturally occurring arsenic in the ground and the wetland basins are lined completely where designed to treat runoff or partially where a retention volume is required in the pond feature.

Areas considered to pose a pollution risk to the environment have used the SuDS management train to ensure good water quality and deal with unforeseen spillage events. The HGV park and the fuel filling area, coach park and service yard potentially pose a serious pollution risk and have an extended management train.

The SuDS management train encourages the control of surface water as close to the source as possible on site and close to the development rather than being transferred and managed in larger components downstream. This improves pollution management, contributes to the overall development, and can help reduce the land take of water in the whole catchment.

Table 2.2 suggests the number of treatment stages or components required to remove pollution from runoff, it is important that silt and pollution is removed before it reaches components like ponds or wetlands and risks of contamination is considered. *The SUDS Manual* (Woods-Ballard *et al*, 2007) provides further detail about water treatment. The National Standards will include a framework for managing water quality, and the approach to managing water quality may change once the Standards are introduced. Urban designers, landscape architects, highway engineers and other stakeholders working together are important for translating such aspirations into reality, and ensuring sustainable development is delivered.

Hopwood Motorway Services (➲ **Case study 2.1**) is an example of how the SuDS management train approach can be applied in practice. The main reason for using this approach was to ensure good water quality. Source control components trap most of the contaminants from the site, protecting the downstream components. When an unforeseen spill occurs, the pollutants can be easily contained, limiting the amount of remedial work required on the whole system and ensuring contaminants do not enter any nearby watercourses.

Table 2.2 SuDS treatment requirements

Runoff pollution content	Catchment characteristics	Number of treatment stages or SuDS components
Low	Roofs	1
Medium	Roads, parking areas, commercial zones	2
High	Refuse collection and industrial areas, loading bays, lorry parks	3

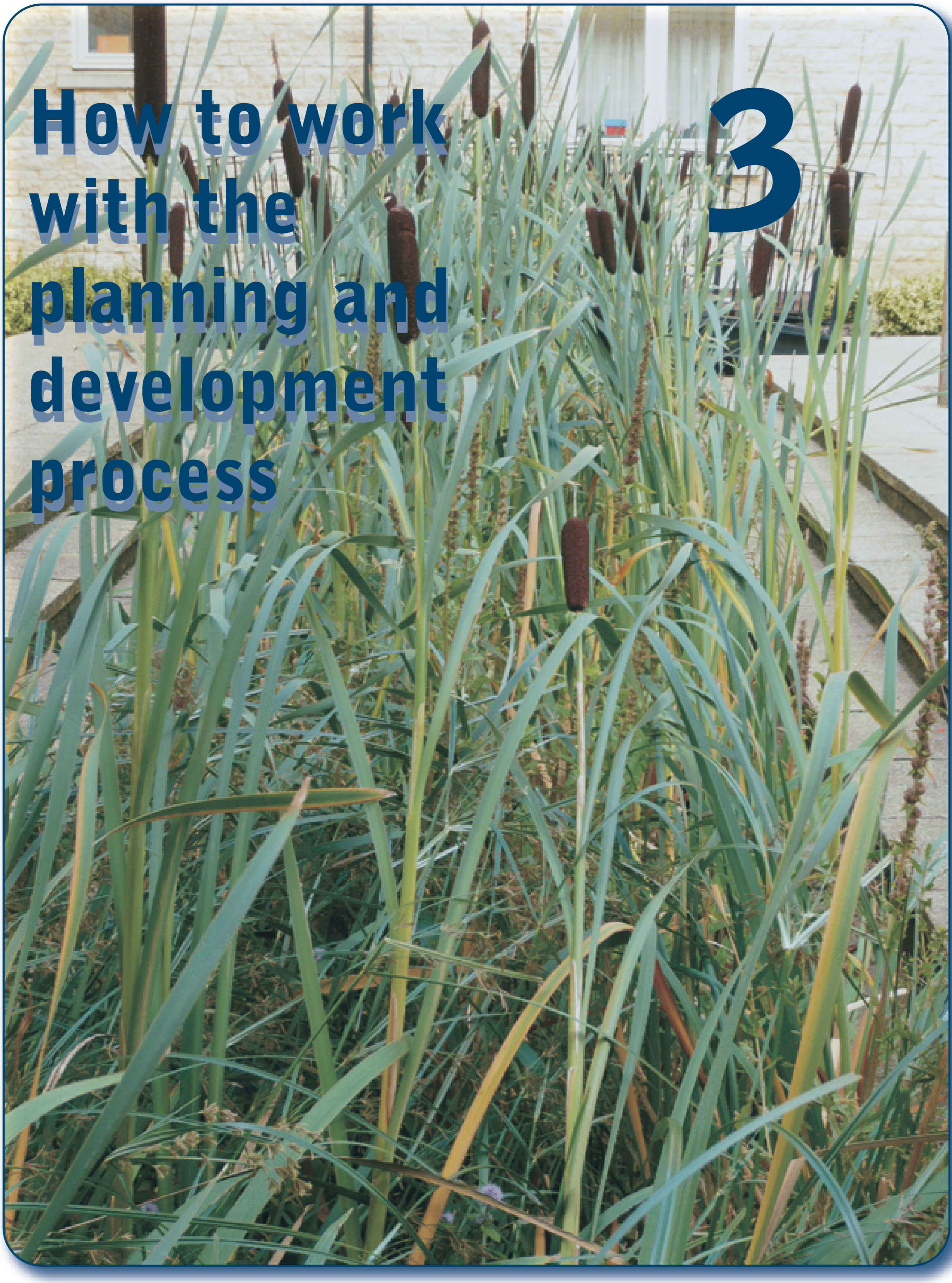
2.4 Key learning points

- there are a variety of SuDS components that are flexible and can be adapted to any site
- managing surface water at source using the SuDS management train approach is important to realising multiple benefits
- planning land-use to provide surface water overland conveyance routes and storage
- urban designers, landscape architects, highway engineers and other stakeholders play an important role in delivering this approach and ensuring benefits are realised.

2.5 References and further reading

WOODS-BALLARD, B, KELLAGHER, R, MARTIN, P, JEFFRIES, C, BRAY, R and SHAFFER, P (2007a) *The SUDS Manual*. C697, CIRIA, London (ISBN: 978-0-86017-697-8)

3 How to work with the planning and development process



This chapter will...

- describe how to deliver SuDS through strategic and regional planning
- describe SuDS and local development planning
- provide advice on supplementary planning documents
- outline interactions with other management plans
- describe who should be involved in the planning and development process for SuDS.

3 How to work with the planning and development process

3.1 How to deliver SuDS through strategic planning

Planning policy provides guidance to local authorities on what can be built and where. National policy states what should be included in strategic and local policies. These provide policies and provisions which are the starting point for all development control decisions, including appeals. Having appropriate SuDS policies at strategic level will assist in achieving multiple benefits at local level. This allows local authorities to influence the pattern of development through a plan led system. The stronger the policy at strategic level, the more likely the multiple benefits of SuDS will be achieved.

At a local level the inclusion of policies on sustainable drainage in local authority's unitary development plans and local development frameworks provides an opportunity to encourage sustainable drainage making necessary linkages with surface water management plan and the wider local flood risk management strategy.

Figure 3.1 Detention basin integrated into roundabout, Leicester, England

Table 3.1 Planning policy statements in England

Policy statement	Aim
PPS1 *Delivering sustainable development*	• regional and local planning bodies should promote sustainable drainage • policies should improve the environment as part of developments.
PPS3 *Housing*	• opportunities should be taken to green residential developments and provide appropriate high density development.
PPS9 *Biodiversity and geological conservation*	• development may provide opportunities to conserve nature and provide biodiversity.
PPS23 *Planning and pollution control*	• encourages the management of diffuse pollution.
PPS25 *Development and flood risk*	• encourages the use of sustainable drainage • encourages source control and drainage exceedance.

Key points

Planning policy in England

- **National planning policies** are set out in planning policy statements and supporting policy guidance notes
- **Planning policy statements** explain statutory provisions and provide guidance on planning policy and the operation of the planning system. Local planning authorities must take their content into account when preparing development plans and decisions on planning applications
- **PPS25** is the main planning policy statement in England promoting sustainable drainage
- **regional spatial strategies** are prepared by each region and sets out their requirements to meet the future needs of the population in the area, such as setting out how many new homes should be built. These strategies are drafted by the regional planning body
- **local development documents** are prepared by local planning authorities and set out the future vision for a district, objectives in pursuit of that vision and a strategy for approaching them. These include local development frameworks and are supported by action plans
- **action plans** can take various forms such as area masterplans, site development briefs, design statements and neighbourhood plans.

Sustainable drainage and the planning process in England

Planning Policy Statement 25 (PPS25) states that priority should be given to sustainable drainage and discusses the impact of new development on flood risk (DCLG, 2006). PPS25 recognises the contribution that SuDS can make to quality of place, wildlife and the delivery of multiple benefits. The variety of planning policy statements in England related to SuDS is presented in Table 3.1.

Sustainable drainage and the planning process in Wales

Wales has a different local government structure to England. Planning Policy Wales (PPW) sets out the land-use planning policies of the Welsh Assembly Government and is supplemented by a series of technical advice notes (TAN) (➲ **Case study 3.1**).

The spatial plan by the National Assembly for Wales (2008) serves a similar role to regional spatial strategies in England, but also sets out a wider ranging spatial vision and strategy. The plan has statutory status, to which all lower tier plans must have regard.

Under the Planning and Compulsory Purchase Act 2004, each unitary authority in Wales is required to produce a local development plan for its area. Unlike the local development framework (LDF) approach in England, this is a single document that sets out the strategy as well as site specific and development control policies. The development plans provide:

- strategic location guidance for development
- detailed site specific policies, including specific SuDS policies
- identification of proposals for development.

The Welsh Assembly Government has a duty under Section 121 of the Government of Wales Act, to promote sustainable development in the delivery of its functions. Technical Advice Note (TAN) 15 (National Assembly for Wales, 2004) provides the technical guidance that supplements the policy set out by the Welsh Assembly Government (2010) in relation to development and flooding. It advises on development and flood risk as this relates to sustainability principles and provides a framework for assessing risks.

Table 3.2 Policy planning statements in Wales

Policy statement	Aim
TAN15 *Development and flood risk*	• encourages the use of sustainable drainage to manage surface water • development should not create additional runoff when compared with the predevelopment situation.
TAN5 *Nature conservation and planning*	• encourages policies that enhance or preserve biodiversity.

Key points

Planning policy in Wales

- **National planning policy** is set out by the Welsh Assembly (2010)
- **Technical advice note (TAN) 15** provides guidance on flood risk management and encourages the delivery of SuDS
- **Wales spatial plan** sets out a strategic framework to guide future development and policy interventions
- **local development plans** provide strategic location based guidance for development and flood risk.

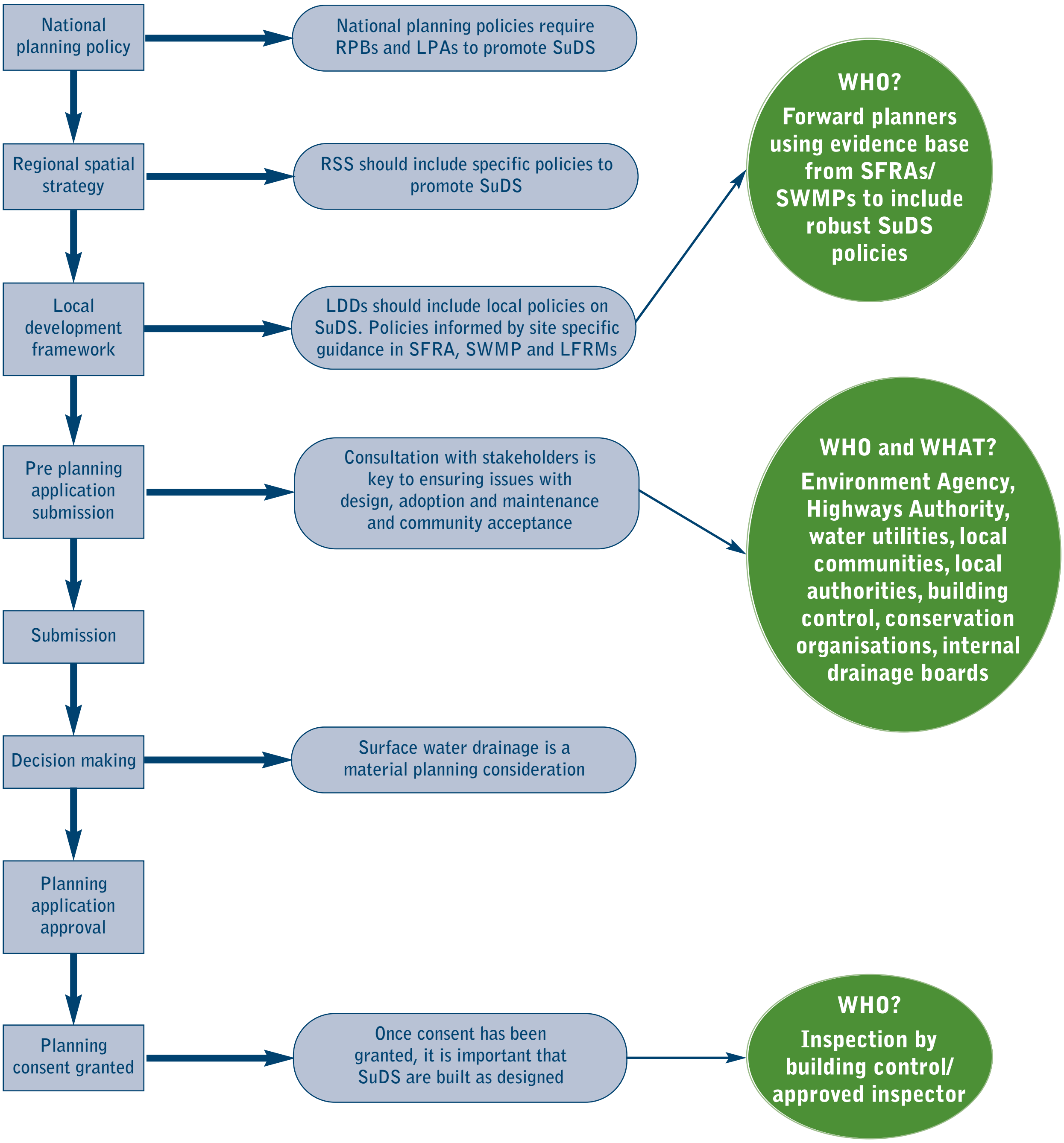
Figure 3.2 Wetland, Caw Burn, Scotland

PPS25 and TAN15 are similar in content and purpose. They both promote sustainable drainage by endorsing the concept at all stages of the planning process. Both documents require developers to use SuDS wherever possible and if they are not used to provide justification as to why they have not been included.

To gain planning permission, all new development in Wales has to be tested against TAN15 for flood risk. The aim is to direct new development away from high risk areas or to justify development in high risk areas.

TAN15 highlights the importance of managing surface water runoff by SuDS to mitigate flood risk. A new development should not create further runoff when compared to the undeveloped situation and runoff should be reduced by retrofitting where possible.

> "SuDS can perform an important role in managing runoff from a site and should be implemented in all new development proposals irrespective of the zone in which they are located"
>
> TAN15



Key

RPB	Regional planning body
SFRA	Strategic flood risk assessment
LPA	Local planning authority
LFRM	Local flood risk management strategy
SWMP	Surface water management plan
LDD	Local development document
RSS	Regional spatial strategy

Figure 3.3 SuDS and the planning process

The Flood and Water Management Act 2010

National Standards for the design and construction of sustainable drainage for new and redeveloped sites are being developed by Defra and the Welsh Assembly Government. The Flood and Water Management Act 2010 states that:

- drainage schemes will be subject to an approvals process in accordance with the National Standards
- new connection to the public sewer will be in accordance with the National Standards
- planning authorities should be required to take the National Standards into account with planning considerations.

