SuDS Guide

Sustainable Drainage System design guidance for Cheshire East

Cheshire East Council

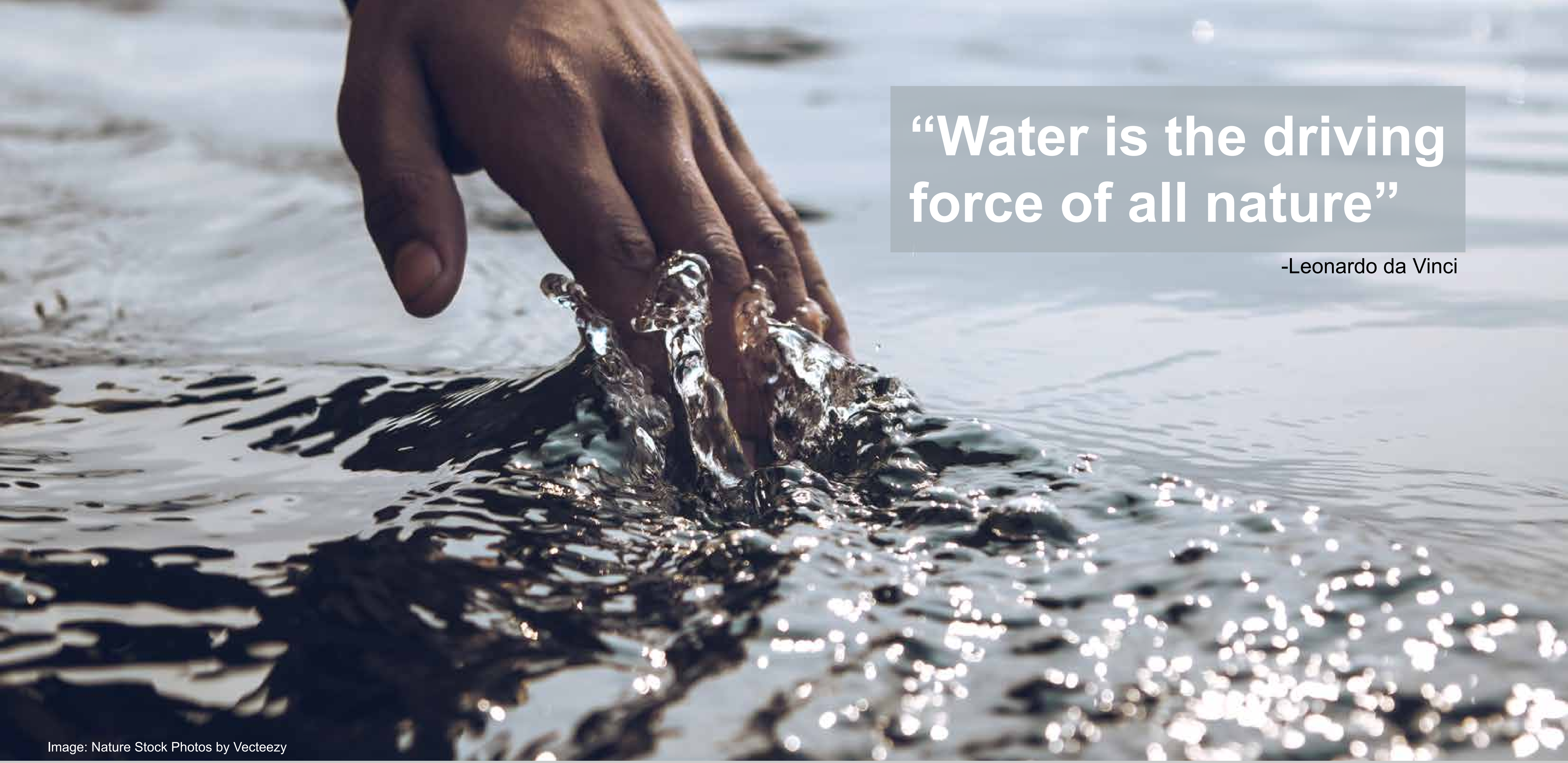

Image: Nature Stock Photos by Vecteezy

Acknowledgements:

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- United Utilities
- Warrington Borough Council
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- Polypipe Ltd
- Timberplay Ltd
- Deeproot Urban Solutions Ltd

Cover Photo:

Caroline Benzies Photography

Foreword

Water has always influenced the location and growth of human settlement - our villages, towns, and cities. Water is a positive force in shaping places, but it can become a destructive one if not given sufficient space and consideration in development.

Climate change is creating more serious and unseasonal weather and, with this, flooding incidents are becoming more commonplace and unpredictable. We must act now to manage water more effectively and reduce the risk to people and property both now and in the future. There is a social and commercial imperative to address this.

This challenge is also an opportunity. Waterscapes are an important and positive aspect of our local landscapes, both urban and rural. Water significantly improves the quality of our environment and our sense of belonging.

In the face of the limitations of traditional drainage systems and continued climate change, sustainable drainage systems (SuDS) provide a solution to the issue of water management as a key element of sustainable growth.

The national and local design agendas promoting beautiful and healthy places provide further impetus to enable creative, well-designed SuDS to play a significant part in shaping places. SuDS can enhance the opportunities for leisure, play and education, improve health and wellbeing and promote high quality environments for home, work and leisure.

This guide will assist developers and designers to help achieve these joint objectives: to reduce climate change and enrich people's lives.

Water is our lifeblood. We should manage it creatively to make our places better and improve quality of life for our communities and for future generations.

Political representatives of Cheshire East tba

PORTRAITS OF LOCAL REPRE-SENTATIVES NEEDED

PORTRAITS OF LOCAL REPRE-SENTATIVES NEEDED

The positive effects of water on our environment, health and well-being (Image: L.Long)

The negative effects of unsustainable drainage (Image: I.Dale)

Primary Purpose

The primary purpose of this Supplementary Planning Document (SPD) for Sustainable Drainage Systems (SuDS) is to provide guidance on the ways and means that planning approval applicants can achieve compliance with policy requirements set out in the NPPF and the Cheshire East Local Plan.

By working with the landscape of a site, a holistic and integrated approach to drainage can be achieved that builds-in a range of surface-level SuDS solutions to deliver multiple benefits and higher quality development. This SPD is a tool to help applicants achieve this objective and to demonstrate how they can do so through the planning process.

Planning proposals that use this SPD to achieve the objectives of the Local Plan will demonstrate policy compliance. Where schemes ignore opportunities to positively work with water on site, planning permission may be refused.

The objective of the policies in the Local Plan is to realise the multiple benefits of positive on-site water-management, that can improve biodiversity, and enhance landscape character and quality of place.

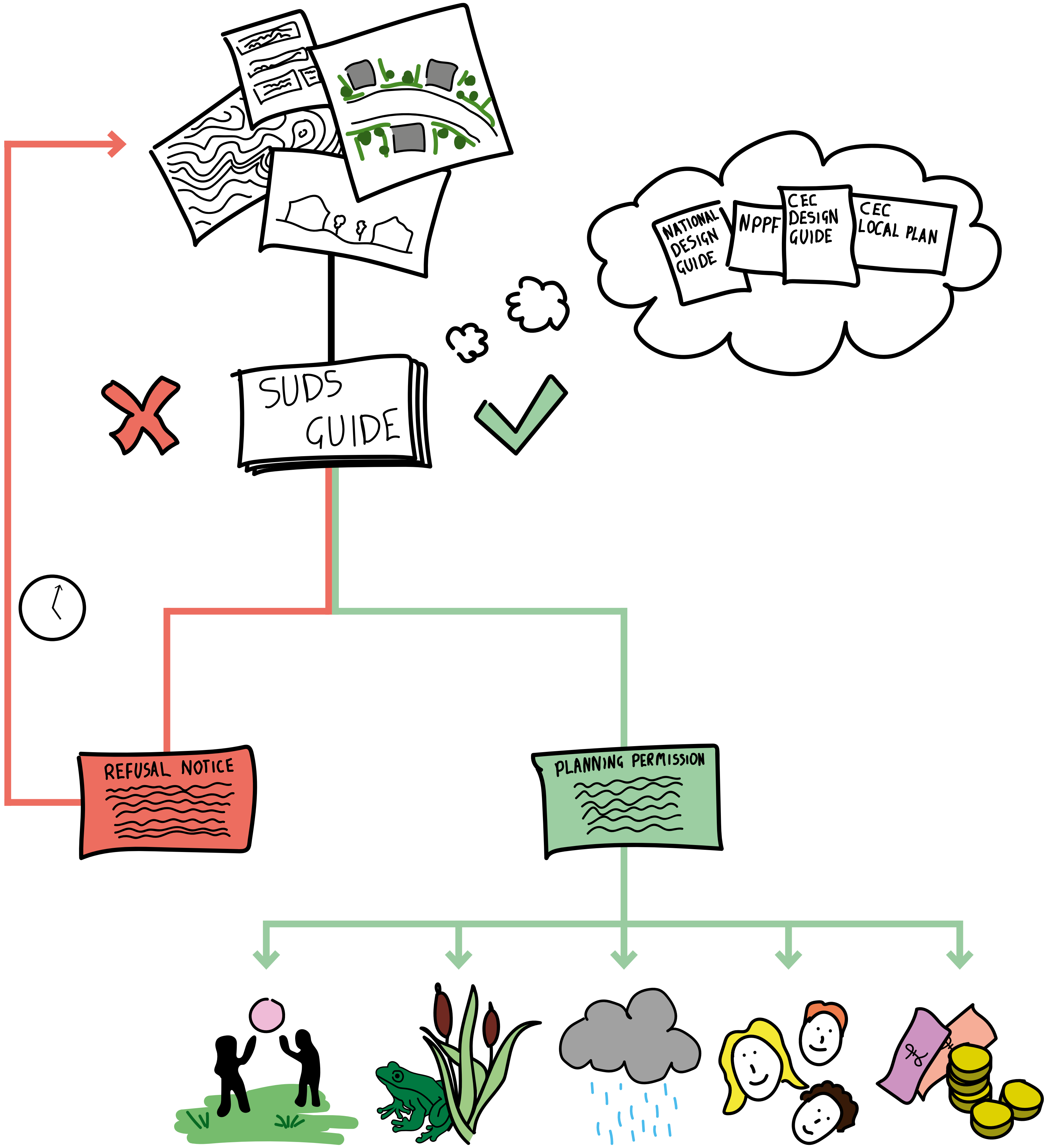
Hard engineering solutions are not the preferred approach and are unlikely to deliver integrated environmental and design benefits. Instead, the Local Plan requires applicants to **incorporate surface level SuDS with multifunctional benefits**. Only where this is not possible will hard engineering solutions be acceptable as part of a surface-water management strategy.

