City of Edinburgh Council

Sustainable Rainwater Management Guidance

2021

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THE CITY OF EDINBURGH COUNCIL

Foreword

This guidance was commissioned by the City of Edinburgh Council to address the practical application of the Water Management Vision for Edinburgh, setting Sustainable Urban Drainage within a local Scottish context. The Vision recognises climate change as a key challenge now, and in the future, and sets out the need to adapt to improve resilience while creating a greener, healthier and more beautiful city.

From an individual householder, to a major developer, planner or roads engineer, we all need to consider where the rainwater should go, not just in new developments, but in our existing streets and open spaces. This guidance is a step change on the way Edinburgh is proposing to go forward on all projects as we plan for a future with reduced risk of flooding for all housing and businesses.

Acknowledgements

The Edinburgh Sustainable Rain Water Management Guidance has been developed by Atkins on behalf of City of Edinburgh Council with support from the University of Abertay and SUSTRANS.

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Introduction

The need for this Guidance

Edinburgh's Sustainable Rain Water Management Guidance forms part of the City of Edinburgh's commitment in response to the Scottish Government's *Climate Change Challenge* to adapt and further sustainable development in accordance with the Climate Change (Scotland) Act 2009, the Planning (Scotland) Act 2006 and the aims set out in Edinburgh Adapts.

Edinburgh's Water Management Vision provides the context for development of LDP 2030 Policies. The aims include creating multifunctional spaces that keep water above ground and reducing stormwater in the combined sewer network.

Policies in the Local Development Plan identify the use of Sustainable Urban Drainage Systems (SuDS) as part of the place making agenda.

The purpose of this Guidance

The aim of this guidance is to raise understanding that all developments and improvement projects in Edinburgh need to actively seek ways to use sustainable drainage as part of placemaking. It provides a practical, accessible guide that covers the 'why, 'how' and 'where' of bringing about positive change, demonstrating how sustainable drainage can support nature, greening our city and creating beautiful inclusive places.

The ESRWMG provides a reference for sustainable drainage design within the Edinburgh Council area including design considerations, constraints and opportunities for Edinburgh's streets and new developments. It should be read in conjunction with the Edinburgh Design Guidance (EDG).

Who is this Guidance for?

Edinburgh's Sustainable Rain Water Management Guidance will be relevant to anyone who designs, builds, manages, maintains or alters any structures, streets or open space in Edinburgh.

The guidance will be of particular relevance to planners, landscape architects, architects, civil engineers, transport engineers, greenspace managers and developers.

Figure 1. Surface Water Flooding, Myreside | Flickr

Figure 2. Swales at Countesswells, Aberdeen | SNH

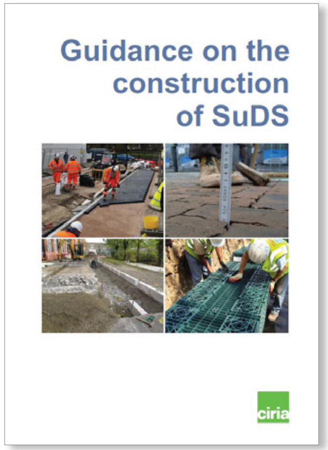
Figure 3. Trees at Grassmarket, Edinburgh | Atkins

Using this guidance with National Guidance

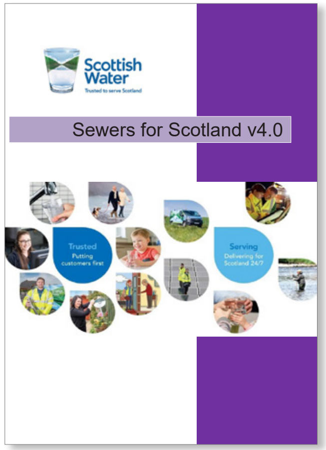
This Guidance should be read alongside relevant national and regional guidance.

Sustainable drainage design for developments in Edinburgh shall in general shall follow the practices detailed in **CIRIA's SuDS Manual C753 (2015)**. This includes the philosophy, design approach, levels of treatment and technical specifications, except where otherwise described in this document.

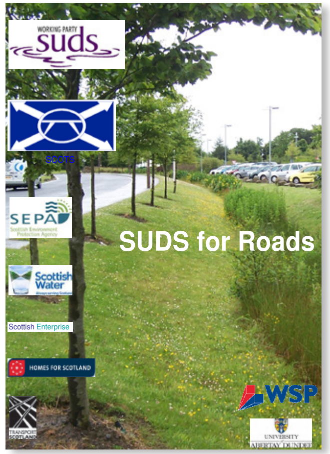
The legal and planning context for sustainable drainage in Scotland is set out in the **Water Assessment and Drainage Assessment Guide (2019).**



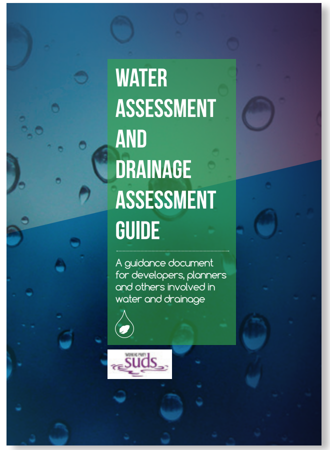
CIRIA: Guidance on the Construction of SuDS (c768)



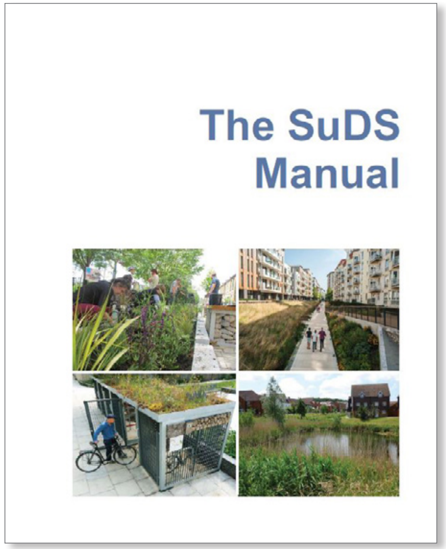
Scottish Water: Sewers for Scotland v4.0



Scots & SEPA: SuDS for Roads



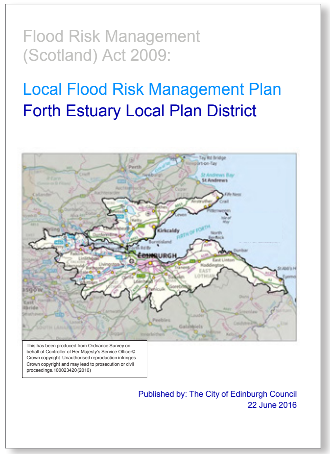
Water Assessment & Drainage Assessment Guide, 2019



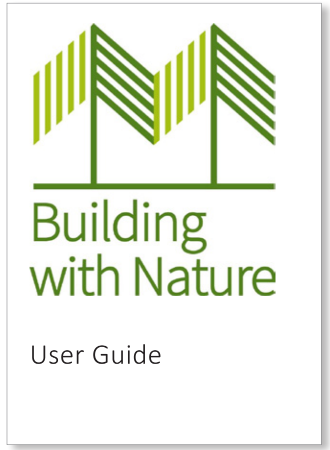
CIRIA: The SuDS Manual v.6, 2015 (C753)

Scottish Government, GREEN INFRASTRUCTURE: Design and Placemaking, 2011

SEPA: Flood Risk Management Strategy, Fourth Estuary



City of Edinburgh Council: Local Flood Risk Management Plan, Forth Estuary Local Plan District, 2016



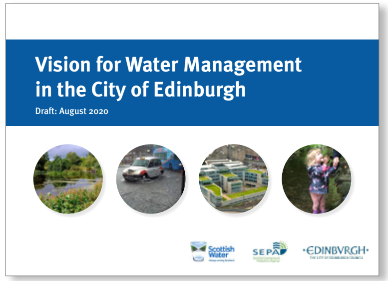
Building with Nature, 2019

Status of this Guidance in the Edinburgh Planning System

Edinburgh's Sustainable Rainwater Management Guidance will be one of several user-focused, non-statutory guidance documents that help to interpret Local Development Plan policies. It is supplementary to the Water Management Vision, Local Development Plan and Local Transport Strategy and sits with the Edinburgh Design Guidance. The standards set out in this guidance will be a material consideration in determining planning applications and appeals.

Further information

If you require any further information or clarification, please visit our website at ***www.edinburgh.gov.uk/planning*** or contact the Planning Helpdesk on 0131 529 3550.



Structure of the Guidance

Parts A and B: High level document:

- Section A: Introduction, why we need this Guidance, how to use the guidance, what is sustainable drainage, and the vision and specific Edinburgh context.
- Section B: Design Principles, describes how SuDS are designed, the different components of SuDS, where and how they might be used, the benefits of SuDS, and links to case studies.

Part C: Detailed Design Manual:

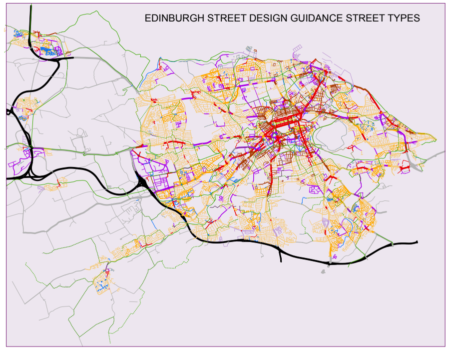
- Section C SuDS Design Guidance Factsheets will offer detailed information on SuDS components and design principals for specific circumstances. Including: design considerations, typical construction, maintenance and potential planting.

As the Edinburgh Sustainable Rain Water Management Guidance was developed it was recognised that most of the guidance would be relevant and useful to local authorities throughout Scotland. Therefore **Edinburgh specific sections providing local guidance have been highlighted in purple** whilst the rest of the guidance provides information applicable nationally across Scotland.

How to use this guidance with the Designing streets, Chapter 4 Edinburgh Design Guidance:

Identify street type – Movement and place

Street Priority (Low – High)		Rural roads / No frontage	Industrial Employment	Low Density Residential	Low Density Residential	High Density Residential	Service Sector Employment	Retail / High Streets
Significance of Movement	Strategic							
	Secondary							
	Local							
Other streets and paths	Footpath/ cycleways	(shared by pedestrians and cyclists)						
	Footpaths	(pedestrians only)						
	Special streets and places	Royal Mile, Princes Street, George Street (with squares), Grassmarket, The Shore, Queensferry High Street, Old Towns closes and stairs						



Edinburgh Design Guide, p120

↓

Identify proposed design treatment – Basic / standard / innovative

↓

Use relevant design principles

↓

Use relevant factsheets

Guidance on masterplanning, greenspace and new development can be found in chapters 1-3 of the Edinburgh Design Guidance (EDG). Section A and B of Edinburgh's Sustainable Rainwater Management Guidance (ESRMG) provides advice on when and where in masterplanning and new development SuDS should be considered.

Information on street design is found in EDG Chapter 4. The guidance identifies seven categories of Edinburgh street by character and provides design principles for each typology. These principles identify opportunities for SuDS. Design principles for SuDS in relation to the EDG street guidance is set out in section B.

Background

What is a Sustainable Drainage System?

In open countryside rain is absorbed into the soil, evaporates or flows over the surface of the land into ditches, ponds, rivers, streams and eventually to the sea. This is part of the natural water cycle that helps to sustain life by replenishing our water resources while managing excess rainwater. This water cycle has been disrupted by houses, roads and other hard surfaces that increasingly alter the way that rainwater finds its way into our soils, rivers and streams. A sustainable drainage system is designed to mimic these natural drainage processes. The overall objective is to return excess surface water to the natural water cycle with minimal adverse effects on people and our environment.

How does Sustainable Drainage Work?

A good sustainable drainage system uses gravity and land form to effectively manage water with minimal need for pumping or hydraulic controls. Section B of this Guidance *Design Principles* describes the typical components of a sustainable drainage scheme, and how and where they might be used.

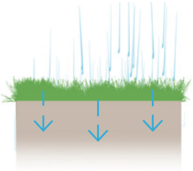
Sustainable drainage is made up of a sequence of features that provide two important services, improving water quality and managing water quantity. Typical features such as swales[2] use a combination of natural processes to slow and filter pollutants while reducing the water quantity before it enters the existing drainage system. This sequence is referred to as the *management train*.

2 A type of shallow open ditch with vegetation

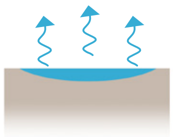
Water quality is improved by:

- **sedimentation** (allowing particles and sediment to settle out),
- **filtration** (filtering pollutants through the soil) and
- **biodegradation** (allowing microbes to break down organic matter).

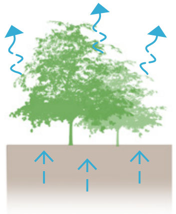
Sustainable drainage features manage water quantity by:



- **Infiltration,** slowing surface water and allowing it to soak into the soil, as for example in a swale, rain garden or filter drain;



- **Evaporation,** allowing water to return to the atmosphere from the surface of still or slow-moving shallow water, for example in a pond or detention basin;



- **Transpiration**, using trees and plants to slow and absorb water, returning it to the atmosphere through their leaves.

Natural Catchment

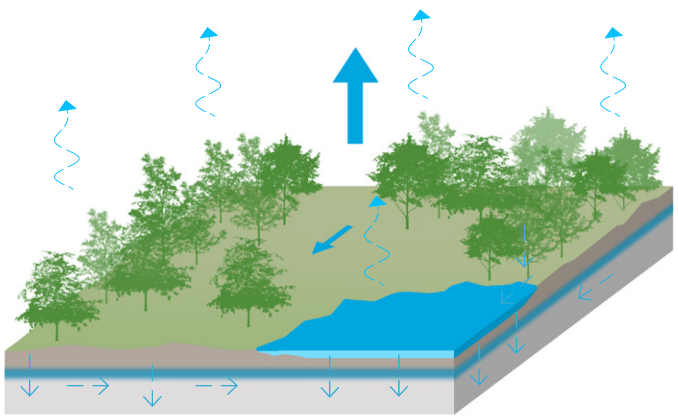


Figure 4. Rural Catchment | Atkins

Urban Catchment

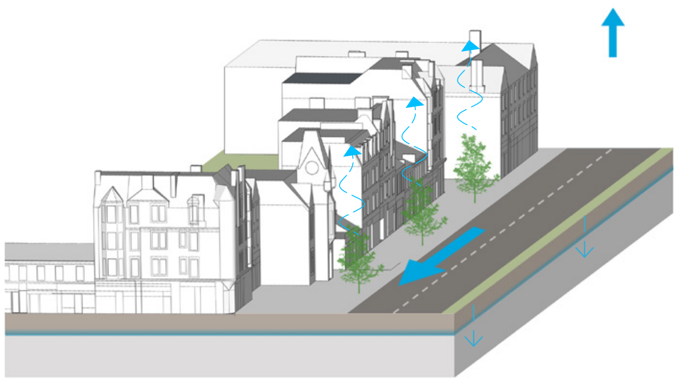


Figure 5. Urban Catchment | Atkins

Planning for Climate Change

Climate predictions include uncertainty, the Met Office *UK CP 18* predictions[4] provide two projections, one based on a reduction in emissions in line with targets (*Low*) and one based on a continuation of current emission levels (*High*). Both scenarios predict more frequent hot dry summers and warmer, wetter winters.

SEPA predict an increase in the intensity of rainfall events in the east of Scotland of around 33% by 2100.[5] This will mean an increasing likelihood of sudden heavy rainstorms during summer months.

New developments and improvements to the built environment of the city should be designed to meet the challenges of a changing climate.

"There was over twice as much rain per day in July to September 2017 than in April to June 2018" (Edinburgh by Numbers 2018 p35)

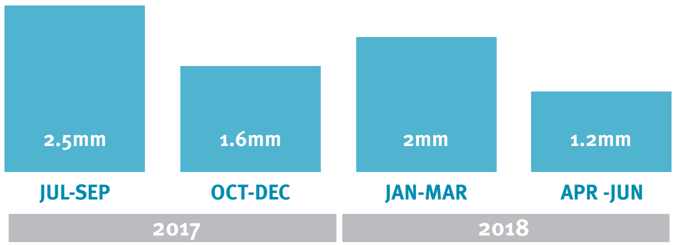
- ***Scottish Environmental Protection Agency (SEPA)***
- ***The Climate Change (Scotland) Act 2009***
- ***Green Future: Our 25 Year Plan to Improve the Environment, UK Government***
- ***SNH Advice for Planners and Developers***
- ***Edinburgh's Water Management Vision 2020***
- ***Edinburgh Adapts., Climate Change Adaptation Plan, 2016 -2020***
- ***Climate Change Adaption Framework (2016)***
- ***Carbon Management Plan (2015-2021)***

4 UJCP18, National Climate Change Projections, The Met Office 2019
5 Climate change allowances for flood risk assessment in land use planning, SEPA 2019

Figure 6. Edinburgh during a downpour, June 2019 | Shutterstock

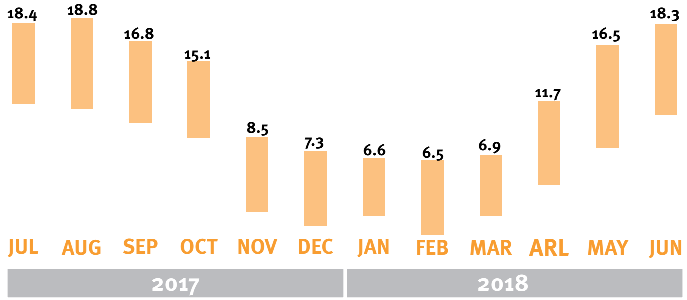
Figure 7. Portobello Beach, May 2017 | Shutterstock

Average rainfall (millimetres) per day by three month period



p35, Edinburgh by numbers, 2018

Edinburgh weather, range in average max and min temperature (in Celsius), July 2017 to June 2018



P35, Edinburgh by numbers, 2018

Predicted Summer and winter changes by the 2070s for Central Scotland:

Rainfall Change

Summer	Winter
30% drier to 6% wetter	4% drier to 9% wetter
40% drier to 8% wetter	3% drier to 12% wetter

Temperature Change

Summer	Winter
-0.1 °C cooler to 2.8°C warmer	-0.3°C cooler to 2.7°C warmer
0.6 °C warmer to 4.8 °C warmer	0.6 °C warmer to 4.5 °C warmer

*All results are for the 10th-90th percentile range for the 2060-2079 period relative to 1981-2000 | REF: THE MET OFFICE UKCP18

Low emission scenario (meeting low emissions targets)

High emission scenario (no concerted effort to reduce emissions)

What are the Benefits of Sustainable Drainage?

A successful design balances water quality, water quantity and benefits for people and nature, this is referred to as the *Four Pillars of Sustainable Drainage Design.*[3]

3 CIRIA C753 The SuDS Manual, p6

Unlike conventional drainage, a sustainable approach can create spaces with several functions for example play areas, parking spaces or wildlife habitats.

Trees and planting that form part of a scheme can also encourage care for the environment and community pride. Street trees, roof gardens, rain gardens and urban green areas can help to offset the effects of climate change by managing water, improving air quality and cooling the city in hot weather.

Even retro-fitting a small number of planted sustainable drainage features to an existing inner-city street can provide extra benefits, making the area more attractive and creating pockets of new habitat for birds and insects.

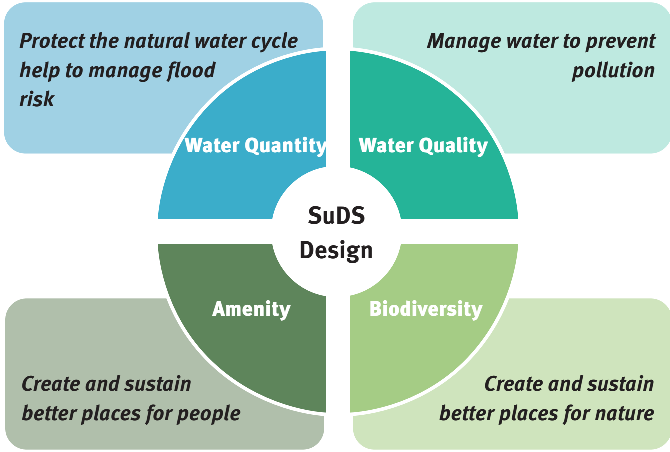


Figure 8. Four Pillars of SuDS Design SuDS, CIRIA C687, p6

For more information on the benefits and whole life costs of sustainable drainage see *Section B*.

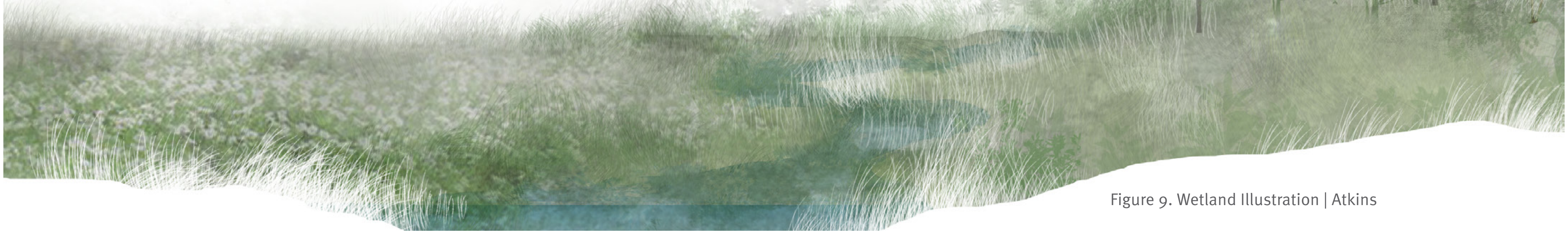


Figure 9. Wetland Illustration | Atkins

Contributing to Quality of Life

The introduction of sustainable drainage features in consultation with local people can provide attractive usable greenspace that recognises the differing needs of communities.

Creating Beautiful Multi-Functional Spaces

Good design In new developments can provide sustainable drainage features that can enhance our streets creating attractive spaces for people and wildlife along with practical surface water (rainwater) management.

A well-designed and beautiful detention basin or bio-infiltration area can provide space for play, walking, seating or outdoor classrooms. Trees, or rain gardens as part of a drainage scheme can be integrated into street improvements to create positive change to the enjoyment of users and enhance the quality of place.

Health and Wellbeing

Local authorities and public bodies across the UK are required to put measures in place to mitigate the increased likelihood of extreme weather events triggered by ongoing climate change. However these effects are not experienced equally across society. The most deprived inner-city areas frequently have a lower proportion of parks, gardens, trees and green spaces; increasing the likelihood of dangerous 'heat island' effects in hot weather and flooding caused by high rainfall.[8]

The practical benefits of sustainable drainage including water management, cooling, and improvements to air quality are therefore of particular relevance to the least prosperous areas of the city.

8 A 'heat Island' is caused in hot weather when heat absorbed by hard surfaces causes temperatures in a localised urban area to be significantly higher than the surrounding countryside.