✓

3.2 SuDS and the planning process

SuDS should be considered at all stages of the planning process. Figure 3.3 describes different tiers of the planning process in England, what stage SuDS should be specified and who should be involved where.

SuDS and regional planning

Regional planning bodies should include specific SuDS policies in their regional spatial strategies. Regional flood risk appraisals should include a high level consideration of surface water management issues.

SuDS and local development planning

Local planning authorities should include specific policies relating to SuDS in their local development documents, particularly the core strategy. Also, strategic flood risk assessments should (for allocated sites) make recommendations on the type of SuDS components appropriate for the site, and an indication of the amount of land required.

Supplementary planning documents

Supplementary planning documents (SPDs) within the local development document (LDD) can support the delivery of specific policy aspects, and may be appropriate to encourage sustainable drainage. They can be used by the local planning authority to highlight the main features of SuDS and provide guidance on how the components should be incorporated into development schemes.

Guidance produced by Cambridge City Council (Wilson *et al*, 2010) and the London Borough of Islington (Bray, 2010) are good examples of documents produced by local authorities to support the delivery of SuDS. These outline the Council's requirements and the local context.

Useful information *i*

Supplementary planning documents

Local planning authorise (LPAs) can develop supplementary planning documents that set out the principles of surface water management and SuDS and provide guidance on how they would expect to see sustainable drainage accommodated in a development, particularly in high flood risk and/or high growth areas.

Area action plans

Area action plans form part of a LDF aimed at establishing proposals and policies for an area and may be used to establish improved surface water management and sustainable drainage.

Town and Country Planning Act Section 106 Agreements

Section 106 of the Town and Country Planning Act (1990) enables a planning obligation from a local authority to be legally binding, which can be used to deliver SuDS and other benefits for developments such as public open space. This is a useful mechanism in securing development aspects and particularly the maintenance of SuDS, as there is currently no legally binding obligation relating to the maintenance of SuDS as opposed to conventional systems. Section 106 agreements assist in improving the quality, or reducing the adverse effect of development, and are potentially wide ranging.

The local planning authority can use a Section 106 agreement together with a commuted sum to develop a SuDS maintenance framework with a developer (the Community Infrastructure Levy is likely to replace Section 106 Agreements as these are phased out).

3.3 SuDS and flood risk assessments

PPS25 and the associated practice guide sets out what should be included in flood risk assessments, from the regional through to specific site level.

Regional flood risk appraisals (RFRA)

National planning policy in England states that RFRAs should include a broad scale consideration of surface water management, focusing on regionally specific issues.

> "A typical FRA shall include 'the incorporation of SuDS in the overall design of the development or justification of why they are not suitable"
>
> PPS25 guidance document

Strategic flood risk assessments (SFRA)

Guidance that supports national planning policy states SFRAs should identify surface water drainage issues and the types of measure (in a surface water management plan if needed) that may be appropriate to manage them. This takes into account location, site opportunities, constraints and geology. LPAs should encourage sustainable drainage practices in their LDDs.

> "Priority should be given to the use of SuDS and where they are not deemed appropriate; justification should be given for not using them"
>
> PPS25 guidance document

Site specific flood risk assessments (FRA)

Guidance that supports national planning policy also states that site FRAs should consider flood risk to and from the site.

3.4 Planning policy and sustainable drainage

It is important that sustainable drainage is considered at all stages in the planning process. This section will discuss, in more detail, the role of planning policy in SuDS delivery. There are many planning policy statements that mention SuDS, which are listed in Section 3.1. This section focuses on the impact of PPS25 and TAN15, as they are most relevant in drainage terms. The PPS25 practice guide suggests that surface water should be considered in all steps of the flood management hierarchy (➲ **Figure 3.4**).

3.5 Sustainable drainage and interactions with other relevant plans

The concept of sustainable drainage interacts with several other management plans including local flood risk management strategies, surface water management plans, catchment flood management plans and river basin management plans.

Figure 3.4 The flood risk management hierarchy

3.6 Stakeholders involved in the planning and development process

There are numerous organisations involved in the planning process. Their level of engagement and participation varies and it is important to include the public and communities planning decisions for best results.

All consultees should be contacted at the earliest available opportunity, to ensure developers are aware of requirements at a site specific level, particularly with regard to flood risk, pollution control and creating better places to live. Many SuDS proposals are not submitted until the planning application stage. In such cases, often pre-application discussions are omitted, which can result in delays in getting a planning application processed. However, when pre-application discussions take place, all calculations and designs are agreed from the start of the process smoothing the way for approval.

The Code for Sustainable Homes is the national standard for the sustainable design and construction of new homes and it has targeted a reduction in carbon emissions by creating homes that are more sustainable (CLG, 2006). For example, by rain and greywater recycling that may reduce potable water consumption for uses where lower quality water may be sufficient, eg toilet flushing.

Table 3.3 provides a list of the roles and aims of some of the key stakeholders. Regional variations in the approach and interpretations of regulations exist – another good reason for early consultation.

Surface water management plans (SWMPs) provide a framework where the main partners with responsibility for surface water drainage work together to understand local constraints on growth or flood risks. The outputs of these plans include the identification of preferred options to reduce the risk of flooding, which is likely to include the use of sustainable drainage.

Catchment flood management plans help understand the factors that contribute to the flood risk in a catchment and to recommend the best ways to manage the risk. They are an important planning tool and take a strategic and active approach to flooding now and in the future, helping spatial planners assess flood risks associated with land allocations and determining the sustainability of proposals. Sustainable drainage is an important tool in delivering effective surface water management on a catchment wide basis.

River basin management plans are required by the WFD. They establish a strategic plan for the long-term management of river basin districts and set out objectives for waterbodies (including rivers, streams, lakes and the land that drains into them) focusing on water quality to protect and improve the water environment.

The use of SuDS can help improve the status of a waterbody by treating some of the diffuse pollution (pollutants associated with runoff). The concept of sustainable drainage has the added benefit of controlling water in relatively small quantities and maintaining the existing flow conditions in a waterbody.

Biodiversity action plans (BAPs) are internationally recognised programme addressing threatened species and habitats. They are designed to protect and restore biological systems. The careful use of SuDS can help to improve the opportunities for habitat restoration and creation. Also, SuDS may provide opportunities to create ecosystems that will be beneficial to wildlife, such as wetlands and bioretention. SuDS can help to protect habitat from future urban development. Biodiversity action plans (BAPs) are internationally recognised programme addressing threatened species and habitats. They are designed to protect and restore biological systems. The careful use of SuDS can help to improve the opportunities for habitat restoration and creation. Also, SuDS may provide opportunities to create ecosystems that will be beneficial to wildlife, such as wetlands and bioretention. SuDS can help to protect habitat from future urban development.

Table 3.3 Stakeholders involved in the planning process

Stakeholders	Role	Desired outcomes
Public and communities	They have a vital role in the vibrancy of a development and the acceptance of sustainable drainage.	• to live, work and play in attractive surroundings • to be involved in the development and how the SuDS scheme works • to be certain that the design is adequate, and the operation and maintenance of SuDS schemes will be taken into account.
Local authority – planners Upper tier – SuDS approval body Lower tier – planning	They control planning applications and can advise on the effect of regional/local policies. They will consult stakeholders to understand the opportunities, constraints and issues of an application.	• to promote development policy • to approve new development • to encourage the inclusion of sustainable drainage.
Local authority – highway engineers	They construct and manage highways and provide standards to developers for the construction and adoption of roads. Managing the quantity and quality of runoff from highways.	• to ensure highways drain to sustainable drainage • to be satisfied SuDS components used meet their requirements • to be satisfied that SuDS can be adopted.
Building control or approved inspectors	Before construction building control officers need to be satisfied development complies with the Building Regulations and will not affect the integrity of any buildings.	• to know location of drainage system in relation to buildings • to ensure it is compliant with Building Regulations.
Environment Agency	They are statutory consultees in the planning process on flood matters covering regional spatial strategies and strategic flood risk assessments.	• to holistically manage runoff rates and volumes • to ensure that sustainable drainage principles have been incorporated • to see the SuDS management train delivered.
Conservation organisations	Natural England and the Countryside Council for Wales are the statutory advisors on conserving and enhancing the natural environment at a regional and national level.	• high quality, sustainable developments • protect sites of special scientific interest, special protected areas or special areas of conservation.
Sewerage undertakers	They have a duty to provide a public sewer connection and are responsible for surface water drainage from developments.	• normally to ensure surface water management systems adhere to Sewers for Adoption • some sewerage undertakers may also adopt SuDS • consider capacity of existing drainage systems and where possible use sustainable drainage.
Developers	They are ultimately responsible for the type of surface water management system used. To achieve successful SuDS involve them with other important stakeholders early in the planning process.	• to meet planning requirements • to comply with the requirements of the Code for Sustainable Homes and National Standards (once introduced) • to provide a cost effective, attractive development, which will be easily sold.
Internal drainage boards	They are an operating authority in parts of England and Wales that have permissive powers to manage surface water and water levels within their district.	• to be consulted on development of strategic flood risk assessments • to be consulted on development within their area.

3.7 Key learning points

- sustainable drainage needs to be considered as early as possible in the planning process and can save money, by reducing the need for retrofit solutions
- sustainable drainage is difficult to deliver successfully if a development layout has been decided without appropriate consideration of drainage
- numerous organisations and stakeholders are involved in both drainage and the planning process so early consultation and discussion about SuDS is vital
- National planning policy statements set out clear requirements for the use of SuDS, particularly PPS25 in England and TAN15 in Wales.

3.8 References and further reading

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Statutes

Government of Wales Act 1998 and 2006

Planning and Compulsory Purchase Act 2004

Town and Country Planning Act 1990

4

How to make sustainable drainage happen

This chapter will…

- explain how to integrate SuDS with the planning and design of development
- explain how to work with the site
- describe the master planning process
- explain the urban design process and how to use design codes
- provide guidance on how to request SuDS.

4 How to make sustainable drainage happen

4.1 Integrating SuDS with planning and design of developments

There is no "one size fits all" solution to delivering SuDS in developments, so good design is crucial. The design process involves both a range of expertise and the understanding of several specific factors. Planners play an important role in involving the right expertise at the right time, and ensure SuDS are seamlessly integrated with the wider design and planning process of developments.

Figure 4.1 ***Swale in development, Upton, England***

Design is an issue at all levels of the planning process with different information and levels of detail needed depending on the planning stage. The following sections discuss the main design and planning considerations alongside various stages of the development planning process. The drafting of SuDS policy requirements and guidance is discussed in Section 4.3.

Working with the site and developer ambitions

Good SuDS design begins with an understanding of both site conditions and the ambition for the development. Sustainable drainage should be considered at the start of the project, preferably at the master planning stage. On sites where planning has already progressed to a more detailed stage, possibilities may be limited, but it is still important to understand the opportunities. At the beginning of a site planning process, planner and designers should seek to understand the following aspects to inform SuDS design:

1. What is the developer seeking from the site in terms of quantity of development, eg the density of development and mix of uses?
2. What is the developer seeking in terms of the type and quality of development, eg its general character and style?
3. Likely mix of impermeable and permeable surfaces?
4. What is the local planning authority seeking from the site, ie what are the policy requirements and best practice ambitions on site?

5 How can the design of the architecture and buildings assist, improve and be part of addressing water in a sustainable way, eg green roofs?

6 How can SuDS shape the development and how can the design of the landscape, and external areas integrate water in a sustainable way, eg public open space used as detention basins?

7 How could SuDS enhance biodiversity on site?

8 How will land-use on site create pollution of runoff and influence treatment requirements for SuDS?

9 How will long-term maintenance and management of SuDS be ensured?

10 Are overland flow routes, eg swales and linear open space, incorporated into the master plan?

Answering these questions requires input from a range of disciplines including engineers, urban designers, architects, landscape architects and ecologists. The design team needs to include the right expertise at the beginning of the project and then at appropriate moments during the planning process to ensure these questions are answered and brought together in the design solution.

Master planning and outline planning applications

The inclusion of SuDS at the master planning or development site planning stage has a significant effect on the viability and cost-effectiveness of SuDS integration and the ability of SuDS to deliver multiple planning benefits. Master planning provides a strategic approach to consider the (sometimes competing) requirements for a development. It is an inclusive urban design approach that brings together stakeholders, to regenerate or develop areas that create better places to live, work and play. A master plan will typically set out the relationship between buildings, infrastructure and public open spaces. Also, it enables a shared understanding of how a development integrates with the surrounding urban context and natural environment.

"Masterplanning is the process by which organisations undertake analysis and prepare strategies and the proposals that are needed to plan for major change in a defined physical area"
CABE, 2004

Good master planning will include the management of runoff, respond to natural topography and begin to locate SuDS and identify possible SuDS components. This process requires sustainable drainage expertise integrated within the master planning team. By developing a sustainable drainage approach at the master planning stage, the team can integrate SuDS design with other large scale planning initiatives that are considered at the master planning stage including connections with:

- the type of architecture, what it is and how it is placed, where it is placed on a site and how much of the site is occupied by it
- open space, public realm, green infrastructure planning and opportunities for blue/green corridor links
- testing of land-use and density arrangements, ie the effect on water treatment and storage requirements
- ecological connectivity and biodiversity strategies.

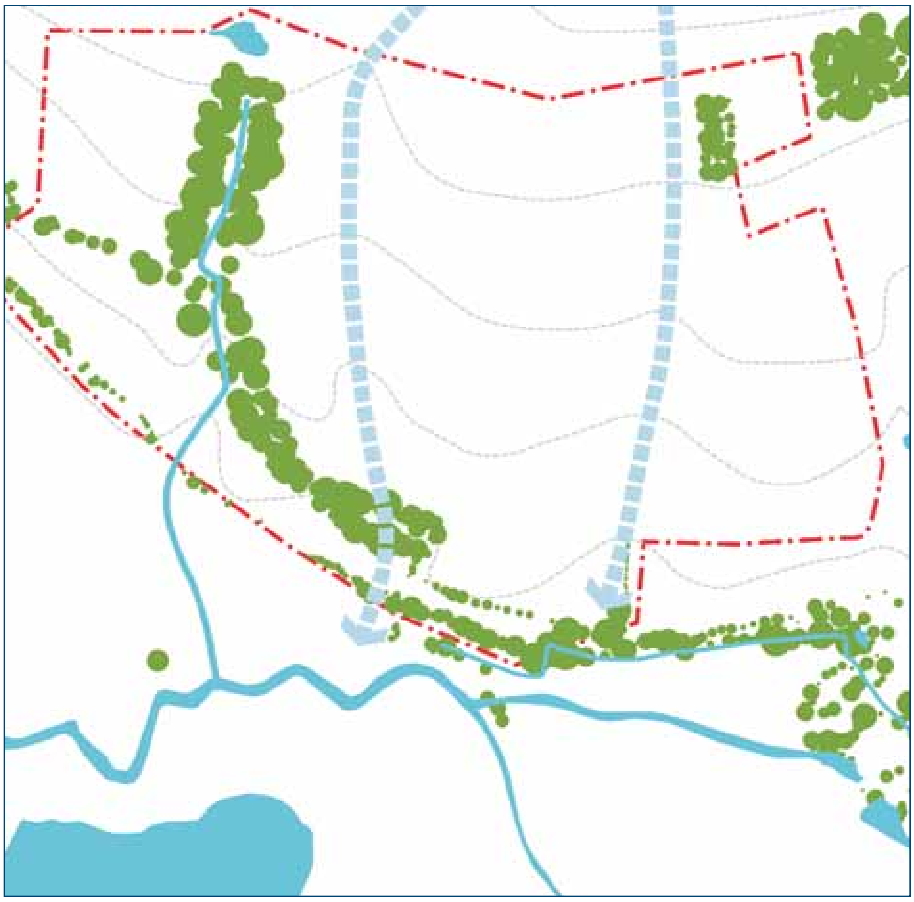
"Planning authorities should make use of design and access statements to obtain from applicants the information necessary to show how their proposed development will contribute to the key planning objectives"
PPS1 supplement

Good master planning is also about looking at a site within its context and designing holistically - where each element, ie buildings and site, are designed as one and working together. The process is explained in Figure 4.3.