This SPD aims to assist all those involved in the design and development process to achieve well designed SuDS, as part of high-quality development proposals. Doing so will ensure that relevant drainage and design policies are met, and can create opportunities to meet other requirements related to greenspace and recreation, community wellbeing and climate change.

To demonstrate compliance with Local Plan policies, applicants should run through the SuDS Component Selection Matrix and SuDS Suitability Matrix (pg.61-62) and follow the guidance set out in sections 5 and 6 - demonstrating how SuDS have been fully considered and addressed throughout the design process.

[Key planning policies]

[Supporting planning policies and guidance]



Contents

Appendices

How to use this document

EXAMPLE WAY MARKER

Information on Way Markers

Throughout the document there will be Way Markers similar to the one shown here. These Way Markers will provide additional information on specific topics, often providing links to external websites/information.

There are also hyperlinks not contained within waymarkers which link to external websites and specific sections of this document.

HYPERLINKS NOT ACTIVE CURRENTLY

Icons

Throughout this document, the following icons have been used to highlight the economic, environmental and social benefits and opportunities of each SuDS method. These can be used to identify and realise the maximum potential of incorporating SuDS within development.


Providing storage during a storm event


Removing suspended sediments


Removal of pollutants

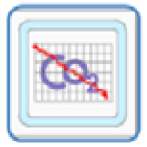

Providing habitats for wildlife


Less expensive than traditional piping


Recreational spaces and additional access routes


Improved water quality and reduced treatment


Aesthetic enhancement


CO_2 reduction


Investment and market value


Promoting water management


Increasing permeable surfaces

1

INTRODUCTION TO SuDS

1 Introduction to Suds

1.1 The Bigger Picture

Cheshire East, like numerous Councils across the country, has declared a state of climate emergency. In essence, this means that in everything we do, we have to consider the impacts upon the environment. The Council's Corporate strategy focuses heavily upon the protection and enhancement of the environment and achieving sustainable development. One of the major impacts of climate change is more extreme and altered weather patterns and, consequently, the increased risk of flooding.

Growth will continue to be a major pressure upon the environment, therefore it is important that we design in ways which improves the quality of places and reduces the impact that new development has on the environment. Creatively designed SuDS provide a real opportunity to enrich both new development and existing areas, reducing the pressure on drainage systems and creating more attractive, nature rich, and enjoyable places within Cheshire East.

1.2 Who is This Guide For?

This guidance is primarily aimed at developers to assist in designing SuDS as part of new developments and to explain the information needed to enable the assessment of SuDS proposals by the Council as the Lead Local Flood Authority (LLFA) and by other Statutory Consultees. This guidance is intended to provide an informed approach to SuDS design. To achieve this, it is intended that this guidance be used by:

- Developers
- Architects and Urban Planners,
- Drainage Engineers,
- Landscape Architects,
- Local Authority Departments and internal stakeholders such as Planners, Building Control, Highways Maintenance and Design Engineers
- The Lead Local Flood Authority (LLFA) as a Statutory Consultee in their assessment of SuDS proposals.
- Local communities and householders
- Maintenance and management professionals
- Other Statutory Consultees involved in the assessment of SuDS proposals.

1.3 What are SuDS?

Water is a defining feature of the landscape, from the large rivers and estuaries to the man-made canals and smaller watercourses that drain to them.

As urban areas grow, and impermeable areas increase, we face challenges in making space for water and ensuring effective management of surface-water run-off and drainage.

These challenges include:

- reduction in green spaces,
- increased pressure on existing infrastructure,
- increased risk of flooding and erosion,
- effective management of soils.

Development, and redevelopment of land, can lead to increased flood risk. The cumulative impacts of development, if left unmanaged, could lead to harmful impacts on the local environment.

Most twentieth-century development employed artificial drainage systems which do not mimic the drainage patterns of undeveloped land leading to faster rates and volumes of run-off. This is unsustainable as increased volumes and flow-rates stress our Water Services Infrastructure and increases the risk of flooding.

This is further exacerbated by the cumulative loss of natural habitat which contributes to the acceleration of climate change, leading to more extreme rainfall events.

The extent of built development and the effects of climate change demand a new, sustainable approach to drainage.

A **Sustainable Drainage System (SuDS)** reduces, slows and controls run-off rates and volumes by emulating natural drainage systems. The effective use of SuDS is an essential aspect of all new development proposals to manage and reduce surface-water run-off.

SuDS provide an approach to surface-water management where water is drained in a more sustainable way than traditionally engineered methods, by controlling surface-water run-off close to where it falls, slowing the rate of run-off and improving infiltration. SuDS reduce the risk of flash-flooding which can occur when rainwater rapidly flows into the public sewerage and drainage systems.

1.4 When Should SuDS be Considered?

The revision of SuDS National Standards (November 2015) provides the opportunity to address pressures on the water environment by establishing systems which aim to mimic the natural processes of interception, infiltration and conveyance to the ground and existing rivers and streams whilst also realising the additional benefits which SuDS can provide.

The National Planning Policy Framework (NPPF) sets out the requirements for SuDS based on development type, size, and location. This is further explored in Section 1.9 which explains the policy context for SuDS.

Developers and stakeholders should use the SuDS Submission Application and Approval Checklist (the Checklist) and processes outlined in this guidance as the basis for SuDS design and subsequent approval.

SuDS provide valuable opportunities to:

- Reduce the causes and impacts of flooding,
- Remove pollutants from urban run-off at source,
- Combine water management with green space benefits for amenity, recreation and wildlife`.

Example in Llanelli, Wales of retrofit SuDs
Permission granted by owners to use the image.

https://www.ice.org.uk/news-and-insight/the-civil-engineer/february/how-suds-are-being-retrofitted-to-a-whole-town

Making space for water is an important consideration for developing safe, sustainable and desirable places to live.

WAY MARKER
SuDS
(Sustainable Drainage Systems)

An approach to water management designed to drain surface water in a more sustainable way than traditional methods.

CIRIA SuDS Manual (C753)
Additional guidance on the design and implementation of SuDS can be found in the CIRIA SuDS manual.

http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

WAY MARKER

Non-statutory technical standards for SuDS:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

WAY MARKER

The **SuDS Submission Application and Approval Checklist (the SuDS Checklist)**

Checklists can be found on the Susdrain website below:

https://www.susdrain.org/resources/SuDS_Manual.html

This **SuDS Checklist** identifies the requirements for SuDS to be submitted as part of a planning application to the Council in line with the National Standards, Local Policy and these guidance documents.

1.5 What is the purpose of this SuDS Guide?

This Guide aims to provide continuity of approach within Cheshire East (with the exception of the Peak District National Park which is specifically covered by its own planning policy and legal framework) and to establish best practice for the design and implementation of SuDS.

The Council is encouraging SuDS design for developments of all sizes and settings, including new development and redevelopment, incorporating SuDS at stages from masterplanning to pre-application and application submission. The council also advocates a range of SuDS components suited to urban, urban fringe and rural settings.

This guidance will help developers to design SuDS schemes as part of the wider place design and to meet the necessary standards.

When undertaking a SuDS design using this guidance, developers should be mindful of the following:

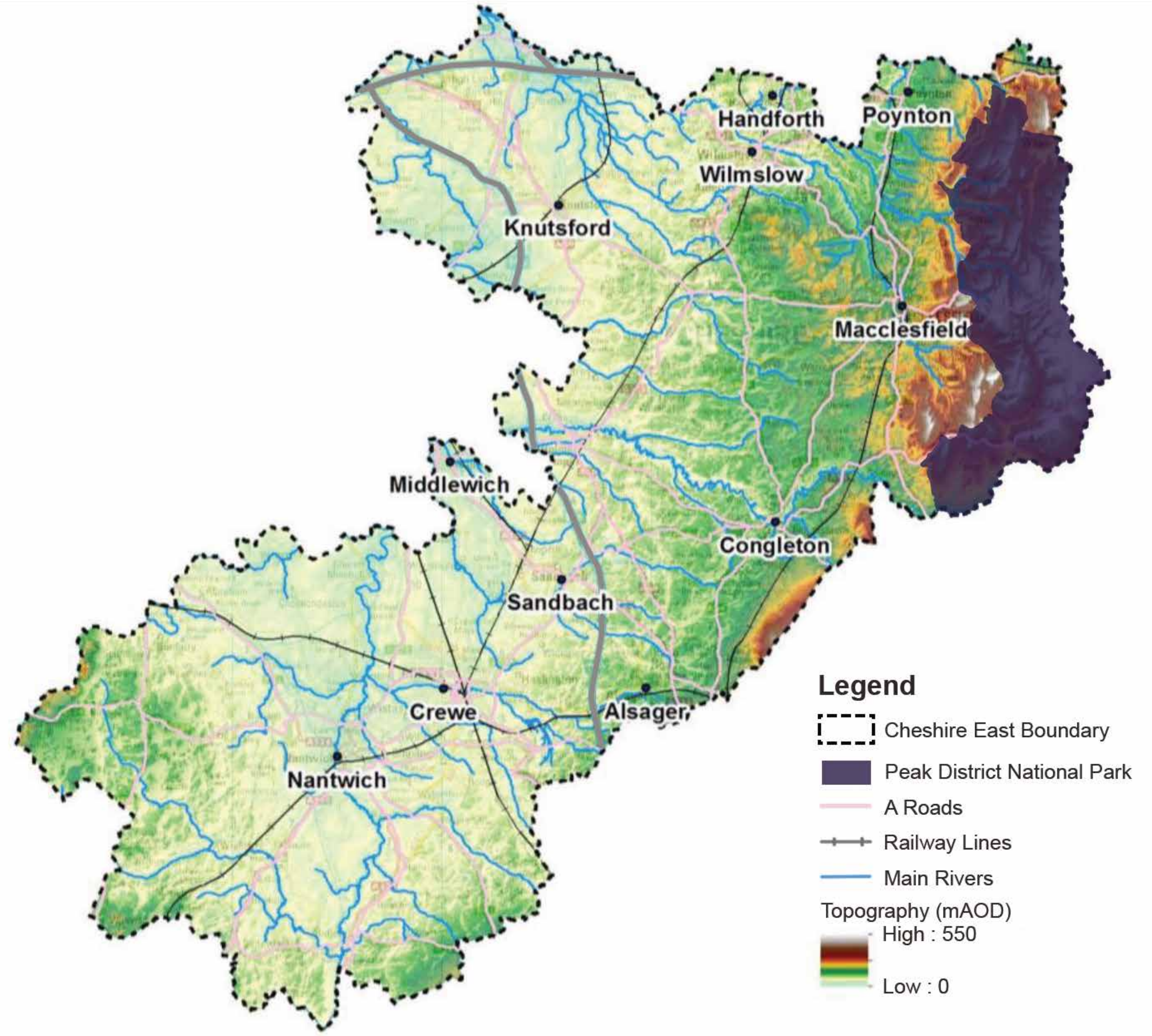
- Pumping stations are not covered in this document
- If your surface-water drainage strategy requires a pumping station, you will need to gain approval from Cheshire East's Lead Local Flood Authority