These areas are also likely to suffer the highest levels of environmental degradation such as graffiti, littering and vandalism which increase perceptions of crime and threat.[9] As a result people are less likely to use the public spaces available with effects on wellbeing and health like higher levels of stress, mental health problems, breathing problems, diabetes and childhood obesity.[10]

The introduction of sustainable drainage components such as trees, rain gardens or bio-infiltration areas can reduce stress, improve the perception of an area and contribute to good health.[12]

9 White, D., Pride in Place: Tackling Environmental Incivilities, 2012,
10 NHS, A Dose of Nature, University of Exeter, accessed March 2019

Figure 10. 'Grey to Green' (pahse 1) , Sheffield | Sheffield City Council

Figure 11. Bridget Joyce Square, London | Robert Bray Associates

Figure 12. Ruskin Square, Croydon | J & L Gibbons

Active Travel

The development of active travel routes (such as cycleways and footpaths) across the city provides opportunities to incorporate sustainable drainage without obstructing movement. Within the corridor of off-road cycle lanes and surfaced footpaths, linear features such as planted swales or infiltration strips can provide drainage while enriching habitats.

On-road segregated cycleways can incorporate perforated kerbs to replace traditional gullies feeding into filter drains or other sustainable drainage components, providing water treatment and a better road surface for cyclists.

On new developments it might be possible to use porous track surfaces allowing water to infiltrate directly into the soil.

Community Engagement

Sustainable drainage systems are made up of surface features that are often a visible change to an area. Public consultation can help to shape proposals and inform local communities so that the benefits can be maximised and the scheme be more acceptable to local people.

In some locations there may be options for local groups to adopt and maintain rain gardens or bio-infiltration planting. Community based schemes have a vital role in connecting people and supporting a sense of pride and local identity.[7]

7 (Brown, R. *The Role of Citizen Activists in Urban Infrastructure Development*, 2008, in Birch, E. L.. & Wachter, S. M., Growing Greener Cities, 2008,

Community Involvement

SuDS schemes can be designed to provide community benefits such as:

- community gardens
- play areas
- informal recreation
- learning opportunities
- wildlife watching

Section B Design Principles provides guidance the types of sustainable drainage that would be suitable in different locations.

Green Infrastructure: Design and Placemaking, The Scottish Government

NHS Forest Study

Active Travel Action Plan 2016

Edinburgh Local Development Plan 2016

Edinburgh Design Guide 2020

Figure 13. Forest Way School, Coalville | DSA Environment + Design

Figure 14. Local children planting a raingarden Melina Road, Shepard's Bush | Atkins

The Role of Biodiversity in SuDS

Trees and vegetation play an important practical role in sustainable drainage by taking up water, increasing the capacity for ground absorption and slowing the flow of surface run off at peak times. A sustainable drainage pond with established native wetland and marginal plants will be both more effective and more attractive than a pond edge that is simply turf while providing a variety of wildlife habitats.

In general, biodiversity gain can be achieved through a sustainable drainage design that creates space for native plants and wildlife. A good SuDS design can provide diverse species rich habitats by providing different water depths, or seasonally wet areas.

At an early stage in the design process the wildlife value of existing habitats and surrounding areas should be surveyed to identify existing trees, protected species and valued habitats **(EDG ch 3)**.

The **Edinburgh Biodiversity Action Plan (EBAP)** sets out specific aims to promote the inclusion of SuDS in new developments to create valuable new habitats for native plants and wildlife that can contribute to Edinburgh's natural heritage.

Practical guidance on how to improve biodiversity gain as part of SuDS in the urban environment can be found in ***Section B Design Principles*** and ***Edinburgh Design Guide Chapter 3***

Figure 15. Wet Swale Saint Ouen – Park Of The Docks | © Agence Ter

Section A1: Sustainable Drainage in Edinburgh

The Vision

The climate is changing. Climate trends predict that we will experience warmer and wetter winters. Summers are expected to become hotter and drier, and occurrences of extreme rainfall events are expected to increase. The Scottish government has declared a Climate Emergency updating targets on carbon fixing and reduced emissions. This guidance is part of the commitment made by City of Edinburgh council's sustainability programme which aims to achieve a carbon neutral status by 2030.

Edinburgh's Water Management Vision 2020 (WMV) sets out a long-term sustainable approach to river, coastal and storm water management across the city and its environs, respecting our unique historic heritage. This will involve all stakeholders and address the flooding and water quality risks associated with our changing climate as a result of increased rainfall intensity and sea level rise.

As a supplementary planning document Edinburgh's Sustainable Rainwater Management Guidance (ESRWMG) provides a practical interpretation of the WMV looking at how sustainable surface drainage can be integrated into public realm and new developments to deliver multiple benefits including an attractive and more resilient environment, better water quality, biodiversity, adaptation to climate change, local identity and liveability.

Edinburgh like many other cities has drainage systems designed to meet 19 century rather than 21 century needs. Throughout the city these traditional sewer networks can become overwhelmed in high rainfall causing localised flooding. A report by the *World Bank Integrating Green and Grey* (2019[1] examined a number of city-scale case studies and concluded that combining green (nature based) engineering and grey (traditional engineering) in drainage infrastructure will lower overall costs to a city and improve climate resilience in the face of environmental change.

Climate change predictions for Edinburgh make it clear there is a need to commit to a vision of an adaptable, sustainable future. In order to bring about change everyone involved in planning, maintenance, change or development in Edinburgh should routinely consider opportunities to identify and integrate sustainable drainage and green infrastructure. T**he design of all new developments, streetscape and public ream projects should include surface ground storm water management systems linking to a citywide green /blue network.**

1 World Bank Group, *Integrating Green and Grey*, 2019, p37

Figure 16. Central Edinburgh | Shutterstock

Section A2: The Edinburgh Context

Edinburgh is a rapidly growing and densely populated city placing intense pressure on resources and infrastructure such as drainage, roads and greenspaces.

KEY FACTS:

"*Edinburgh population is projected to grow to 583,140 by 2041. - (13.6% increase on 2017)*"

p5, Edinburgh by Numbers 2018

"*In 2017 Edinburgh population density was 1,950 residents per square kilometre.*"

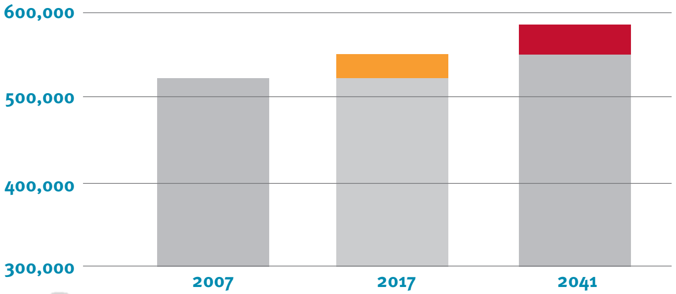
p6 Edinburgh by Numbers 2018

"*Edinburgh Tourism:*

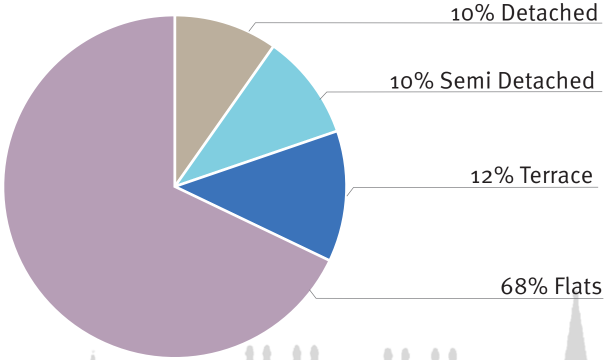
- *in 2016, there were around 15.6 million visitors nights in Edinburgh and the Lothians*
- *The total tourist expenditure in 2016 from this group was £1.5 billion.*"

p21 Edinburgh by Numbers 2018

Population change in Edinburgh



Proportion of households:



2050 City Vision

Sustainable Edinburgh 2020

Edinburgh By Numbers 2019

Edinburgh's Natural Environment

Geology and Topography

Geology has dictated the structure and layout of Edinburgh as a city shaped by two distinct types of rock:

- Carboniferous Sandstone and Shale deposits formed by the slow accumulation of sediment in shallow waters, along with
- Volcanic lava flows creating igneous extrusions forming Edinburgh's hills and intrusions forming dense underground layers.

Softer sedimentary rocks were eroded by ice sheets during the last ice age leaving the gently rolling Edinburgh landscape, while the harder volcanic outcrops resisted to form dramatic hills. The iconic silhouette of Castle Rock is an example of the typical 'crag and tail' shape created by glacier erosion of igneous rock.

As the ice sheets retreated, melt waters filled the rivers carving deep gorges and creating a network of lochs and wetlands right across the Lothians. Over the following millennia sea levels rose and fell flooding the plains around the Forth Estuary leaving behind deposits of silt and gravel.

Over time most of the historic wetlands have been drained as part of cultivation or urban expansion, including areas of the city centre like the Meadows and the Nor' Loch (now Princes St Gardens).

A SuDS design is influenced by underlying geology which effects the type of soil, fertility and the drainage capacity of areas within a site.

British Geological Survey & Infiltration SuDS Map

British Ordnance Survey

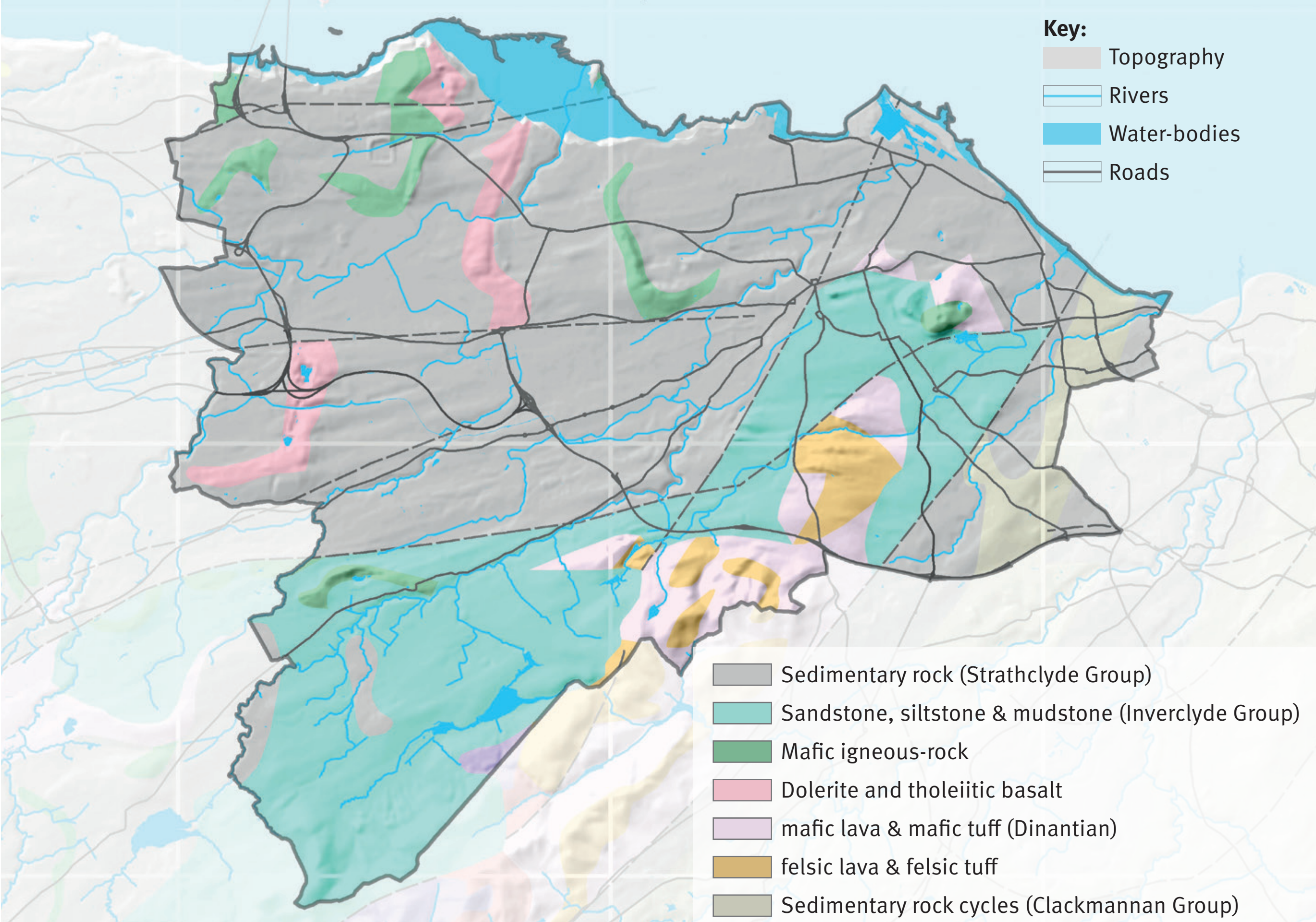


Figure 17. Geology, Topography and River Systems • Contains OS data © Crown copyright and database right British Geological Survey ©UKRI. All rights Reserved & 'Based upon BGS Geology 625k. Ordnance Survey Licence number 100023420

Edinburgh's Soils

Due to the built-up nature of Edinburgh the quality and permeability of soil will vary considerably with:

- Large areas of ground altered, compacted or backfilled during past construction.
- Recent areas of expansion to the south and west of the city on fertile farmland.
- Much of the former dockland areas to the north of the city built on land reclaimed from the sea in the 19th and early 20th centuries.

Most of the city is underlain by Devensian Till (created by glacier erosion also called Glacial Till) with a variety of soils including sandy silty clay, gravels and sands. Clay has low permeability however groundwater can move moderately well through sand and gravel layers.

In the north of the city, as far south as Stockbridge there are raised deposits of sand and gravel. These layers drain fairly well and may contain a groundwater aquifer. Along the Water of Leith is a corridor of alluvium (river deposits of clay, silt and gravel) which is fertile but less free draining.

Across the city there are also localised areas of sand and gravel left by ice age glaciers which may drain moderately well. Other places which were once lakes or lochans have layers of clay, silt and sand sediments which can drain poorly.

Within any development site the soil conditions and drainage capacity may vary significantly.

Understanding the soil and underlying geology on site is essential to inform a design so that SuDS features maximise their effectiveness.

"We are dependent on soil to support the range of ecosystem services that provide us with clean water, food, building materials and a healthy environment" - Edinburgh Biodiversity Action Plan

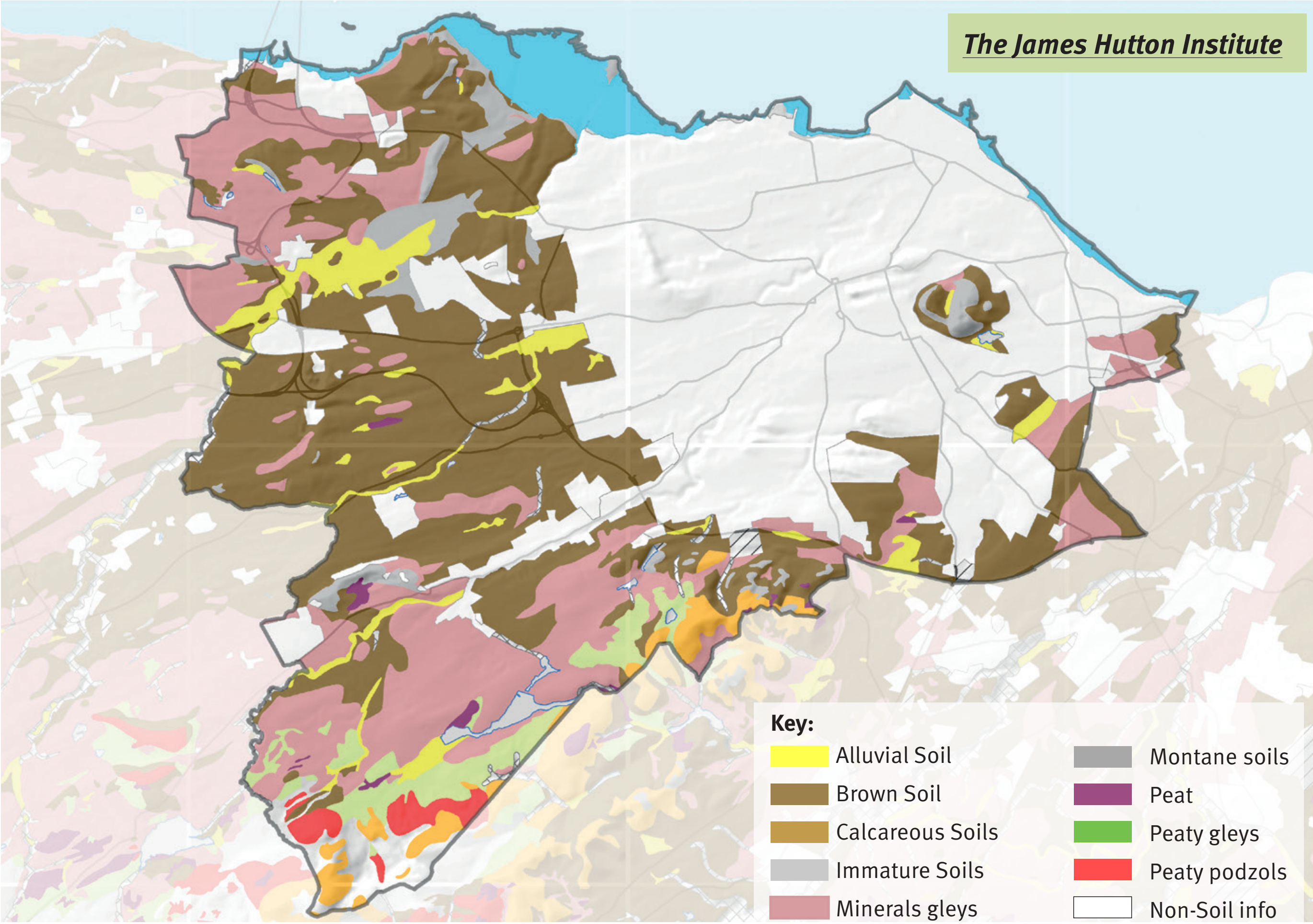


Figure 18. Soils • Contains OS data © Crown copyright and database right 2019 All rights reserved. Ordnance Survey Licence number 100023420 • ©The James Hutton Institute 1:25,000K V9 Phase6

Edinburgh's Blue/Green Corridors

Many of the benefits of blue/ green spaces overlap with the aims of sustainable drainage. It is therefore vital to protect the network of existing green infrastructure when designing a sustainable drainage system.

Trees and green spaces allow rain to be absorbed naturally into the soil reducing pressures on traditional street drainage, while the connectivity of green spaces and water bodies provide support for wildlife to coexist with people in an urban environment.

The City of Edinburgh Council's aspirations to safeguard and expand these green /blue assets as part of future development are set out in ***Cityplan2030***, ***Edinburgh's Open Space Strategy 2021*** and the ***EDG (Ch 3)***.

Existing Greenspace in Edinburgh:

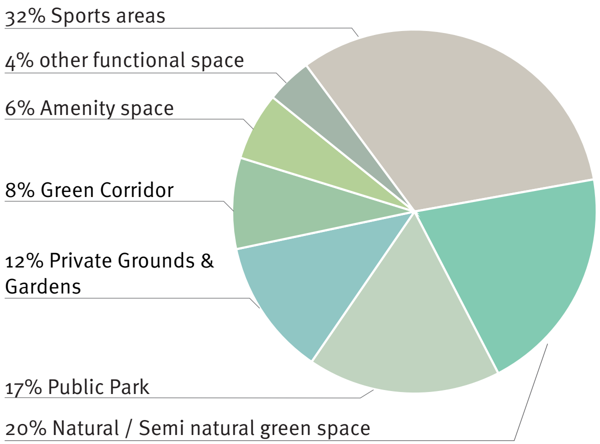


Figure 20. Edinburgh Open Space Types, 2021, p6

Benefits of Green/Blue Infrastructure

- Intercepts rainfall
- Attenuates water
- Maintains soil permeability
- Improves water and air quality
- Reduces heat island effects
- Reduces flood risk
- Provides amenity space
- Enhances biodiversity

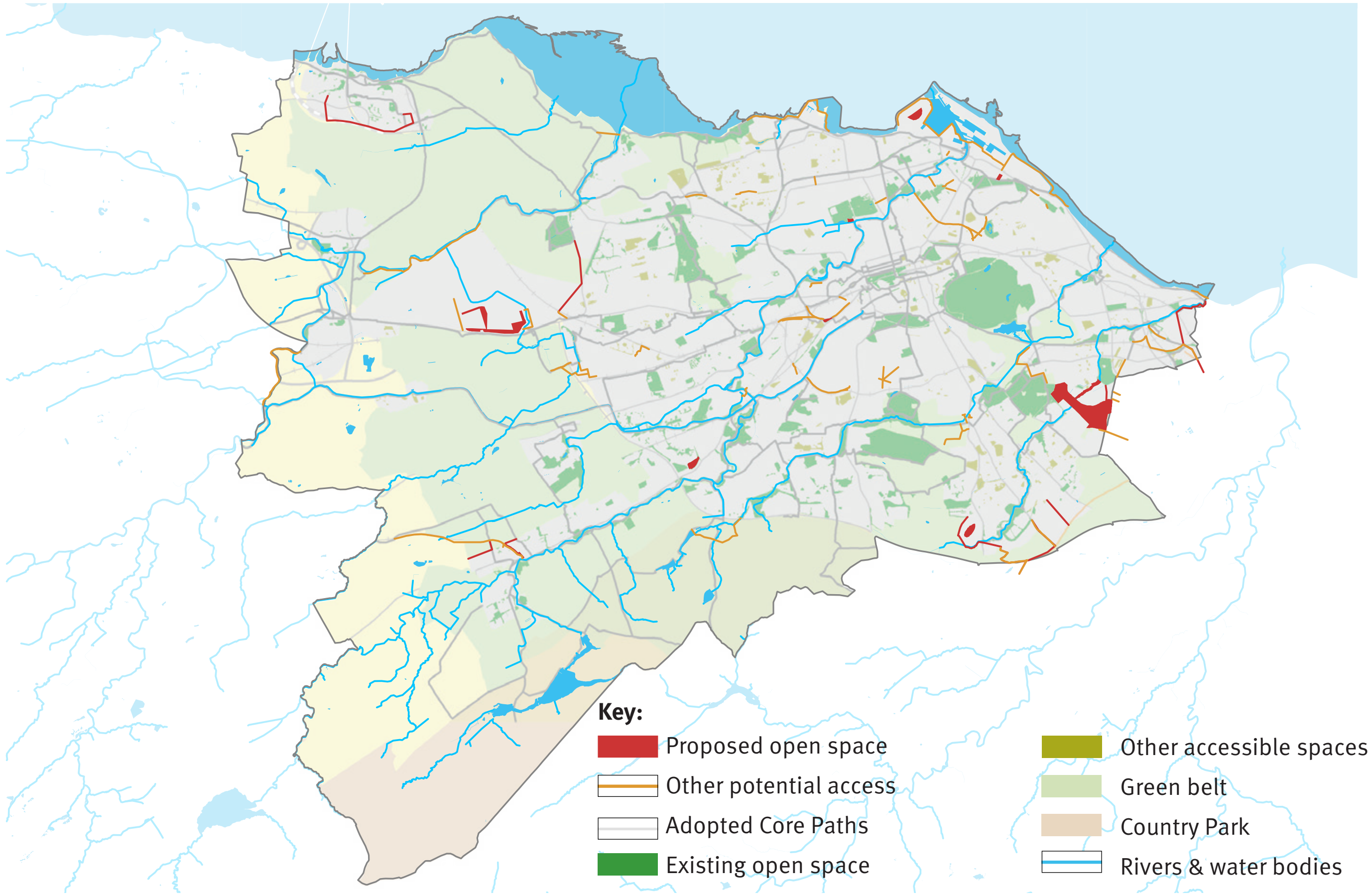


Figure 19. Edinburgh's Green Network, Edinburgh Local Development Plan. CEC, Edinburgh Open Space Strategy, 2021, p13 Contains OS data © Crown copyright and database right 2019 All rights reserved. Ordnance Survey Licence number 100023420

Why do we need Sustainable Drainage Systems?