Many organisations have expanded the master planning process to include a full consultative, participatory and collaborative design process. This typically engages stakeholders, including the community to assess and review a complex range of design requirements for the development site. SuDS are an important part of this consultation process to identify local issues and opportunities. This was undertaken at Upton, Northampton (➲ **Case study 4.1**).

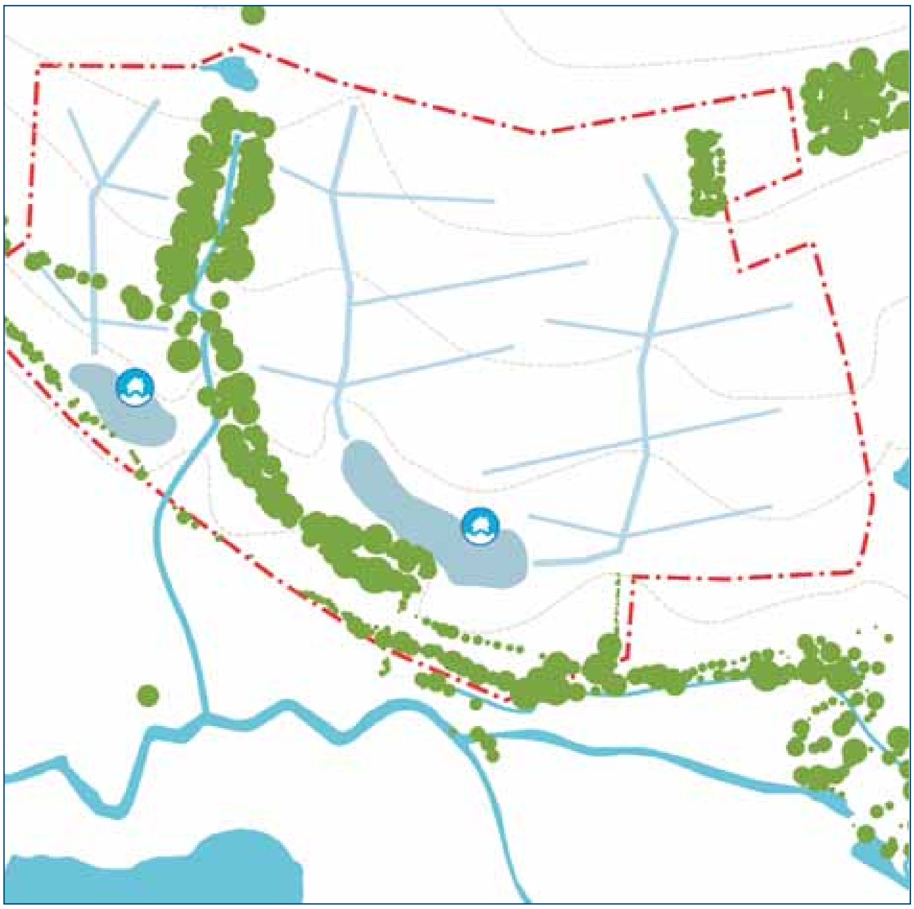
Area action plans delivered by local authorities are an example of where this should happen. However, a SuDS approach and integration with spatial design are important aspects to include within the requirements of a design and access (D&A) statement in support of an outline planning application. D&A statements explain the considerations behind a planning application and the aspirations and ambition for a development. When reviewing a master plan at outline planning stage, the planner should ensure that the spatial layout both minimises runoff, and incorporates SuDS components.

Figure 4.2 Detention basin integrated in public open space, Ipswich, England



Examine site typography and geology

Aim to mimic the natural drainage systems and processes as far as possible. Identify key natural flow paths, existing water bodies and potential infiltration areas to understand opportunities and constraints.

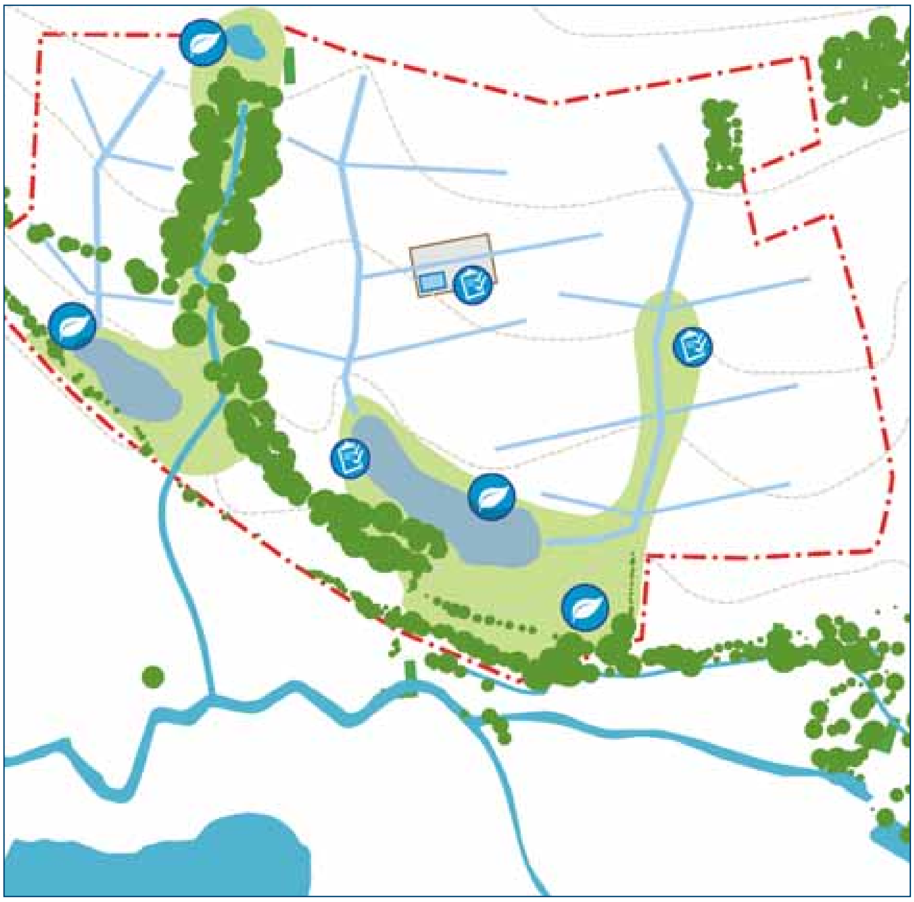


Create a spatial framework for SuDS

Minimise runoff by rationalising large paved areas and maximising permeable surfaces. Consider likely space needs for site control SuDS based on character of development and the proposed degree of source control. Use flow paths and possible infiltration or storage areas to inform development layout.

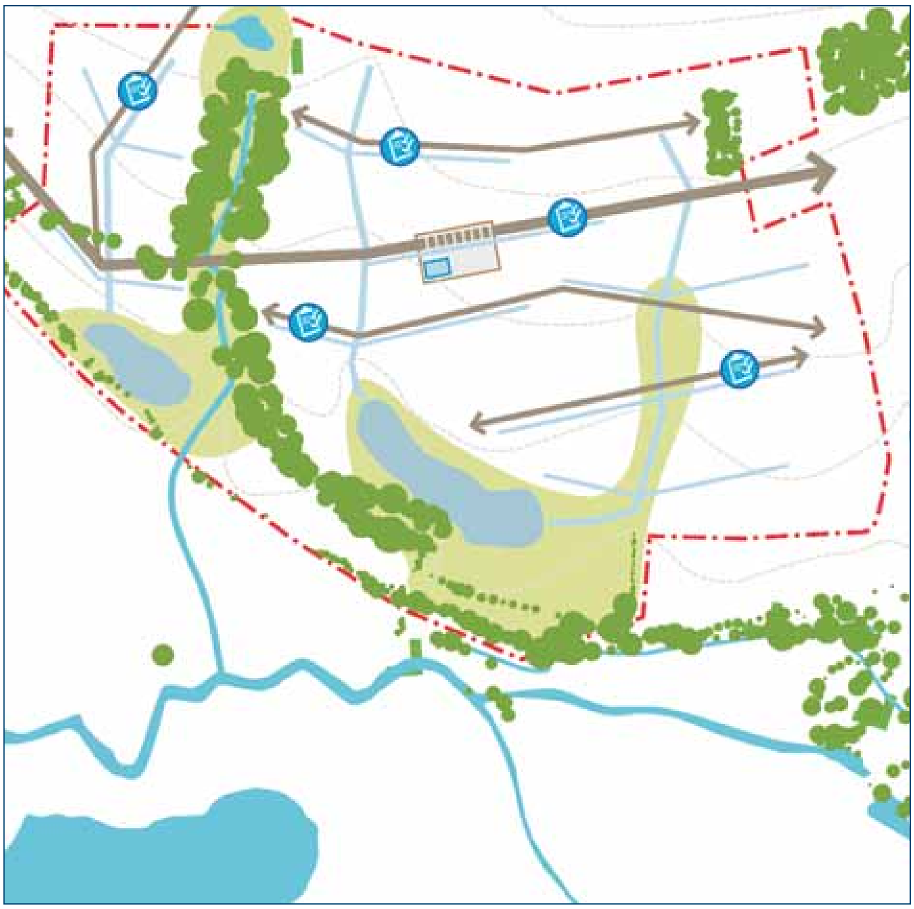
Figure 4.3

The master planning process



Look for multifunctional spaces

Consider how SuDS features could be co-located with open space and public realm areas to create multifunctional spaces. SuDS can be designed to be valuable amenity and ecological features.

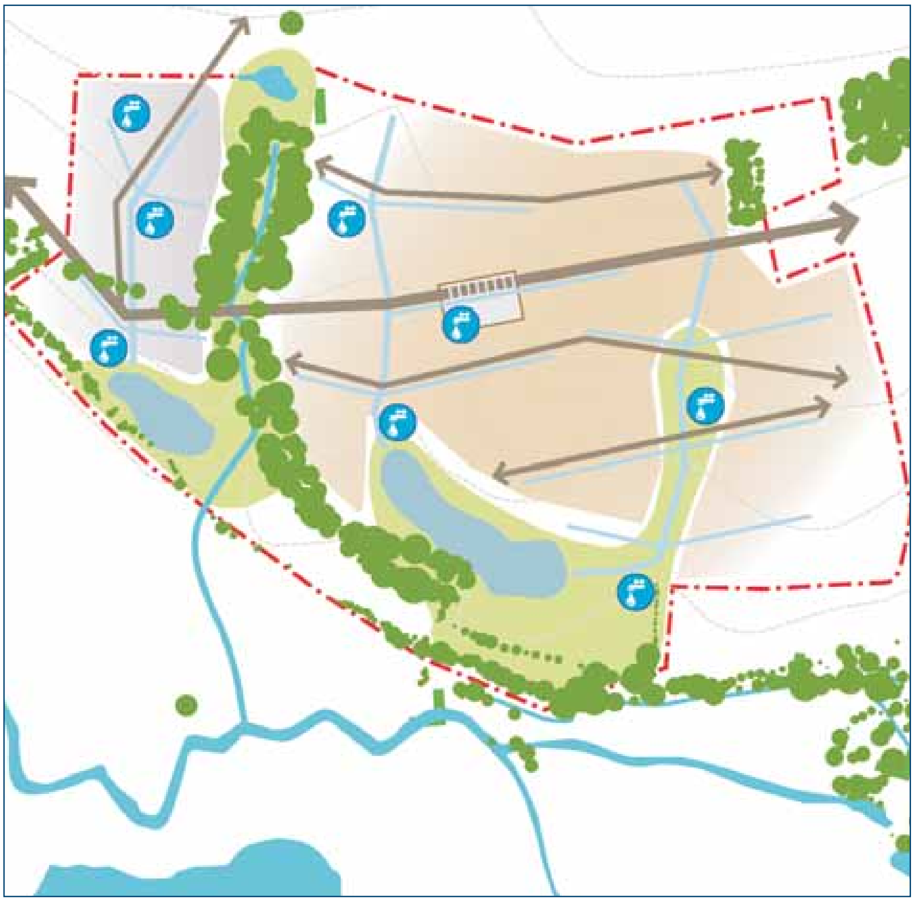


Integrate the street network with SuDS

Structure the street network to complement and manage flow pathways. Integrate SuDS features into street cross-sections, ensuring street widths are adequate. SuDS should be used to improve the streetscape providing amenity and multifunctionality by integrating with other street features including tree planting, traffic calming, parking bays, verges and central reservations.

Figure 4.3

The master planning process (continued)



Cluster land uses to manage pollution

The number, size and type of SuDS will be affected by land uses and the corresponding pollution risk. Potential polluters, eg industrial developments, should have their own isolated SuDS network. Integrate a series of SuDS features that will provide water treatment throughout the networks, responding to the level of pollution risk. Clustering should be considered alongside other mixed use ambitions.

Figure 4.3

The master planning process (continued)

Key

- Site boundary
- Contours
- Natural flow path
- SuDS network
- Attenuation feature (soft landscape)
- Attenuation feature (hard landscape)
- Public green space
- Streets
- Local flood risk management
- Multifunctional benefit
- Biodiversity and habitat benefit
- SuDS treatment feature
- Residential/mixed uses
- Industrial uses

Urban design integration

Good urban design is only possible where the design and management of water in a scheme is integrated as an important part of the whole concept.

> "(Urban) design is not just about creating something which is beautiful or aesthetically pleasing. It is about creating something that is useful, usable, enjoyable and which responds well to the needs of people. Good urban design is then about making places which respond well to people's needs"
>
> NWDA/RENEW Northwest, 2007

SuDS can be designed without urban design input, but this leads to the creation of water management features that are disconnected with the character and aesthetic of the place. Making SuDS attractive and integrating their design with other urban features (ie roads and public open space) is vital to their acceptance, performance and longevity. Communities and stakeholders are more likely to approve, operate and maintain SuDS when they are delivered using good urban design principles. Figure 4.5 demonstrates how a wetland can be integrated with the transport network.

Figure 4.4 SuDS component combined with street furniture, San Francisco, America

Figure 4.5 Linear wetland, Edinburgh, Scotland

Some of the following principles of urban design (based on the *Urban design compendium*, Llewelyn-Davies *et al*, 2000) provide a framework for integrating SuDS, make a positive contribution to a scheme and add value to a development.

Table 4.1 and Figures 4.6 to 4.8 demonstrate SuDS components for different development settings.

Places for people

SuDS should be safe, varied and attractive. If creatively designed and integrated SuDS can add character and develop a sense of place, as well providing the opportunity for education, play and recreation.

Enrich the existing

Applying SuDS as a positive design tool can enrich the design and the quality of the existing urban places. Design and selection of SuDS should respond to the scale and setting of development.

Manage the investment

For places to be successful they must be economically viable, well managed and maintained. Designing SuDS to be attractive and integrated with other urban infrastructure will ensure that SuDS and long-term maintenance is given more attention. To ensure SuDS are economically viable, design integration is vital from the start.