Figure 1-2

This guidance will:

- Provide a clear and consistent approach to implementing SuDS within the administrative area of the Local Authority
- Enable developers to complete efficient site assessment, SuDS selection and detailed design
- Provide an organised structure for developer applications to the LPA
- Enable planning/engineering officers to identify the key design specification requirements and legislation issues
- Allow efficient assessment of submitted SuDS proposals through the planning process
- Facilitate successful operation and maintenance

Figure 1-1



1.6 A new context for SuDS design

There is now a much stronger focus on the quality of new development. The 2017 Housing White Paper "Fixing our broken housing market" formalised the debate. It identified areas of weakness across many aspects of housing delivery, including the quality of design in new development. As a consequence, it advocated stronger neighbourhood planning and design including use of a recognised design standard such as Building for Life, as well as use of local design tools.

Subsequently, the Building Better, Building Beautiful Commission (BBBBC) developed practical measures to ensure better quality in new development. The commission's final report "Living with Beauty" provides a blueprint for creating well-designed places and the concept of ensuring all aspects of place-making are considered in an integrated and co-ordinated way.

BBBBC (website): https://www.gov.uk/government/groups/building-better-building-beautiful-commission

The National Design Guide produced in late 2019 identifies how to achieve well-designed places that are beautiful, enduring and successful – in support of the Policy set out in the updated NPPF. The aim of the guidance is to set out the ingredients, namely ten key characteristics of well-designed places. A number of these are applicable to SuDS, if well-designed and integrated within high quality new development.

The Government's intends these essential requirements to be translated within local design guidance, to meet specific priorities whilst maintaining the "golden thread" in relation to achieving well-designed places.

National Design Guide (pdf file):

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843468/National_Design_Guide.pdf

A National Model Design Code is also in production. Its purpose will be to set a structure that local design codes should follow, founded on the principles set out in the National Design Guide.

1.7 Evidence supporting place quality

Significant research has been undertaken to gauge the positive benefits of nature, green space, landscaping and water upon our wellbeing and the impact this can have on place quality. The Place Alliance, a body working for the collective aim of better place quality, has recently reviewed extensive past research identifying the virtuous loop between place quality and value, and its impact upon key aspects of national and local policy and governance.

Their report entitled "Place Value and the Ladder of Place Quality" summarises place attributes, both positive and negative, within the "ladder of place quality" – with the upper rungs demonstrating positive attributes that should be essential/aspirational elements, and lower rungs demonstrating negatives ones which should be avoided. Unsurprisingly, greenness in the built environment (trees, grass, water and high-quality open space) is at the top of the list of required elements.

The recent pandemic and the impacts of confinement on people's sense of wellbeing has also served to highlight the importance of accessible and attractive landscape, waterscape and open space.

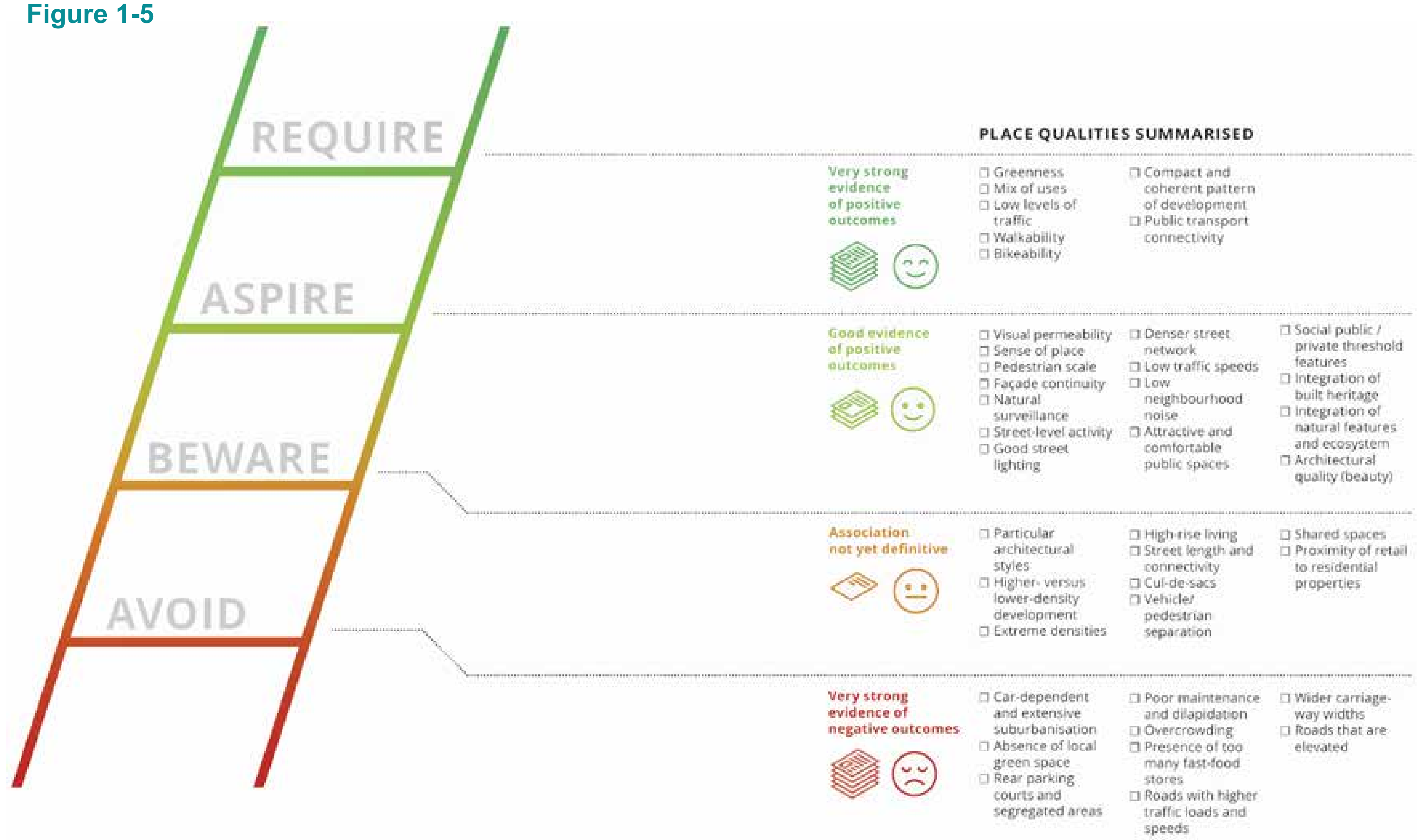
This SuDS Manual provides the ideal opportunity to develop a much more creative design and management approach, to help deliver place quality, and secure enhanced wellbeing and resilience across our Borough.

Place Alliance "Place Value" (website): http://placealliance.org.uk/research/place-value/

Figure 1-4

Extract from the National Design Guide page 8

Figure 1-5



Extract from the Place Alliance: "Place Value and the Ladder of Place Quality" (pp 14/15)

1.8 How SuDS can help achieve a well-designed place

Place design should be a multi-disciplinary process of knitting together a variety of interconnected elements when planning for change in the built environment to achieve a successful, attractive and enduring place.

CEC Residential Design Guide Parts 1 & 2 found at:

https://www.cheshireeast.gov.uk/planning/spatial_planning/cheshire_east_local_plan/supplementary_plan_documents/design-guide-supplementary-planning-document.aspx

It is important to think more widely than the red line of a site. Only by properly appreciating an area's positive and defining qualities and characteristics, its opportunities, and its limitations, can a successful place be achieved, as set out by the Cheshire East Residential Design Guide. Whilst there are differences in character across Cheshire East, new development must build upon the inherent qualities of the area.

The green and blue infrastructure for a site and its surroundings should be the foundation for any new development. Thinking positively about this could help to achieve maximum social, environmental, and economic value for a development.

SuDS provide an opportunity for habitats within and around a development. The incorporation of open water, both permanent and temporary, and associated reedbeds, wetlands and ditches provides a range of habitats for wildlife increasing the biodiversity value of a scheme.

Creatively designed SuDS, designed as a system (or train) of positive components, can be a major structuring element for new development - even on a site that has few pre-existing features or which is quite heavily constrained. They can build upon and cement the existing character of a place or help to build a new, positive identity. They can also help to educate on the environment and climate change and promote social interaction and a sense of community.

A positive example on a neighbourhood scale is Upton in Northampton where, as part of the Masterplanning and design coding for a new community, SuDS were integral elements of the place infrastructure. This fulfilled a practical need but did so in a way that also brought a distinctive townscape quality.