As the city continues to grow and incidents of high rainfall become more frequent there are ever increasing pressures on Edinburgh's sewer systems. Adopting sustainable approaches to drainage will help to protect the health of Edinburgh's water-bodies, reduce flood risks and is a legal requirement of new developments.

For many years surface water in towns and cities has been collected and piped directly into our ditches, rivers or sewers. Carrying water away as quickly as possible may protect the immediate area from flooding, but it increases the risks downstream. In some areas of the city existing drains struggle to cope with the increasing frequency of high rainfall causing localised flooding.

A more sustainable approach to drainage is necessary to improve this situation and ensure that any new developments will not create greater flood risks.

Figure 21. Road Gullies overwhelmed by rain, Polworth Edinburgh June 2019 | Atkins

Managing Flood Risks in Edinburgh

The City of Edinburgh Council has a responsibility to reduce the risk of flooding in extreme weather conditions. The ***Water Management Vision*** *(WMV)* includes an objective to develop integrated drainage and surface water management plans across the city and environs.

A significant proportion of flood risk is caused by surface water (rainwater). All new developments have a responsibility to ensure that any changes to the environment do not create or worsen risks of flooding on site or elsewhere. As part of the planning process all developments must provide a *Surface Water Management Plan* allowing for a 1 in 200 year weather event.

The Water Assessment & Drainage Assessment Guidance *(WADAG)* sets out the legal responsibilities and requirements for water management and water quality in Scotland.

Local Development Plan Policies that define requirements for Sustainable Drainage:

- ***Des 3 – Development Design***
- ***Des 6 – Sustainable Buildings***
- ***Des 7 – Layout Design***
- ***Env 21 – Flood Prevention***

(CEC, Local Development Plan, 2016)

Flood risk and Surface Water Management Plan Requirements, 2017, CEC

Water Management Vision (WMV) 2020

Water Assessment & Drainage Assessment Guide, 2019 (WADAG)

Average Annual Damages Caused by Flooding in the Forth Estuary Plan District :

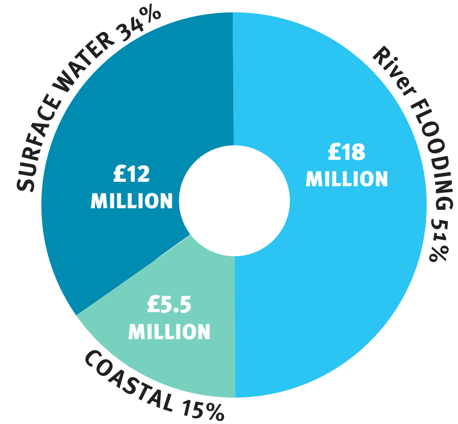


Figure 22. Annual average damages by flood. Reproduced from Fourth Flood Rick Management Strategy. p13 SEPA (December 2015)

Edinburgh has been identified as the area with the highest risk of flood damage in the Forth Estuary region with average annual damages to the value of £8.5 million.[6] A significant proportion of that flood damage is caused by surface water during high rainfall.

6 SEPA, The Forth Estuary Risk Management Strategy 2015

Figure 23. Surface water flooding, A90 at Cramond Brigg, August 2019 | ©Road Policing Scotland/ Twitter

Predicted Flood Risks and Edinburgh's Drainage Systems

This map highlights the areas where of greatest flood risk in Edinburgh identified by SEPA.

Surface Water and River Flooding Risk

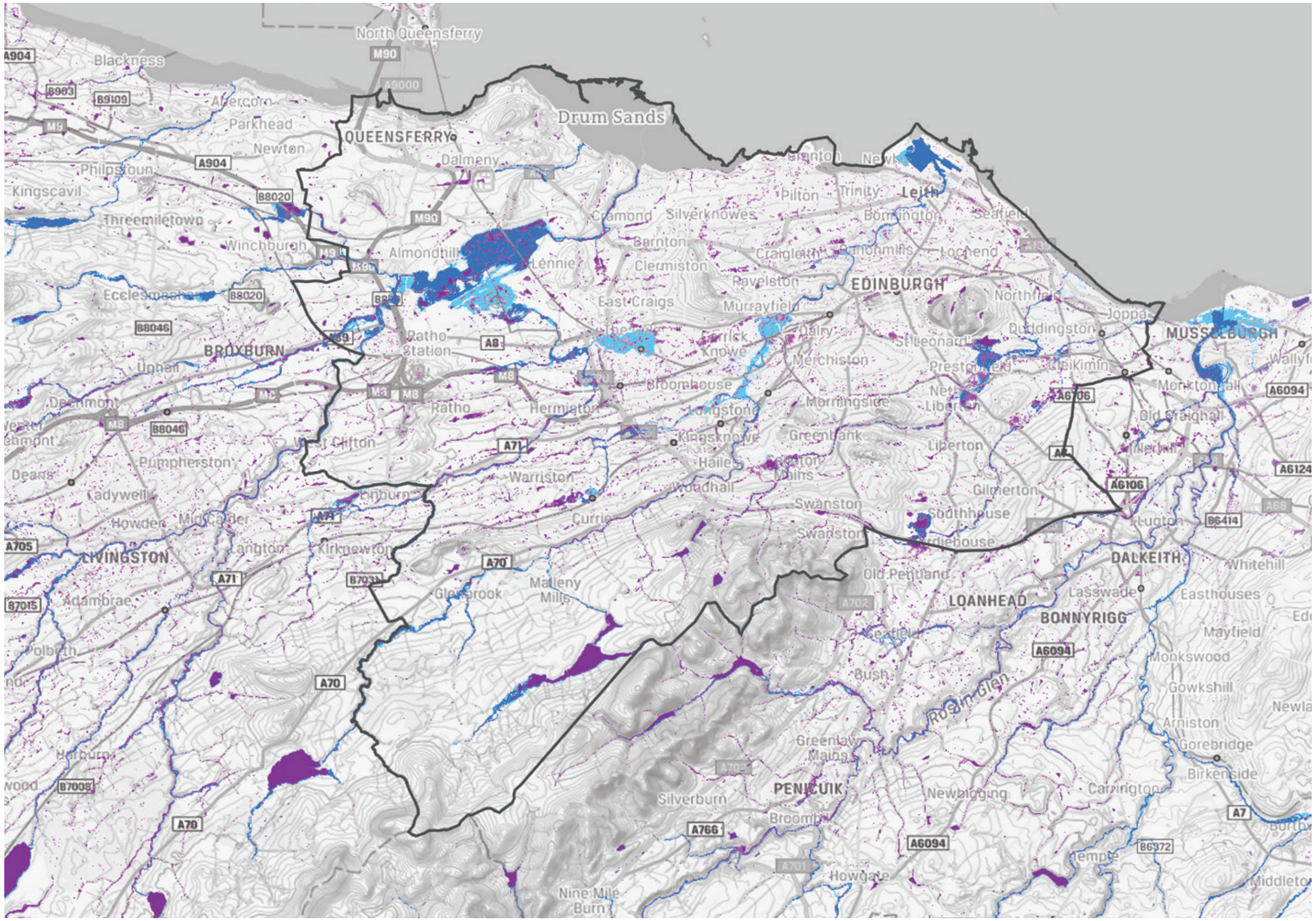


Figure 24. Surface Water and River Flooding, ©SEPA 2019

Key:

- River Flood Extent - high risk
- River Flood Extent - medium risk
- River Flood Extent - low risk
- Surface Water Flood - high risk
- Surface Water Flood - medium risk
- Surface Water Flood - low risk

A detailed Strategic Flood Risk Assessment (SFRA) for the City of Edinburgh has been developed as part of Cityplan 2030.

SEPA Flood Maps

Edinburgh's Built Environment

The Edinburgh Design Guidance (EDG) sets out the importance of the historic environment and describes a hierarchy of street types, such as highstreets or residential streets, categorised into high- or low-density areas. The guide provides a framework of design principles for each of these types including urban realm, historic streets and new developments.

General guidance on sustainable drainage in relation to highways and new roads is set out in ***SuDS for Roads (2009)***. However, the guidance recognises the difference between roads, which mainly serve motor vehicles and streets which also have pedestrian, residential and commercial uses.

Section B ***Design Principles*** explains how the information in this guidance relates to the Design Principles of the ***EDG*** and ***Edinburgh Street Design Factsheets (ESDGF)*** and sets out the types of sustainable drainage components that might be suitable in different areas. However these design principles should not exclude creative or innovative approaches that will enhance the city.

"Edinburgh has the greatest concentration of built heritage assets in Scotland" with "49 conservation areas covering 25% of the urban area."
(CEC, Design Guide, 2018, p9)

Heritage

The historic fabric of the city includes two World Heritage Sites, 'The Old and New Town 'and 'Forth Bridge' (recognised by UNESCO as places of outstanding universal value) and a significant number of conservation areas. Outside the centre there are post war residential streets and historic settlements absorbed into the city as it expanded. Each of these local areas has their own distinct identity.

An understanding of the valued characteristics and visual attributes of an area will allow designers to create sustainable drainage features that enhance rather than detract from the unique qualities of the city.

Figure 25. Edinburgh's New Town | Christoph Lischetzki

The Union Canal

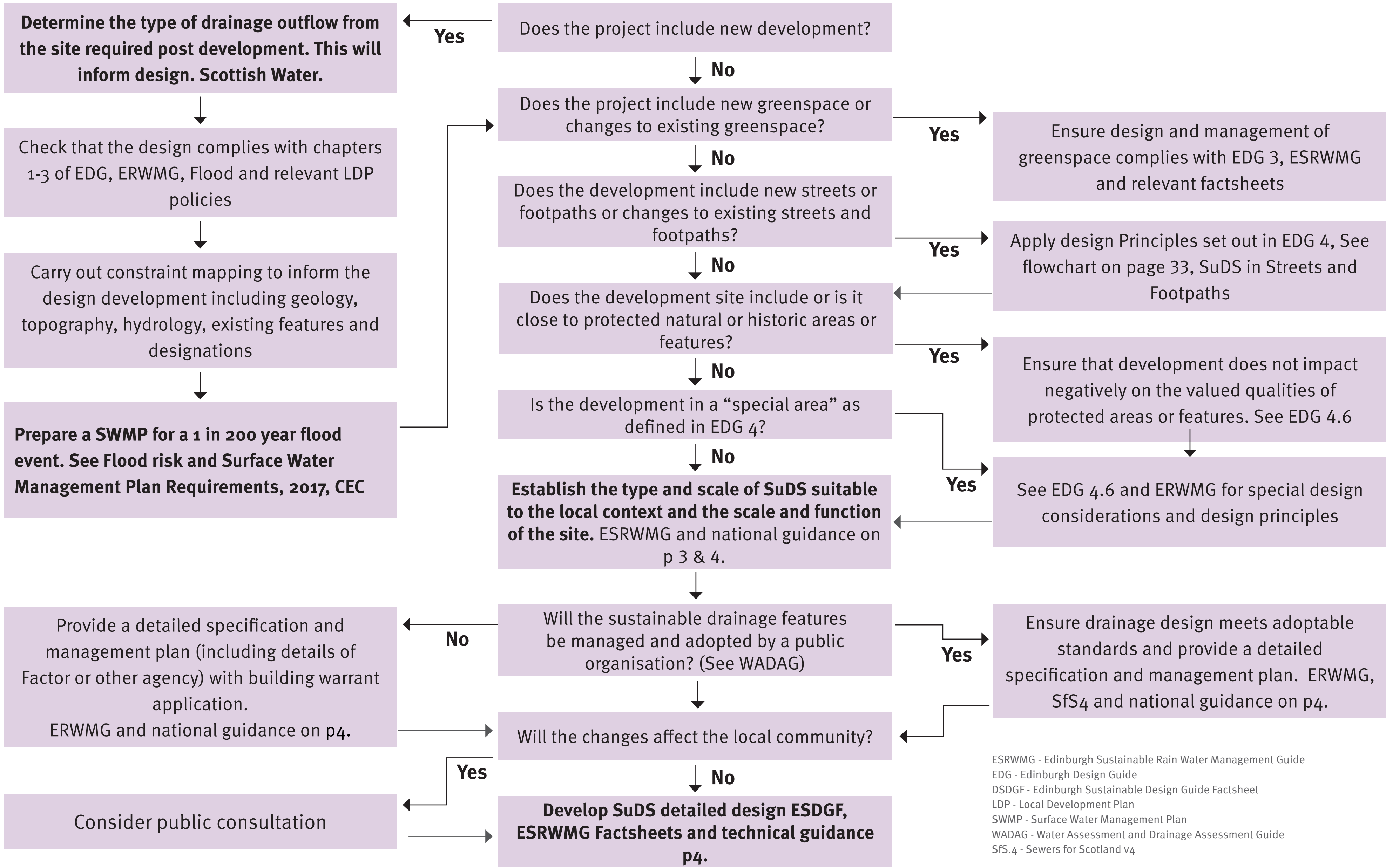
Scottish Canals have been involved in innovative surface water management schemes. Due to the topography of Edinburgh, there are limited opportunities for similar schemes. However any development in close proximity to the canal network could consider the potential opportunities.

Contact: ***ThirdPartyWorks@scottishcanals.co.uk***

Figure 26. Union Canal, Edinburgh | Shutterstock

All new developments must include sustainable drainage (SuDS) within the design to deal with surface water runoff, improve water quality and reduce flood risk. An explanation of the context and the scale and type of works where SuDS should be considered is provided in Section B ***Design Principles*** for SuDS in Edinburgh.

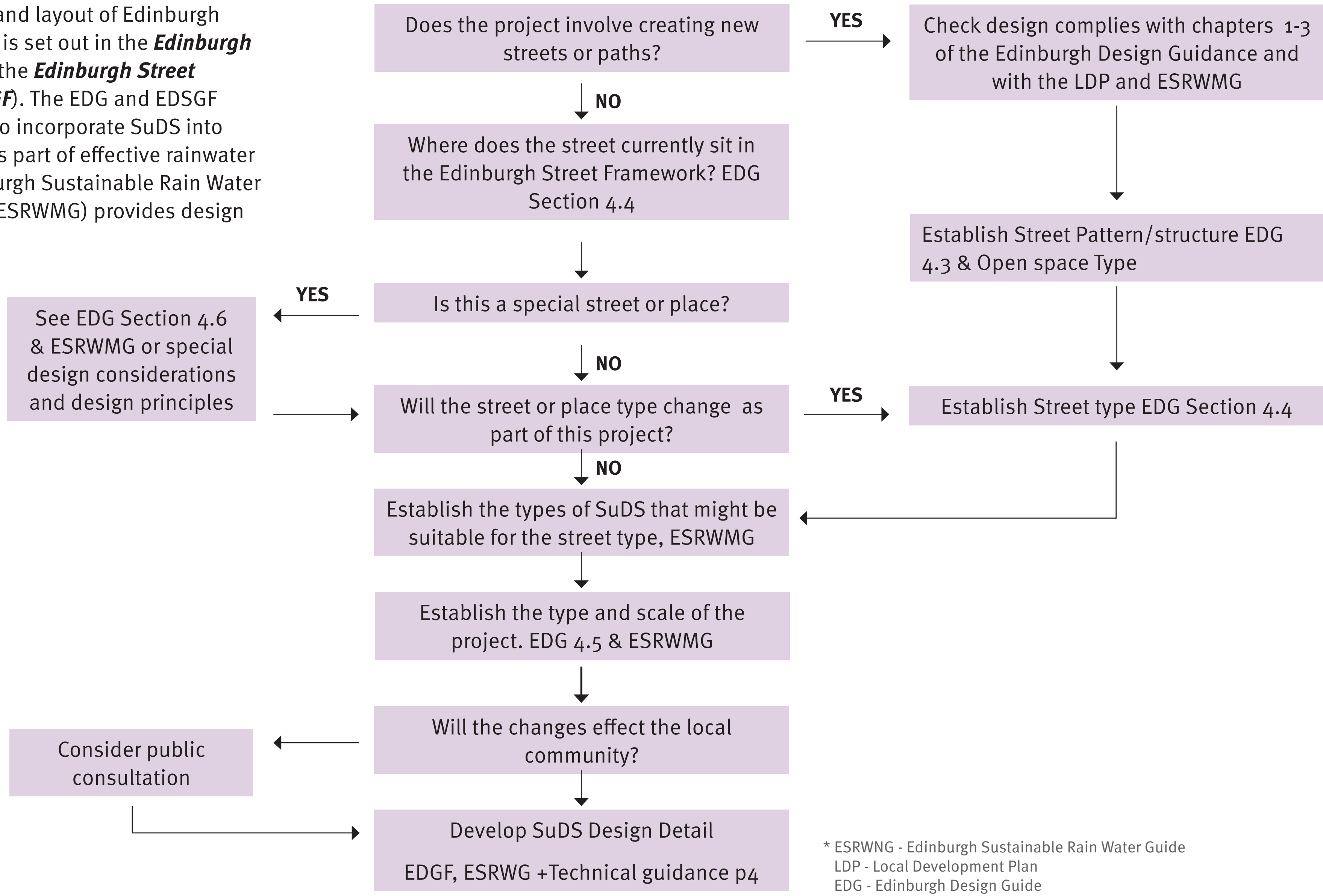
Using the Design Principles for Masterplanning and New Development in Edinburgh



ESRWMG - Edinburgh Sustainable Rain Water Management Guide
EDG - Edinburgh Design Guide
DSDGF - Edinburgh Sustainable Design Guide Factsheet
LDP - Local Development Plan
SWMP - Surface Water Management Plan
WADAG - Water Assessment and Drainage Assessment Guide
SfS.4 - Sewers for Scotland v4

Using the Design Principles For Streets and Footpaths in Edinburgh

Guidance on the design and layout of Edinburgh Streets and open spaces is set out in the ***Edinburgh Design Guide (EDG)*** and the ***Edinburgh Street Design Factsheets (ESDGF)***. The EDG and EDSGF both highlight the need to incorporate SuDS into the urban environment as part of effective rainwater management. The Edinburgh Sustainable Rain Water Management Guidance (ESRWMG) provides design principles for SuDS .



* ESRWNG - Edinburgh Sustainable Rain Water Guide
LDP - Local Development Plan
EDG - Edinburgh Design Guide

Figure 27. SuDS in Streets & Footpaths Flow Chart

Fitting SuDS into the Edinburgh Street Frame work

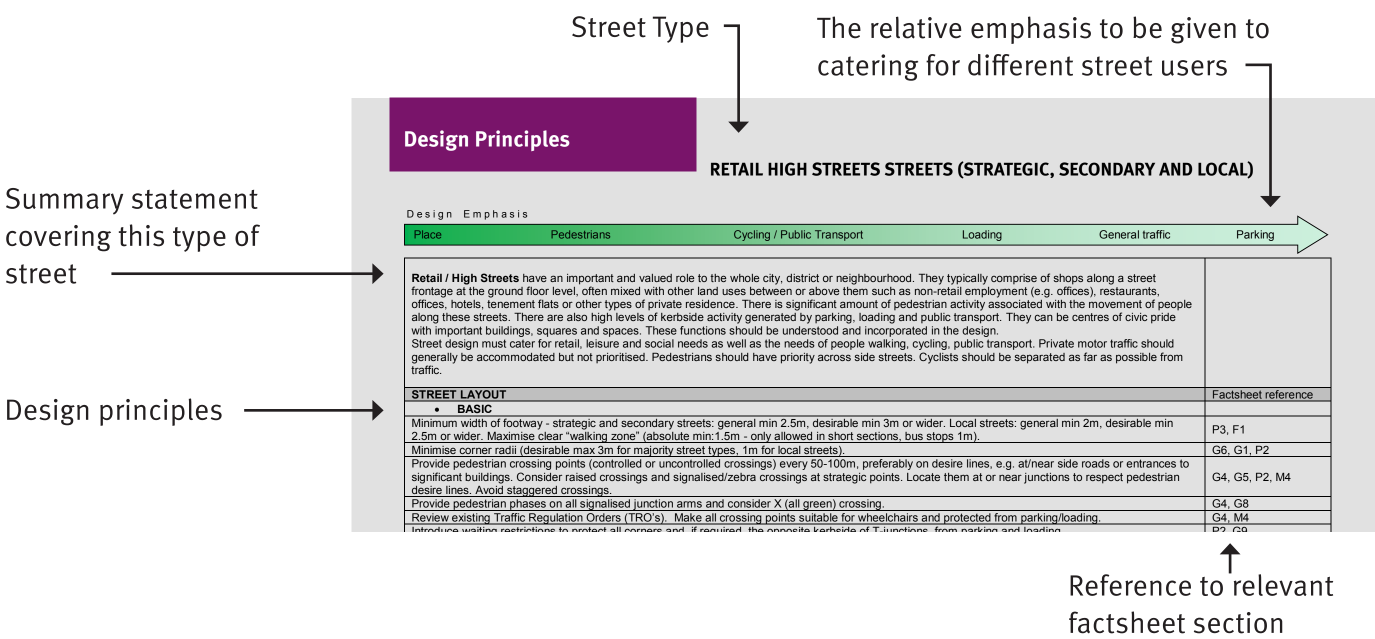
The **EDG** section 4.4 identifies seven categories of Edinburgh street by character varying from Rural Roads to High Streets (shopping streets). These are further divided by how busy they are and their significance as routes through the city into three categories: Strategic, Secondary and Local. Some sensitive areas (such as historic streets) described as Special Places will also have locally specific design considerations . This hierarchy determines the Design Principles in section 4.6 of the EDG that will apply to developments or improvements in a distinct street type.