Work with the landscape

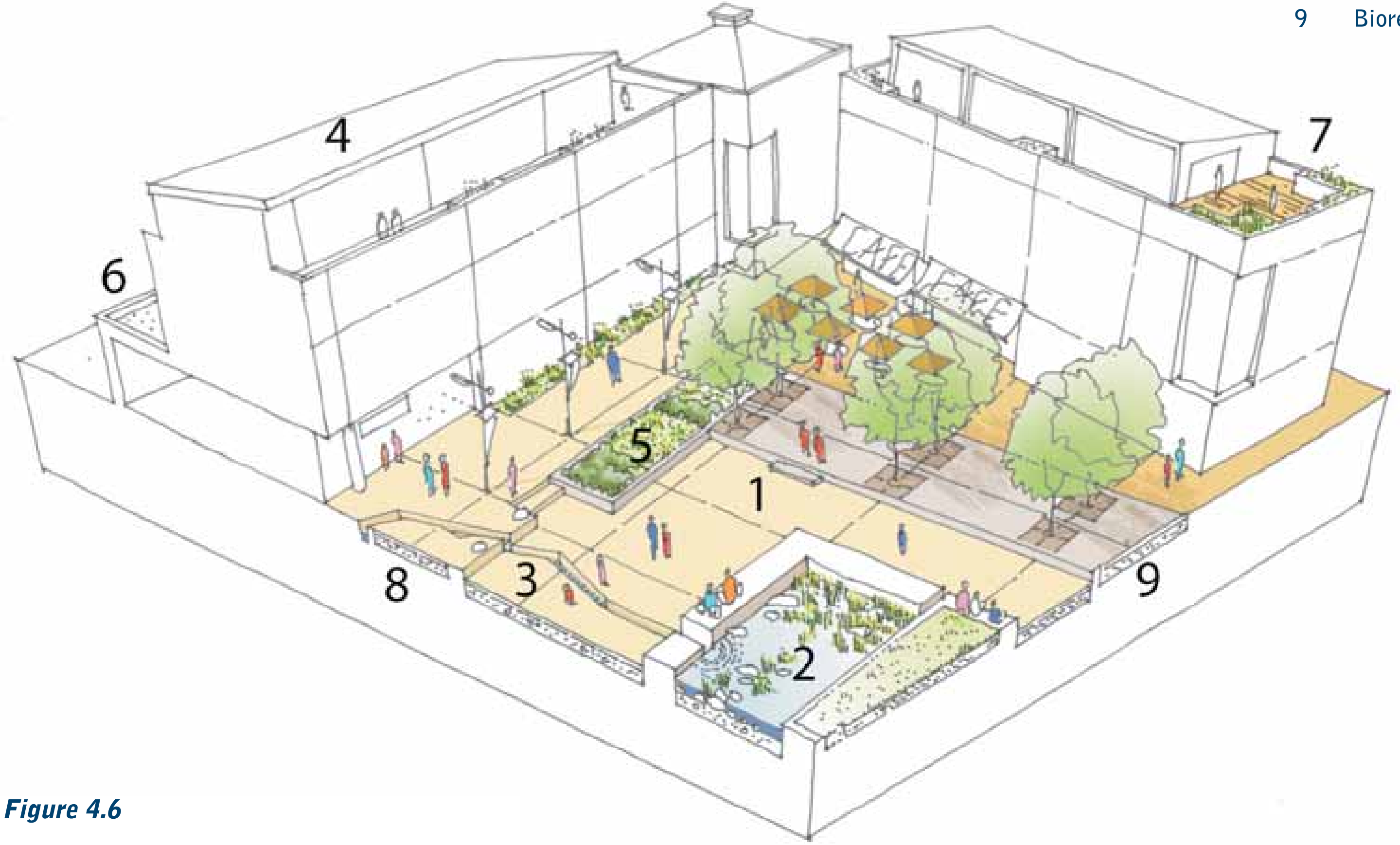
To give the greatest value, SuDS design should use the site's intrinsic resources – climate, landform, landscape and ecology. SuDS should respond to local topography and landscape character and incorporate local biodiversity needs. As in the design of a landscape or in public, shade and sun exposure should be considered in the placement of SuDS and the effect on plant species and material selection.

Design for change

SuDS should be flexible enough to respond to future changes in climate, urban character and land-use. It is important to consider future uses of surrounding areas in SuDS design, and to account for the affects of climate change. Vegetated and permeable SuDS will assist in the mitigation of the urban heat island effect.

Table 4.1 Main SuDS components to consider for different development settings

		Development settings		
		High density	***Medium density***	***Low density***
Most suitable SuDS components	Integrated buildings	• green roofs • rainwater harvesting.	• green roofs • rainwater harvesting.	• green roofs • rainwater harvesting.
	Streetscapes	• permeable paving • road-side bioretention components.	• road-side swales • permeable paving • road-side bioretention components • filter strips.	• road-side swales • permeable paving • road-side bioretention.
	Public realm and open space	• permeable paving and underground storage • rills and channels • hardscape pools • micro-wetlands or bioretention components in squares, courtyards or hard paved spaces.	• micro-wetlands or bioretention components in squares, courtyards or hard paved spaces • open space integrated ponds and wetlands.	• ponds and wetlands • swales.

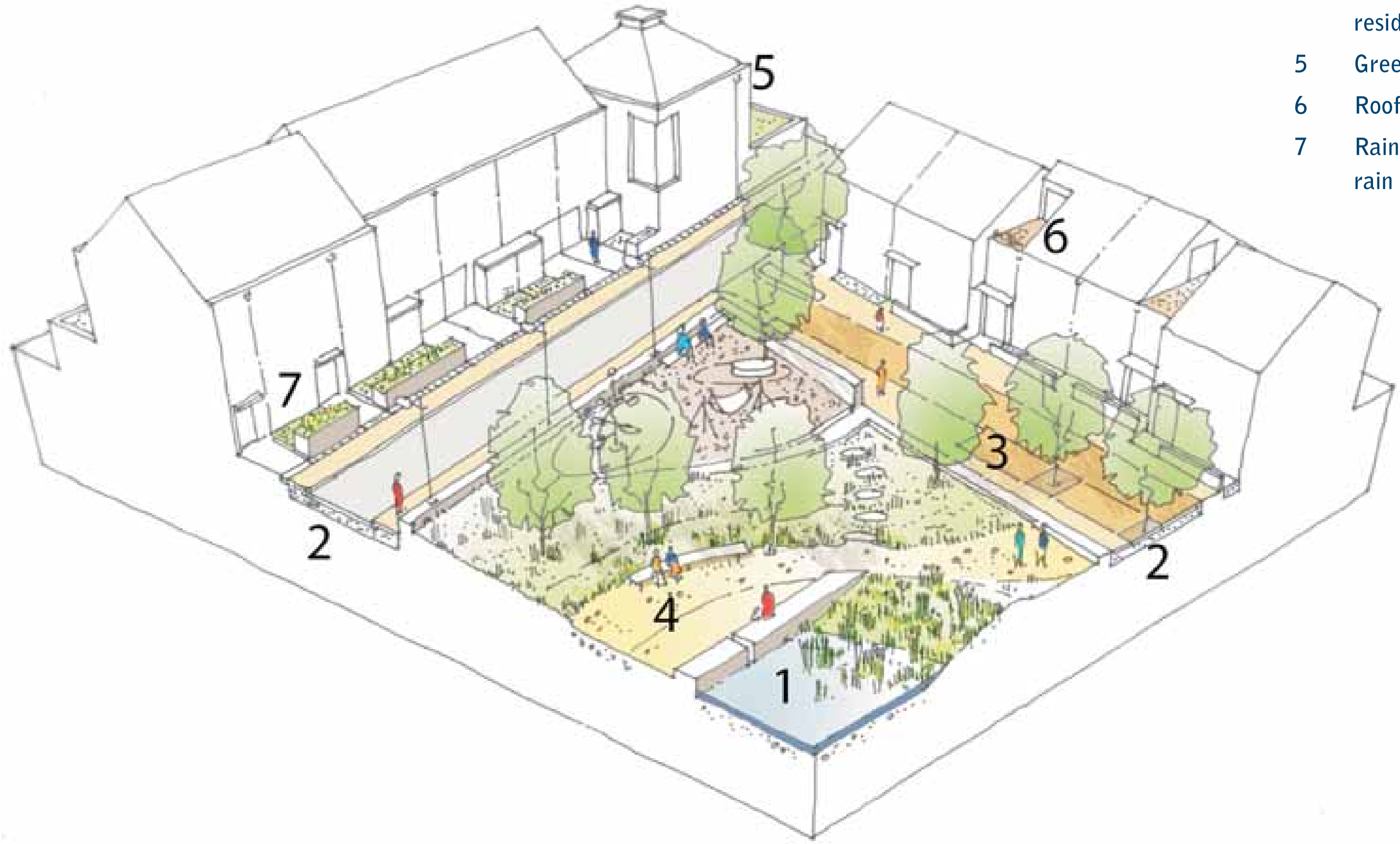


Key

1 Urban square with permeable paving
2 Retention pond with integrated seating
3 Rill within pedestrianised shopping street
4 Brown roofs within town centre
5 Rain garden/planted bioretention element
6 Green roofs
7 Roof gardens
8 Permeable paving within street
9 Bioretention tree pits within square

Figure 4.6

SuDS in a high density development setting

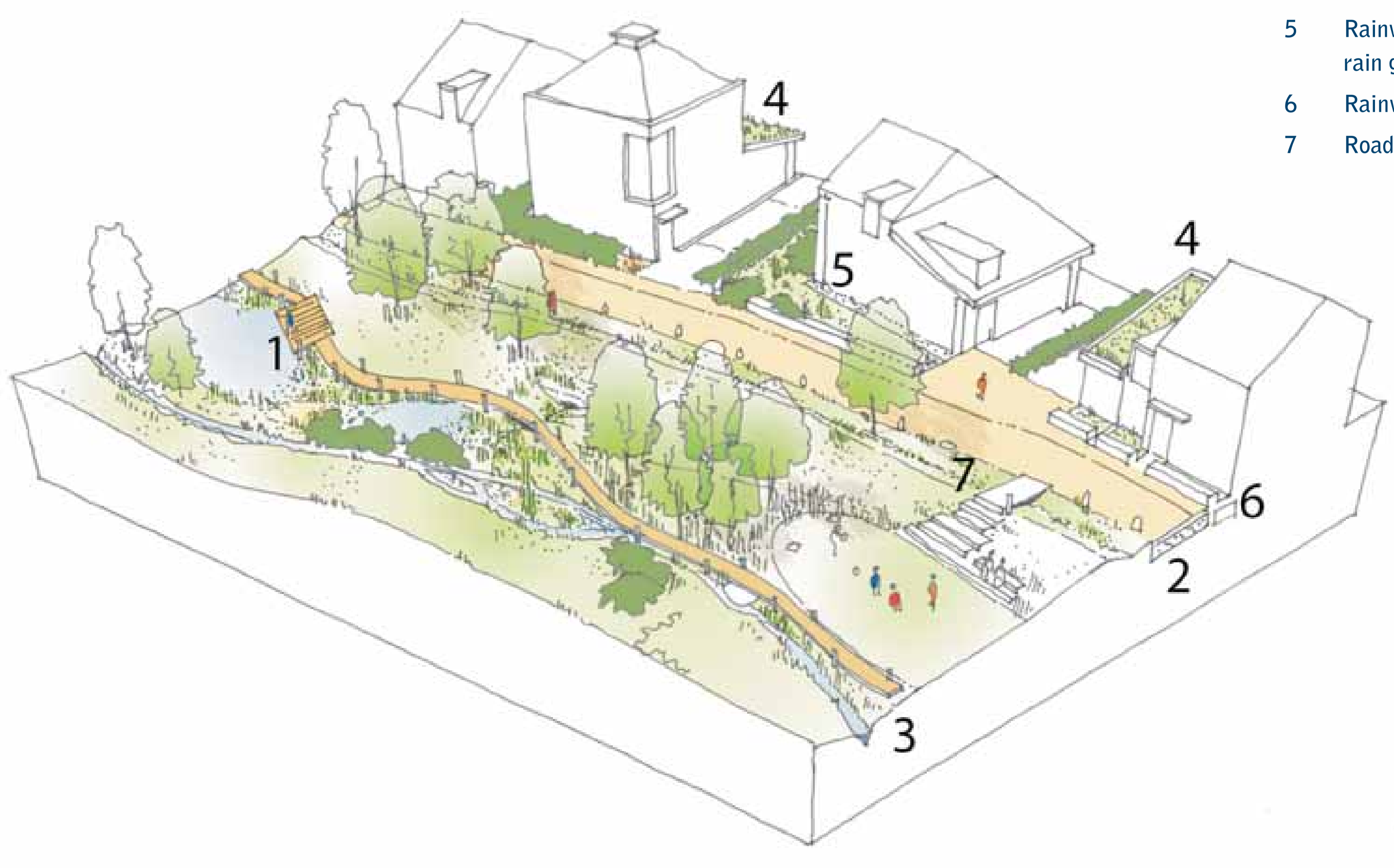


Key

1. Filter strip and retention pond within residential square
2. Permeable paving within residential street/mews
3. Roadside bioretention tree pits
4. Gravel/permeable surfaces within residential square
5. Green roofs
6. Roof gardens
7. Rainwater collection from roofs in front rain gardens/ water butts

Figure 4.7

SuDS in a medium density development setting



Key

1 Wetland areas within large open space
2 Permeable paving within residential street/ mews
3 Natural waterway
4 Green roofs
5 Rainwater collection from roofs in front rain gardens/water butts
6 Rainwater harvesting
7 Roadside swale

Figure 4.8

SuDS in a low density development setting

Using design codes

Design codes are a tool to help direct the design of a development. They are rules and instructions about specific design features and how those features interrelate. Design codes inform the master plan shaping the layout and location of components and describes their quality and aesthetics. The urban design priorities for SuDS can be communicated and enforced through the use of a design code (or for smaller sites design statements).

Design codes can be very prescriptive, but this is not desirable as it can prevent the potential to develop creative design solutions. It is more important that a design code provides a framework of key design rules in which more detailed design decisions can take place. The level of prescription is determined by an understanding of the site, how the site will be developed and by whom. They can include as little or as much information as is deemed necessary to control and achieve a scheme with integrated and effective SuDS including standards relating to restrictions on the flow and volume of runoff or any other performance target. A design code should outline the desired character and possible suitable types of SuDS to be included in the development along with key considerations for different urban settings (eg streetscapes, urban centre, suburban neighbourhood).

Upton, Northamptonshire (➲ **Case study 4.1**) shows how using design codes and involving stakeholders early in the process can deliver a sustainable drainage scheme that improves the local environment, deals with surface water runoff effectively and provides better places for people to live. The main reason for using this approach was to ensure control surface water runoff following flooding in the catchment in 1998.

PPS25 suggests that strategic flood risk assessments identify land requirements to accommodate SuDS on larger allocated sites. Developers are made aware of the land required for SuDS from the start of the development process, providing a greater opportunity for a management train approach to be adopted.

It is vital that SuDS site layout and open space requirements are considered at the same time as the SuDS design. Space for SuDS should be allocated at an early stage.

Figure 4.9 Swale in Upton, England

Case study 4.1

Location	Upton, Northamptonshire
Type of development	Residential
SuDS used	Water butts, green roofs, permeable paving, swales and ponds

Background

Managing surface water effectively was a priority for the urban extension at Upton. Many SuDS elements were incorporated into the design, including water butts, green roofs, permeable surfaces, swales and storage ponds. This has allowed surface water to be limited and controlled.

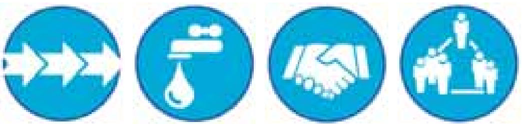
Sustainability was embedded in both the Upton design code and urban framework plan for SuDS by ensuring:

- stakeholders were involved at an early stage
- surface drainage should be managed by SuDS
- the drainage of the site from extreme events and effect on downstream systems should be explicitly mitigated.