Images: e*SCAPE Urbanists

On a smaller infill scale, the Riverside Court scheme, at Stamford, demonstrates a different approach to SuDS as part of a creative urban design approach for a very constrained site. A full management train including canalised SuDS has enriched the townscape, and softens what could otherwise have been a hard, and somewhat featureless, development.

Images: D.Hallam

1.9 National SuDS Standards

The non-statutory technical standards for SuDS (March 2015) provide guidance for Councils to define their own standards for approval of SuDS proposals within planning applications to ensure developments suit local requirements and address common site challenges for SuDS.

Ideally, SuDS should be designed with the minimum amount of underground or traditional piped linkage as possible. The designer should always aim to use easily accessible features to connect SuDS features wherever possible.

SuDS should therefore be designed with these needs in mind: design, construction, maintenance, and operation. The following criteria should also be considered:

- **Function** - as well as treating and attenuating run-off, SuDS should be designed with multiple benefits in mind such as public-friendly spaces, enhanced and new landscape features, habitats encouraging wildlife to flourish, which in turn create better places for people.
- **Maintenance** - all SuDS components should have suitable access provisions included and component design should enable safe and easy maintainance.

1.10 Planning Policy

National and local policies provide a positive framework in relation to sustainable drainage. In addition, Cheshire East Borough Council has a residential design guide, which sets out the integration of SuDS as part of achieving sustainable development, but it isn't specific about the process of design SuDS systems or their management. This manual seeks to build upon that policy and design guidance, specifically focusing on SuDS system design, with a strong focus on place-making and creative design as part of new development. It also considers the practical matters of SuDS design to show how creative SuDS design can be delivered and managed effectively and deliver a wide range of benefits.

This section outlines the key policies in the national and local planning policy framework, whilst other relevant policies and guidance are set out in Appendix B.

National Policy

The National Planning Policy Framework (NPPF)

The framework presumes in favour of sustainable development, i.e. development that meets interdependent social, environmental and economic objectives, as set out in its various chapters.

Chapter 14 Meeting the challenge of climate change, flooding and coastal change

Establishes principles in relation to, water management, the need to plan for climate change and coastal impact from rising sea levels. In regard to water management and flooding, it requires a rigorous approach to assessment of flood risk. Paragraph 165 identifies the requirement for major development to include SuDS, stipulating specific requirements including, where possible, that they provide multifunctional benefits.

Chapter 12 Achieving well designed places

Describes the importance of achieving high quality design by creating beautiful and characterful places, influenced by an area's existing qualities and the opportunities presented by a site and its surroundings. It also emphasises the importance of design that functions well and which is responsive and resilient to change. Explicitly it requires that planning permission should not be granted where these are opportunities are not realised.

Cheshire East Local Policy*

Cheshire East Local Plan Strategy (CELPS):

SE 13 Flood risk and water management

Requires a sequential approach to site selection to ensure development in areas of lower flood risk, whilst ensuring that all schemes have appropriate flood risk assessment, also accounting for climate change. It also requires that all developments seek improvement to the surface water drainage network, including appropriate forms of SuDS that seek to reduce the run off rate.

SE1 Design

Aims to ensure new development is well designed and makes a positive contribution to its surroundings by achieving sense of place, achieving sustainable design solutions, ensuring design quality is managed throughout the development process and, to achieve a high quality of life, in our living, leisure and working environments.

Emerging Policy

Cheshire East Site Allocations and Development Management Policies (SADPD) Draft:

The SADPD will form the second part of the Local Plan. It will set non-strategic and detailed planning policies to guide planning decisions and allocate additional sites for development to assist in meeting the overall development requirements set out in the LPS.
A revised publication draft version of the SADPD was published for a period of public representations between the 26 October and the 23 December 2020.
Although the SADPD is in draft and has a few stages to go through before adoption, this draft SPD has been prepared in a way to be consistent with emerging planning policies. Whilst this is not a legal or national planning policy requirement, this approach provides opportunity for this SPD to complement and support the implementation of future development plan policies too.

ENV16 Surface water management and flood risk

The principal detailed Development Management policy in relation to sustainable water management and overlays policy SE13 of the CELPS requiring sustainable urban drainage systems (SuDS). With a preference to incorporate surface level SuDS with multi-functional benefits for the management of surface water.

GEN1 Design Principles

This reinforces policy SE1 of the CELPS to achieve well designed new development through place identity, creating sustainable and responsive developments that can adapt to climate change and other changing circumstances, that create active lifestyles and promote health and wellbeing, and which integrate positively with the natural and built environment.

*Excluding that part of the Peak District National Park within its area

2

EXISTING SITE DRAINAGE

2.1 Working with existing site drainage

An understanding of a site's existing drainage system is needed prior to designing development proposals, especially with regard to appropriate site use, scale of built development and site layout. The physical landscape characteristics of a site, and of its local and regional setting, have a major effect on its drainage. This applies to both natural and built environments.

Natural environments include visible **natural drainage system components** on the land's surface. Some of these components are indicators of water conveyance, such as streams and rivers, and others indicate water storage, such as ponds and lakes. There may also be less obvious natural drainage system components such as reed-beds which filter water and slow run-off rates, or peat-bogs which store water. Other evidence of natural drainage includes erosion which indicates areas with high run-off speeds and/or volumes, and reveals the direction of travel in its soil-scraping and silting patterns. Seasonal flooding can also be seen and can indicate areas with low and/or slow infiltration. Below ground there are hidden components including bedrock and groundwater aquifers (underground water-stores).

In built environments, **traditional artificial drainage components** accelerate drainage. Some traditional artificial drainage components may be obvious, such as hard-surfacing, hard roofs, down-pipes and gutters, however artificial routes for conveying water away from roads and hard-standings may be less obvious as they are often pipes buried underground. Identifying buried artificial drainage components usually requires site-history investigation, and/or targeted exploratory site-excavation. Traditional artificial drainage components take water more swiftly into our natural drainage system.

A **sustainable drainage system** works with natural site drainage and reduces run-off rates by emulating natural water-movement. Before a sustainable drainage system can be designed, an understanding of the site's natural drainage is needed.

Characteristics which determine your site's natural drainage

The physical landscape characteristics of your site and its surroundings determine its natural drainage. The key characteristics include:

- Geology (the underlying bedrocks)
- Topography (the lie-of-the-land, its surface-shapes and textures)
- Soils (natural subsoils and topsoils, and any imported soils or soil-forming materials)
- Vegetation (from mosses & liverworts through to high canopy woodland)

It is important to identify and understand the effects of the characteristics of surrounding land as these will influence your site, for example, higher ground to the west will prevent surface flow in that directions, and will introduce additional surface water onto your site.

Figure 2-1

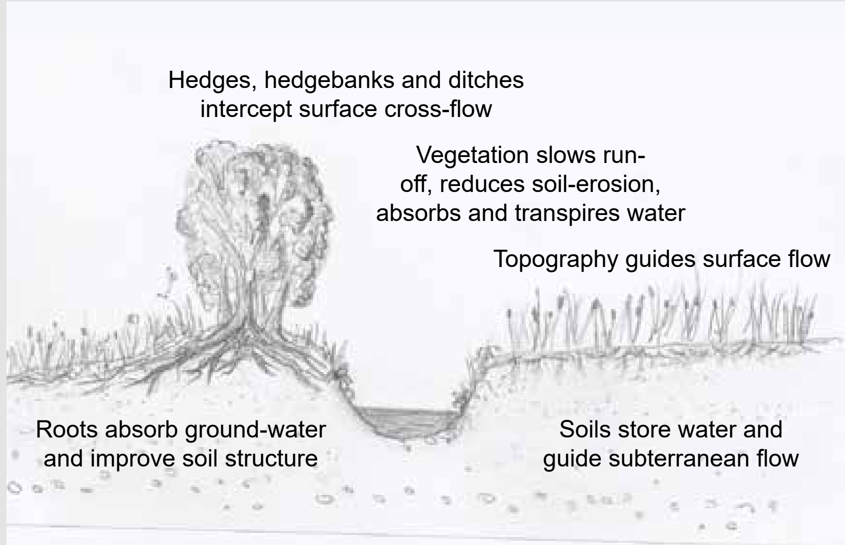
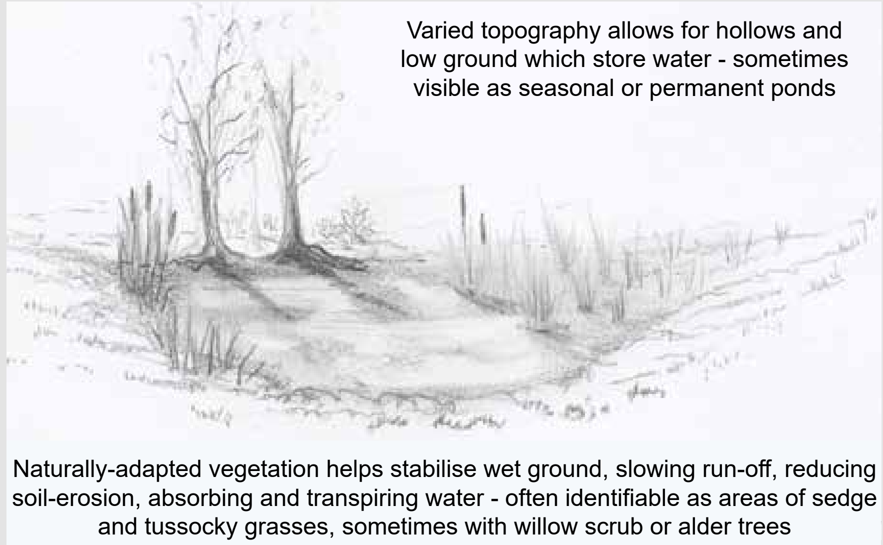