Each set of Design Principles describes the various streetscape elements to be considered in that locale including SuDS features. Expectations and aspirations for Edinburgh's open spaces are set out in the EDG section 3. **However the design of SuDS cannot just be solely based on street or open space type but must also take into account physical and social context such as geology, hydrology, biodiversity, community and the wider green/blue urban networks.**

Street Priority

Low — High

		Rural roads / No frontage	Industrial Employment	Low Density Residential	Medium Density Residential	High Density Residential	Service Sector Employment	Retail / High Streets
Significance of Movement	Strategic							
	Secondary							
	Local							
Other streets and paths	Footpath/ cycleways	(shared by pedestrians and cyclists)						
	Footpaths	(pedestrians only)						
	Special streets and places	Royal Mile, Princes Street, George Street (with squares), Grassmarket, The Shore, Queensferry High Street, Old Towns closes and stairs						



Design Principles

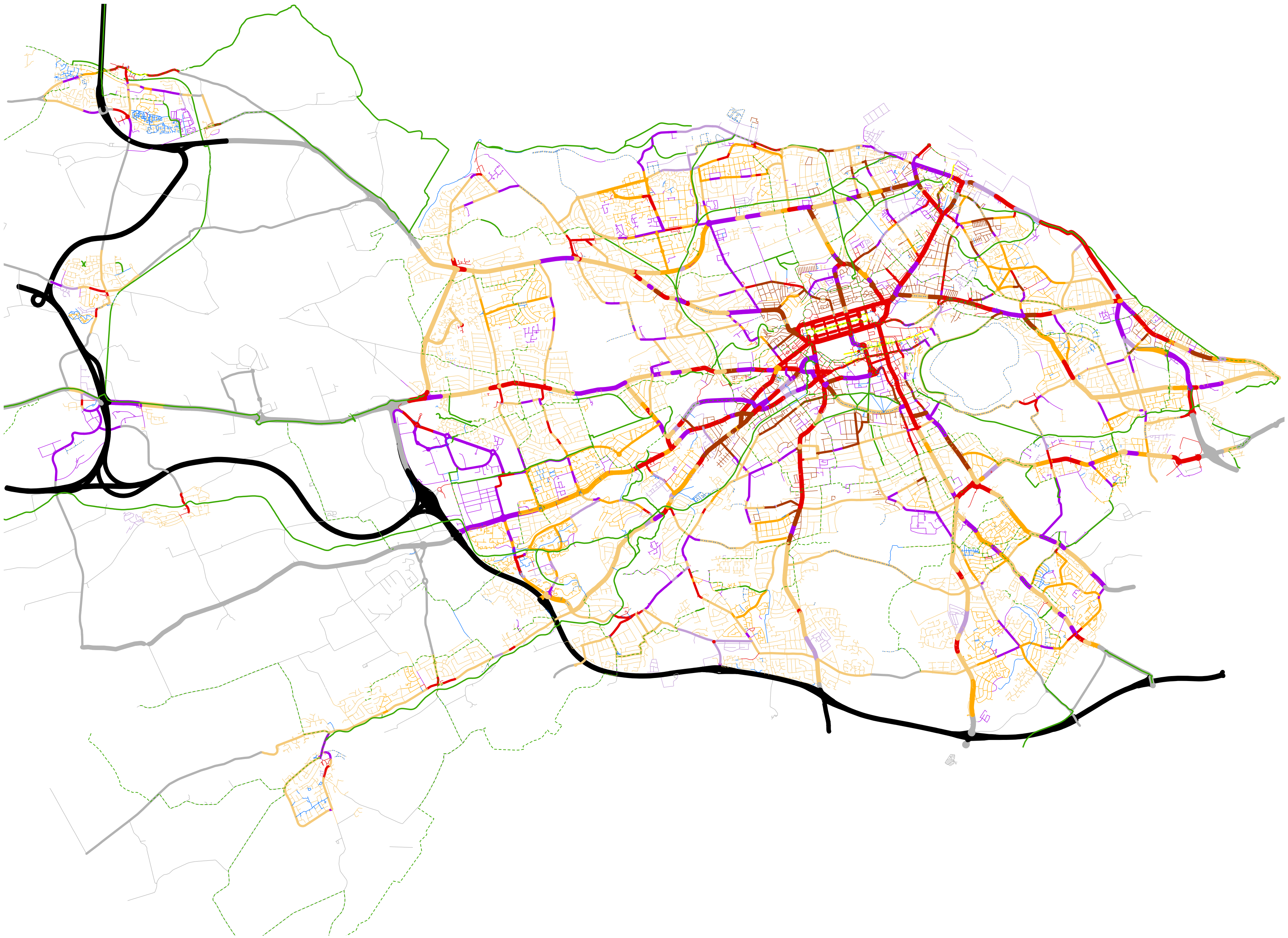
RETAIL HIGH STREETS STREETS (STRATEGIC, SECONDARY AND LOCAL)

Design Emphasis: Place — Pedestrians — Cycling / Public Transport — Loading — General traffic — Parking

Retail / High Streets have an important and valued role to the whole city, district or neighbourhood. They typically comprise of shops along a street frontage at the ground floor level, often mixed with other land uses between or above them such as non-retail employment (e.g. offices), restaurants, offices, hotels, tenement flats or other types of private residence. There is significant amount of pedestrian activity associated with the movement of people along these streets. There are also high levels of kerbside activity generated by parking, loading and public transport. They can be centres of civic pride with important buildings, squares and spaces. These functions should be understood and incorporated in the design.
Street design must cater for retail, leisure and social needs as well as the needs of people walking, cycling, public transport. Private motor traffic should generally be accommodated but not prioritised. Pedestrians should have priority across side streets. Cyclists should be separated as far as possible from traffic.

STREET LAYOUT	Factsheet reference
• **BASIC**	
Minimum width of footway - strategic and secondary streets: general min 2.5m, desirable min 3m or wider. Local streets: general min 2m, desirable min 2.5m or wider. Maximise clear "walking zone" (absolute min:1.5m - only allowed in short sections, bus stops 1m).	P3, F1
Minimise corner radii (desirable max 3m for majority street types, 1m for local streets).	G6, G1, P2
Provide pedestrian crossing points (controlled or uncontrolled crossings) every 50-100m, preferably on desire lines, e.g. at/near side roads or entrances to significant buildings. Consider raised crossings and signalised/zebra crossings at strategic points. Locate them at or near junctions to respect pedestrian desire lines. Avoid staggered crossings.	G4, G5, P2, M4
Provide pedestrian phases on all signalised junction arms and consider X (all green) crossing.	G4, G8
Review existing Traffic Regulation Orders (TRO's). Make all crossing points suitable for wheelchairs and protected from parking/loading.	G4, M4
Introduce waiting restrictions to protect all corners and, if required, the opposite kerbside of T-junctions, from parking and loading.	P2, G9

Edinburgh Street Types Map



** For the detailed Edinburgh Street Types Map see: http://www.edinburgh.gov.uk/downloads/file/6161/street_design_guidance_street_types_map*

SuDS Design Principles for Streets

Design Principles **SuDS Components**

EDG Street Type	Protect and maintain or enhance existing trees and green space.	Create small rain gardens or bio-infiltration areas.	For buildings consider fitting water butts or rain planters	New SuDS trees, infiltration strips, and filter drains	Roads or paths with adjacent green space could introduce swales.	Disconnect building down pipes to feed into adjacent bio-infiltration areas	De-pave areas of hardstanding to introduce trees, bio-ifiltration areas or rain gardens	New or re-purposed existing green space to provide swales, ponds, or wetlands.	Hard surface or green multi- purpose basins as parking or recreation areas with capacity for storing water during high rainfall.	Avenues of trees planted in SuDS trenches and filtration drains in hard landscaping	Porous road surfaces and paving	Green roofs on buildings and other structures,	Formal water features such as rills or canals.	New woodland planting in semi-rural locations
Retail High Street	○	○		◑			◑			●	●	●	●	
Service Sector Employment Streets	○	○		◑			◑	●	●	●	●	●	●	
Industrial Employment Streets	○			◑	◑		◑	●	●	●	●	●		●
High Density Residential	○	○	○	◑		◑	◑	●	●	●	●	●	●	
Medium Density Residential	○	○	○	◑		◑	◑	●	●	●	●	●		●
Low Density Residential Streets	○	○	○	◑	◑	◑	◑	●	●	●	●	●		●
Rural Roads and streets with no frontages	○				◑			●			●			●
Paths	○				◑			●			●			●

Project Scale

○ Enhanced maintenance

◑ Medium to large scale local improvements

● New developments and regeneration projects

The Practical Interpretation of Design Principles in Relation to Project Scale

The **EDG** recognises that type of practical change achievable will depend on the scope, and budget of a project. Therefore each set of Design Principles for a particular type of street (for example a Strategic High Street or a Local Residential Street) is divided into three scales identified as:

- **Basic-** small scale local improvements in existing streets
- **Standard-** renewal or changes to existing roads and urban realm.
- **Innovative-** the design of new streets or redesign of an existing street or area.

The following chart sets out the range of SuDS features that could potentially be included at the three different project scales.

EDG Design Principles / Level of Intervention	The Type of work to be carried out	Which SuDS elements could be included
Enhanced maintenance *Basic*	**Retrofitting in existing streets** including small scale local improvements, decluttering street furniture and improving accessibility.	Protect and maintain or enhance existing trees and greenspace. Provide small rain gardens where there is space. For buildings consider fitting water butts or rain planters
Medium to large scale local improvements *Standard*	**Retrofitting as part of wider changes to existing streets** that include renewal or changes to roads and urban realm. This can include new street layouts.	New SuDS trees, infiltration Strips, filter drains, disconnecting building down pipes, bio- infiltration areas, permeable paving, roads or paths with adjacent green space could consider swales.
New developments and regeneration projects *Innovative*	New developments and regeneration projects that include the design or redesign of a whole street or area.	New or re-purpose existing greenspace to provide swales, ponds, or wetlands. Hard surface or green multi- purpose basins as parking or recreation areas with capacity for storing water during high rainfall. Avenues of trees planted in SuDS trenches. Filtration drains in hard landscaping, Porous road surfaces and paving, green roofs on buildings and other structures, formal water features such as rills or canals. In semi-rural locations wet woodlands and wetlands

Project Scale

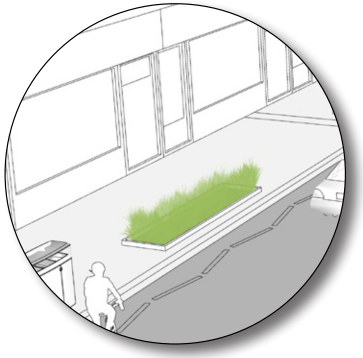
Existing

The following illustrative examples demonstrate how the EDG Levels of Intervention might be interpreted at each of the three project scales Basic, Standard and Innovative in a local high street or shopping area.

Edinburgh Street Design Guide 2020, p125

Small Scale Improvements to Existing Streets

Basic

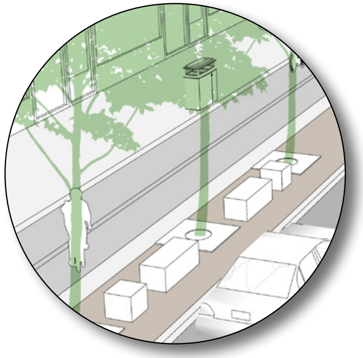


The EDG “Basic" Design Principles include small scale works that meet the requirements specified in the design principles for each street type. The introduction of sustainable drainage features at this scale should aim to provide additional benefits and/or improve small areas of localised rainwater management.

This example shows small rain gardens fitted into existing footways and the protection of existing trees.

Changes to Roads and Urban Realm in Existing Streets

Standard



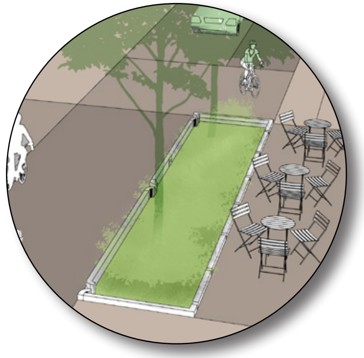
EDG "Standard" Design Principles can include medium to large scale works to fulfil both the “basic” and “standard” design elements for each street type.

At this scale the introduction of sustainable drainage should aim to provide multiple benefits while providing some improvement to rainwater management.

This example shows a pedestrian island with SuDS tree pits and porous paving built in conjunction with a separated cycleway.

New Developments and Regeneration Projects

Innovative



EDG “Innovative" Design Principles include large scale changes to a street or construction of new streets. Designs should include both the “basic” and “standard” design elements along with the “innovative” design principles.

The design of sustainable drainage at this scale should aim to deliver multiple benefits along with improvements to rain water management

This example shows a street with shared surfaces, including SuDS trees, trees in a bioretention area and porous paving.

Edinburgh Areas where "Special" Design Considerations Apply

EDG 'Special Areas' include:

Visually sensitive areas such as the World Heritage Site, conservation areas and listed structures or buildings;

- Where environmental designations for biodiversity, geodiversity or natural heritage apply;
- Local areas that are visually distinct or are of historic importance; and
- Busy places that need to allow for the free movement of pedestrians such as a high-street (as defined in EDG 4).

Figure 28. Newhaven Conservation Area | ©Google Street View, 2019

Figure 29. Victoria Terrace, Old Town, UNESCO Site | Atkins

Figure 30. Leith Docks, Conservation Area | © City of Edinburgh Council

Figure 31. Drummond Place | ©Google Street View, 2019

Because SUDS are often made up of visible components, any changes in historic areas must be developed in consultation with relevant heritage organisations and council departments.

Any works close to valued or designated natural features (like wetlands or protected trees) including areas that may be affected downstream, should consult with relevant council departments.

The design principles for SUDS set out in Section B are not prescriptive and SUDS designs should always be interpreted to reflect local context to match in with local materials, practical constraints and levels of activity. Specific guidance on selecting materials, street furniture and street trees is available in the ESDGF.[19]

19 See CEC, ESDGF Factsheets,2019, P1, G1 F1, F5, M1

Section B : Design Principles

Practical Application of the Guidance

Anyone who designs, plans, constructs, alters or maintains streets or built development in Edinburgh should be considering opportunities to include sustainable drainage (SuDS)

The *Edinburgh Design Guidance* sets out the design criteria for creating better places and supporting the vibrant character of Edinburgh. The management of rainwater (surface water) is a critical issue in maintaining and growing the city both now and in the context of future climate change. Sustainable drainage can contribute to better water management while enhancing our environment helping Edinburgh become a more resilient city. Well designed features such as SuDS trees, rain gardens, rills and swales can turn rainwater from a problem into an asset as part of attractive placemaking.

New developments are required to incorporate sustainable drainage by law. In order to achieve positive change that will help to safeguard the city for future residents and visitors sustainable drainage should also be routinely considered in the improvement and maintenance of existing Edinburgh streets and open spaces.

The following guidance identifies key design considerations and sets out the SUDS features that may be suitable in different types of place or street. However, each design must also be site specific, allowing for available space, activity, service locations, context and character.

In some locations potential for introducing sustainable drainage may be constrained by practical or other reasons (such as activities or designations). Including consideration of sustainable drainage from the outset of a project will allow the possibility of design solutions tailored to the specific challenges of each site.

Figure 32. Bertha Park, Perth | RaeburnFarquharBowen

All SUDS must be designed, built and maintained in the context of the development control system in Edinburgh and the standards for streets, open spaces public realm and new developments set out in ***The Edinburgh Design Guide, The Edinburgh Street Design Guide Factsheets***, and ***Edinburgh's Open Space strategy***.

The standard for SUDS design in Edinburgh shall in general shall follow the practices detailed in ***CIRIA's SUDS Manual C753 (2015)*** in line with standards proposed by Scottish Water. This includes the philosophy, design approach, levels of treatment and technical specifications, except where otherwise described in this document.

Figure 33. Spring Park, Woodberry Down, London| Susdrain, CIRIA

Designing a SuDS System

The choice and design of SuDS features should be sensitively considered and appropriate to the location. At an early stage developers should seek early pre-application advice to establish the potential connections from the development site to the wider drainage system as this will help to determine what the SuDS requirements will be. Requirements will differ depending on whether water discharges to a natural water body, is managed on site or discharged to the public sewer system.

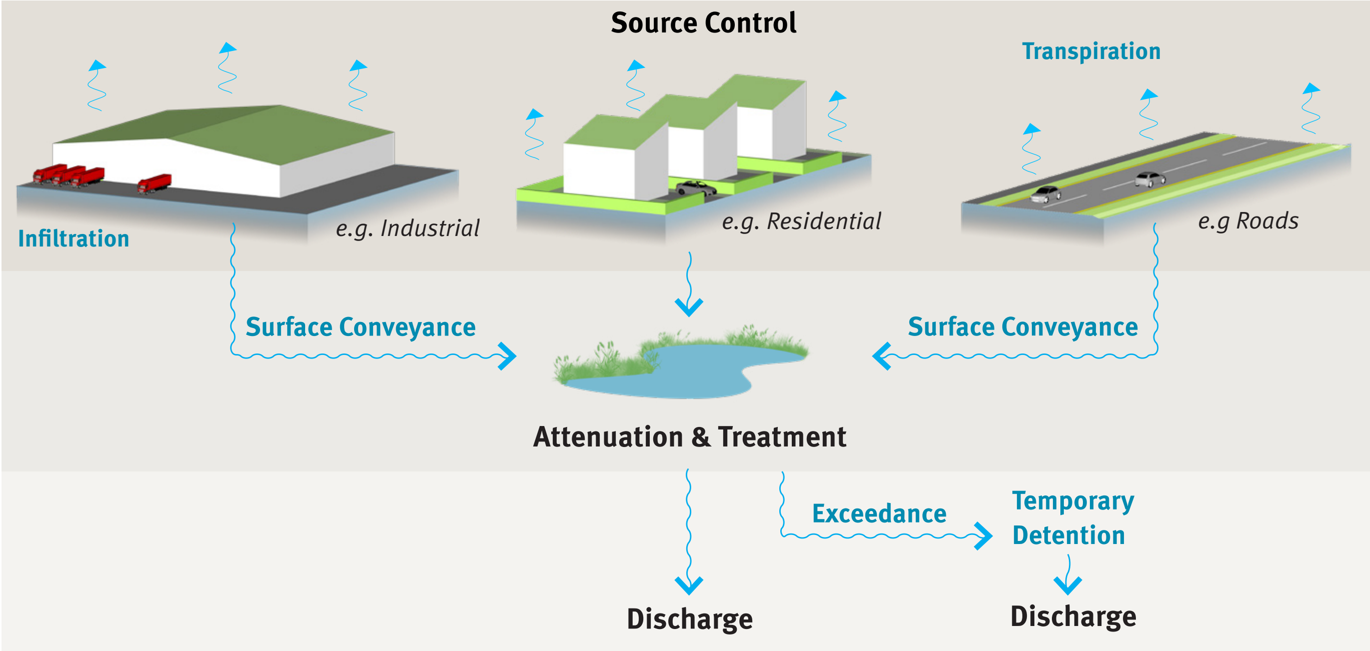


Figure 34. The Principles of Sustainable Drainage | Atkins

The Principles of Sustainable Drainage

The best practice approach to rainwater (storm water) management is to allow **infiltration**[14] as close to the point where rain falls as possible. In areas where infiltration is not possible due to ground conditions or location, rainwater will require treatment (in the form of SUDS) before discharging into the public sewer system or watercourse.

Surface water that can't soak away needs to be **attenuated**[15] before discharging off-site. Any drainage system discharging to a natural waterbody will need to include SUDS water treatment to remove sediment and pollutants along with attenuation.

Interception storage or source control is the temporary collection and treatment of small quantities of rainwater at source. Detention storage retains water at times of high rainfall allowing:

- water to be slowly discharged in a controlled way; and
- filtering of pollution and sediments improving water quality on site before discharge.

The design of all SUDS should consider where water can flow away safely in the event of **exceedance** during exceptional rainfall when a SUDS component reaches capacity and cannot accommodate more water. Typically for SuDS this would be a 1 in 30 year event however surface water management in new developments must include 1 in 200 year events.

Proposals should take full account of the **site constraints** and opportunities including access and health and safety issues for both site users and maintenance operatives. Careful consideration should be given to the siting, layout and landform of the SuDS design to ensure it is fully integrated with the site and wider setting.

14 Where rainwater soaks away into the ground.
15 The quantity and rate of water flow reduced and managed

National and Local Policy on Rainwater Management Systems

Scottish Water's Stormwater management Policy (2020) includes the following commitments:

- **No new connections** into the existing combined sewer network will be allowed from new or redeveloped sites
- Scottish Water will Work with stakeholders to **reduce the quantity of water** entering the combined sewer system or look at **removing storm water (rainwater) from the existing combined sewer system** into sustainable drainage systems
- Scottish Water will **always seek to manage storm water on the surface**
- Scottish Water will **support SuDS as part of placemaking** to enable blue- green city landscapes; and
- Scottish Water will seek to **identify opportunities for stormwater (rainwater)** re- use as a local resource through rainwater harvesting

Scottish Water: Stormwater Management Policy V4 28.02.20

The following Edinburgh Cityplan policies reflect and expand on Scottish Water Policy for rainwater (surface water) management:

- Designing for Surface Water,
- Reducing Flood Risk
- Greenblue Infrastructure Policy

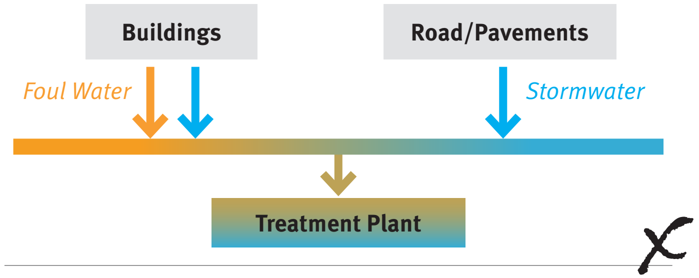
Intercepting or Diverting Rainwater from Entering Combined Sewer Systems

Old combined drains mix foul water with rainwater (stormwater), a practice that is no longer acceptable. To relieve pressure on the traditional drainage network, improve water quality and reduce the likelihood of localised flooding rainwater (stormwater) can be removed from the existing combined sewer system in two ways:

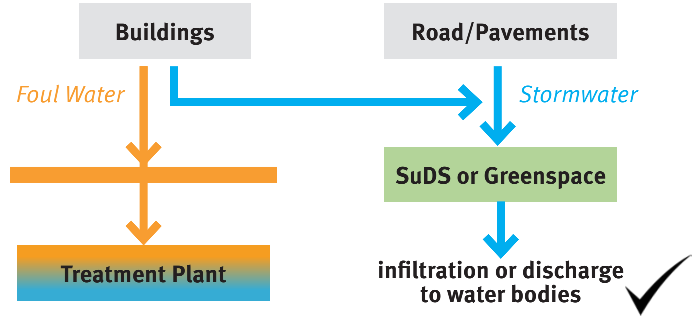
- By **intercepting** rainwater (stormwater) runoff before it enters the sewer system using sustainable drainage features such as on street raingardens and SuDS trees.
- By **disconnecting** an existing storm water sewer before it connects to a combined sewer and **diverting** the water into sustainable drainage surface features such as a pond.

The principles of designing a sustainable drainage system separating runoff from existing sources to bypass the combined drainage network must follow the same pattern of surface conveyance, treatment, attenuation and must meet relevant Scottish Water / SEPA standards prior to infiltration or any discharge offsite or to natural water bodies.

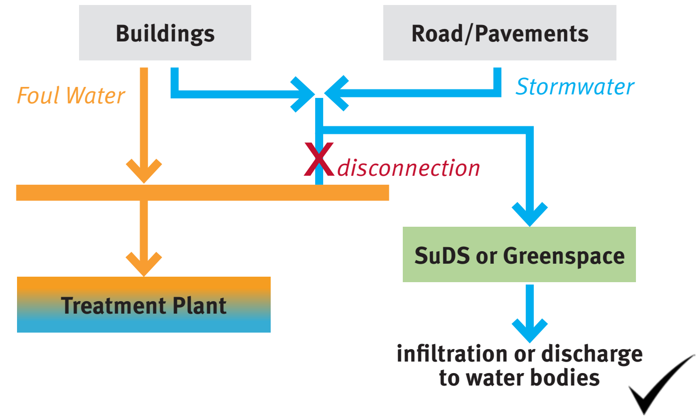
Combined Sewer System



Intercepting Stormwater



Diverting Stormwater



Designing Out Risk

In designing SuDS, the safety of the public along with those carrying out surveys, inspections construction and long-term maintenance must be considered.

Open water as part of a SUDS is often perceived as a public risk. However, while it would be impossible to design out all possible risks it is possible to minimise risks and avoid significant dangers.

A design risk assessment should be carried out at each design stage. This will allow a project team to review and mitigate residual risks[16] (and record it for the next stage) as part of the design process in accordance with the requirements of the CDM Regulations 2015.

The most serious risk is that of drowning which can be minimised by providing shallow water depths, gently sloping banks, scramble rocks and stepped gradients to create 'safety benches'.