Using the codes helped delivery of SuDS and reduced the time for planning approval. The codes provide clear design guidance and instruction for all parties.

The drainage schemes have enhanced the high quality open green spaces with the swale and pond network, providing 'green fingers' extending from the country park into the public realm, enhancing local biodiversity.

By carefully identifying the paths for exceedance flood routes through the development, the damaging effects of flooding have been managed. In this case, the conveyance of the large resulting flood volumes is more effective than local storage. However, discharging these flows into the receiving water would have proved unacceptable due to the potentially damaging effects of flooding downstream. The provision of local surface storage as a dual use area has helped to mitigate these effects. The scheme could have been improved further with the inclusion of more source control components to attenuate flows and more attention on the detailing of some of the components.



Design codes and large sites

When outline planning permission has been granted for a large site, but the landowner sells parcels of land to other parties for development, is another common challenge. Although SFRAs requires that a certain amount of land is set aside for SuDS, these frequently take the form of large end of pipe systems that may not contribute much in terms of amenity. Also, it is important that source and site controls are considered and design codes can set a requirement for these to be included in each development parcel or subcatchment. The ideal solution is to introduce restrictions on the flow rate and volume of runoff leaving each parcel, before water discharges into regional control components downstream. Also, the design codes should incorporate some form of design standards to ensure effective SuDS design over a large area and ensure optimum benefits are realised. SuDS should be designed in-line with the guidance in CIRIA C697 *The SUDS Manual* (Woods-Ballard *et al*, 2007),

When SuDS are considered at an early stage, there is greater chance that they can be integrated into the master plan as features of the development and that adequate land can be set aside to accommodate these structures. It should be noted that a site specific flood risk assessment will be required for all sites larger than 1 hectare in areas of low flood risk and all sites situated in medium or high risk areas.

4.2 Overcoming challenges during the design process

Challenges faced during the design of SuDS schemes should be overcome with early discussion with the stakeholders. Typical challenges and questions likely to be raised are discussed in Section 7.1. Further guidance can be found in *The SUDS Manual* (Woods-Ballard *et al*, 2007).

Site specific applications have their own challenges, especially those that are not allocated in the local development documents. It is unlikely that the local SFRA will address SuDS requirements at such sites. Usually it is up to the individual planning officer to apply their local authority's SuDS policy and determine whether the application meets the requirements of PPS25 (this is likely to be formalised with the introduction of the National Standards).

Contaminated land

A common misconception is that SuDS cannot be used in a site with contaminated land that is proposed for redevelopment. Certain SuDS components such as soakaways and infiltration trenches may need to be avoided in parts of the site that might be contaminated. However, other components that do not infiltrate into the underlying ground and attenuate and store runoff on the surface can be used. The design of the system will be site specific and dependent on the contaminants found at the site and a risk assessment should be undertaken.

Land take

Often, the land taken to accommodate SuDS (land take) is quoted as an issue, particularly in constrained high density sites. Planning Policy Statement (PPS) 3 promotes the use of high density development for new sites and encourages a large number of units to be located in a smaller area. This can cause some tension with the specifications of PPS25, as there may be requirements to use space for SuDS. However, numerous types of SuDS are ideal for use in high density areas. The use of source control components will also minimise the amount of land needed for site and regional controls (➲ **Section 2.3**).

Figure 4.10 ***Conveyance feature within a housing development, Gloucestershire, England***

The introduction of green roofs allows rainwater to be controlled as close to source as possible. Permeable paving can be used to minimise the amount of impermeable area and the amount of runoff generated by a development. Permeable paving is frequently employed in low trafficked areas such as driveways, car parks and minor shared access roads and do not require any additional land take. Also, they provide an attractive visual landscape in highly urbanised areas.

In some cases, depending on ground conditions, infiltration components provide a good solution to SuDS in high density areas. Bioretention facilities offer the opportunity not only for water quality improvements and storage, but also for biodiversity and amenity. These components provide pockets of green areas in often highly urbanised areas. Examples include areas used as islands in car parks and areas where green space would be required anyway.

Figure 4.11 SuDS in a high density development, Stamford, England

Securing adoption of SuDS

Historically Section 106 of the Town and Country Planning Act 1990 allowed a planning obligation to a local authority to be legally binding. This is a useful mechanism in securing the maintenance of SuDS (➲ **Section 6.2**), but these are now being phased out. The Community Infrastructure Levy (Planning Act 2008) was introduced to provide a flexible local levy that local authorities in England and Wales can choose to levy on development within their area to fund infrastructures (drainage, roads etc).

The Flood and Water Management Act 2010 and the associated National Standards should simplify the adoption proces. In advance of their introduction the Waterlooville project (➲ **Case study 4.2**) demonstrates the importance of consultation and how it can help overcome the challenge of allocation long-term responsibility for SuDS maintenance.

4.3 Securing sustainable drainage

This section provides guidance on how to ask for a sustainable drainage approach to surface water management. Figures 4.12 and 4.13 presents an approach to specifying SuDS for both new and existing developments. In addition to the step by step guidance Chapter 3 provides more information on how to work with the planning and development process, and Chapter 5 provides more detailed guidance on setting the design criteria for SuDS.

Securing SuDS at a strategic level

Sustainable drainage is an integral part of national planning policy in England and Wales. Local authorities should encourage their use at all stages of the planning process. Figure 4.13 describes at what stages in the planning process SuDS should be considered.

Securing SuDS at a site specific level

The use of a sustainable drainage approach to control surface water has national policy backing, so when developers say that they cannot use SuDS then they need to show no other viable option. Figure 4.13 describes how and when to ask for SuDS at a site specific level (➲ **Section 5.3**).

Case study 4.2

Location	Waterlooville, Hampshire
Type of development	Mixed
SuDS used	Permeable paving, detention basins, swales, retention ponds

Background

A steering group addressed SuDS maintenance and adoption challenges, and ensured that these did not become a barrier to the delivery of SuDS on this site.

The adoption meetings were attended by representatives from the two local authorities, Highways Agency, Southern Water, the developers, consultants for the developers, and representatives from the Environment Agency.

Both local authorities were supportive of SuDS in principle but were reluctant to commit to adoption. Through a steering group approach, the local authorities were persuaded that by designing systems appropriately, such as incorporating gentle side slopes on swales, they would have the experience and the machinery available to carry out the maintenance required.

The Waterlooville steering group provided a framework delivering SuDS into a major development area. The success of the project demonstrated that a partnership approach enabled barriers to be overcome through discussion and negotiation.

Agreement was reached on maintenance rates for systems including swales, wetlands, and detention basins. Ponds would be examined individually. The exercise demonstrated that the cost for the local authorities to carry out routine works for public open spaces was similar to that identified for SuDS maintenance. A commuted sum was agreed between the developers and the local authority, and SuDS maintenance costs were then written into a draft Section 106 agreement of the Town and Country Planning Act 1990.

In this case, the Environment Agency helped to facilitate the SuDS adoption processes by organising steering group meetings and working closely with all interested parties to ensure that contentious issues with adoption and maintenance of SuDS were tackled and solved at the pre development stage. The scheme is to be monitored to support and promote the future use of SuDS through creating a better understanding of how these systems operate. The project will endeavour to demonstrate that the development will not increase flood risk, worsen water quality or affect the ecology of local watercourses, which is consistent with the objectives of sustainable development.

STEP 1 National planning policy

PPS1 and PPS25 require regional and local planning authorities to encourage the use of SuDS.	National planning policies encourage the use of SuDS.

STEP 2 Regional spatial strategy

Must include specific policies to promote SuDS, in accordance with PPS25.	Need to provide robust policies at strategic level that encourage the use of SuDS.

STEP 3 Local development framework

Must include specific policies to promote SuDS, in accordance with PPS25.	Local authorities need to provide robust policies that encourage the use of SuDS at a local level.

Figure 4.12 Securing SuDS at a strategic level

STEP 1 Pre-application discussions

The developer should meet with the local authority and other consultees (particularly the Environment Agency) as early as possible to agree the SuDS principles and design criteria. The SFRA should be checked to confirm potential development restrictions. Once the National Standards for Sustainable Drainage have been introduced, this process should be formalised.	Discuss issues of design, integration and adoption of SuDS. The local authority should encourage multifunctional benefits of SuDS at this stage in accordance with planning policies.

STEP 2 Review of proposals

The developer should provide an indication of the SuDS scheme (integration, components etc) and some initial calculations demonstrating that runoff can be appropriately controlled.	The local authority and Environment Agency should review whether sustainable drainage has been adequately provided and whether the proposals will increase flood risk and adversely affect water quality.

STEP 3 Submission of FRA

The developer should submit a draft FRA for comment and then a finalised FRA to support the planning application (and D&A statement) to the local authority, which is then sent to consultees to provide advice.	The local authority should send the draft and final flood risk assessment to consultees for review and obtain advice on suitability of proposals. The design approach and maintenance plan are agreed at this stage.

STEP 4 Decision making

Local authority grants planning permission (subject to conditions) or refuses planning permission.	Conditions should only be used if the local authority is satisfied that the proposals will not affect the aquatic environment, but insufficient design detail has been provided to support the application. Building control/approved inspectors may check the design before approval.

STEP 5 Construction phase

If successful then construction phase begins.	Building control/approved inspectors check the design and construction of SuDS is in accordance with planning permission. This is likely to be a function of the SAB.

STEP 6 Post implementation phase

Maintenance and post construction monitoring.

Figure 4.13 Securing SuDS at a site specific level

Case study 4.3

Location	The Dings, Bristol
Type of development	Residential
SuDS used	Permeable paving

Background

The Dings home zone is situated in central Bristol in an area of social deprivation. It is a mixed development with a severe parking and traffic problem that motivated residents and the council to look for an innovative solution, so a home zone was proposed.

A shared surface (block) paving was created in many areas to stop the traditional distinction between pedestrian and car space, encouraging interaction between all users to bring vehicle speeds to a walking pace.

Using SuDS was encouraged as the existing combined sewer system in the area was already working at capacity and the drainage authority did not want to increase flow into these sewers.

Permeable paving allows rain to infiltrate through a permeable concrete block paved surface into a stone sub-base where it is cleaned by natural processes, before being released in a controlled manner into sewers or watercourses, or infiltrated directly into the sub-grade.

Permeable paving was used in some of the streets, removing the need for traditional drainage channels, which can form a barrier to mobility-impaired people and also delineates between car and pedestrian space. The Dings home zone was the first area of SuDS permeable paving to be laid as adopted highway in Bristol and is one of the largest areas in Britain.

SuDS were championed by the design team to convince the Highway Authority Maintenance (HAM) to adopt a new concept for Bristol's roads. This was aided by HAM's suggestion to bring in a specialist consultant to provide advice on the suitability proposal and educate on the use of SuDS.

4.4 Key learning points

- SuDS should be considered as early as possible in the planning process
- master planning has a significant effect on the viability and cost effectiveness of SuDS integration
- integrating SuDS with an urban design process can help community acceptance of schemes
- design codes help to direct the design of a development.

4.5 References and further reading

CABE (2006) *Design and access statements: How to write, read and use them.* Commission for Architecture and the Built Environment, London. Go to: <http://www.cabe.org.uk/files/design-and-access-statements.pdf>

CABE (2008) *Creating successful masterplans: A guide for clients.* Commission for Architecture and the Built Environment, London. Go to: <http://www.cabe.org.uk/files/creating-successful-masterplans.pdf>

DCLG (2010) Planning Policy Statement (PPS) 3: *Housing*. Department for Communities and Local Government, HMSO, London

KELLAGHER, R (2005) *Use of SuDS in high density developments.* SR666. HR Wallingford Oxfordshire, UK

LLEWELYN-DAVIES AND ALAN BAXTER & ASSOCIATES (2000) *Urban design compendium.* English Partnerships and The Housing Corporation, London. Go to: <http://www.urbandesigncompendium.co.uk>

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Statutes

Community Infrastructure Levy (Planning Act) 2008

Flood and Water Management Act 2010

Town and Country Planning Act 1990

5 How to specify sustainable drainage

This chapter will…

- explain how to specify SuDS
- explain how to set design criteria
- describe the design process
- explain how schemes should be reviewed

5 How to specify sustainable drainage

5.1 Setting the design criteria

Setting the design criteria at the start of the project and establishing a clear SuDS vision ensures that the drainage components are not secondary to other requirements for the site. Sustainable drainage should be integrated into the urban form, whether using hard engineering or soft landscaping features. Failure to allocate areas for SuDS at the start will result in poorly designed components that do not meet the design criteria or fully deliver multifunctional benefits.

Design criteria provide a useful framework for delivering a scheme that meets objectives agreed by the client and design team. These will ideally relate to flood risk management, water quality management, and the provision of biodiversity and amenity. It may not be possible to maximise opportunities for all three objectives and the extent that this happens should be discussed with the relevant stakeholders. When introduced the National Standards should provide a framework for these objectives to be agreed and delivered. The design criteria approach is flexible enough to respond to client aspirations as well as site opportunities and constraints.

The design criteria are given in Table 5.1 and more specific guidance can be found in *The SUDS Manual* (Woods-Ballard *et al*, 2007a).

Table 5.1 Design criteria for sustainable drainage

Design criteria	Key principles
Water quantity (hydraulics, flooding, runoff etc)	People and property must be protected from all flooding sources, including watercourses, the drainage system and overland flows. Development should not exacerbate flood risk within the wider catchment. The flow rate and volume of runoff should be managed to agreed levels.
Water quality (pollution control, management etc)	Potential pollution risks should be mitigated by the use of the SuDS management train. Adequate retention time should be provided to enable pollutants to be treated.
Amenity and biodiversity	SuDS can positively influence urban design and landscape value through provision of green space, vegetation integrating water into the built environment, providing opportunities for biodiversity. This is essential if sustainable drainage is to be included in public open spaces and contribute to green infrastructure. Health and safety concerns should be addressed and designed out. SuDS components should have shallow side slopes, and ponds should have shallow shelving edges, and make good use of vegetation to prevent access.

5.2 How to specify sustainable drainage

Sustainable drainage is designed using similar principles as conventional drainage systems, but applied in a different way. Alongside the more technical issues are those of amenity and improving the environment. Opportunities to create interesting and attractive developments improving the quality and reducing the flow and volume of water leaving a development should be exploited by designing SuDS that are imaginatively integrated into the urban form. The planning system is fundamental to specifying sustainable.

Specifying SuDS in strategic plans

Regional spatial strategies (RSS) and local development frameworks (LDF) should refer to sustainable drainage opportunities (➲ **Chapter 3**) to reduce the effect of development. Strategic flood risk assessments (SFRA) should refer to SuDS on new developments and should:

- identify site opportunities for SuDS, taking into consideration location, constraints and geology
- identify suitable SuDS components
- require SuDS to reduce and treat runoff
- identify retrofit opportunities.

Specifying SuDS in surface water management plans

Surface water management plans (SWMPs, and local flood risk management strategies) make it possible to connect site specific FRAs across developable catchments, and can help to master plan sustainable drainage requirements in a co-ordinated manner.

Useful information *i*

The intention is to make "sustainable urban surface water management decisions that are evidence based, risk based, while taking climate change into consideration, and are inclusive of stakeholder views and preferences" Defra, 2010.

A SWMP can contribute to the requirements for surface water drainage within new developments and urban extensions, as identified in the RSS and LDDs, so that it does not cause flooding, and does not exacerbate flood risk elsewhere in the catchment. Any proposed drainage should be designed to be future proof against further development and climate change. SWMPs can promote and support the use of SuDS within urban areas.