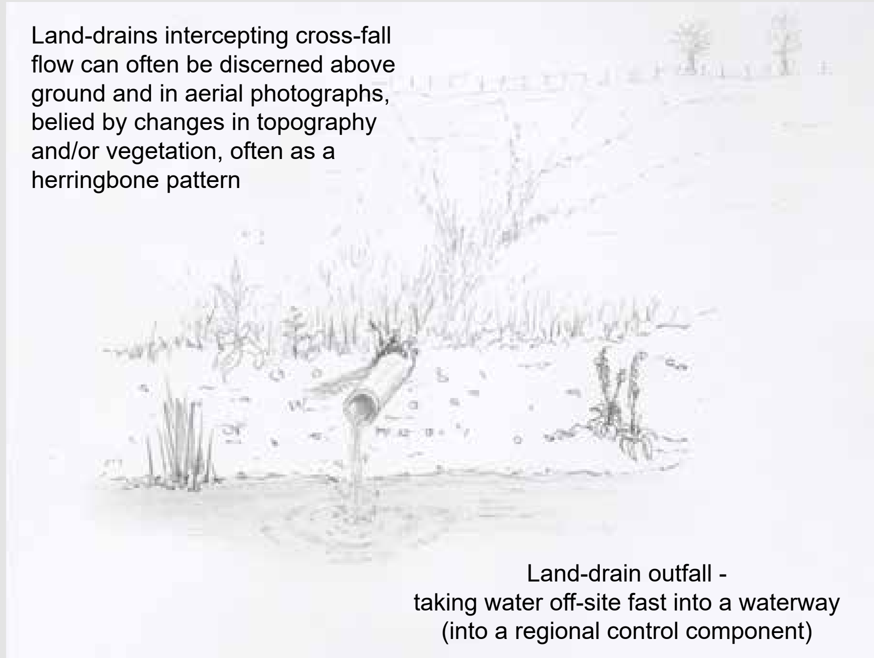
Figure 2-2



Examples of Visible Surface Components of a Natural Drainage System

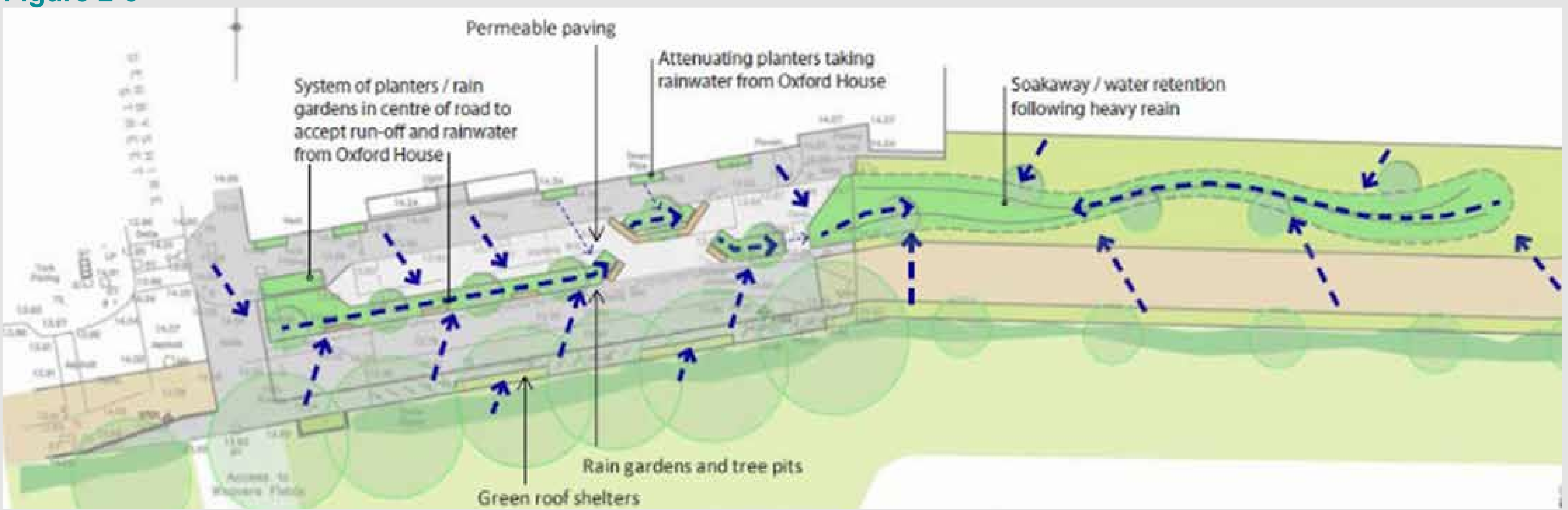
Figure 2-3

Figure 2-4



Examples of Visible Surface Components of a Traditional Artificial Drainage System

Figure 2-5



Examples of Visible Surface Components of a Sustainable Drainage System

Image: Susdrain.org

2.2 Working with Geology

The geology of your site's local area will influence your site's ability to store and convey water, and determine its links to groundwater aquifers (natural underground water-stores). The types of bedrock under and around your site will affect the direction and speed of water flow, both into and out-of the site.

> **WAYMARKER**
>
> You can find baseline information for hydrogeological mapping from the British Geological Society (BGS) at:
>
> https://www2.bgs.ac.uk/groundwater/datainfo/hydromaps/home.html

> **WAYMARKER**
>
> Ground investigation should be undertaken to understand site-specific hydrogeology. Specialist surveyors can be found through:
>
> https://www.hydrogroup.org.uk/

The general geology of Cheshire East is dominated by Triassic rocks of the Mercia Mudstone Group, interspersed with smaller areas of more variable rocks, including siltstones, limestone and coal, and areas of Sherwood Sandstone to the north. The north-east of the borough is dominated by the Carboniferous Millstone Grit of the Peak District National Park.

Mercia Mudstones have a generally weak structure which has led to the formation of extensive low-lying flatter land of the Cheshire Plain. The Cheshire Plain is bisected by a ridge of Triassic sandstone, running in a generally south-north direction from Peckforton and Beeston up to Runcorn Hill, with another sandstone outcrop at Alderley Edge.

The properties of different bedrocks are very variable. The bedrock properties which are particularly relevant to drainage include permeability, angles of slope, density and hardness. These properties affect the bedrock's rate of erosion, ability to store or convey water, and its effects on the directions of underground ('groundwater') flow.

Geological faults can affect aquifers and groundwater flow in a range of ways, with faults sometimes acting as barriers to flow, or, where they have a high permeability they may form a preferential flow-path.

Figure 2-7

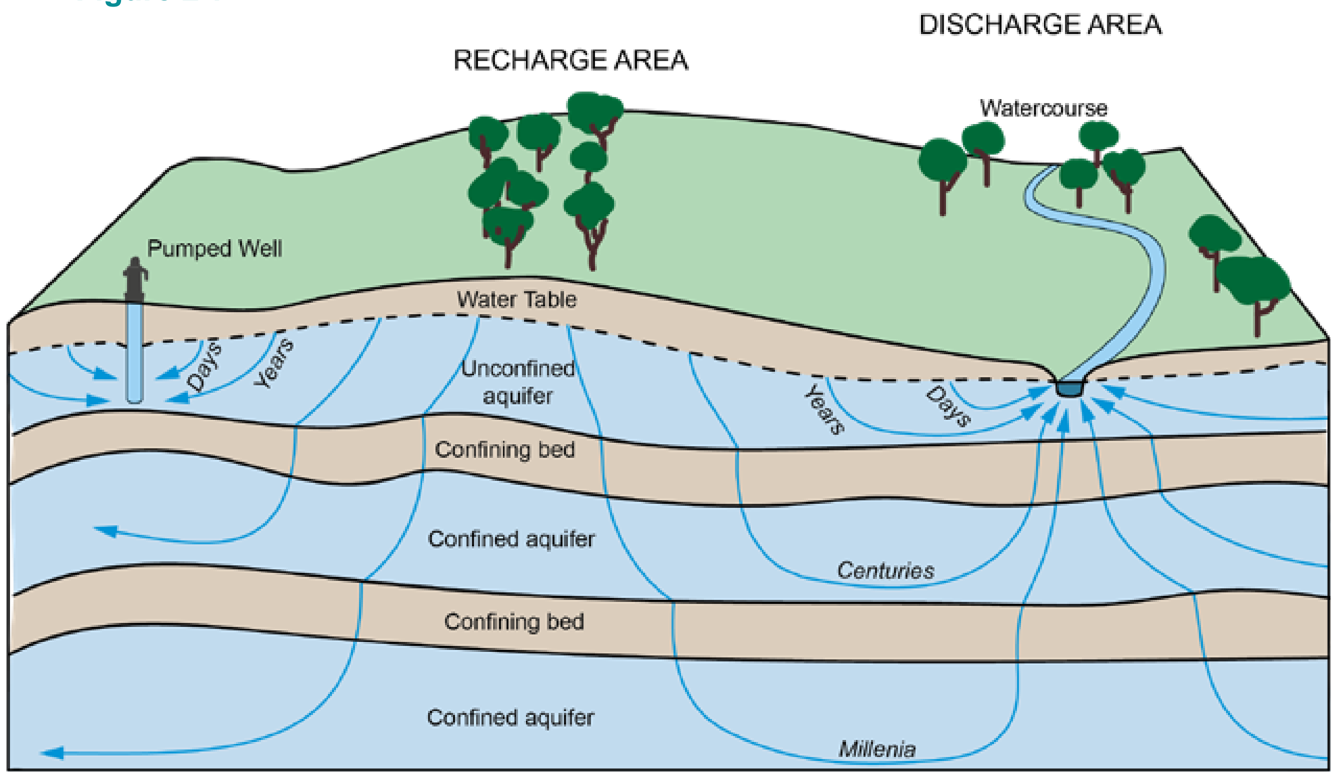


Diagram illustrating the influence of different-permeability bedrocks on underground water-movement

The Sherwood Sandstone which dominates the north and west of Cheshire is an example of an aquifer - an underground water-store. Groundwater abstraction from the Sherwood Sandstone is important in this region for public water supply, and for industry and agriculture.