In streets and urban spaces design out trip hazards or obstructions and be aware of the needs of blind or disabled pedestrians. Features adjacent to roads may require a road safety audit.

Considering the context and needs of local residents in the design should help balance very small residual risks with environmental and amenity benefits of SUDS. This can include issuing educational materials to local residents or the use explanatory signage in urban environments.

16 To reduce the seriousness of any risks that cannot be designed out

Minimise the need for Fencing

If appropriately designed there should be no need to fence off SUDS features. However:

- Any fencing should be proportionate to levels of risk
- if a person could fall more than 2m, a fence should be provided

Provide safe and easy access in and out of the water

Provide earth 'benches' (narrow level terraces) for people and wildlife to safely rest, access or exit consisting of:

- a level dry bench at the top of all open structure, (1m minimum width)
- a wet bench within a water feature, (1m minimum width)

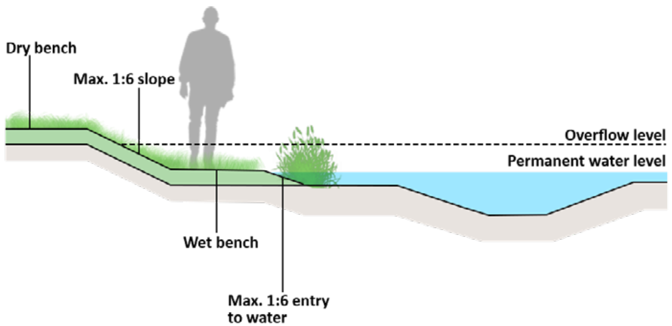


Figure 35. Mitigating Risk Associated with SuDS

Designing out Risk - Do's and Don'ts

- ☑ **DO** carry out risk assessments at each design stage
- ☑ **DO** create banks and shallow edges to waterbodies with gentle stepped gradients of less than 1 in 4 (if planted up) or 1 in 6 (if grassed) that allow easy access and escape.
- ☑ **DO** Avoid trip hazards within 1m of the water's edge
- ☑ **DO** ensure path surfaces close to water are safe and even
- ☑ **DO** provide clear sightlines to the waters
- ☑ **DO** ensure engineered outlets and control points are safe and set well back from areas of public access
- ☑ **DO** consider the needs and risks to the main users of the area through consultation and address local concerns.
- ☑ **DO** avoid the need for danger signs and lifesaving equipment by designing out risk
- ☑ **DO** avoid creating gullies, catchpits and other sumps that can be a risk to people and wildlife
- ☒ **DON'T** create high vertical drops or headwalls
- ☒ **DON'T** provide a maximum central depth of more than 1 m for ponds and a maximum of 600mm in other features
- ☒ **DON'T** create steep sided banks or steeply shelving waterbodies
- ☒ **DON'T** create fast flowing water or areas that will flood quickly.

Designing SuDS for Biodiversity

In general, biodiversity gain can be achieved through a SuDS design that creates space for native plants and wildlife. A good SuDS design can provide diverse species rich habitats by providing different water depths, or seasonally wet areas. Planting should be appropriate for the location and habitat, type of soil, slopes, water depth or soil dampness. A diverse range of species including a mix of native and non native plants can improve adaptability and climate resilience. Native plant species will support a wider range of wildlife and where ever possible should be of local or Scottish provenance.[17]

17 The 'Provenance' is the origin of the plant. Plants of 'Scottish Provenance' are bred from seed harvested from a wild ancestor in Scotland.

The potential to develop habitat rich areas will be dependent on the location of the SuDS. Inner city streets will be less likely to support a large diversity of wildlife but can still contribute to the urban green network. Planting should be more formal and may include suitable non-native species that include robust attractive plants that provide nectar or berries. **The Edinburgh Biodiversity Action Plan (EBAP)** sets out specific aims to promote the inclusion of SuDS in new developments to create valuable new habitats for native plants and wildlife that can contribute Edinburgh's natural heritage.


Figure 36. King Fisher | City of Edinburgh Council


Figure 37. Amphibians | City of Edinburgh Council


Figure 38. Marsh Marigolds | City of Edinburgh Council

RSPB & WWT Sustainable drainage systems: Maximising the potential for people and wildlife: A guide for local authorities and developers, (2012)

Building with Nature, 2019

ESDGF 5 Tree Factsheet

SuDS Factsheets W1, W2, W.3

CEC, EDG chapter 3

CEC, Edinburgh Biodiversity Action Plan

CEC, Edinburgh's Open Space Strategy

Trees and Woodlands

Environmental assets such as established woodlands and mature trees play an important role in water management.

Woodlands and wetlands provide natural water storage within a catchment area. Trees and vegetation also release water back to the atmosphere through transpiration. A mature tree in leaf will slow heavy rainfall reducing soil erosion beneath it's canopy.

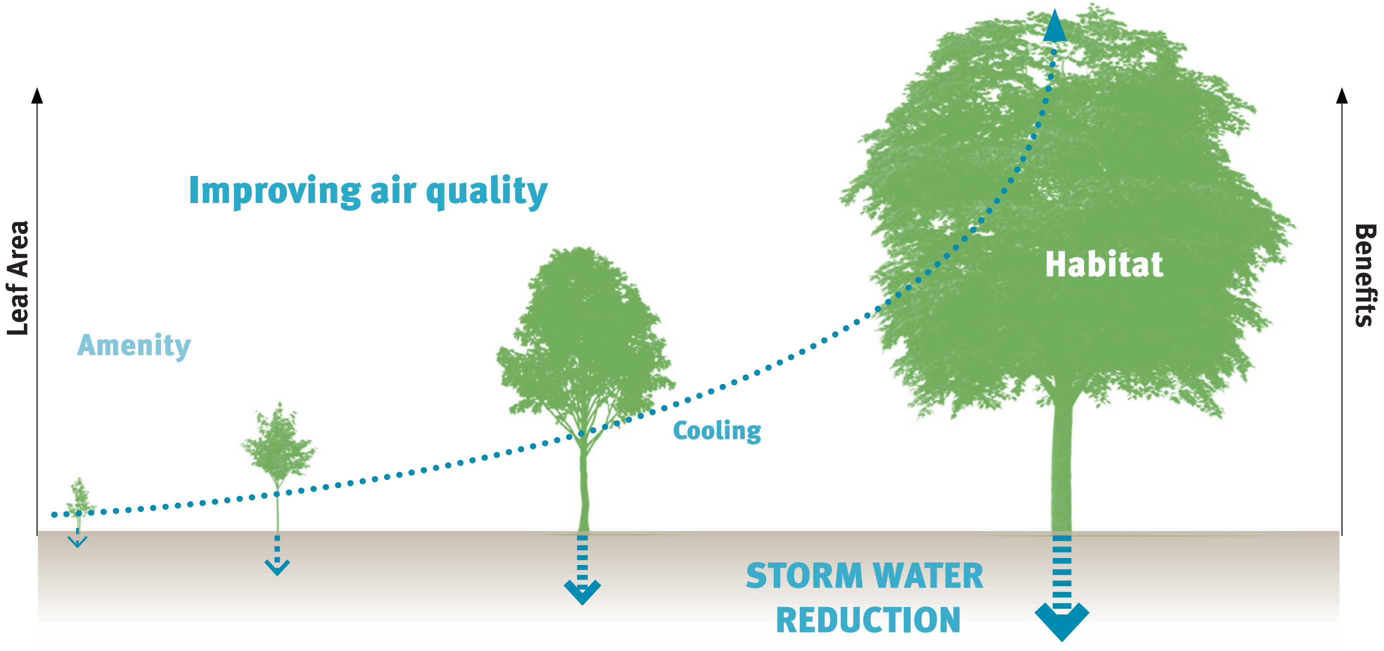
A study by the University of Manchester indicated that an increase in tree cover of 6% in an urban area can deliver a 10% reduction in the amount of rain water entering drains[11] and cool heat island effects by 4°c.[12]

The roots of established trees provide channels through the soil that can increase the capacity of the ground to absorb water by 60% or more depending on the size, tree species and the soil conditions. This effect is particularly significant in areas of compacted soil.[13]

11The Ecologist ,Trees a 'low-cost' solution to air pollution and biodiversity loss in cities, 2 July 2010
12 University of Manchester, *Build Parks to Climate Proof our Cities*, 14 May 2007

In recognition of the important role they play in our environment protection of mature trees should be a key consideration in designing a sustainable drainage system.

13 K.R. Chandler, C.J. Stevens, A. Binley, A.M. Keith, *Influence of Tree Species and Forest land use on soil hydraulic conductivity and implications for surface runoff generation*, Geoderma, Volume 310, 2018,Pages 120-127



Tree Size in Relation to Environmental Benefit
Figure 39. Benefits of Trees. Adapted from CEC Trees and Woodlands Action Plan – January 2014

Figure 40. Mature trees at Shadwick Place, Edinburgh | Atkins

Practical guidance on how to integrate SuDS trees into the urban environment can be found in **Section B Design Principles for SuDS in Edinburgh.**

Edinburgh Local Development Plan Polices

Edinburgh Design Guide, Chapter 3 - 3.5 Trees

Edinburgh Biodiversity Action Plan 2019-2021

Forestry and Natural Heritage Nature Conservation Report (2018)

The Role of Soils in SuDS

Soils that contain organic matter (humus) play a vital role in regulating climate by storing water and carbon. By filtering and slowing the movement of water, soil can reduce pollution and sediment entering our rivers.

SuDS components based on water soaking into the ground (infiltration) such as swales, permeable paving or filter drains can play a valuable role in retaining and managing surface water on site. However, the potential to use a ground infiltration system is dictated by location and the type of soil.

Soil nutrient levels, aeration and composition are vital to the healthy growth of plants and trees in SuDS. It is important that during construction soil is not compacted as this will destroy soil structure and obstruct drainage.

Consider Soil in SuDS Design

Information on soil will inform the design of SuDS, the choice of SuDS elements and minimize the space they require to be effective. An early stage a designer should establish:

- how free draining the soil is,
- whether ground stability will be affected by waterlogging, and any potential for polluting effects.

Some types of SuDS such as tree pits require engineered soils that drain freely while providing sufficient nutrients and structure for growth.

Guidance on the on the suitability of different soil types for SuDS is available in SuDS for Roads (Scottish Water 2009).

"Engineered soils are designed and manufactured to provide specific drainage and horticultural properties."

CIRIA Guidance on the Construction of SUDS p210

Technical Guidance:

SuDS for Roads 4

CIRIA C753 The SuDS Manual Part E 24 &25

CIRIA SP25 Site investigation manual

BS3882:2015 Specification for Topsoil

BS1377 :2016 Methods of test for Soils for Civil Engineering

CIRIA Contaminated Land Guidance Tool

Figure 41. Soil | Atkins

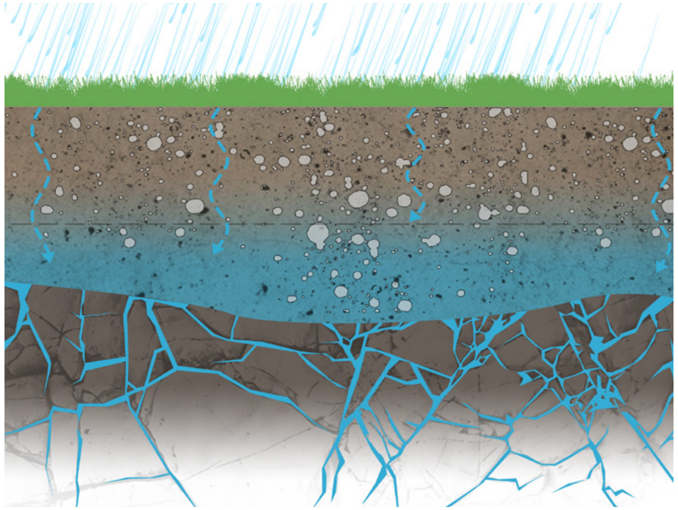


Figure 42. Soil Structure

Unsaturated/ Aeration Zone
Upper soil layers that hold both air and water

Water table at the top of the Zone of Saturation

Ground Water / Zone of Saturation
Lower soil layers where all spaces are filled with water

Aquifer
water in pores and fractured rock

Designing with Nature- Do's and Don'ts

☑ **DO provide clean water for wildlife by including features that filter pollutants.**
Design a sequence of SuDS features to filter pollutants and sediment to ensure a controlled flow of clean water before the water enters a wetland SuDS or pond features to create conditions for wildlife to flourish.

☑ **DO create connections to surrounding green networks.**
Proximity or indirect links between existing and proposed wetlands or ponds will enhance natural colonisation and habitat resilience for wildlife.

☑ **DO create a range of different habitats**
Providing a varied range of landforms, slopes and water depths will provide a greater variety of potential habitats. Include opportunities for wildlife (such as woodlands, hedgerows or meadow) beyond the wetland areas to provide connections and integrate nature into the overall design of the site.

☑ **DO provide gentle slopes and shallows to waterbodies**
Gentle slopes and shallow shelving edges to ponds and other waterbodies provide safe access for both wildlife and people and creates opportunities for marginal planting

☑ **DO provide undisturbed sections of bank along water features**
Provide undisturbed areas away from public access to encourage nesting birds and wildlife.

☑ **DO control nutrient levels in soil and water**
In general, lower soil fertility will support a diversity of native habitats and reduce maintenance costs. Most native trees and wild plants will thrive on low nutrient top soils while ponds can develop algal problems if fertility is too high.

☑ **Do create ponds, or wetland areas within flying distance of similar habitats**

☑ **DO use native plants**
Using plants of local or Scottish provenance will protect and enhance our natural heritage while maximising the benefits to wildlife.

☑ **Do consider access for toads**
Consider access for toads to SuDS ponds and wetlands during their breeding season. In the local vicinity consider temporarily covering gullies or grills with mesh to aid safe migration

☑ **DO Mix native and non native plants**
Use a diverse range of plant species to enhance biodiversity and increase climate resilience.

☒ **Don't Plant Invasive Species**
Avoid planting invasive species near waterways and transport routes

☑ **DO plant flowering and berrying plants**
In more formal locations where informal native planting might not be suitable choose species that provide berries and flowers attractive to wildlife (including cultivars or garden varieties of native species).

☑ **DO manage your wildlife areas**
Use mown access paths and edges to create public access and an acceptable appearance to wildlife friendly SuDS areas of vegetation and meadow grasses. Grass areas of different heights can create a network of different interlinked habitats (mosaic habitats).

☑ **DO use existing established trees as part of your design**
Established mature trees are environmental assets, important habitats and attractive features that will provide multiple benefits if incorporated into the design of the site

☑ **DO link hedge patterns, avenues of trees or woodland planting**
To encourage birds, bats, small animals and insects.

☒ **DON'T economise on soils in SuDS Tree pits**
It's a false economy to use cheaper sand-based soils instead of proprietary engineered SuDS soil mixes. The tree is unlikely to thrive and will either need to be replaced or will never reach the level of growth which will deliver meaningful SuDS benefits.

☒ **DON'T directly link SuDS water features to protected natural areas**
Avoid direct links from the SuDS to environmentally sensitive waterbodies or wildlife areas to avoid transferring pollutants or sediment.

☒ **DON'T excavate too close to the roots of established trees**
Cutting or damaging roots may destabilise or kill existing trees. See British Standard 5837 (2012) – Trees in relation to design, demolition and construction.

The Components of SuDS

The SuDS Management Train

A sustainable drainage system is made up of a series of different stages called the management train. Each stage of the management train will perform a function, reducing water quantity, slowing water flow and filtering sediments and pollutants.

Larger sites may need several management trains draining to separate locations. In locations where the final out flow from site could affect water quality in an area of high environmental sensitivity, extra treatment stages may be needed.

The CIRIA guidance also provides a detailed description of how and which SuDS features are most effective in treating different kinds of sediment and pollution.

The number of stages and the type of SuDS features used will depend on:

- the location, geography and character of the site
- the environmental sensitivity of the surrounding area
- the type of waterbody or drainage system the site will discharge to
- the type of development
- the size of the site
- the type of activity on the site
- the nature of the surface water runoff

Designing for Water Quality

- ☑ Do use good housekeeping to prevent pollutants entering the water system wherever possible
- ☑ Do use Interception (infiltration at source into the ground and vegetation to fix pollutants in the surface layers of the soil).
- ☑ Do provide Water treatment -using SUDS to convey, filter and attenuate water (removing sediments).
- ☑ Do plan for maintenance and remedial work to remove pollutants captured in sediment
- ☑ Do create a resilient system that allows for future climate change and urban creep.

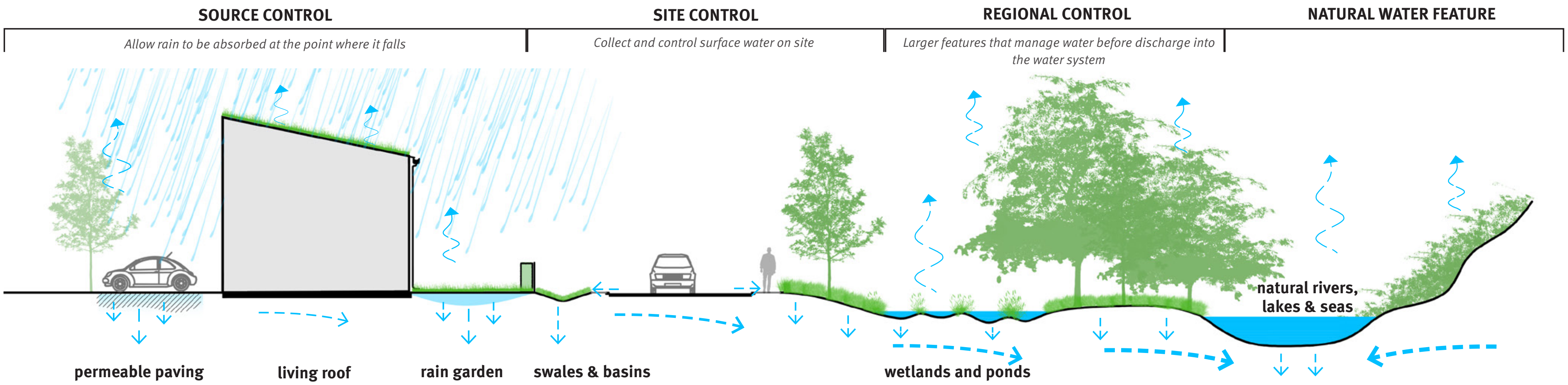


Figure 43. SuDS Management Train

How Suds Features Work

A typical SuDS management train would contain a selection of the following SuDS features:

Source Control Features – reducing the amount of run off by absorbing water at the point where the rain falls. Examples include living roofs, street trees, permeable pavements, water butts and rainwater planters.

Filtration Features – help to trap sediment and pollutants before draining excess water to the next stage of treatment. Examples include filter drains, rain gardens and bioretention filter strips (as part of a grass verge).

Open Channels – features that gather and move water while slowing water flow to allow settlement of sediments. This would include wet or dry swales, or in an urban context canals or rills.

Infiltration Features – allow water to soak into the ground and include soakaways, infiltration basins or trenches. Mature trees and shrubs also play an important role in increasing the potential for ground infiltration.

Detention Features – provide temporary storage of excess surface water at times of high rainfall, allowing water to released slowly and safely. Examples include grassy detention basins that are dry for most of the year and detention basins with hard surfaces that may double as parking areas or playgrounds.

Retention Features – keep and manage water on site. Features such as a pond or self-contained (end of line) swale are wet year-round but can accommodate excess water during high rainfall. Shallow wetlands can also act as retention features. These areas usually planted for biodiversity and can provide valuable habitats while providing a practical function.

Some sustainable drainage features can overlap or be tailored to carry out several functions, over the length of a swale for example it may be designed to provide:

- filtration using vegetation to slow and trap sediments;
- an open channel moving water through the site;
- infiltration areas where water can soak away;
- an area of shallow sloping banks that provide a detention capacity at times of high rainfall; and
- retention areas that remain wet throughout the year.

Figure 44. Queen Caroline Schotterasen Gravel Garden | Susdrain, CIRIA Flickr

Figure 45. Rain Garden in Malmö, Sweden | Sudsnet, Abertay University

SuDS Features

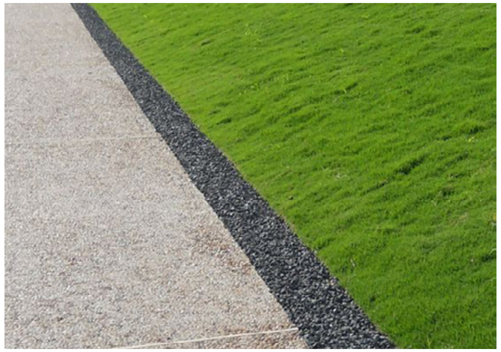
Figure 46. SuDS feature grid
Refer to reference page for further information


A | Green Roofs


B | SuDS Trees


C | Permeable Surfaces


D | Rain water planters


E | Filter drains


F | Rain Garden


G | Swales


H | Canals or rills


I |Detention Basins


J | Hard Detention Basin


K| Pond


L | Wetland

Rainwater Harvesting

Rainwater harvesting is the process of collecting and storing rainwater from roof run off for practical use.

By capturing and recycling rainwater it is possible to reduce the quantity of water to be disposed of offsite while gaining practical benefits. Rainwater harvesting can be carried out at a range of scales with various proprietary systems readily available.

A Rainwater Harvesting System consists of:

- **Filtration** – rainwater collected from a roof may contain contaminants such as dead leaves, bird droppings, bacteria or dust that needs to be filtered out.
- **Storage** – Water is stored in tanks above or below ground
- **Conveyance** - water is moved to the point of use using a pump or gravity feed, this may include a second header tank within the building.

Water collected this way is not potable (suitable for drinking or personal washing) but can be used for practical domestic or commercial functions such as irrigation, toilet flushing, car washing or industrial cooling.

Standards and Regulation

- A water butt for a domestic garden will not usually require planning permissions.
- While no separate planning permission is required for rainwater harvesting systems, the design and installation should meet the standards set out in Scottish Building Regulations for all structural, electrical and plumbing works.
- Large commercial or industrial systems may require a Building Warrant. Outflows from these systems (after use) should comply with Scottish Water or SEPA standards.
- A rainwater harvesting system where the captured water is isolated from groundwater or inland water bodies does not require a water abstraction license.
- Design and installation of rainwater harvesting systems should comply with standards set out in BS EN 16941-1:2018.

BS EN 16941-1:2018 Rainwater Harvesting Systems

CIRIA: The SuDS Manual, Chapter 11 Rainwater Harvesting, p207

Rainwater Harvesting and other water reuse systems (SW)

Water Regulations Advisory Scheme (WRAS)

Rainwater harvesting regulatory position statement (GOV.UK)

Scottish Building Regulations (Gov.Scot)

Figure 47. St Josephs Primary school Rain water harvesting | ExmouthJournal

Examples of Rainwater Harvesting Schemes

A domestic water butt can easily be fitted to a down pipe to a provide water for gardening.

Figure 48. Water Butt | FreeFlush

Water captured by a blue roof in cellular tanking is filtered by the layer of vegetation above and can be connected to a system to store and re- use the water within the building to flush toilets.

Figure 49. Blue roof system, Aylesford, Kent | livingroof.org

Roof run off from a large commercial building such as a bus depot is collected, filtered (or treated) in storage tanks and used to wash down the vehicles.