Specifying SuDS in flood risk assessments

Site specific flood risk assessments (FRA) should also refer to SuDS options for minimising the effect of new development by applying the management train philosophy. The design of sustainable drainage will be carried out when submitting a full planning application. When selecting SuDS it is important to consider the design criteria, although these will have to reflect the site characteristics, opportunities and constraints. SuDS should be viewed as an opportunity to incorporate features into the urban landscape that can be visually appealing, provide opportunities for habitat creation and amenity value while carrying out functional drainage requirements.

5.3 Design process and SuDS

It is useful to structure the design process around the delivery of the SuDS management train. It should start by considering what can be done to reduce impermeable surfaces (prevention) and then consider source control. Often these are excluded from the management train due to limitations with space and SuDS can become token features. Runoff is transported via conventional drainage networks to off-site storage and the benefits of SuDS are lost.

The design process and their purpose are highlighted in Table 5.2. It is likely that throughout the process the local planning authority will act as co-ordinator and maintain contact with the Environment Agency, sewerage undertaker and other local authority functions. With the introduction of the Flood and Water Management Act 2010 the SuDS approval body will co-ordinate this process and the stages outlined in Table 5.2 may change.

A successful scheme will require the design team to work with other stakeholders involved in the planning and development process (➲ **Section 3.6**).

Selection of SuDS components

Once the design criteria have been set and an assessment of the site's constraints has been made, drainage components can be selected based upon the following:

- the overall vision for the site and management of surface water
- delivering the surface water management train
- suitability in-line with site opportunities and constraints. For example, if a site is contaminated then it may not be possible to use a component that involves letting water soak into the ground (infiltration)
- performance of SuDS component – relating to how well a particular component can, for example, improve water quality. Table 2.1 provides some initial indication of SuDS performance against water quality, water quantity (flood risk) and biodiversity/amenity considerations.

The site should be split into subcatchments for the management of surface water runoff. The use of development compartments can also be helpful in managing the rate and volume of runoff in discrete areas of a development helping to reduce the size and scale of SuDS components.

Useful information

SuDS should be the primary method of conveying, attenuating and storing surface water. Developers should demonstrate that there is no practicable alternative to control runoff. The design team should consider SuDS at the feasibility stage of development and integral stages during the SuDS.

For detailed design guidance see CIRIA C697 *The SUDS Manual* (Woods-Ballard *et al*, 2007a)

Table 5.2 Stages in the design process

Stage	Purpose and outcomes
Pre-application stakeholder discussions	Developer initiates contact with the local planning authority as early as possible to: • make sure everyone is aware of the proposed development • ensure effective lines of communication are clear • identify the design criteria and opportunities/constraints for the site • ensure SuDS are integrated with the rest of the development • understand the approaches for the adoption of SuDS in the public realm.
Outline planning application and outline drainage proposal	Develop outline drainage proposals via initial discussions that will define the approaches to integrate the SuDS scheme into the landscape. This could be incorporated into a design and access statement. Specific requirements will include: • demonstrating that sustainable drainage principles have been applied and system operation has been accounted for in the overall design parameters • information on approximate sizing of drainage components • using SuDS management train principles • initial calculations of the flow rate from the site • initial estimates on the amount of runoff that needs to be controlled for a storm with 1% probability (1 in 100 year event) • an outline of the SuDS scheme with flood routes mapped • demonstrating that initial scheme design considers climate change • agreement on adoption maintenance and operation of the systems • identifying space for storage areas and conveying exceptional overland/exceedance flows (for extreme events) • compliance with the Code for Sustainable Homes.
Full planning application and detailed drainage assessment, design and consultation	Prepare a detailed drainage design for submission with full planning application. The scope of the drainage assessment is likely to include: • adequate land set aside for SuDS • SuDS designs that are integrated into the overall site concept and layout • calculations showing peak runoff flow rates before and after development • an indication of overland flow routes and that drainage exceedance has been considered • an indication that opportunities to deliver SuDS have been maximised • calculations showing that runoff flow and volumes can be appropriately controlled and managed • need for investigation and further remediation of contaminated land • a method statement on how surface water will be controlled during construction • agreement on adoption maintenance and operation of the systems • the need for long-term monitoring.

5.4 Evaluating sustainable drainage plans

Regulators and more increasingly local authorities will evaluate designs to ensure that they are delivering what was expected in-line with national and local policy as well as the agreed design criteria. Evaluation should be undertaken in consultation with a drainage practitioner, probably within the local authority, but also the Environment Agency may have a role. With the introduction of the National Standards this process should be formalised with the SuDS approving body (SAB) reviewing designs and checking that schemes have been constructed in accordance with the Standards.

The constructed SuDS scheme should reflect what was presented during the planning and design stages and that any alternatives should be rigorously evaluated.

Designers should demonstrate an awareness of the local site conditions and that they have been considered in the SuDS design, eg contamination from previous site uses, and water table and topography to demonstrate that the proposals are the most appropriate for the site.

Plans should indicate the amount of surface water runoff from the impermeable areas and the effect of the proposed SuDS on the volume. Also, there should be a clear indication as to the pollutants removed. A maintenance plan developed by the designer should be considered (➲ **Section 3.6.1**).

Useful information *i*

SuDS should be evaluated according to the design criteria and objectives set at the beginning of the design process.

Evaluation checklist

- does it deliver the agreed design criteria:
  - management of flood risk
  - management of water quality
  - provision of biodiversity/amenity
- has the SuDS management train been delivered
- does it provide source control
- where possible is water managed on the surface
- have all the opportunities of the site been exploited (location, site topography, views)
- has existing flood routes and drainage exceedance been considered
- has health and safety been considered (gradients, inlets, outlets control structures)
- has maintenance and access been considered
- is there a maintenance plan
- has adoption been resolved.

✓

Designers should demonstrate that they have followed current best practice and procedures contained in the following CIRIA guidance:

The SUDS Manual (C697) (Woods-Ballard *et al*, 2007a)

Site handbook for the construction of SUDS (C698) (Woods-Ballard B, *et al* (2007b)

Designing for exceedance in urban drainage: good practice (C635) (Digman, C, Balmforth, D, Kellagher, R and Butler, D 2006)

Building Greener. Guidance on the use of green roofs, green walls and complementary features on buildings (C644) (Newton, J, Gedge, D, Early, P and Wilson, S 2007)

5.5 Retrofitting SuDS

Retrofitting SuDS can help address existing problems, in terms of pollutant reduction and flood risk. They are likely to be used more extensively in the future, as many existing sewer networks are struggling to cope with changing climatic conditions.

The example of The Dings, Bristol (➲ **Case study 4.3**) demonstrates how retrofits can be used to address water quality and quantity issues, but also can be used to improve the quality of life in an area. The case study demonstrates that opportunities exist in regeneration areas to deliver the multiple benefits of SuDS and that the issue of adoption can be resolved.

Another example where it was possible to retrofit source control includes the housing development in Ethelred, Lambeth where a green roof was retrofitted (➲ **Case study 5.1**). The green roof planted with sedum to store rainwater, improve insulation and provide biodiversity benefits. Opportunities for retrofitting will be site specific, however options to consider include:

- disconnection of downpipes (diverted to swales, rain gardens, eg Malmo, Sweden)
- use of permeable surfaces for minor roads and/or car parking
- road runoff diverted to a rain garden integrated as part of traffic calming or the streetscape.

Case study 5.1

Residential housing development, Ethelred, Lambeth

Location	Ethelred, Lambeth
Type of development	Residential
SuDS used	Green roof

Background

The Ethelred housing development was considered for demolition in the early 1990s due to the poor state of repair of the roofs and failure to meet with current building regulations. However the residents and the tenant management organisation fought to keep the buildings open. The solution that was eventually agreed was for a retrofit green roof.

A retrofit green roof scheme was suggested as a way of bringing environmental value to the buildings, visually improving the area and extending the life of the waterproofing. The roofing refurbishment was part of a phased programme of works. With an area of 6000 m², covering roofs of nine of the buildings in the estate, the Ethelred project was the largest retrofit project in Europe at the time. In this instance, the green roof has provided visual improvements, biodiversity and helped improve the thermal comfort of residents. The solution contributes to a healthier lifestyle for the residents, as well as reduced maintenance costs, and sets a sustainable example for others to aspire to.

5.6 Some Do's and Don'ts

As well as considering Table 5.2 when detailing the design process, specifiers and evaluators of sustainable drainage might benefit from some simple Do's and Don'ts:

Do's

- encourage early dialogue between interested parties
- ensure SuDS are integrated with the rest of the development as early as possible
- ensure that the SuDS vision and desired outcomes are set out at the early stages of design
- ensure an appropriate maintenance regime is agreed early on
- agree designs with the local authority and Environment Agency through pre-application discussions
- design inlets/outlets that are sympathetic to their surroundings, eg using locally based stone rather than concrete structures
- use locally sourced plants, to prevent invasive species taking over
- ensure that health and safety of the scheme is considered with a risk assessment
- provide barrier planting where required, so that access to open water can be appropriately controlled. Consider providing access points such as boardwalks and beaches
- provide irregularity along the banks of ponds, such as scrapings and small basins as wildlife habitats
- ensure ponds and wetlands have sediment forebays, where sediment settles out in a controlled manner, reducing the amount of maintenance required
- create islands in ponds and wetlands, providing wildlife with a sanctuary, where they won't be disturbed
- provide walkways around the SuDS, making them a water feature rather than hiding them
- provide check dams for swales if the site is steeply sloping. This will slow down the runoff and prevent erosion of the slopes
- locate filter strips upstream of infiltration devices to prevent them clogging.

Don'ts

- leave discussions with the consultees in the planning process too late
- get the levels wrong so water cannot flow into the facility through gravity
- avoid discharging water to a single point in a swale. This can lead to erosion and much of the sediment accumulating in one place rather than being spread across a wide area. For this reason avoid end of pipe swales
- avoid designing ponds and basins with the inlets and outlets located too close together, limiting the amount of time water stays in the component
- use infiltration devices for impermeable soils
- allow construction runoff from building sites to enter SuDS components unless you are prepared to carry out remedial work, as there is likely to be significant sediment accumulation
- design ponds or basins with steep sided slopes, they can be dangerous and provide little wildlife value. Also, deep ponds may suffer from wave action that re-suspends sediment
- use garden centre plants as they can be contaminated by invasive species.

✓

5.7 Key learning points

- the specification process should include early stakeholder involvement
- consideration of SuDS early in the design process
- a good SuDS design meets the local requirements for water quantity and quality, but also will seek to provide amenity and habitat opportunities
- designs should be simple to understand and maintain
- designs should comply with existing guidance.

5.8 References and further reading

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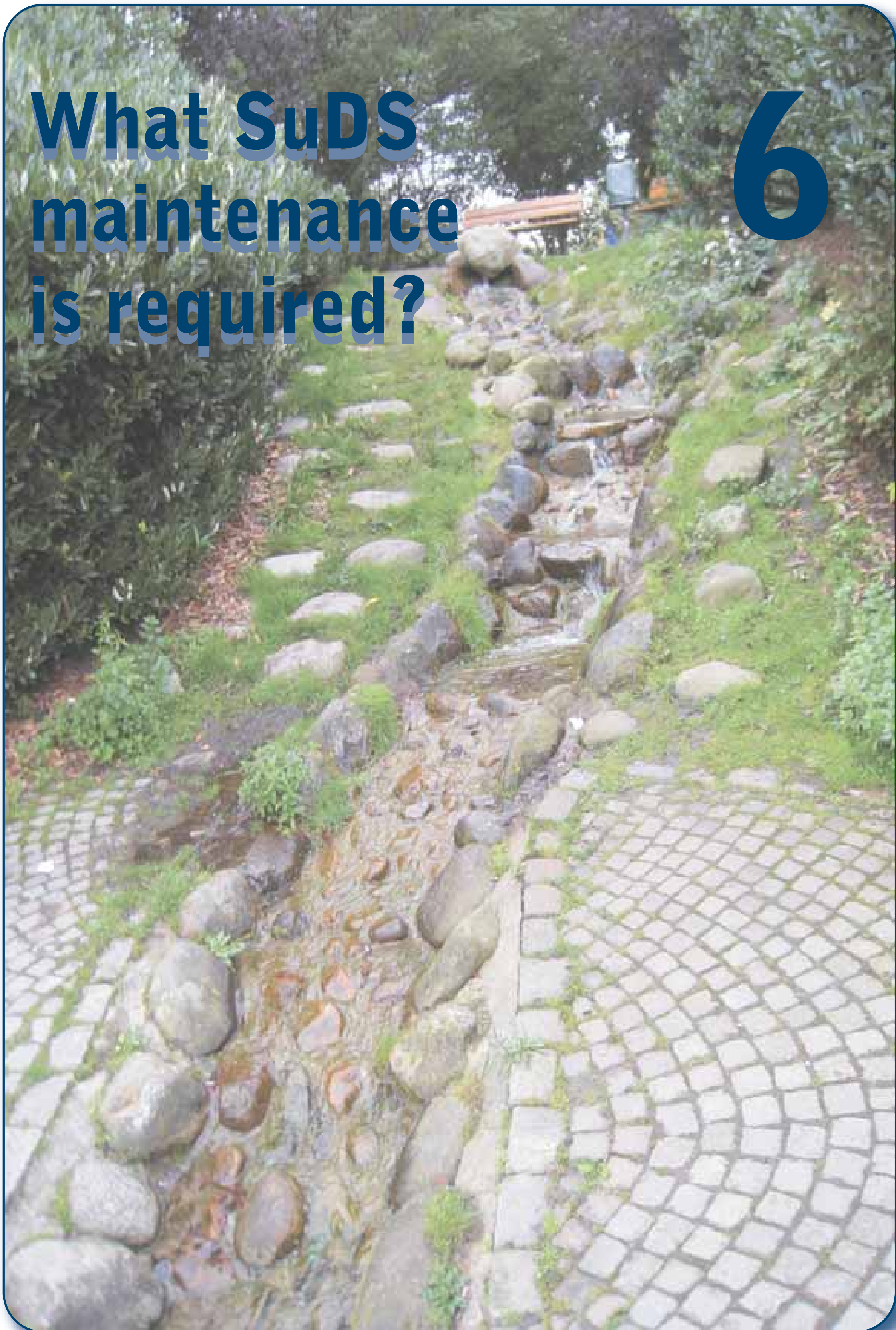
Statutes

Flood and Water Management Act 2010



What SuDS maintenance is required?

6

This chapter will…

- explain the types of maintenance required
- describe who adopts SuDS at the moment
- provide an example of where adoption issues have been overcome.

6 What SuDS maintenance is required?

6.1 Maintenance requirements

Like all drainage systems, SuDS components should be inspected and maintained. This ensures efficient operation and prevents failure. Usually, SuDS components are on or near the surface and most can be managed using landscape maintenance techniques. For below-ground SuDS such as permeable paving and modular geocellular storage the manufacturer or designer should provide maintenance advice (➲ **Case study 6.1**). This should include routine and long-term actions that can be incorporated into a maintenance plan. Also, the design process (➲ **Section 5.3**) should consider the maintenance of the components including any corrective maintenance to repair defects or improve performance. A SuDS management plan for the maintenance of SuDS should be prepared. This should include an overview of the design concepts (➲ **Chapter 5**) and a maintenance schedule for the scheme to ensure that it continues to function as intended.

Funding for maintenance may need to be resolved at the start of the process to ensure that either the local authority, a maintenance company, local residents or the water company have sufficient resources to maintain the system in the long-term (➲ **Case study 6.2**).

Maintenance can be categorised into three main groups (➲ **Table 6.1**):

- regular
- occasional
- remedial.