Figure 2-7

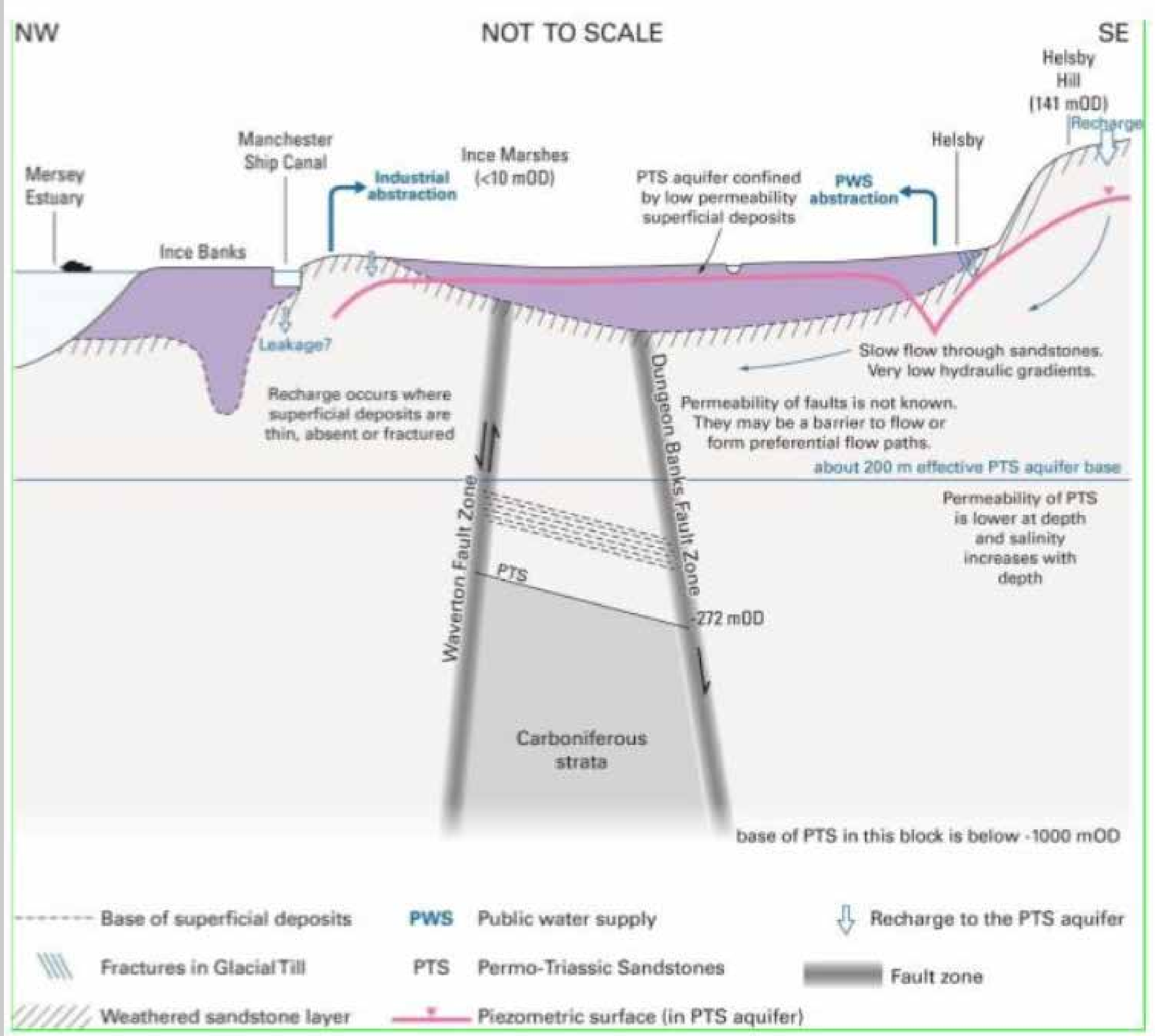


Diagram illustrating hydrogeological cross-section where the Weaver and Mersey rivers conjoin.
(SEEK PERMISSION https://www.ukgeos.ac.uk/cheshire/geological-and-hydrogeolocal-context#hydrogeology)

Figure 2-8

The inundated floodplains of the Weaver and Mersey rivers over low permeability sandstones (Image:LLong)

2.3 Working with Topography

An area's topography is primarily shaped by its geology (underlying rock) and hydrology (water movement), and to a lesser degree, wind. Topography includes the land's slopes (steepness), aspects (angles in relation to the sun) and relief (surface texture).

Harder bedrocks can resist erosion more than softer bedrocks so different bedrocks lead to different types of topography. Although localised differences may be found due to unusual events, such as glacier movement or quarrying, harder bedrocks often lead to more angular and dramatic topography.

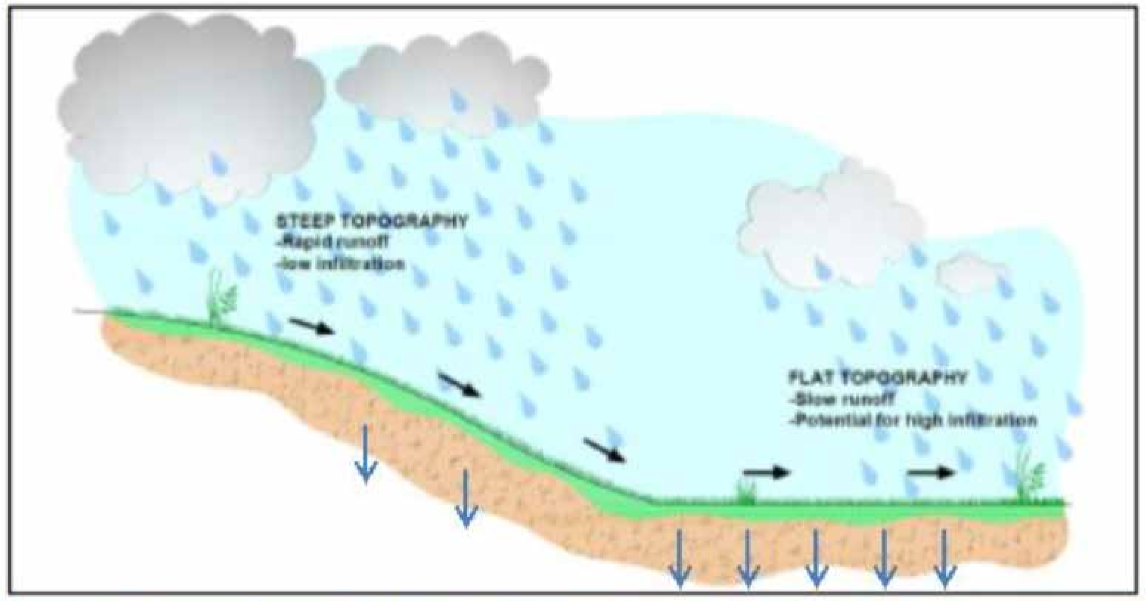
Assessing topography:
Steeper slopes where harder bedrock has resisted erosion and run-off will be faster

Assessing topography:
Flatter land where geological layers have succumbed to erosion and run-off will be slower.

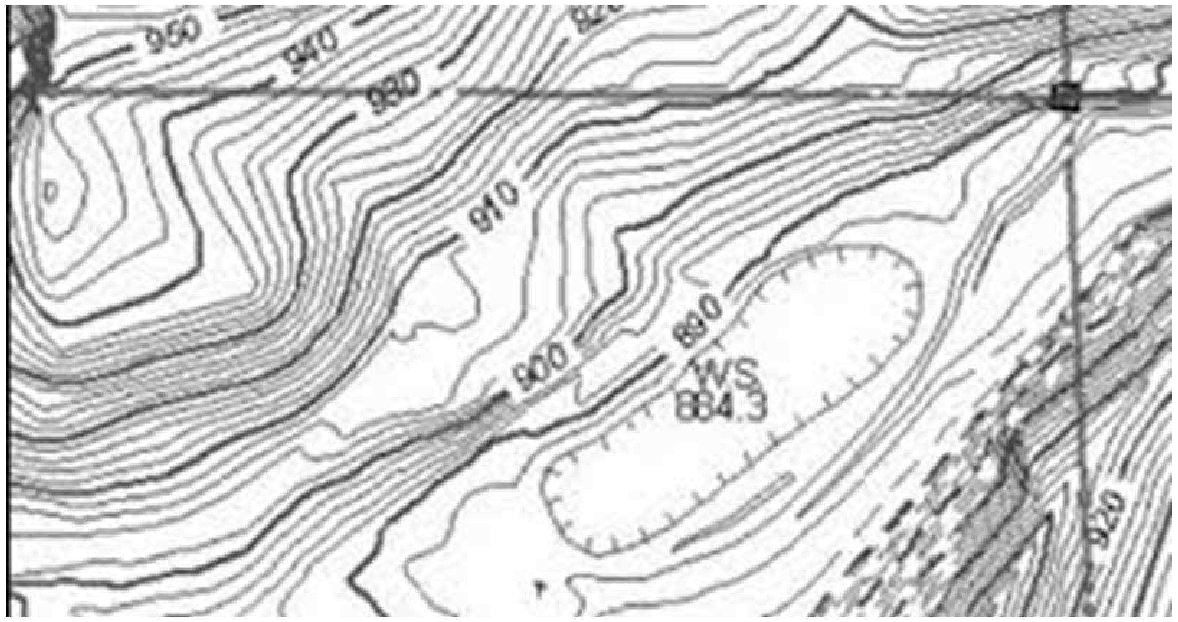
Assessing topography:
Undulating land where water run-off has accumulated on lower ground and is stored until it infiltrates or evaporates.

The topography of your site and its surrounding land will affect drainage patterns. Steeper slopes create faster water-flow, whereas shallow slopes allow gentler flow and a flatter area may slow the flow almost to a stop, encouraging the formation of water-storage areas, such as bogs or fens. Hollows, ponds and ditches all add water-storage capacity, prolong infiltration opportunity and mitigate run-off speeds and volumes.

Existing watercourses must be accommodated and appropriately managed in development proposals. In Cheshire East, CEC Byelaw 10 prevents building within 8m of a watercourse without prior consent, and 'daylighting' is encouraged, meaning any culverted watercourses should be opened-up where possible, and any existing open watercourses should not be culverted.