Figure 50. Bus Wash water recycling system | Lothian Buses

Design Considerations

- Ensure there is a separation between mains water supply systems and harvested rainwater systems to avoid contamination.
- In systems that include a facility to be topped up by mains water ensure there is no risk of back flow that could contaminate the mains water supply.
- Consider clearly labelling any pipes or fittings using harvested rainwater as ‘not suitable as drinking water’.
- Use appropriate professionals to design and construct a rainwater harvesting system to ensure it meets national standards.
- Consider how the used rainwater will be disposed of at the end of the system, if it contains no harmful pollutants consider a potential further stage as plant irrigation or SuDS management train.

SuDS and Services

When designing in a new development, it is important to allow enough space to separate public utilities from sustainable drainage features including the space for ongoing maintenance and future upgrades to utilities.

In existing streets it is important to establish the location of utilities and work closely with service providers in the design of sustainable drainage to avoid conflicts.

In some locations SuDS street trees can be positioned down one side of the street only or staggered along the length of a street where new footways are too narrow to allow separation from utilities. The interaction between SuDS trees, street lighting and CCTV must be carefully managed as what may appear to be suitable position when the tree is planted could become inappropriate as the tree grows.

Mature trees are environmental assets that provide important environmental functions. Care should be taken to avoid unwanted interaction between services or surface water drainage features and roots of existing trees. Where possible existing trees should be integrated to the SuDS design to make some use of runoff as a source of water. To protect services, use root intrusion resistant pipe technology wherever possible and if necessary, consider retrofitting root barriers.

Figure 51. SuDS Tree pits under construction at Goldhawk Road | Robert Bray Associates

Figure 52. Retro fitting permeable paving, Mendora Road, Fulham | Atkins

Opportunities for retrofitting sustainable drainage features should be considered as part of:

- road maintenance, reconstruction or resurfacing
- road drainage improvements
- planned road modernisation
- development, redevelopment or regeneration
- investment in the public transport network,
- cycle route infrastructure
- place making projects

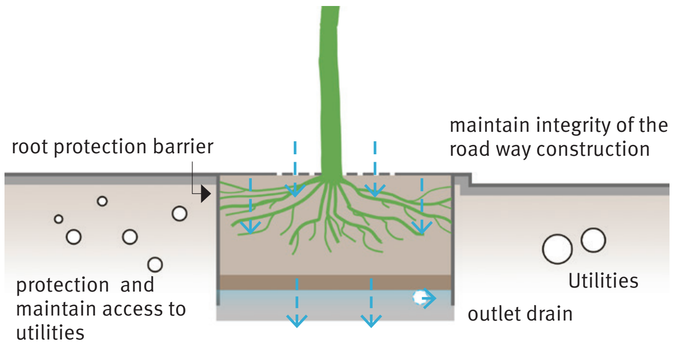


Figure 53. Trees and utilities - adopted from DTAG 2014. p89

Trees and SuDS tree pits are discussed in Factsheet 1 of this guidance.

SUDS Close to Buildings, Roads and Other Structures

Designing SuDS features that allow infiltration in close proximity to foundations should be done in consultation with a professional ground engineer or geotechnical advisor.

Scottish building standards advise a 5m distance between a traditional soakaway and the foundations of a building however they also state:

"… the volume of surface water run-off, ground strata or permeability of the soil may influence this dimension and it may be reduced, or indeed may need to be increased…" [18]

Traditional soakaways can infiltrate quite large quantities of water within a small area which may affect foundations or ground stability. Depending on soil type the safe distance between a soakaway and foundations may be less or more than 5m.

SUDS surface features such as raingardens and permeable surfaces function differently from soakaways acting as a blanket or plane infiltration system that spreads water over a wide area.

Where the rate of infiltration is no greater than an equivalent area of open grass (such as permeable paving for example) there is unlikely to be a problem.

18 Scottish Building Regulations, Environment, 3.6 Surface Water Mandatory Standards 3.63 Surface Water Discharge

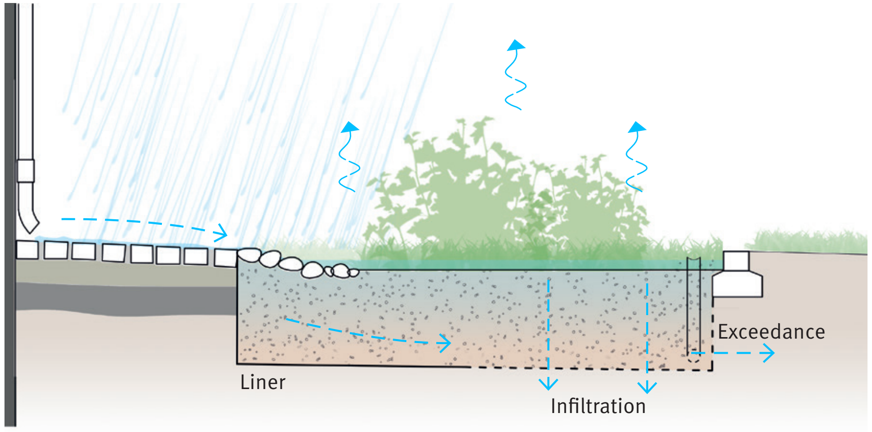


Figure 54. Disconnected Down pipe with Rain Garden

Figure 55. Queen Caroline Estate, London | susdrain

Depending on the type of foundations and appropriate soil conditions SUDS infiltration features draining relatively small quantities of water (such as roof run off) can be considered within 5m. It's wise to take a cautious approach, seek professional geotechnical advice and if conditions are favourable half line the SuDS feature directing infiltration away from foundations.

Scottish Building Regulations, Environment, 3.6 Surface Water Mandatory Standards 3.63 Surface Water Discharge

S.Wilson, Using SuDS close to buildings, Susdrain Fact sheet, September 2012

Figure 56. Permeable paving next to buildings, Stevedore Place, Leith | Atkins

Connecting Source Control to the Wider SuDS System

Interception

In new developments small rainstorms (up to 5mm) should be managed on the private ground within a building plot. This can be achieved using any of the following sustainable drainage features to slow, infiltrate and take up water close to where the rain falls as the first stage of rain water management (source control).

- Raingardens
- Living Roof
- Filter Strip
- Permeable Paving
- Rainwater planters
- Rainwater harvesting

Conveyance

To cope with larger rainfall events these first stage drainage features need connections that allow water to flow away safely to sustainable drainage These connecting features should allow water to soak into the ground while moving slowly through the system. It is important that these are shallow structures to allow them to connect with the next feature in the sustainable drainage treatment train.

- Filter Drain
- Swale

CIRIA: The SuDS Manual, Chapter 7 The Design Process p95 & Part C, chapter 8 Applying the Approach, p179

Scottish Building Regulations, Environment,3.6 Surface Water Mandatory Standards 3.63 Surface Water Discharge

S.Wilson, Using SuDS close to buildings, Susdrain Fact sheet, September 2012

ESRWMG, Infiltration Close to Buildings, Roads and Other Structures, p42

EDG, 2.4 Design, Integration and quantity of Parking, Technical Guidance p54-59

Design Considerations

- ☑ **Do** use interception features to manage roof run off and surface water in parking areas
- ☑ **Do** consider suitable entry and exit points for the water.
- ☑ **Do** ensure levels allow surplus rainwater to drain away into a surface feature such as a swale or filter drain

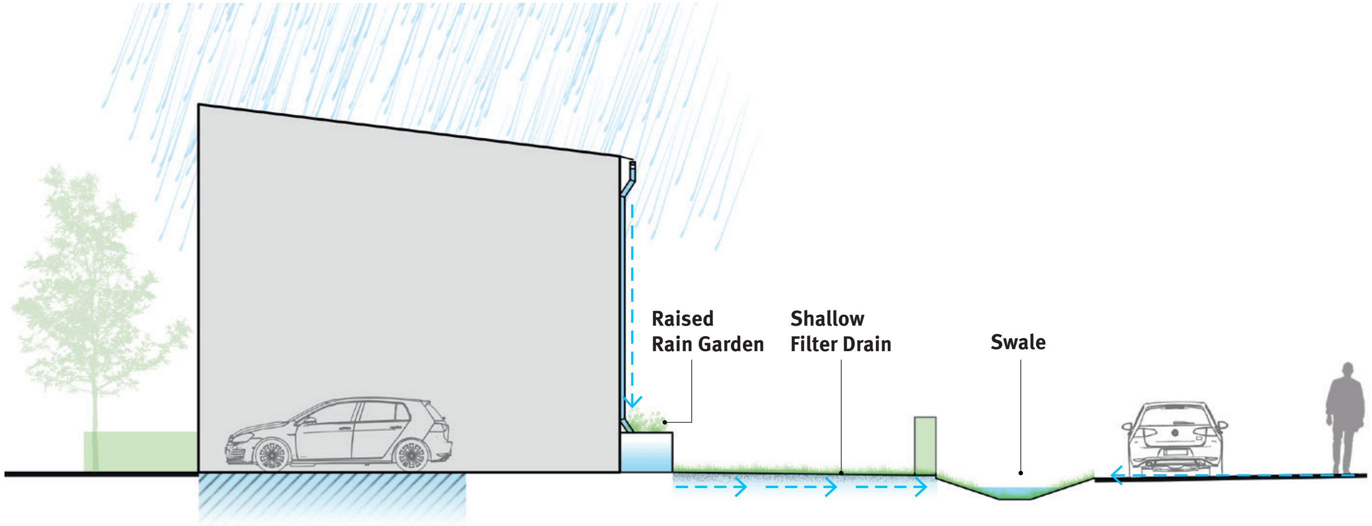


Figure 57. Example of first stage Interception | Atkins

Rainwater Management and Changes to Existing Buildings - Extensions

The paving or building over small greenspaces in the city for parking or building extensions has a cumulative effect, reducing the capacity for rainwater to soak away naturally and increasing the likelihood of local flooding. Homeowners and proprietors of privately owned building can help to mitigate these effects by retrofitting sustainable drainage features and responsible development to manage small rainstorms (up to 5mm) on site.

The gradual piece meal loss of these small spaces is significant both for biodiversity and rainwater management. This process of infill development and hard surface areas gradually increasing within an urban area is called **'urban creep'.**

CIRIA SuDS Manual: Chapter 11 Rainwater harvesting, 206 & Chapter 12 Greenroofs, P232

ESRWMG, Infiltration Close to Buildings, Roads and Other Structures, p42

Rainwater Harvesting, p39

ESRWMG W2 Raingarden Factsheet

Edinburgh Design Guide: 2.4 Design, integration and quantity of parking, p54

Building Extensions

Building extensions to private property are often built over garden spaces.. A well-designed extension should include sustainable drainage with the objective of providing water management equivalent or better than the lost area of open ground.

This could consist of any or all of the following :

- Green roofs
- Small rain gardens and disconnected down pipes
- Water butts
- Rainwater planters

Figure 58. Example an extension with a green roof | Green Roof Naturally

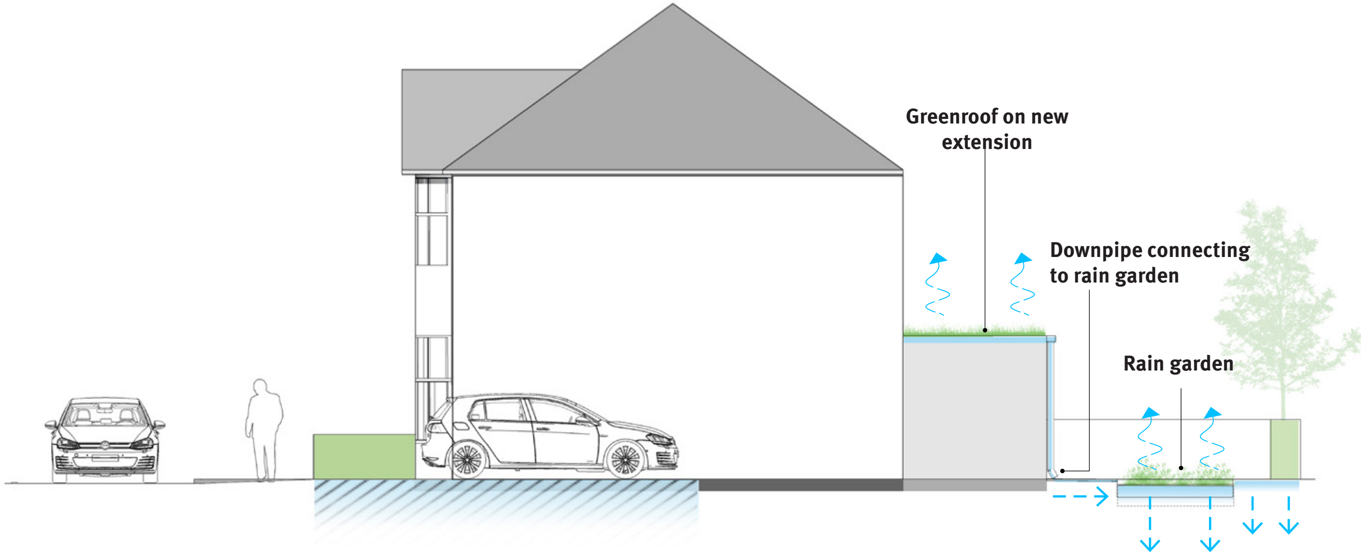


Figure 59. Existing property water management adaptations | Atkins

Rainwater Management and Changes to Existing Buildings - Hard Surfacing

Avoid paving over Front Gardens

On street parking in central Edinburgh is at a premium often encouraging residents to pave or tarmac over garden spaces to create private parking. Although it is better for the urban environment to avoid converting a garden area, if it is unavoidable consider:

- Minimising the area converted to parking
- Surfaces that allow water to soak away such as gravel or permeable paving
- Wherever possible retain planting, particularly existing trees and hedges.

Permitted Development

Creating or replacing a hard surface within the grounds of a private building is classed as permitted development[1] only if

- it is located between an adjacent highway and the building; and
- it is a permeable surface OR water from the hard surface is drained to a permeable area or sustainable drainage feature within the property grounds. No additional drainage to existing sewers will be permitted.

1 With the exception of conservation areas or the curtilage of listed buildings.

ESRWMG, Infiltration Close to Buildings, Roads and Other Structures, p42

Edinburgh Design Guide: 2.4 Design, integration and quantity of parking, p54

PART 1 Class 3C.-(1) hard surfaces within the curtilage of a dwellinghouse

The Town and Country Planning (General Permitted Development) (Scotland) Amendment Order 2011

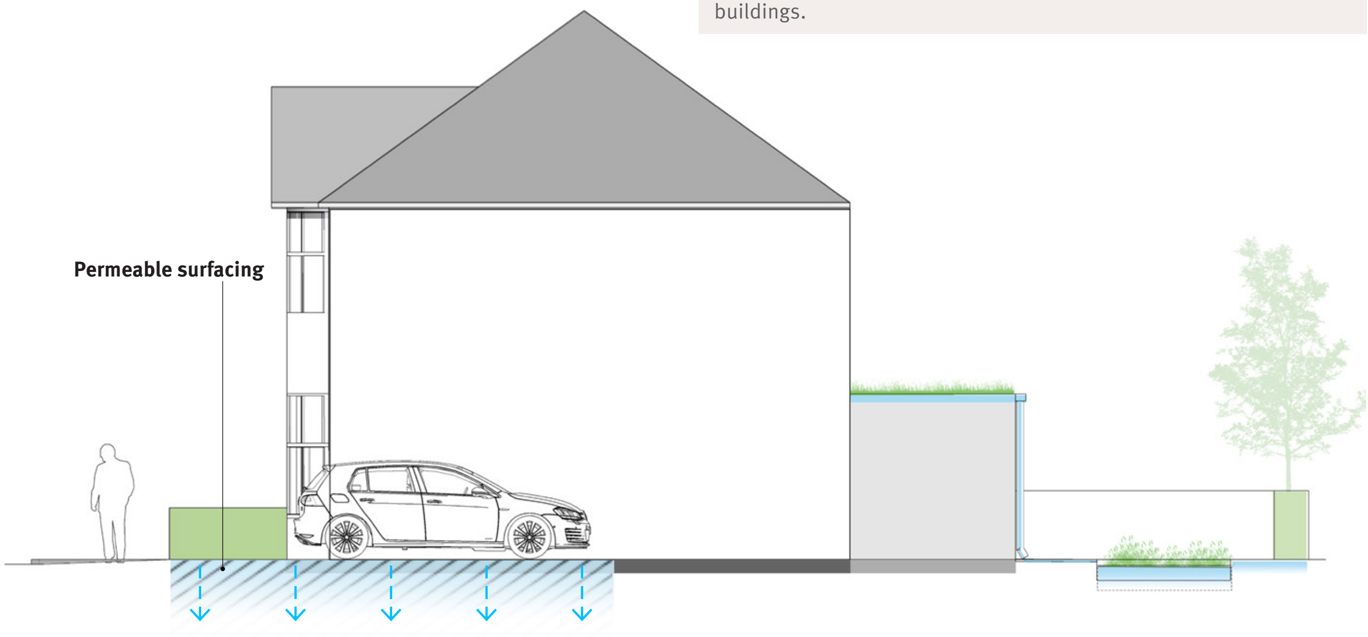


Figure 60. Example of first stage Interception | Atkins

> ***"The average annual rate of urban creep in Edinburgh (around buildings and their gardens and grounds), between 1990 and 2015, is 6.44ha/year. This is equivalent to losing over eight football pitches of vegetated land per year."***

CREW, *Quantifying rates of urban creep in Scotland: results for Edinburgh between 1990, 2005 and 2015*, 2015

Why Underground Water Storage is a Last Resort

There are various types of underground water storage including concrete tanks, oversized pipes and geocellular storage systems. Where underground storage is unavoidable, it should be combined with other systems to filter and remove sediment wherever possible.

"Underground storage does not provide treatment and shall only be used in conjunction with SUD techniques for discharges direct to a watercourse in urbanised city/town centre development sites. Systems shall in all cases fully comply with the Water Environment (Controlled Activities) (Scotland) Regulations 2011.

Scottish Water, Sewers for Scotland4, p25

Sewers for Scotland 4

CIRIA: The SuDS Manual, Section D, chapters 13 & 21, p465

BRE 365 Soakaway Design, 1991

Bettess, Infiltration Drainage: Manual of Good Practice:, CIRIA R156, 1996

BS EN 1295-1 : Structural design of buried pipelines under various conditions of loading. General requirements 2019

Highways Agency specification for highway works (Highways Agency et al, 1998).

Structural design of modular geocellular drainage tanks CIRIA Report C680.

Underground water storage as an alternative to sustainable drainage systems are the least favoured option because:

- Although the capacity of a tank may be designed to accommodate up to 1/200 year weather event, water may not be able enter the storage tank quickly enough to be effective during intense rainfall increasing the likelihood of flooding.
- Underground tanking does not treat water quality or reduce water quantity.
- Because the system is underground it can be difficult to maintain and expensive to fix if things go wrong.
- Designing underground storage requires appropriate geotechnical and hydraulic engineering expertise to avoid problems like ground subsidence or adverse effects on adjacent foundations
- The landscaping of ground above an underground tank is limited to grass or hard surface potentially creating a 'dead space' and excludes the opportunity to plant trees in the vicinity as they can be damaged by tree roots.

Geocellular Systems

Shallow geocellular systems can be combined with permeable surfacing and filtration; and can also be designed to allow water to infiltrate the ground.

Figure 61. Geocellular systems under construction, Mendora Road, Fulham | Atkins

Figure 62. Completed permeable paving with geocellular storage, Mendora Road, Fulham | Atkins

Retrofitting SuDS in Streets

The aim of introducing SuDS components to existing streets should be to enhance the environment while reducing pressure on the city's drainage infrastructure. Attenuating and treating rainwater before any residual rain water returns to the drainage system.

For example, busy streets and high-density inner-city developments might use SuDS features with an urban character such as street trees, rain gardens, permeable paving, channels or rills. These features can be designed to enhance the streetscape through layout and choice of appropriate hard landscape materials.

Figure 63. Retrofitting rain gardens in Sheffield | © Google Street View

Figure 64. Retrofitting rain gardens in Sheffield | © Google Street View

Retrofitting SuDS in Edinburgh Streets Check List

☑ Survey the site

Depending on the scale of the project carry out appropriate surveys including existing trees, levels, and street layout. Include a walkover to better understand the site and local context.

☑ Services

Obtain service information and identify constraints and opportunities. Contact any service providers who's infrastructure may be affected by the proposals.

☑ Carry out an investigation into soil permeability

Use a trial pit to determine the type, permeability and underlying ground conditions.

☑ Edinburgh Planning Guidance

Use the guidance in the EDG Section 4 to establish the streetscape Design Principles.

- First establish the type and scale of the street or urban space.
- Then determine the scale and of the project (referred to as (*'Levels of Intervention'*)
- Look up the relevant Street Design Principles and cross reference with the SuDS Design Principles set out in this document to see what type of SuDS components could be considered as part of the project.

☑ Is this a 'Special' Place' as defined by the EDG?

'Special' Places' are defined in the EDG Section 4 and include areas or features protected by heritage or environmental designations, the World Heritage Site and City Parks. There are additional design considerations that apply in Special Places that will affect the type, layout and materials of SuDS components. (See ESDG Factsheets).

Planning

For council projects in existing streets establish whether work can be carried out under Permitted Development or whether a planning application or Building Permit will be required.

Works affecting trees in Conservation Areas or under Tree Protection Orders will need permission from Edinburgh Council. (see EDG Section 3.5)

Consultation

As SuDS are visible components, in areas where designations apply carry out consultations with appropriate bodies such as WHS, HS, SNH, SEPA, and relevant council departments.

In residential areas or on projects where SuDS will introduce extensive visible change to an area carry out local public consultations to inform and tailor proposals.

Survey the existing drainage

Survey gullies and establish the existing hydraulic conditions, and the amount of surface water that typically needs to be drained. Ensure that any proposed changes to the street will not increase surface water flows or overburden the existing drainage system at the point of discharge.

Establish where existing gullies discharge

Traditional gullies may connect to Scottish Water sewers, culverted waterbodies, or private pipes. Establish were water will discharge and ensure appropriate permissions and determine any constraints.

Determine the space available for SuDS

Dependant on the scale of changes to the street or open space environment establish where and how SuDS components can be fitted into the street.

Designing gradients within a SUDS feature

Ensure that there is sufficient gradient within the sequence of SuDS features to allow gentle movement of water through the system.

Discharging to drainage pipes

If a SUDS feature discharges to a new drainage pipe (installed as part of the SUDS design) ensure the pipe meets with Scottish Water and Edinburgh Council standards including drainage gradients, depth of cover and access for maintenance.

Design of SuDS Components

- Use the design principles in the ESRWMG
- use appropriate CIRIA technical guidance
- use the ESRWMG Factsheets
- use the ESDG Factsheets

Design components for Exceedance

If the SuDS component reaches capacity during exceptional rainfall, ensure that the component does not obstruct the safe flow of water away from properties and carriageways. (see EDG 3.7 and CEC Surface Water Management and Flood Risk Guidance)

Planting

Provide robust planting appropriate to the location and function of the SuDS component, (see SuDS Factsheets S1 Raingardens S2 SuDS Trees in Streets).

Maintenance

Consider the maintenance requirements during the design process and secure agreement from relevant public sector or private bodies. Provide a detailed specification and maintenance plan as part of a planning or building warrant application.

Risk

Carry out designers risk assessments at each stage of the design process for SuDS in public streets, if road layouts or sight lines may be affected traffic modelling and a road safety audit may be required as part of the design process.