The level of inspection and maintenance will vary depending on the type of SuDS component and scheme, the land use, types of plants as well as biodiversity and amenity requirements. Further information on maintenance can be found in *The SUDS Manual* (Woods-Ballard *et al*, 2007a).

The SuDS scheme is unlikely to be handed over for maintenance until all parties are confident that the scheme is constructed and performs as designed. An interim maintenance plan can be incorporated on larger schemes.

Operation and use

The design and maintenance of SuDS schemes need to be undertaken in accordance with the Construction and Design Management (CDM) Regulations 2007 to help cover health and safety concerns. Unlike traditional drainage, SuDS components may be located above ground and can fill with water during operation. Care should be taken in the design to ensure that maintenance can be carried out safely and that safe access/egress is possible at all times.

The community should be involved in the development and use of the SuDS scheme. Community engagement can help local residents understand how the SuDS scheme works, allay fears about safety and reduce the chances of residents altering schemes. Many SuDS schemes have interpretation boards and include paths and picnic seating to enable people and particularly young families to make the best use of the areas.

Table 6.1 Typical inspection and maintenance activities

Activity	Indicative frequency	Typical tasks
Routine/regular maintenance	Monthly (for normal care of SuDS)	• litter picking • grass cutting • inspection of inlets, outlets and control structures.
Occasional maintenance	Annually (dependent on the design)	• silt control around components • vegetation management around components • suction sweeping of permeable paving • silt removal from catchpits, soakaways and cellular storage.
Remedial maintenance	As required (tasks to repair problems due to damage or vandalism)	• inlet/outlet repairs • erosion repairs • reinstatement of edgings • reinstatement following pollution • removal of silt build up.

6.2 Adoption

Some important differences between adoption and maintenance are demonstrated in Waterlooville, Hampshire (➲ **Case study 4.2**) and Springhill, Stroud (➲ **Case study 6.2**). Adoption is related to someone or an organisation taking responsibility for management. Maintenance includes the activities undertaken.

Adoption and source control components

Source control SuDS components within private property is the responsibility of the landowner or property manager. There should be information on how these components function and to reduce the risk of unintentional damage.

Adoption of site control and regional control SuDS components

The Flood and Water Management Act 2010 formalises the approval and delivery of sustainable drainage and suggests that a SuDS approval body (SAB) should have responsibility for their approval and adoption. The SAB will be responsible for the adoption of SuDS components within the public realm, which is likely to include site and regional control SuDS components.

Some local authorities like Cambridge City and the London Borough of Islington have already begun to provide guidance to developers on the delivery of SuDS to meet their specific local requirements and aspirations.

For examples of local authority guidance on SuDS please see

Sustainable drainage – Cambridge design and adoption guide (Wilson, S, Bray, B, Neesam, S, Bunn, S and Flanagan, E, 2010)

Promoting Sustainable drainage systems – design guidance for Islington (Robert Bray Associates and Islington Council, 2010)

Adoption should not be seen as a barrier to SuDS delivery and should be discussed early in the process. There are examples where local authorities, water utilities, private companies and other organisations have adopted SuDS. Potential mechanisms include the use of legal/model agreements together with commuted sums (➲ **Case study 4.3**). Some of the approaches include:

- using a model agreement and commuted sum, Section 106 agreements from the Town and Country Planning Act, 1990

- using a model agreement and commuted sum, Section 38 from the Highways Act 1980
- using private management companies that are funded through a commuted sum or service charge and pay an assurance bond.

The example of Springhill, Stroud (➲ **Case study 6.2**) demonstrates that the issue of adoption does not necessarily need to be an insurmountable barrier.

Useful information

Early discussions about adoption should overcome any issues.

Case study 6.1

Residential housing development, Eden Park, Littlehampton

Location	Eden Park, Littlehampton
Type of development	Residential
SuDS used	Infiltration basins, wetland and geocellular storage

Background

Three separate house builders were involved in the development to provide 400 new homes on the site of a former nursery. As there were no public surface water sewers or watercourses near to the site, a conventional solution would have involved expensive civil engineering works including a surface water pumping station and significant off-site surface water sewers. The alternative solution using a combination of infiltration, wetlands and geocellular storage delivered a reduced cost solution, and enabled low maintenance and easy access to the infiltration system once installed.

The above-ground SuDS components were designed into open spaces, incorporating play areas and landscaping that, following funding by the developers, the local authority adopted. This ensured that the local authority was able to obtain and control funds for future maintenance of the SuDS, to ensure the long-term viability and quality of management and maintenance for the public open spaces and play areas on the Eden Park Estate. Also, it made certain that adequate maintenance would be carried out on the SuDS to allow it to function to its design capabilities.

The geocellular storage provides effective silt and sediment separation. Maintenance is limited to sump emptying of silt and sediment following major storm events.

Case study 6.2

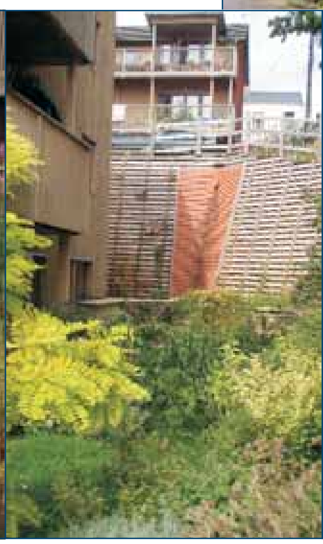
Location	Springhill, Stroud
Type of development	Residential
SuDS used	Permeable paving, swales, rills, ponds

Background

Housing density is 50 units/hectare, which exceeds PPS 3 recommendations. Vehicle access to the site is from the top and leads to a level parking area designed to adoptable standards but managed by the community. The parking comprises lined permeable block paving with a shallow geocellular modular tank to store runoff ensuring clean water enters the storage structure with all silt and debris left in the surface. The car park receives additional flows from nearby roofs and hard surfaces before passing through a control structure to a tile hung cascade on the retaining crib wall. Also, some roof water flows to the T-piece cascade creating a visual spectacle when it rains.

The upper sub-catchment flows to a gabion erosion control and garden swale before entering a feature pool in front of the community building. Roofs contribute extra water to this small visual and biodiversity pond.

Runoff from the lower pedestrian street flows to a rill channel in front of the lower terrace of housing. This collection mechanism was discussed and agreed with prospective residents during the design process. Once the rill is full, excess volumes flow through a silt trap into geocellular boxes below the pavement. These provide 1 in 2 year storage with additional volumes directed to a detention basin that is also an informal play space. Eventually water flows to the spring fed stream at the bottom of the development. It enters the stream at "greenfield rate" of runoff. Maintenance of the site is undertaken by residents.



6.3 Key learning points

- inspection and maintenance ensures efficient operation and prevents failure
- inspection and maintenance can be broken down into three important tasks:
  - routine
  - occasional
  - S remedial
- information should be provided to property owners and managers on how source control SuDS components work and should be maintained
- until SABs become operational the adoption of SuDS in the public realm is something of a grey area, but there are ways to overcome these issues
- the Interim Code of Practice for SUDS (NSWG, 2004) provides useful advice on how to overcome adoption issues
- with appropriate vision the issue of adoption can be overcome
- early discussions during the planning process can ensure that SuDS are readily adopted and maintained.

6.4 References and further reading

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ROBERT BRAY ASSOCIATES and ISLINGTON COUNCIL (2010) *Promoting sustainable drainage systems – design guidance for Islington,* Islington Council. Go to: <http://www.islington.gov.uk/DownloadableDocuments/Environment/Pdf/Sustainability/islington_suds_gd_web_small.pdf>

Statutes

Construction and Design Management (CDM) Regulations 2007

Flood and Water Management Act 2010

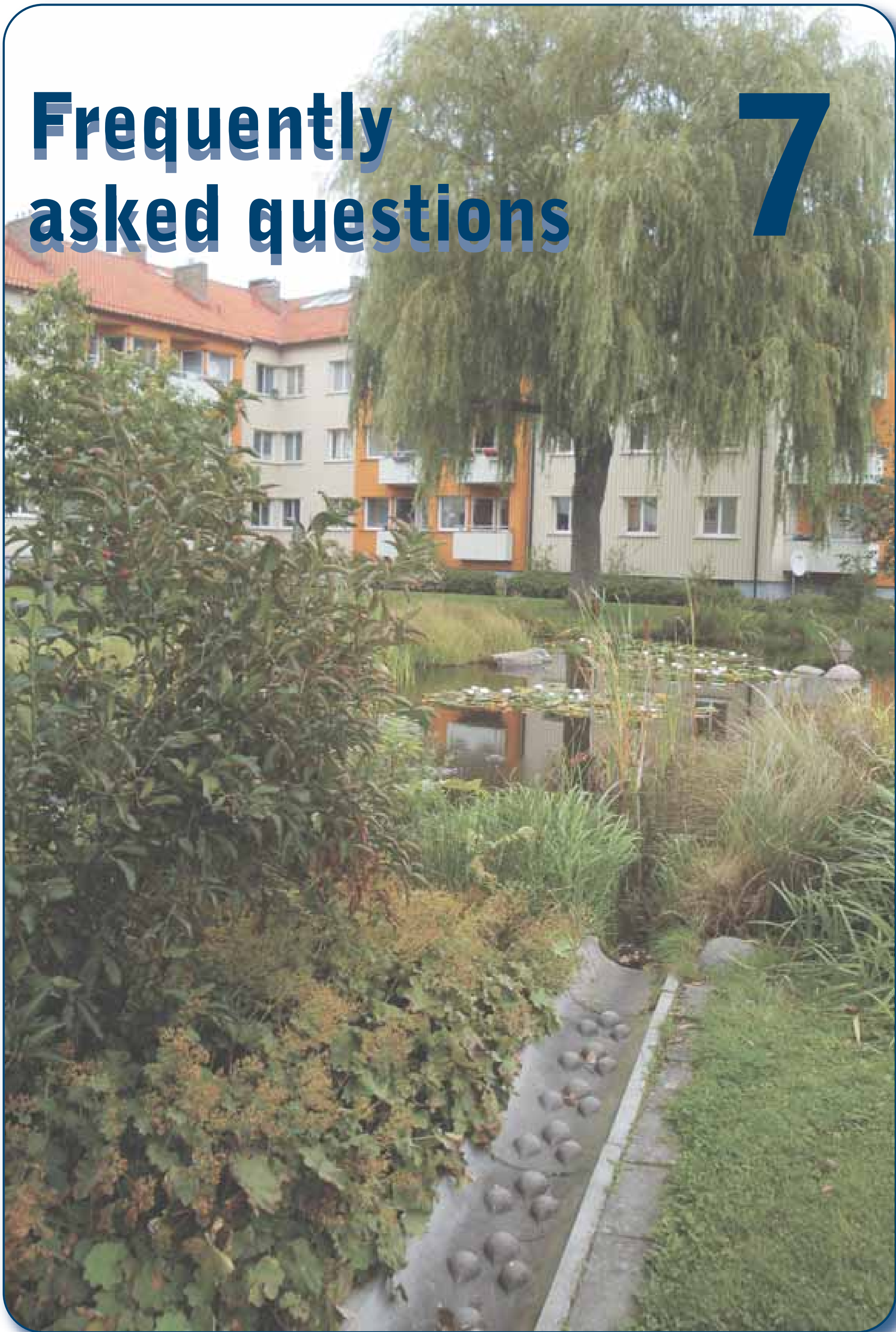
Highways Act 1980

Land Drainage Act 1991

Town and Country Planning Act 1990

Frequently asked questions

7



This chapter will…

- answer questions on common challenges about SuDS delivery
- dispel some common myths associated with SuDS.

7 Frequently asked questions

7.1 What are the potential challenges?

Sustainable drainage is the preferred approach to managing surface water, due to the multiple benefits it provides compared to conventional drainage. Traditionally drainage of urban areas has been in underground piped systems. However as urban development has continued drainage systems can no longer cope in many areas and, coupled with climate change predictions, this can only get worse with time. Over time practitioners' attitudes toward sustainable drainage have become more positive. Their reluctance to deliver sustainable drainage might have originally been due to:

- lack of available guidance
- venturing into the unknown
- complicated regulatory framework
- uncertainty about capital and operational costs
- difficulties in getting SuDS adopted.

Now there are many organisations supporting the delivery of sustainable drainage. Over the last few years several guidance documents have been produced providing practitioners with information on planning, designing, constructing and managing SuDS. Also, the development of guidance has been supported by many conferences and training courses. With this level of support available practitioners now have greater confidence to deliver SuDS.

7.2 Are SuDS more expensive than traditional drainage?

Limited public information on the cost of SuDS exists. However there is strong evidence suggesting that the construction and operational costs of SuDS, particularly multifunctional landscaped components, are less expensive than traditional drainage. This is because SuDS do not involve deep excavation or expensive materials.

As sustainable drainage approaches are relatively new and need to be tailored to the site it is thought that the design process may be slightly more expensive. However this should be evaluated against the delivery of the wider opportunities over and above the provision of traditional drainage. For example SuDS can be used where landscaping is provided and can be used as a feature on a site such as ponds or wetlands, and hard landscaping such as channels and rills. Also, it can provide amenity features within a development that reduces the overall cost of providing landscaping and drainage separately.

Lamb Drove, Cambridge had a 10% saving on design and capital costs compared to traditional drainage systems, a saving that may have been higher if consultation had taken place before the layout of the development was decided.

For information on whole-life costing for SuDS see: *Performance and whole life costs of best management practices and SuDS* (UKWIR 2009)

7.3 What guidance is there?

SuDS have been successfully designed and incorporated into an increasing number of developments from residential and schools to motorway service areas and commercial properties. There are a range of design manuals to help ensure that designs are fit for purpose and that the SuDS management train principles are applied, ie source control, site control and finally regional control. *The SUDS Manual* (Woods-Ballard *et al*, 2007a) will guide you through the design process and can be referred to by those checking designs and calculations to ensure that sustainable drainage principles have been applied.

References to specific guidance documents can be found in the references and further reading sections at the end of each chapter in this guidance.

7.4 Do SuDS take up a lot of land and can they be used on high density developments?

Often the need for higher density developments from PPS3 Housing (➲ **Section 4.1**) and the land take required for some SuDS components can be considered a challenge. With creativity and careful planning this can be overcome. Springhill, Stroud (➲ **Case study 6.2**) shows how careful design and consideration of sustainable drainage issues ensures that SuDS can be incorporated into the built environment landscaping and some more harder components can form an integral part of the site drainage.

The SuDS management train approach, with source control components upstream of regional controls, reduces the need for larger SuDS components such as retention ponds and wetlands to be situated on site. Also a series of smaller ponds can be used upstream on the catchment limiting the volumes that need to be controlled downstream. This can then provide visually interesting features and enhance biodiversity within the development. For new developments there may be a planning requirement to incorporate public open space and car parking, providing an ideal opportunity to simultaneously integrate SuDS and offer multifunctional benefits. When planning sustainable drainage in high density developments both innovative design and specific SuDS components are fundamental to success.

Figure 7.1 ***A canal in a high density housing development, Stamford, England***

SuDS components for tight spaces

- green roofs
- rainwater harvesting
- permeable paving
- infiltration devices
- sub surface drainage systems
- bioretention areas

✓

Green roofs (➲ **Table 2.1**) allow rainwater to be controlled as close to source as possible, and research has suggested that green roofs reduce annual runoff from roofs by about 50% (Newton *et al*, 2007).

Permeable paving or other permeable surfaces can replace standard impermeable tarmac to reduce the amount of runoff generated by a development.

In some cases, depending on ground conditions, infiltration components (or facilities that allow water to soak into the ground) (➲ **Table 2.1**) can help provide SuDS in high density areas. Bioretention facilities (underdrained landscaped areas) (➲ **Table 2.1**) offer good opportunities for water quality improvements, storage, and for amenity. For example in bioretention areas that would be used as landscaped features in car parks, and in areas where green space would be required anyway.