Speed of run-off and potential for infiltration are affected by angle of slope



A topographical survey is essential for understanding site context

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Guidance from Topographical surveys:
Royal Institute of Chartered Surveyors (RICS)

https://www.rics.org/globalsets/rics-website/media/upholding-professional-standards/sector-standards/land/measured-surveys-of-land-buildings-and-utilities-3rd-edition-rics.pdf

Responsibilities relating to Watercourses include local byelaws and national legislation:

Owning a watercourse - (www.gov.uk)

2.4 Working with Soils

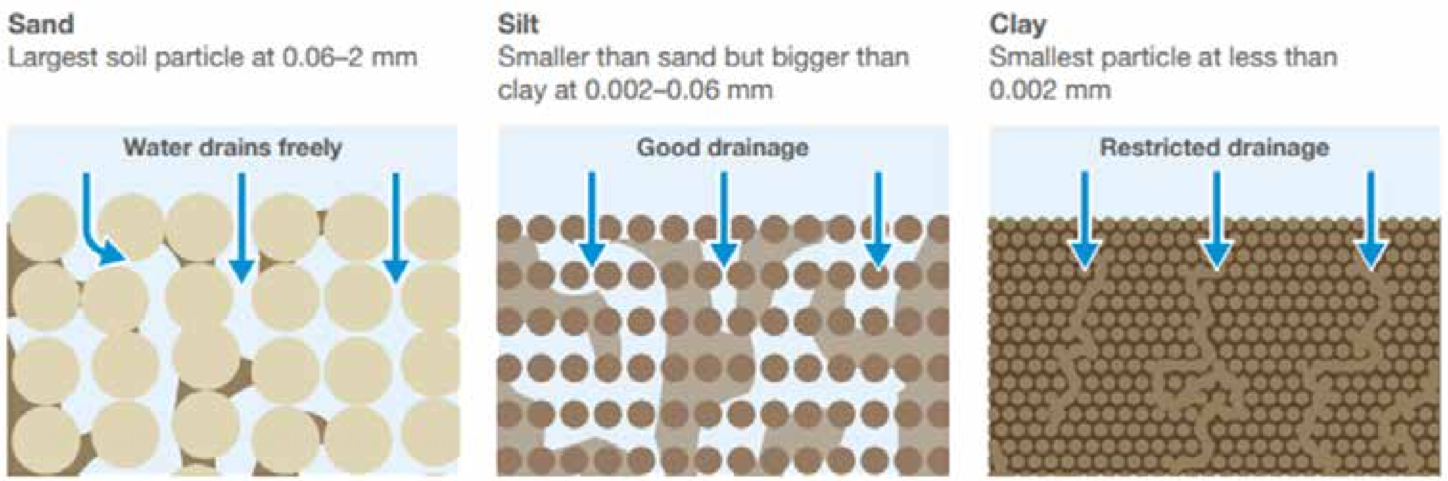
The capacity of your site to store or convey water is heavily dependent upon soil structure.

The types of soils you have will also affect your site's drainage. The grain-size of soil particles (or aggregated particles) affects the ability of a soil to retain and transport water. Fundamentally, the larger the **pore size** the more space there will be for water to move.

A soil's **porosity** determines its capacity to store water. Soil water-storage capacity increases as soil texture becomes finer because it becomes more capable of trapping water. Small pores not only restrict the passage of water but they also keep it closer to the particle surface where chemical-bonding can further slow its movement.

A soil's **permeability** determines the ease of movement of water through that soil. Soil-permeability increases as soil texture becomes coarser as soil pores are larger and water can flow through more easily.

Clay and humus affect both porosity and permeability by binding soil grains together into aggregates, thereby creating a network of larger pores, 'macropores', that allow water to move more easily.



Soils with smaller gaps between particles will hold water for longer.

Groundwater and Percolation testing should be undertaken to BRE365 / CIRIA C753 to determine suitability for site drainage/infiltration.

Well-structured and deeper soils decrease surface run-off and have greater water-storage capacity (depth limits to ensure good soil health are discussed to the right).

Compacted and shallower soils increase surface run-off and increase the site's susceptibility to erosion and flooding.

1 - James Hutton Institute; STARS; British Geological Society; CIWEM; British Ecological Society; Dr Tim Harrod; Prof Mark Hodson; Institute for Global Food Security; Lancaster Environment Centre; Microbiology Society; Soil Security Programme; Robert Palmer; Soil First Farming

Soils Management to improve or maintain Health, Depth and Structure

Soils are created by a combination of weathering of bedrock and decomposition of organic matter by soil-ecology. Soil-ecology counts for a quarter of the earth's biodiversity including earthworms, fungi and bacteria.[1] One hectare of healthy topsoil can contain up to 5 tonnes of living organisms. Potential pollutants carried-by or dissolved in water entering soils must be considered and managed.

Soil Quality

Soil movement leads to loss and deterioration of its structure and health and should be avoided where possible. Where soils require movement, whether those are in-situ site-soils or imported, SuDS proposals should show compliance with the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. This code of practice provides guidance for soil surveys, soils management plans and methodologies for soil stripping, storage and re-laying).

Where site soils have to be relocated to planting areas or where imported soils are required:

subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use

topsoil must meet BS 3882:2015 Specification for Topsoil.

Soil Depths

Existing in-situ site-soils must be re-used where suitable and possible to prevent loss of natural resources, prevent unnecessary transportation and prevent transit-damage to soil structure.

Soil-depths required for new planting are:

	Minimum Topsoil Depth	Maximum Topsoil Depth*	Minimum combined depth of Topsoil + Subsoil**
Grass and herbaceous species	150mm	400mm	450mm
Shrubs and hedgerows	200mm	400mm	600mm
Trees (including hedgerow trees)	300mm	400mm	900mm

*Due to particle-size and compaction, topsoil depths exceeding 400mm can lead to anaerobic conditions so subsoil should be used below 400mm depth to create suitable conditions for rootzones.

**For example: for trees 350mm topsoil to BS 3882:2015 could be laid over 700mm subsoil to BS 8601:2013 giving a rooting-depth of 1050mm.

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Code of Practice for the Sustainable Use of Soils on Construction Sites - DEFRA (includes advice for Soil Resource Surveys and Soils Management Plans):

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/716510/pb13298-code-of-practice-090910.pdf

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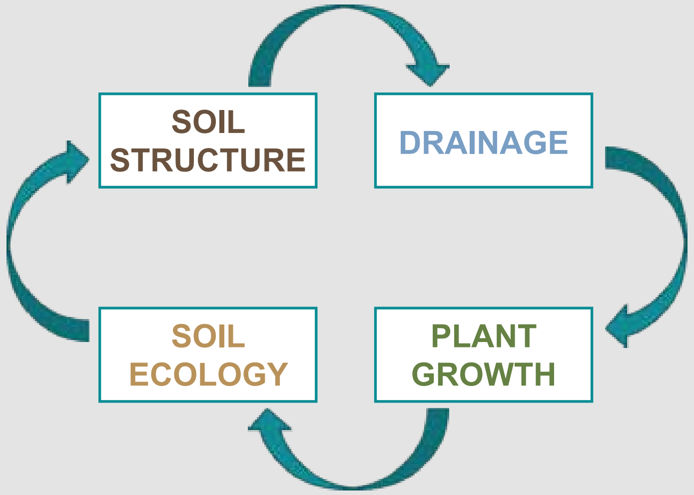
BS 8601:2013 Specification for subsoil and requirements for use
https://shop.bsigroup.com/ProductDetail?pid=000000000030209662
BS 3882:2015
Specification for topsoil
https://shop.bsigroup.com/ProductDetail/?pid=000000000030297815

2.5 Working with Vegetation

Plants are an essential component for the natural drainage system.

Plants provide the food necessary for the development of healthy soil ecology, which in turn develops good soil structure, which in turns helps with the storage and conveyance of water.

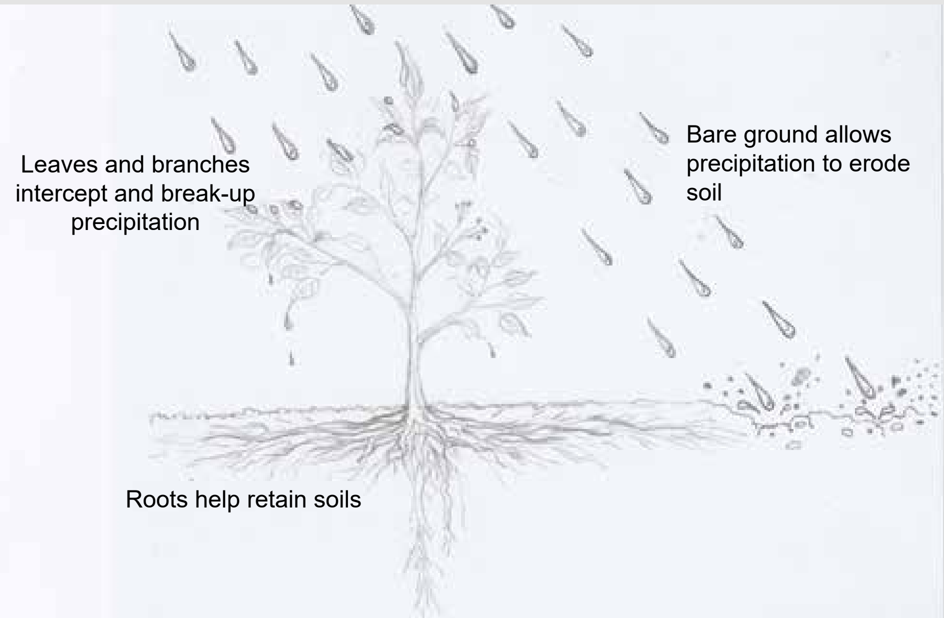


Natural vegetation cycling needs to be employed to effect sustainable drainage systems. When deciduous leaves are dropped or plants die, plant material (humus) feeds soil organisms and improves the structure of the soil, creating a less dense structure which can store or convey more water. The movement of soil organisms increases this process, helping soil pores to enlarge to macropores. As soil organisms digest and decompose humus, they release nutrients back to the soil which in turn feeds new plants.

Living plants perform other key drainage tasks:-

As plants grow, their roots open pores between soil particles, enabling increased storage and movement of water.

The growth of plant roots also helps to physically bind soil and resist erosion.