Sustainable Rain Water Management in New Developments

Guidelines for new developments in the EDG and LDP highlight the requirement for surface water (rain water) management which is best achieved through sustainable drainage. All new development proposals should follow the design principles set out in the design guidance documents published by the City of Edinburgh Council *(see p3)*.

Considering the Drainage Design from the Outset

As SuDS are made up of surface features that are far more visible than conventional types of drainage, so it is important to take a multi-disciplinary approach to site planning and design. Drainage engineers, highway engineers, landscape architects and ecologists should all be involved from the outset of a development design.

Investing in the design of sustainable drainage at the early stages of a project will be repaid in the long-term, helping to create good quality places where people wish to live and work.

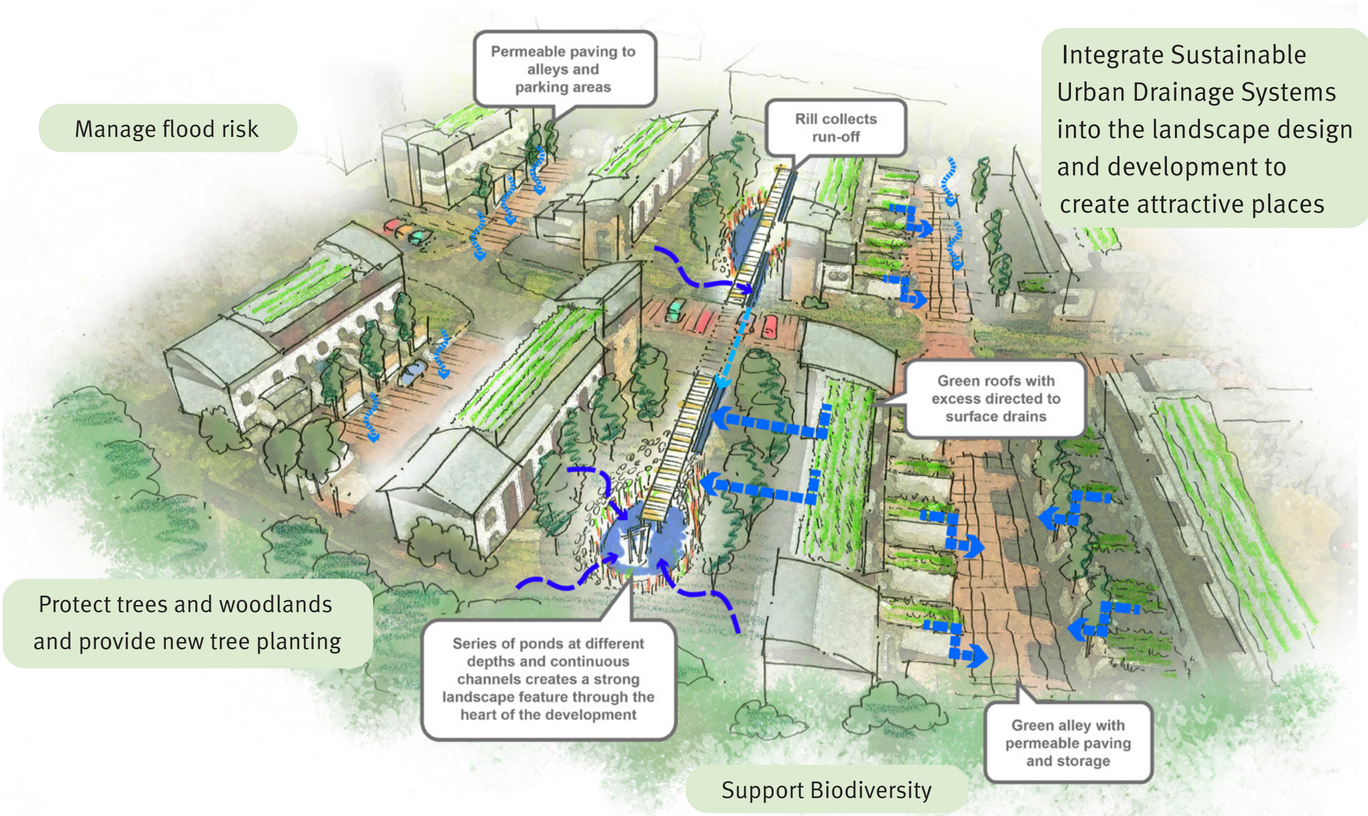


Figure 65. Consider Drainage Design in New Developments | Atkins

- ☑ **DO** reduce land-take and save time in the design and application process by working out the SuDS requirements at an early stage to inform the layout of buildings, roads and open spaces;
- ☑ **DO** integrate existing landscape features and natural assets such as mature trees in to the design to reduce costs;

- ☑ **DO** identify the most appropriate locations for SuDS features by mapping ground conditions and environmental constraints. This can allow the design to maximise effectiveness and reduce the amount of water storage required;
- ☑ **DO** design SuDS features to create an attractive setting for the development increasing desirability;

- ☑ **DO** use opportunities to create multi-functional SuDS features that can provide informal recreation spaces or new biodiverse habitats
- ☒ **DON'T** start thinking about SuDS design too late in the design process to alter layouts
- ☒ **DON'T** separate your SuDS design from the design of streets and public spaces.

Residential streets and SuDS in New Developments

In new residential developments SuDS can be integrated into **shared surfaces** and **road layouts to enhance placemaking qualities** while providing effective rainwater management.

Providing one-way streets within new developments can release extra space for SuDS, active travel and play.

SuDS elements can also be used as **modal filters** providing traffic management to support the creation of **low traffic** or **quiet neighbourhoods**.

Ensure that new streets comply with Edinburgh council's key objectives as set out in the **EDG** and the technical standards set out in the **Edinburgh Street Design Guidance Factsheets.**

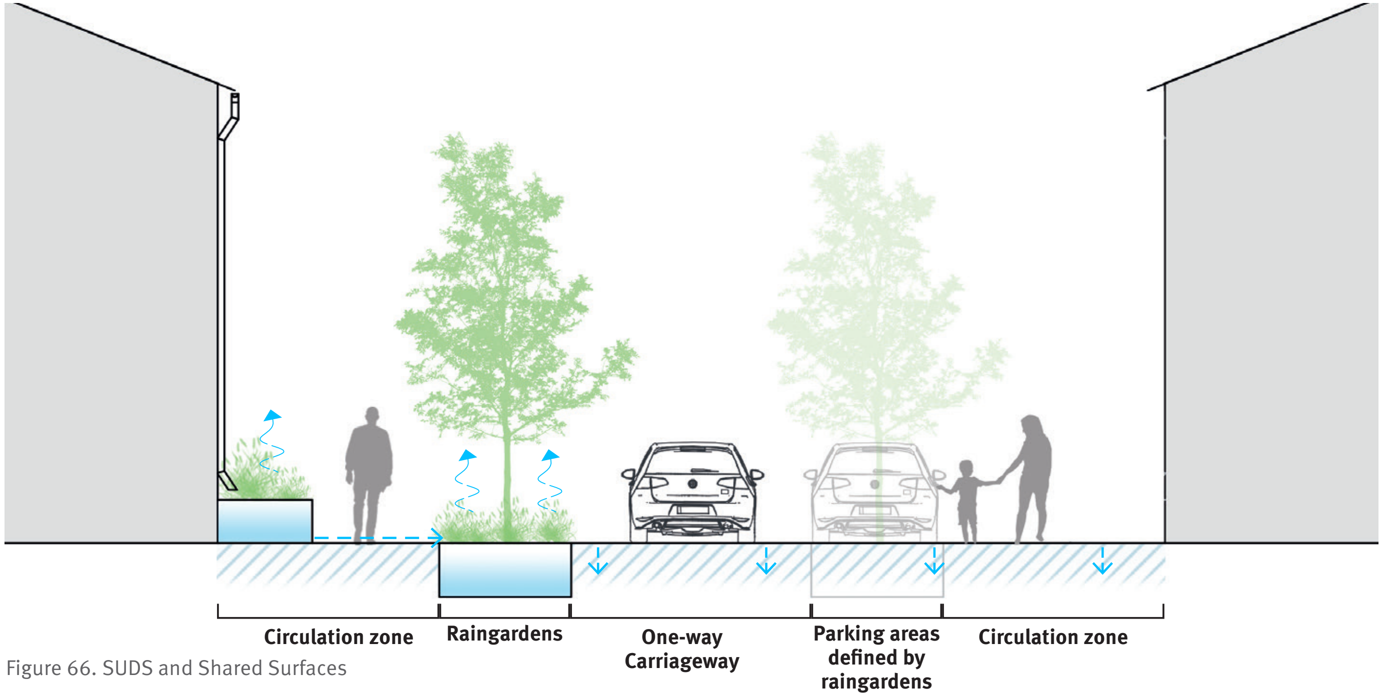


Figure 66. SUDS and Shared Surfaces

For example

- Permeable surfaces can reduce the amount of rainwater runoff at source.
- Disconnected drainpipes and filterdrains can direct roof runoff to other SuDS elements
- Raingardens and trees provide attractive features that can take up roof run off or run off from paved areas or roads. They can also be used to define parking or pedestrian areas.

Figure 67. Stevedore Place

CIRIA SuDS Manual section C

EDG: Chapters 2.4 3.1 & 3.7, & 4

ESDG Factsheets: P1street as Place, P2 Promoting Pedestrian Movement and Activity, P8 Pedestrian Streets, C1 Designing for Cycling, G1 Street geometry and layout, G2 Carriageway widths*, G6 Speed reduction and Traffic Management,*

ESRWMG Factsheets

Developing New Green Spaces in Edinburgh

There are a number of policies in the *Edinburgh LDP (2016)* that protect the city's open spaces and set out requirements and standards for creating new greenspace within developments. SuDS can form part of and enhance new green spaces contributing to attractive settings and enriching their wildlife value, and can be integrated into spaces that also provide other functions like recreation or parking.

Edinburgh council sets out its standards and expectations for open space in new developments *Edinburgh's Open Space Strategy* and the EDG (Section 3). Design principles for SuDS in Streets and Open Spaces are set out in *section B.*

Edinburgh Local Development Plan Policies:

- ***G5 – Promote the integration of Green Networks in New Developments***
- ***B17 – Identify opportunities for natural flood management***
- ***B38 - Blue Networks SuDS***

(CEC, Local Development Plan, 2016)

CEC, Flood Risk and Surface Water Management Plan Requirements, 2017


Figure 68. Oxgangs, Edinburgh | City Council Edinburgh


Figure 69. ForthQuarter, Granton, Edinburgh | Hyland Edgar Driver


Figure 70. Street trees in rain gardens, | Sudsnet, Abertay University


Figure 71. Alma Road Rain Gardens, London | Susdrain CIRIA

Design Considerations for SuDS in New Developments

Assemble a Design Team

Drainage engineers, highway engineers, landscape architects, urban designers and ecologists should all be involved from the outset of the development design.

Contact Scottish Water

Establish where and how surface water will be discharged. This will dictate the level of requirement for SuDS on site. Early and ongoing discussion will save time and inform the design process.

Look at Flow Patterns and Hydrology

Survey the topography and existing drainage patterns including water entering the site from run off upstream and outflows downstream. Establish the types of soil and geology, carry out infiltration tests to establish how well the soil drains. Calculate predicted rainfall and the flood risks (up to and including 1 in 200-year events plus climate change) both before and after development. This should include a calculation of any downstream effects outside the site. Calculate overland flow patterns within the site in extreme rainfall.

This will inform the SuDS design and site layout.

Look at Ecology and Natural Assets

Carry out ecological and arboricultural surveys to identify valuable habitats, the presence or absence of protected species and environmental assets such as mature trees. Include areas downstream of the site. Consult with any relevant organisations such as local nature reserves, SEPA, SNH or Edinburgh Council. Look at the surrounding wider Green / Blue network and look for opportunities to create links such as hedgerow or tree patterns.

This will inform the design to maximise biodiversity and amenity while protecting valuable natural features and wildlife.

Look at Heritage and Landscape Character

Carry out desk surveys to identify any historical or archaeological features, designations or protected areas. Carry out a heritage appraisal to identify the valued characteristics and archaeological value of the area and consult with any relevant organisations or council departments. Look at landscape and townscape character assessments to understand how the development will fit with the surrounding area. This will inform the layout, appearance and materials used in SuDS components.

Prepare an Environmental Constraints Plan

Collate desk studies and environmental surveys as GIS layers to inform the design development, SWMP and support the planning application.

Contact City of Edinburgh Planning Department

Applicants are encouraged to request pre – application advice on development of your site. This can help to shape the proposals and save time in the planning approval process. https://www.edinburgh.gov.uk/downloads/download/14273/planning-pre-application-advice

Look at Edinburgh Planning Guidance

The Edinburgh Design Guidance and the Edinburgh Street Design Guidance Factsheets along with this guidance provide advice on the practical interpretation of the policies in the Edinburgh Local Development Plan. Use this guidance to inform the development of the masterplan and detailed design.

Prepare The SWMP

Prepare a Surface water Management Plan for 1 in 200 year flood events for planning submission along with the masterplan.

Include Source Control

Include design features that ensure first 5mm of rainfall is managed close to the point where the rain falls and use surface features to carry heavier rainfalls into a wider SuDS system.

Design for Exceedance

In the event of extreme weather or blockage to outflow causing sustainable drainage components to reach capacity, ensure surface water will flow away safely from properties and roads.

Consider Beauty and Amenity

Provide multifunctional usable spaces by using shallow slopes or permeable surfaces in areas that double as SuDS features.

Engage with local people to provide spaces that support the needs of local communities

Provide SuDS features that create an attractive setting for a development or help to improve the perception of an area.

Consider Maintenance, Health and safety

Consider the maintenance requirements in the design development including appropriate provision for safe maintenance access and public interaction in amenity space.

Avoid fencing off SuDS schemes by designing out risks but do consider location if designing areas of standing water.

Consider Standards and adoptability

For most SuDS components use the technical standards for SuDS set out in the CIRIA Guidance. For new and innovative SuDS features not covered by the guidance ensure early discussion with Edinburgh Council and Scottish Water. Innovative non-standard solutions can potentially be vested through a Waiver process.

Early discussions with Edinburgh Council and Scottish Water will help to establish what parts of a scheme might be adoptable under a joint maintenance agreement and schemes or elements that remain the responsibility of the landowner.

Use Edinburgh Design Guidance Factsheets

Use the Edinburgh Planning Guidance Factsheets to inform the detail design. ESDGF and ESRWMG Factsheets contain Edinburgh specific guidance on street layouts, materials, furniture, SuDS features, street trees and lighting.

Use Appropriate Planting and Maximise Biodiversity

Use appropriate species that support the function of the SuDS features and will thrive in the wet, damp or mainly dry conditions as appropriate.

Use SuDS planting that is suitable to its location, for example inner city developments might need a more formal planting scheme than informal greenspace around new housing.

Use SuDS to create a variety of habitats and to make space for and wildlife support biodiversity.

See p24-25 and EDG 3.

Provide interpretation

Provide signs or waymarkers that explain the SUDS features and their benefits to the community. Include the design and positioning of signs in the landscape or streetscape design from an early stage .

Multiple Benefits and Whole Life Costs

Managing rainwater sustainably is a vehicle for economic growth, unlocking potential, driving social change, providing health benefits and promoting environmentally sustainable and resilient sites prepared for the challenges of climate change.

The UK Government's ***25 year Environment Plan*** highlights that improving the quality of the environment is vital, and calls for us to halt environmental decline, generate natural capital and reduce carbon footprint through infrastructure delivery. Inclusion of SuDS, and understanding the wider benefits that they can deliver, can help identify interested stakeholders and encourage a partnership approach to funding schemes.[20]

Developing green (sustainable) infrastructure to supplement or replace grey (traditional) infrastructure, has many benefits and provides better value for money compared to traditional drainage systems.

Sustainable drainage systems also contribute to vibrant place making in housing and commercial developments; thereby attracting residents, businesses and growing the local economy. Boulevards lined with trees, plazas, green roofs and walls make attractive settings for shopping and leisure providing urban cooling and cleaner air, attracting business and the creation of jobs, healthy lifestyles and social improvements.

20 CIRIA, reference here

The RICS guide on green infrastructure in urban areas identifies that green infrastructure may provide developers with a 'quick win' to enhance BREEAM scores and can substantially contribute to positive ratings in Building for Nature and other quality accreditation schemes.[21]

21 RICS, 2011, *RICS practice standards, UK: Green infrastructure in urban*

H.M Government, A Green Future: Our 25 Year Plan to Improve the Environment, 2018

World Bank Integrating Green and Grey, 2019

W074b B£ST Guidance – Guidance to assess the benefits of blue and green infrastructure using B£ST, version 3, 2019

Environment Agency, 2015, "Cost estimation for SUDS – summary of evidence"

RICS, 2011, "RICS practice standards, UK: Green infrastructure in urban areas", 1st edition

SCOTS and SuDS working group, 2010, "SUDS for roads whole life cost tool",

SCOTS and SuDS working group, 2009, "SUDS for roads"

Susdrain Case studies

Figure 72. The Multiple Benefits of Sustainable Drainage | Atkins

Designing SuDS for Multiple Benefits

SuDS features	Benefits									
	Amenity	Biodiversity	Health	Flooding	Water Quantity	Water quality	Building temperature	Carbon reduction	Sequestration	Traffic calming
Rain gardens	●	●	●	●	●	●	●	●	●	●
Bioretention Areas	●	●	●	●	●	●	●	●	●	●
Filter drains	●			●	●	●				
Permeable surfacing	●			●	●	●				
SuDS Tree pits and Trenches	●	●	●	●	●	●	●	●	●	●
Swales		●		●	●	●		●	●	
Living roofs	●	●	●	●	●	●	●	●	●	
Rain Planters	●	●	●	●	●	●		●	●	
Rills in hard landscapes	●			●						
Multifunctional Hard retention basins	●			●	●					
Multifunctional green retention basin	●	●	●	●	●	●		●	●	
Attenuation ponds	●	●	●	●	●	●		●	●	
Wetlands	●	●	●	●	●	●		●	●	

What are the Benefits of Sustainable Drainage?

Due to the nature of SuDS they also deliver a range of additional benefits. SuDS provide the opportunity for multi-party working, as the wide range of benefits they produce can help different organisations to deliver solutions that address various drivers they may have. When proposing a drainage approach, consider which additional benefits would add value to the site, and consider SuDS that will deliver these additional benefits.

Understanding the value of benefits delivered by sustainable drainage can support a business case, or funding application or help to demonstrate best value approaches in the public sector.

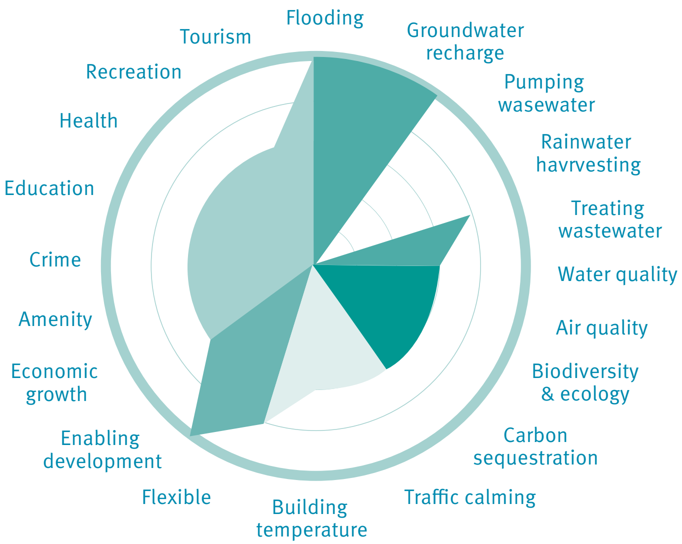


Figure 73. Example of how the magnitude of different benefits provided by a SuDS feature can be assessed using the B£ST Tool

Assessment Methodologies

CIRIA's Benefits of SuDS Tool *(B£ST)* provides a methodology and guidance on calculating the value of the benefits that SuDS can deliver.[22] The approach allows for the qualitative, quantitative and monetised estimate of the magnitude of benefits delivered by SuDS.

These estimates are based on research and provide a robust evidence base for decision making. Calculating the magnitude and value of benefits provided will give you confidence that the SuDS you are considering will be cost effective. *Designing Multiple Benefits Table* gives a list of the benefit categories and whether or not they can be monetised using B£ST.

Additional types of benefit and associated funding streams or enabling partnerships may be identified by local stakeholders which can be included in any assessment. Assessing these benefit types, will enable you to engage with stakeholders and may ease the passage of your proposed development.

22 CIRIA, 2019, "W074b B£ST Guidance – Guidance to assess the benefits of blue and green infrastructure using B£ST", version 3

SuDS Benefits that have a monetary value:

☑	Amenity
☑	Asset performance
☑	Biodiversity and ecology
☑	Building temperature
☑	Carbon reduction and sequestration
☒	Crime Reduction
☒	Economic growth
☑	Education
☑	Enabling development
☑	Flood Management
☑	Health
☑	Noise
☑	Recreation
☒	Tourism
☑	Traffic calming
☑	Water quality
☑	Water quantity

Figure 74. Benefit categories and whether they can be monetised, CIRIA

Calculating Whole life costs

Whole life costs include capital expenditure and also anticipated maintenance (and replacement) costs for the selected measures, whether they be traditional or SuDS. Chapter 6 of the SuDS for Roads document[23] provides information on factors to consider regarding the costs associated with implementing SuDS and traditional solutions, as well as how to approach whole life costing.

This has subsequently been augmented by the provision of a whole life cost and carbon toolkit[24]. Indicative construction costs and maintenance costs can be found in report **SC080039/R9 ("Cost estimation for SUDS – summary of evidence")**, produced by the Environment Agency in 2015.

Being sure to calculate the whole life costs of both traditional and SuDS solutions will give you confidence that you have accounted for all the likely costs associated with your development's drainage, and that there will be no unexpected costs over the lifetime of the development.

Example of Costing a SuDS feature:

Capital and operational costs of permeable block paving.	
Permeable block paving characteristics 2500m² area total infiltration system, 80mm black paving, 50mm bedding, 350mm sub-base Annual maintenance activities: inspection and monitoring (12 times a year), weed control (2 times a year)	
Capital Cost	**Annual Maintenance Cost**
WLC Toolkit £1,230,000 (£49/m² paving) C697: £30-40 / m² paving Interpave research: for housing estate initial construction costs for permeable block paving were £300,000 to £400,000 for a 7,540m² paving area - this equates to £40-53/m² paving area.	WLC Toolkit £6,000 (£0.5/m2 stored volume) C697: £0.5-1 / m² stored volume

Figure 75. An example of whole life costs | SCOTS and SuDS Working Party

Figure 76. Permeable Paving | Marchalls

Figure 77. Permeable paving, Dumbarton Academy| Tobermore

23 (SCOTS and SuDS working group, 2009)
24 (SCOTS and SuDS working group, 2010)

Creating an Enhanced business case

Understanding the monetised value of benefits that SuDS can bring, can enable an enhanced business case based on a solid understanding of whole life costs.

This enables an evidence based decision to be made regarding the holistic performance of different surface water management approach. SuDS which may be perceived to have a higher installation cost may deliver more value over their life than the equivalent traditional drainage options.

Looking at an enhanced business case will help understand this and to enable informed decision making on types of drainage measures to include in developments.

Enhanced Business Case Example:

Greener Grangetown

The greener Grangetown project in Cardiff catches, cleans and diverts over 40,000 square meters of rainwater run-off directly into the River Taff, instead of pumping it over eight kilometres through the Vale of Glamorgan for treatment, before being pumped into the sea. The scheme collects surface water from roofs and roads from twelve residential streets in Grangetown, channelling and filtering it through over 100 rain gardens before draining to the River Taff.