Traffic calming can incorporate SuDS (➲ **Case study 4.3**), eg using rain gardens to remove road gulleys, and runoff into the sewerage system, by intercepting highways runoff at source and controlling discharge into the underlying ground. Examples of this system have been successfully included in Portland, Oregon, where roadside rain gardens are planted with native species to reduce the width of the road (and the speed of vehicles) and removing runoff from the drainage network.

> For guidance on delivering SuDS in small areas see: *Use of SuDS in high density developments – guidance manual* (SR666) (HR Wallingford, 2005)

By careful consideration, and sometimes using innovative solutions, runoff from urban areas can be removed at source, while providing supplementary benefits. Similarly, roof runoff can be intercepted and diverted into rain gardens or rainwater harvesting systems for reuse.

7.5 Can SuDS be used on contaminated land?

A common misconception is that SuDS cannot be used at a contaminated land site that is proposed for redevelopment. When considering sustainable drainage some components may not be appropriate for contaminated sites, such as those using infiltration, which may re-mobilise pollutants in the ground. However, components that store or convey water on the surface are likely to be more suitable. Ground investigation information will indicate that components are applicable to the local conditions, and it might be that certain parts of the development can use infiltration if there is no risk of pollution.

Using liners to prevent infiltration into the underlying ground will enable the use of swales, wetlands, ponds and permeable paving on sites. As SuDS tend to be shallow there will be less disruption to any contaminated ground as can happen when installing traditional piped drainage, eg where a contaminated site has been capped, trenches for piped systems can break through this layer, potentially re-mobilising contaminants. Also, traditional systems can provide a pathway for contaminants via the pipe surround. SuDS may provide a pathway, but above-ground systems will quickly show if this is occurring and SuDS may offer some water quality improvements if polluted. Traditional drainage systems will not.

SuDS can reduce the effect on watercourses, which may have been historically polluted, by improving the quality and reducing the rate and volume of runoff. SuDS can provide biodiversity and habitat opportunities on contaminated sites through careful and considerate design.

SuDS can be used during construction to trap and remove contaminants from development. For example, when a site has been cleared runoff can be rapid and may contain high levels of silts, sediments and polluted material.

Components that have permanent open water can be planted to restrict access, but other features such as detention basins and swales may have occasional water above ground and may need signage to advise the public of their primary use. Often the permanent waterbodies will be used as public amenity and so safety fears may be allayed. Effective communication will be vital for mitigating health and safety risks, and this should be established at an early stage of the planning and design process.

> For guidance on delivering SuDS on contaminated land see: *SuDS Advice note – brownfield sites* (SEPA, 2003)

7.6 Are SuDS safe?

There are many ways to reduce the chances of accidents in and around sustainable drainage schemes. With appropriate design these risks can be minimised particularly if components are visible and successfully integrated into the public. It is recommended that open water components incorporate barrier planting (usually densely planted marginal vegetation and/or thorny plants to restrict access) and gently inclined side slopes. Options include the design of banks for ponds and swales with a maximum of a 1 in 4 slope and the depths of ponds and wetlands should be kept to a minimum, with the maximum depth of water being located away from the edges. Often, information signs are used demonstrating the benefits of sustainable drainage. Educating the public how the SuDS scheme works and the risks is a vital part of involving the community.

7.7 How can the issue of adoption be solved?

Adoption is still considered one of the main barriers to SuDS even though most SuDS are simple to look after, often using standard landscape gardening techniques. It is important that early discussions take place between stakeholders to resolve this issue as early as possible. The approval process with the National Standards will enable this to happen and provide a framework for adopting SuDS.

As discussed in Section 6.2 there are examples and mechanisms where adoption has been resolved.

Figure 7.2 SuDS interpretation board, Cambridgeshire, England

Figure 7.3 SuDS rill at a school, Exeter, England

7.8 Can SuDS be retrofitted?

Retrofitting SuDS can help address existing capacity and drainage problems, in terms of pollutant reduction and flow control. They are likely to be used more extensively in the future, as existing sewers continue to struggle with development and changing climatic conditions.

The example of The Dings, Bristol (➲ **Case study 4.3**) demonstrates how retrofit projects can be used to address water quality and quantity issues, but can be used to improve the quality of life in an area. The case study demonstrates that opportunities exist in regeneration areas to deliver the multiple benefits of SuDS and that the issue of adoption can be resolved (➲ **Case study 7.4**).

Careful consideration to retrofitting SuDS may be needed to ensure that they are incorporated into the existing urban form, this has been successfully achieved in Malmo, Sweden (➲ Figures 1.5, 2.5, 2.6 and 7.5). There are examples of SuDS retrofits into highways to form traffic calming, by reducing the road width and removing existing gulleys (for example in Portland, USA and Auckland, New Zealand). Permeable paving can be installed in car parks and low trafficked areas and runoff from individual buildings can be removed from the public sewerage system by disconnecting downspouts from piped drainage systems and diverting runoff into rain gardens or soakaways.

Figure 7.4

The Dings before and after, Bristol, England

Figure 7.5

Retrofitting SuDS, Malmo, Sweden

7.9 References and further reading

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SUSTAINABLE URBAN DRAINAGE SCOTTISH WORKING PARTY (SuDSWP) (2003) *SuDS advice note – brownfield sites*. SEPA, Stirling, Scotland

8 Glossary

Amenity	The quality of place being pleasant or attractive, ie agreeableness. A feature that increases attractiveness or value, especially of a piece of real estate or a geographic location.
Attenuation	Reduction of peak flow and increased duration of a flow event.
Basin	A ground depression acting as a flow control or water treatment structure that is normally dry and has a proper outfall, but is designed to detain stormwater temporarily.
Biodiversity	The diversity of plant and animal life in a particular habitat.
Bioretention area	A depressed landscaping area that is allowed to collect runoff so it percolates through the soil below the area into an underdrain promoting pollutant removal.
Brownfield site	A site that has been previously developed.
Catchment	The area contributing surface water flow to a point on a drainage or river system. Can be divided into sub-catchments.
Combined sewer	A sewer designed to carry foul sewage and surface runoff in the same pipe.
Contaminated ground	Ground that has the presence of such substances that, when present in sufficient quantities or concentrations, is likely to have detrimental effects on potential targets.
Conventional drainage	The traditional method of draining surface water using subsurface pipes and storage tanks.
Conveyance	Movement of water from one location to another.
Construction (Design and design Management) (CDM) Regulations 2007	Emphasise the importance of addressing construction health and safety issues at the phase of a construction project.
Culvert	A closed channel carrying a watercourse beneath an obstruction such as a road, railway or canal.
Curtilage	An area of land around a building or group of buildings for the private use of the occupants of the buildings.
Design and access statement	Formal documents explaining the design philosophy behind a planning application.
Design codes	These are defined as detailed design guidance, which is stricter and more exact than other guidance.
Design criteria	A set of standards agreed by the developer, planners, and regulators that the proposed system should satisfy.
Design statement	In the context of a planning application, a written statement to a local authority prepared by an applicant setting out the design principles adopted in relation to a proposed design for a site and its wider context.

Designing for exceedance	An approach that aims to manage exceedance flows during rainfall events, eg using car parks during extreme events.
Detention basin	A vegetated depression that is normally dry except following storm events. Constructed to store water temporarily to attenuate flows, and may allow infiltration of water to the ground.
Detention pond/tank	A pond or tank that has a lower outflow than inflow. Often used to prevent flooding.
Diffuse pollution	Pollution arising from land-use activities (urban and rural) that are dispersed across a catchment, or sub-catchment, and do not arise as a process effluent, municipal sewage effluent, or an effluent discharge from farm buildings.
Ecology	All living things, such as trees, flowering plants, insects, birds and mammals, and their habitats.
Ecosystem	A biological community of interacting organisms, and their physical environment.
Ecosystem services	Services provided by the natural environment that benefit people.
Environment	Both the natural environment (air, land, water resources, plant, and animal life) and habitats.
Environmental regulators	These include the Environment Agency in England and Wales, the Scottish Environment Protection Agency in Scotland.
Erosion	The group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the Earth's surface.
Evapotranspiration	The process that the Earth's surface or soil loses moisture by evaporation of water and by use of and transpiration from plants.
Filter drain	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage.
Filter strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
Filtration	Removing sediment or other particles from a fluid by passing it through a filter.
Flood routing	Design and consideration of above-ground areas that act as pathways permitting water to run safely over land to minimise the adverse effect of flooding. This is required when the design capacity of the drainage system has been exceeded.
Flood and Water Management Act 2010	Legislation to clarify the framework for managing flood risk (particularly surface water management) in England and Wales.
Flora	The plants found in a particular physical environment.
Forebay	A small basin or pond upstream of the main drainage component with the function of trapping sediment.
Geocellular structure	A plastic box structure used in the ground, often to attenuate runoff.
Green infrastructure	A strategically planned and delivered network of high quality green spaces and other environmental features (often including water features).
Green roof	A roof with plants growing on its surface, which contributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater, and promotes evapotranspiration. Sometimes referred to as an alternative roof.

Groundwater	Water that is below the surface of ground in the saturation zone.
Habitat	The area or environment where an organism or ecological community normally lives or occurs.
Highways Agency	The government agency responsible for strategic highways in England, ie motorways and trunk roads.
Highways authority	A local authority with responsibility for the maintenance and drainage of highways maintainable at public expense.
Impermeable	Will not allow water to pass through it.
Impermeable surface	An artificial non-porous surface that generates a surface water runoff after rainfall.
Infiltration (to the ground)	The passage of surface water into the ground.
Infiltration basin	A dry basin designed to promote infiltration of surface water to the ground.
Infiltration trench	A trench, usually filled with permeable granular material, designed to promote infiltration of surface water to the ground.
Local development framework (LDF)	A non-statutory term used to describe a folder of documents that includes all the local planning authority's local development documents (LDDs). The LDF will comprise the statement of community involvement, the local development scheme and the annual monitoring report.
Master plan	A master plan includes both the process by which organisations undertake analysis and prepare strategies, and the proposals that are needed to plan for major change in a defined physical area.
National Standards for Sustainable Drainage	Referred to as the National Standards. A regulatory document providing standards and guidance on the design, construction and maintenance of SuDS for approval and adoption by the SuDS approval body.
Non-wholesome water	Water not suitable for drinking and has the same meaning as in Part G of Schedule 1 to the Building Regulations 2000 (SI 2531) (as amended).
Pathway	The route by which potential contaminants may reach targets.
Pavement	The road or car park surface and underlying structure, usually asphalt, concrete, or block paving. Note that the path next to the road for pedestrians is known as the footway.
Permeability	A measure of the ease that a fluid can flow through a porous medium. It depends on the physical properties of the medium, for example, grain size, porosity, and pore shape.
Permeable pavement	A permeable surface that is paved and drains through voids between solid parts of the pavement.
Permeable surface	A surface that is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration of water to the sub-base through the pattern of voids, for example concrete block paving.
Pollution	A change in the physical, chemical, radiological, or biological quality of a resource (air, water or land) caused by human/human activities that is injurious to existing, intended, or potential uses of the resource.
Pond	Permanently wet depression designed to retain stormwater above the permanent pool and permit settlement of suspended solids and biological removal of pollutants.

Porous paving	A permeable surface that drains through voids that are integral to the pavement.
Potable/mains water	Water company/utility/authority drinking water supply.
Prevention	Site design and management to stop or reduce the occurrence of pollution of impermeable surfaces and to reduce the volume of runoff by reducing impermeable areas.
Public realm	Public space between private buildings including pavements, streets, squares, parks
Public sewer	Has the same meaning as given by paragraph 219(1) of the Water Industry Act 1991. A sewer that is vested and maintained by the sewerage undertaker.
Rainwater butt	Small scale garden water storage device that collects rainwater from the roof via the drainpipe.
Rainwater harvesting or rainwater use system	A system that collects rainwater from where it falls rather than allowing it to drain away. It includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces.
Recharge	The addition of water to the groundwater system by natural or artificial processes.
Regional control	Management of runoff from a site or several sites, typically in a balancing pond or wetland.
Retention pond	A pond where runoff is detained for a sufficient time to allow settlement and biological treatment of some pollutants.
Risk	The chance of an adverse event. The combination of the probability of that potential hazard being realised, the severity of the outcome if it is, and the numbers of people exposed to the hazard.
Risk assessment	"A carefully considered judgement" requiring an evaluation of the consequences that may arise from the hazards identified, combining the various factors contributing to the risk and then evaluating their significance.
Rill	Open surface water channels with hard edges.
Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or rainfall is particularly intense.
Section 38	An agreement entered into pursuant to Section 38 Highways Act 1980 where a way that has been constructed or that is to be constructed becomes a highway maintainable at the public expense. A publicly maintainable highway may include provision for drainage of the highway (drainage of highways is defined in Section 100 (9) of the Highways Act 1980).
Section 106 Town and Country Planning Act 1990	A section of the Act that allows a planning obligation to a local planning authority to be legally binding.
Sewerage undertaker	This is a collective term relating to the statutory undertaking of water companies that are responsible for sewerage and sewage disposal including surface water from roofs and yards of premises.
Site control	Management of water in a local area or site, eg routing water from building roofs and car parks to a large soakaway, infiltration or detention basin.
Soakaway	A sub-surface structure into which surface water is conveyed, and designed to promote infiltration.
Source control	The control of runoff at or near its source (normally within the cartilage of a property).

Strategic flood risk assessment (SFRA)	Provides information on areas at risk from all sources of flooding. The SFRA should form the basis for flood risk management decisions, and provides the basis to apply the sequential test and exception test (as defined in PPS25) in development allocation and development control process.
Sub-catchment	A division of a catchment, to allow runoff to be managed as near to the source as reasonably practicable.
Sustainable drainage systems (SuDS)	A sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques.
SuDS approval body	An organisation formed by an upper tier or unitary authority responsible for the approval and adoption of drainage schemes in accordance with the National Standards for Sustainable Drainage (once introduced).
SuDS management train	The management of runoff in stages as it drains from a site.
Surface water	Water that appears on the land surface, ie lakes, rivers, streams, standing water and ponds.
Swale	A shallow vegetated channel designed to conduct and retain water, but also may permit infiltration. The vegetation filters particulate matter.
Treatment	Improving the quality of water by physical, chemical and/or biological means.
Treatment stage	A component of a sustainable drainage system improves the water quality of the water passing through it.
Waste	Any substance or object that the holder discards, intends to discard, or is required to discard.
Watercourse	Includes all rivers, streams, ditches, drains, cuts, culverts, dykes, sluices, and passages that water flows through.
Water Framework Directive (WFD)	A Directive designed to integrate the way waterbodies are managed across Europe. It requires all inland and coastal waters to reach "good status" by 2015 through a catchment-based system of river basin management plans, incorporating a programme of measures to improve the status of all natural water bodies.
Water table	The point where the surface of groundwater can be detected. The water table may change with the seasons and the annual rainfall.
Wetland	Flooded area where the water is shallow enough to enable the growth of bottom-rooted plants.

9 Abbreviations

BAP	Biodiversity action plan
BMP	Best management practice
DCLG	Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency (England and Wales)
EC	European Commission
LA	Local authority
LDD	Local development document
LDF	Local development framework
LPA	Local planning authority
MUGA	Multi-use games area
PPS	Planning Policy Statement
RPB	Regional planning body
RSS	Regional spatial strategy
SAB	SuDS approval body
SFRA	Strategic flood risk assessment
SPD	Supplementary planning document
SSSI	Site of special scientific interest
SuDS	Sustainable drainage system
SWMP	Surface water management plan
TAN	Technical Advice Note (Wales)
TCPA	Town and Country Planning Act 1990
WFD	Water Framework Directive