Costs of construction £2M

Benefits from SuDS:

- Removing 155000 sqm of impermeable areas from combined sewer network to reduce flooding
- Releasing capacity to develop 6000-12,000 new homes not otherwise possible due to drainage capacity
- Annual monetised benefits of £250,000
- 16,500sqm increase in green space
- 400 additional trees

Figure 78. Grangetown before SuDS scheme | Atkins

Figure 79. Grangetown After, Rain Gardens | GreenBlue Urban

Figure 80. Grangetown After, Suds Trees | GreenBlue Urban

Case Studies and Useful Resources

Here are many relevant case study examples available online:

Susdrain host a broad collection of case studies that is continuously added, including exemplary schemes submitted for the **Susdrain SuDS Award 2020**

SuDS for London Case Studies provide examples of urban realm, greenspace and residential SuDs schemes.

The City of London Green Roof Case Studies describe the barriers, benefits and lessons learned on a variety of living roof types.

Commercial suppliers of living roof and SuDS tree systems can also provide useful cases studies that demonstrative successful establishment of particular SuDS elements.

The World Bank report **Integrating Green and Grey** provides international case studies.

Links to European examples of **Climate Adapt** case studies (including sustainable rain water management) can be found on the European Environmental Agency website.

Figure 81. Grey to Green | Sheffield City Council

Figure 82. Gardens by the Bay, Singapore | Wiki commons

Other Useful Online Resources:

CIRIA provide a wide range of technical SuDS guidance some of which is free to download.

Susdrain provide access to a variety of resources including the **B£st** calculation tool with guidance and examples.

Susdrain also provide factsheets that address specific **technical issues**.

Suds.net is a networking group for anyone interested or involved in sustainable drainage, sharing news, information and resources.

10,000 Raingardens for Scotland provides useful information on building your own small domestic raingarden.

Figure 83. Green Roof, London | Verdico

References

Figure References

Figure 1. Surface Water Flooding in Myreside
ccbb7766. Flickr (2011). *Surface Water Flooding in Newington* [ONLINE].
Available at: https://www.flickr.com/photos/39014236@N05/7521126050/in/faves-191188973@N06/ [Accessed 25 November 2020]

Figure 2. Swales at Countesswells, Aberdeen
Image courtesy of Scottish Natural Heritage [taken n.d.]

Figure 3. Street Trees at Grassmarket, Edinburgh | Atkins
Lovell, S. 2018 Street Trees in Grassmarket, Einburgh [photograph] [taken: September, 2019]

Figure 4. Rural Catchment | Atkins
Drainage in a Rural Catchment Diagram, Atkins

Figure 5. Urban Catchment | Atkins
Drainage in an Urban Catchment Diagram, Atkins

Figure 6. Edinburgh during a downpour , June 2019
Clark. T. *Street Flooding in Edinburgh* [taken: n.d] Available at: https://www.shutterstock.com/image-photo/street-flooding-edinburgh-scotland-1437805658

Figure 7. Portobello, May 2017
Edinburgh Portobello Beach, Scotland may 2017. [taken: 26.05.2017] Available at: https://www.shutterstock.com/image-photo/26may-portobello-beac-edinburgh-scotland-people-647661025

Figure 8. Four Pillars of SuDS Design SuDS, CIRIA C687, p6
Diagram adapted CIRIA (2015). *The SuDS Manual v.6(C753)* [ebook] London: CIRIA, p6
Available at: https://www.ciria.org/

Figure 9. Wetland Illustration
Wetland Illustration, Atkins

Figure 10. 'Grey to Green' (pahse 1) , Sheffield
Image courtesy of Sheffield City Council

Figure 11. Bridget Joyce Square, London
Robert Bray Associates, 2018. *Bridget Joyce Square, London.* Available at: https://robertbrayassociates.co.uk/ [Accessed 1 September 2019]

Figure 12. Ruskin Square, Croydon
Image courtesy of J.L Gibbons / Sarah Blee
Available at: https://www.susdrain.org/case-studies/pdfs/suds_awards/031_18_04_24_susdrain_suds_awards_ruskin_square_croyden.pdf. [Accessed 1 September 2029].

Figure 13. Forest Way School, Coalville
Image courtesy of DSA Environment + Design
Available at: https://www.susdrain.org/case-studies/case_studies/forest_school_coalville_leicestershire.html

Figure 14. Local children planting a raingarden Melina Road, Shepard's Bush
Atkins, (2018), *Fig 5; Local school engaged in planting at Melina Road, Shepard's Bush* [ONLINE].
Available at: https://www.susdrain.org/case-studies/pdfs/suds_awards/005_18_03_28_susdrain_suds_awards_counters_creek_suds_retrofit_pilot_study_london.pdf [Accessed 1 September 2019].

Figure 15. Wet Swale Saint Ouen – Park Of The Docks | © Agence Ter
Agence Ter, (2019), St Ouen [ONLINE]. http://landezine-award.com/5094-2/ [Accessed 1 August 2019].

Figure 16. Central Edinburgh | Shutterstock
[ONLINE] www.shutterstock.com

Figure 17. Geology, Topography and River Systems
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Available at: http://www.bgs.ac.uk/products/digitalmaps/digmapgb_625.html

Figure 18. Soils
Contains OS data © Crown copyright and database right 2019 All rights reserved. Ordnance Survey Licence number 100023420 • ©The James Hutton Institute 1:25,000K V9 Phase6.
Available at: https://www.hutton.ac.uk/

Figure 19. Edinburgh's Green Network
Edinburgh Local Development Plan. CEC, Edinburgh Open Space Strategy, 2021, p13 Contains OS data © Crown copyright and database right 2019 All rights reserved. Ordnance Survey Licence number 100023420 •
Available at: https://www.edinburgh.gov.uk/downloads/download/12910/open-space-strategy-and-audit

Figure 20. Edinburgh Open Space Types, 2021, p6
City of Edinburgh Council, 2016. *Edinburgh's Open Space Strategy.* [online guidance]. p6
Available at: https://www.edinburgh.gov.uk/downloads/download/12910/open-space-strategy-and-audit

Figure 21. Road Gullies overwhelmed by rain, Polworth Edinburgh June 2019
Images taken by Sian Lovell, Atkins. [taken July 2019]

Figure 22. Annual average damages by flood
SEPA, 2016. *Flood Rick Management Strategy: Fourth Estuary* [online guidance] p13
Available at: https://www2.sepa.org.uk/frmstrategies/pdf/lpd/LPD_10_Full.pdf

Figure 23. Surface water flooding, A90 at Cramond Brigg, August 2019
Road Policing Scotland/Twitter, (2019). *A90 at Cramond Brigg* [ONLINE].
Available at: https://twitter.com/polscotrpu [Accessed 30 August 2019]

Figure 24. Surface Water and river flooding, ©SEPA 2019
SEPA, (2019), Flood Map, Edinburgh [ONLINE].
Available at: https://www.sepa.org.uk/environment/water/flooding/flood-maps/ [Accessed 1 July 2019]

Figure 25. Edinburgh's New Town | Christoph Lischetzki
Lischetzk, C. Aerail Image of Edinburgh's New Town, [taken n.d] [ONLINE] Available at: https://www.shutterstock.com/image-photo/edinburgh-city-historic-town-sunny-day-514379308

Figure 26. Union Canal, Edinburgh
Image courtesy of City of Edinburgh Council/ © Shutterstock [taken n.d]

Figure 27. SuDS Tree pits under construction at Goldhawk Road
Image courtesy of Robert Baray Associates. Available here: https://www.watersensitiveurbandesign.co.uk/index.php [Accessed September 2019]

Figure 28. Newhaven Conservation Area
Google Maps, (2019), Fisherman's cottages, Newhaven High Street [ONLINE]. Available at: https://www.google.co.uk/maps?hl=en&tab=wl1 [Accessed 1 January 2020].

Figure 29. Leith Docks, Conservation Area |
Image courtesy of City of Edinburgh Council [taken n.d]

Figure 30. Victoria Terrace, Old Town, UNESCO Site
Image courtesy of Atkins [taken August 2018]

Figure 31. Drummond Place
Google Maps, (August 2018), W Bar, Sheffield [ONLINE]. Available at: https://www.google.co.uk/maps/@53.3852293,-1.468484,3a,75y,90.6h,89.09t/data=!3m7!1e1!3m5!1sG3fxdLXt7hxGkOJEiHul_A!2e0!5s20180801T000000!7i13312!8i6656?hl=en [Accessed 1 January 2020].

Figure 32. Bertha Park, Perth
Image courtesy of RaeburnFarquharBowen [taken n.d]

Figure 33. Spring Park, Woodberry Down, London
Susdrain, (2018), 181104 Woodberry Down Spring Park SuDS [ONLINE]. Available at: https://www.flickr.com/photos/139555361@N08/46995937161/in/album-72157689442761953/ [Accessed 1 December 2019].

Figure 34. The Principles of Sustainable Drainage | Atkins
Diagram [drawn November 2019]

Figure 35. Mitigating Risk Associated with SuDS
Diagram [drawn November 2019]

Figure 36. King Fisher
Image courtesy of City of Edinburgh Council [taken n.d]

Figure 37. Amphibians
Image courtesy of City of Edinburgh Council [taken n.d]

Figure 38. Marsh Marigolds
Image courtesy of City of Edinburgh Council [taken n.d]

Figure 39. Benefits of Trees. Adapted from CEC Trees and Woodlands Action Plan – January 2014
City of Edinburgh Council, 2014. *Trees in the city: Trees and Woodlands Action Plan* [Online Guidance]. p5
Available at: https://www.edinburgh.gov.uk/downloads/file/22574/trees-in-the-city-action-plan

Figure 40. Mature trees at Shadwick Place, Edinburgh
Image courtesy of Atkins/ Lucy Duerden [Taken September 2019]

Figure 41. Soil
Image courtesy of Atkins

Figure 42. Soil Structure
Diagram [drawn September 2019]

Figure 43. SuDS Management Train
Diagram [drawn September 2019]

Figure 44. Queen Caroline Schotterasen Gravel Garden
Susdrain, (2016), 181104 Woodberry Down Spring Park SuDS [ONLINE]. Available at: https://www.flickr.com/photos/139555361@N08/39260445824/in/album-72157689917356882/ [Accessed 1 December 2019].

Figure 45. Rain Garden in Malmö, Sweden
Image courtesy of Sudsnet, Abertay University
Alison Duffy, (2016), Rain Garden in Malmö, Sweden [ONLINE]. Available at: https://www.abertay.ac.uk/business/services/sudsnet/sudsnet-photos/rain-gardens/ [Accessed 1 December 2019].

Figure 46. SuDS feature grid
A) Green Roof. Image of Waverley Court, Market Street: Creative Commons Licence

B) SuDS Trees, Fletton Quays. Courtesy of GreenBlue Urban

C) Permeable Surfaces. Image Courtesy of Marchalls. Available at: https://www.marshalls.co.uk/commercial/product/priora-permeable-block-paving [Accessed September 2019]

D) Rain water planters. Available at: https://www.susdrain.org/case-studies/pdfs/greening_streets_retrofit_rain_gardens_nottingham_final_v2.pdf. [Accessed September 2019]

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J) Hard Detention Basin. Water Square Benthemplein. http://www.urbanisten.nl/wp/?portfolio=waterplein-benthemplein [Accessed September 2019].

K) Pond. Inverness Great Glen House Pond. Image courtesy of SNH

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Ife, Y. (2018) *'Trailblazing' Exmouth primary school joins water-saving crusade'* [online] Availble at:
https://www.exmouthjournal.co.uk/news/st-josephs-rainwater-harvesting-tank-1-5827176 [accessed : July 2020]

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Blueroof, Aylesford Kent [online]. Available at https://livingroofs.org/introduction-types-green-roof/blue-green-roof-cities-stormwater/ [Accessed: July 2020]

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Available at: https://www.susdrain.org/case-studies/pdfs/suds_awards/005_18_03_28_susdrain_suds_awards_counters_creek_suds_retrofit_pilot_study_london.pdf [Accessed 1 September 2019].

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Google Maps, (July 2011), W Bar, Sheffield [ONLINE]. Available at: https://www.google.co.uk/maps/@53.3852293,-1.468484,3a,75y,90.6h,89.09t/data=!3m7!1e1!3m5!1sG3fxdLXt7hxGkOJEiHuI_A!2e0!5s20180801T000000!7i13312!8i6656?hl=en [Accessed 1 January 2020].

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Available at: https://www.abertay.ac.uk/business/services/sudsnet/sudsnet-photos/rain-gardens/ [Accessed 1 December 2019].

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Abbreviations & Glossary

Abbreviations

BRE	Buildings Research Establishment
CAR	The Water Environment (Controlled Activities) (Scotland) Regulations
CEC	City of Edinburgh Council
CDM	Construction (Design and Management) Regulations 2015
CIRIA	Construction Industry research and Information association
DMRB	Design Manual for Roads and Bridges
EBAP	Edinburgh's Biodiversity Action Plan
EDG	Edinburgh Design Guidance
ESDGF	Edinburgh Street Design Guidance Factsheets
ESRWMG	Edinburgh's Sustainable Rain Water Management Guidance
FRMS	Flood risk management strategy
LDP	Local Development Plan
LA	Local Authority
LFRMP	Local flood risk management plan
LPA	Local Planning Authority
RCC	Road Construction Consent
SCOTS	Society of Chief Officers for Transportation in Scotland
SNH	Scottish Natural Heritage
SEPA	Scottish Environment Protection Agency
SSSI	Site of Special Scientific Interest
SuDS	Sustainable urban drainage systems
SUDSWP	Sustainable Urban Drainage Scottish Working Party
SWMP	Surface water management plan
WADAG	Water Assessment & Waters Drainage Assessment Guide

Glossary

Act	Flood Risk Management (Scotland) 2009 from where the Lead Local Flood Authority and need for SuDS adoption arises.
Adoption	related to someone or an organisation taking responsibility for management and maintenance of the SuDS components.
Amenity	a general term used to describe the tangible and intangible benefits or features associated with a property or location that contribute to its character, comfort, convenience or attractiveness.
Approval	the process of approving all qualifying drainage designs before construction starts. In order for adoption to take place, certain drainage requirements will need to be met.
Aquatic bench	the level edge in a pond planted with aquatic plants situated just under water level
Aquifer	an underground body of water stored in the natural rock sub-structure.
Attenuation / detention of water	the process of slowing down the rate of flow, reducing the peak, and increasing duration of a flow event.
Basin	A ground depression to hold water and attenuate or provide water treatment that is normally dry and has a proper outfall, but is designed to detain stormwater temporarily.
Biodiversity	the variety of species of plants, animals and ecosystems within a habitat.
Bioretention areas	are planted areas with engineered topsoil over drainage layers that allow water to soak into the ground.
Block paving	Pre-cast concrete or clay brick sized flexible modular paving system.
Blue /Green Networks	The linkages connecting urban greenspaces and water environments (public and private) that allow the movement of wildlife and provide cumulative environmental benefits.
Brownfield site	a site that has been previously developed.
Construction (Design and Management) Regulations 2015 (CDM)	Construction (Design and Management) Regulations 2015, which emphasise the importance of addressing construction health and safety issues at the design phase of a construction project.
Catchment	– A catchment is an area contributing to a flow at a point in a drainage network or river.
Combined sewer	A combined sewer collects sanitary sewage and stormwater run-off in a single pipe system. Combined sewers can cause serious pollution issues when heavy rain reduces the capacity in the sewers for foul water and overflows pass into the environment. The use of such systems is rarely used in modern drainage design.
Conventional drainage	The traditional method of draining surface water using subsurface pipes and storage tanks
Conveyance	movement of water from one location to another.
Detention basins	Detention basins are dry flat areas with shallow depressions used for the temporary storage of excess storm water. In a storm event water accumulates in the depression and then is either slowly discharged to the next SuDS component or to a receiving watercourse.
Ecology	The study of environmental systems, particularly the relations of organisms to one another and to their physical surroundings.
Ecosystem	a biological community of interacting organisms and their physical environment.
Environmental Asset –	a natural feature such as a mature tree or wetland area that carries out important environmental functions such as water management, improving air quality etc.
Erosion	natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface

Exceedance routes	allow water volumes exceeding the capacity of the SuDS system to escape from the site without causing damage to property. This route must be clear of obstructions at all times
Filter drain	Filters drains (also referred to as filter trenches or French drains), are linear excavated trenches which are backfilled with graded rubble or stone and convey water to another feature or allow it to soak into the ground. They are sometimes with a perforated pipe in the bottom. These may be enlarged to treat dirty water, as treatment trenches, or increase soakage into the ground, as infiltration trenches.
Filter strips	are grass verges that allow run-off to flow through vegetation to a swale, wetland, infiltration area or other SuDS technique.
Filtration	fluid flow through a filter to remove particles and pollutants.
First flush	initial run-off room a site after a rain event. The first flush often contains the greatest concentration of pollutants.
Flow control structures	usually small orifices in control chamber, slots or vee-notches in weirs. They are usually near the surface so are accessible and easy to maintain.
Geocellular	a proprietary system of box shaped cells (normally made from modern plastic materials) used to form an underground void intended to provide attenuation of collected surface water run-off. These can be wrapped in geotextile to provide coarse filtration for pollutants.
Geomembrane	a permeable or impermeable sheet made from modern plastic materials. These are usually placed in the ground as drainage membranes, allowing the passage of water but not fine soil particles. Can also be use as protection from sharp objects for e.g., pond liners.
Geotextile	a plastic fabric usually applied to improve ground strength for bearing.
Greenfield land –	land which has not been developed before, other than for agriculture or forestry buildings or buildings associated with parks, recreation grounds and allotments.
Green Infrastructure	The network of green spaces or natural elements carrying out environmental functions over an urban area.
Green roof	Green roofs are planted with vegetation cover/ landscaping. Green roofs are designed to intercept and retain precipitation, reducing the volume of run-off and attenuating peak flows. Green roofs can also add biodiversity and aesthetic benefit to an area.
Greenspace	publicly accessible amenity areas of open space with trees, grass or planting.
Groundwater	water that is below the surface of the ground in the saturation zone.
Gully	an inlet taking run-off from a road into a drainage system, usually through a metal grate and into a sump.
Habitat	The area or environment where an organism or ecological community normally lives or occurs
Impermeable	a surface or material which water cannot penetrate or pass through.
Infiltration	the soaking of water into the ground.
Infiltration basins,	trenches, soakaways and other SuDS features that allow water to soak into the ground.
Infiltration trench	A trench, usually filled with permeable granular material, designed to promote infiltration of surface water to the ground.
Interception storage	the storage of small rainfall events (up to 5mm).
Inlets and outlets	structures are often conveyance pipes protected with mesh guards. They must be free from obstruction at all times to allow free flow through the SuDS.
Local Development Framework	the collective term for the whole package of planning documents which are produced by a local planning authority to provide the planning framework for its area.
Maintenance plan	a plan for the SuDS to record information on its functionality and maintenance requirements. This will ensure that the long term performance of the feature meets the needs and expectations.
Open water	a body of water exposed to the atmosphere – i.e. the water surface is free from emergent and marginal vegetation
Overflows	can be below ground through gratings and chambers or over grass weirs in the open. They must be kept clear at all times to protect areas from flooding.
Pavement	any paved surface and underlying structure, usually asphalt, concrete, or blockpaving. Can we used as road, parking or footway. A permeable surface that is paved and drains through voids between solid parts of the pavement
Peak flow	the maximum flow rate of water in a river during a particular period.
Permeable surface	can be either porous or permeable. Porous surfacing is a surface that infiltrates water across the entire surface. Permeable surfacing is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration through the pattern of voids.
Pollution	a change in the physical, chemical, radiological or biological quality of a resource (air, water or land) caused by man or man's activities that are injurious to existing, intended or potential use of the resource.
Public open space	The open space required under our planning policies is defined as any land laid out as a public garden or used for the purposes of public recreation. This is space which has unimpeded public access, and which is of a suitable size and nature for sport, active or passive recreation or children and teenagers' play. Private and shared private amenity areas, or private buffer landscape areas are not included as public open space.
Rainfall event	A single occurrence of rainfall before and after which there is a dry period that is sufficient to allow its effect on the drainage system to be defined
Raingardens	a planted basin designed to collect and clean run-off.
Recharge	water re-entering the ground water supply.

Regulations	the Water Environment (Controlled Activities) (Scotland) Regulations 2011
Retention basins	A retention basin is a SuDS feature akin to a pond. The basin holds water permanently, although may empty during prolonged dry weather. The design of ponds and retention basins are very similar.
Return period	the statistical chance of an event happening expressed in terms of a single change in a given number of years. For example, the 1 in 30 year event is likely to be exceeded at least once every 30 years.
Risk	The chance of an adverse event. The impact of a risk is 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.
Runoff	the flow of water over the ground surface. This occurs if the ground is impermeable or saturated, if rainfall is particularly intense, or if surface water drainage systems exceed their capacity and overflow.
Sediments	the layer of particles that cover the bottom of water-bodies such as lakes, ponds, rivers and reservoirs. Can include silt, stones etc.
Sewer –	A pipe or channel taking domestic foul and/or surface water from buildings and associated paths and hard-standings from two or more cartilages and having a proper outfall.
Sewers for adoption –	standards agreed between sewerage companies and developers to specify allowable sewer dimensions and characteristics to allow adoption of responsibility
Soakaway	A sub-surface structure into which surface water is conveyed, designed to promote infiltration.
Soil	The terrestrial medium on which many organisms depend, which is a mixture of minerals (produced by chemical, physical and biological weathering of rocks), organic matter, and water. It often has high populations of bacteria, fungi, and animals such as earthworms
Source control	surface water run-off dealt with at or close to its source.
Storm	An occurrence of precipitation: rainfall, snow, or hail
Subbase	A layer of material on the subgrade that provides a foundation for a pavement surface.
Sump	a pit that can be lined or unlined and is used to collect water and sediments before being pumped out.
Surface water	water which occurs on the land surface. e.g. ponds, lakes watercourses, standing water...etc.
Sustainable drainage systems (SuDS)	a sequence of management practises and control structures often referred to as SuDS, designed to drain water in a more sustainable manner than some conventional techniques. SuDS processes are designed to replicate natural drainage systems which improve water quality and amenity as well.
Swales	A swale is a linear shallow channel which can convey run-off from one place to another, holding water and, ground conditions permitting, infiltrating water to the ground. Swales can be used in conjunction with other SuDS features to link components. For example, a swale could link areas of permeable pavement and raingardens to retention or detention ponds.
Treatment	Improving the quality of water by physical, chemical and/or biological means
Urban Creep	The incremental loss of permeable ground within urban areas; for example the paving over front gardens, extensions to existing buildings, infill developments, or carparks.
Water cycle	the cycle of processes by which water circulates between the earth's oceans, atmosphere, and land, involving precipitation as rain and snow, drainage in streams and rivers, and return to the atmosphere by evaporation and transpiration.
Watercourse	all types of passages in which water flows i.e. rivers, streams, ditches, drains, culverts, dykes and sluices.
Water table	the level at which the water in the ground lies. This is variable with the seasons and annual rainfall.
Wetlands	are open areas of shallow water creating habitats and storage for excess water as well as water quality and biodiversity benefits.
Weir	Horizontal structure to a predetermined design height which controls flow.