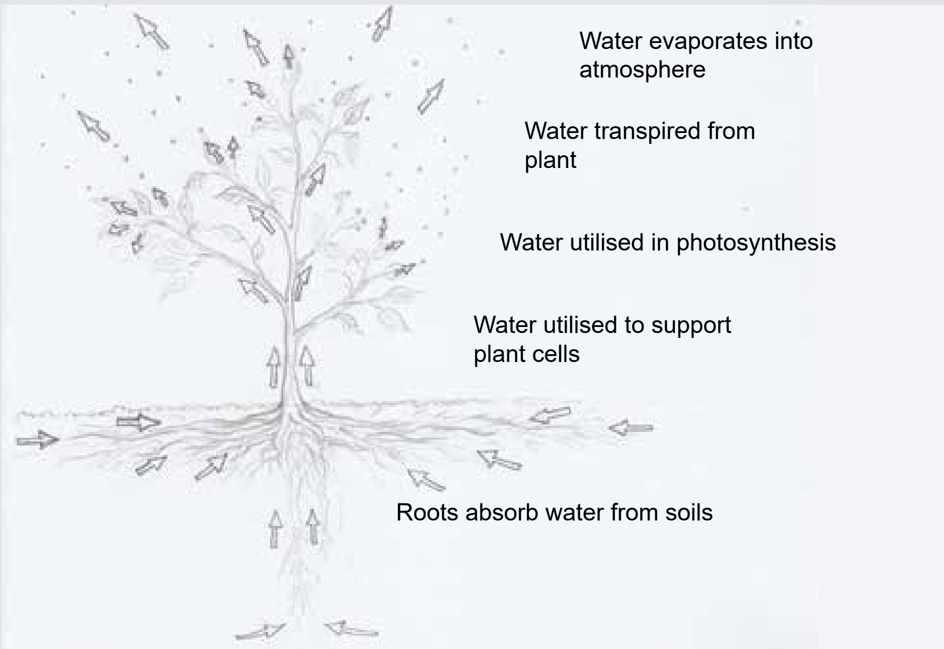


Schematic Diagram of Roots Increasing Erosion Resistance

Vegetated land showing better erosion resistance during flood conditions

Attibution: Image from: https://www.frontierag.co.uk/blog/protecting-soil-from-erosion

Plants also transpire - removing water from the ground and releasing it back into the atmosphere. Root hair cells absorb water from the soil by osmosis, some of that water is used for photosynthesis to feed the plant, some gives plant cells their rigidity, and some is released through leaf stomata.



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Surveying vegetation: Joint Nature Conservation Committee (JNCC) Handbook for Phase 1 Habitat Survey
https://data.jncc.gov.uk/data/9578d07b-e018-4c66-9c1b-47110f14d-f2a/Handbook-Phase1-HabitatSurvey-Revised-2016.pdf

A Phase 1 Habitat Survey of your site will provide you with a summary of the existing vegetation coverage on your land, and may suggest areas for improved vegetation-density and vegetation-diversity.

It is important to record and consider all vegetated surfaces, including vegetation that survives on man-made structures, such as climbing plants, succulents, ferns and mosses.

Single species vegetation:
water uptake will be restricted to the limited rootzone

Image from https://www.pennington.com/all-products/grass-seed/resources/erosion-control-planting-slopes-and-hills

Diverse vegetation:
rooting at different soil levels extends ability to absorb water

Image attribution: https://www.treeworks.co.uk/where-are-the-roots/

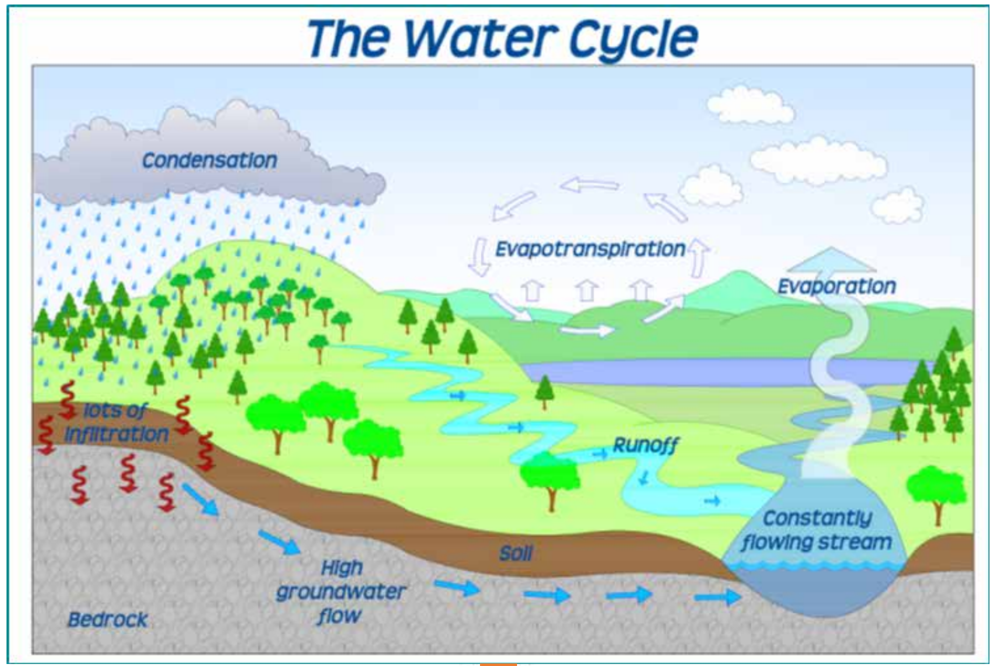
All vegetation will help to absorb and transpire water, reduce run-off volumes and slow run-off speeds.

Higher vegetation density will help provide a higher quantity of drainage benefits.

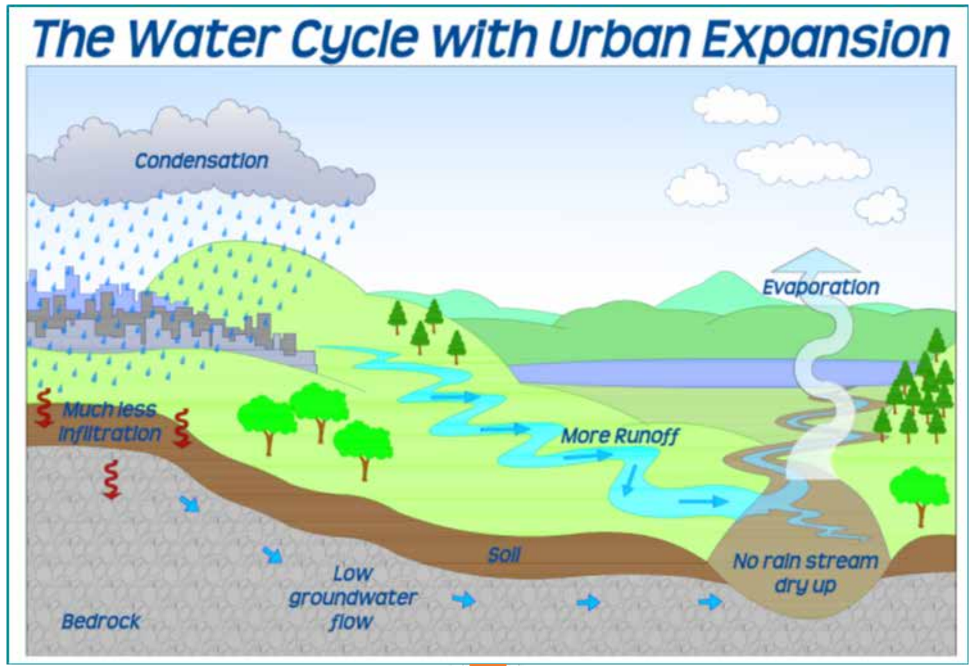
- more diverse rooting depths
- more diverse plant heights for transpiration
- greater opportunity for filtering
- greater sustainability of the natural water-cycle

2.6 Why use SuDS?

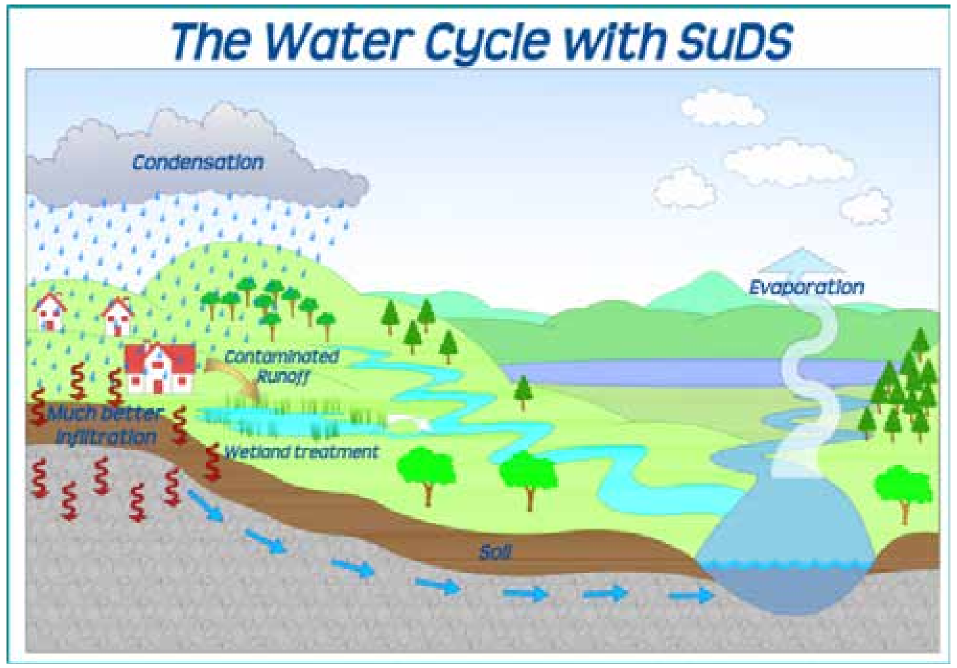
Impervious areas such as roads, footpaths, roofs, and car parks are traditionally connected to sewer systems that transport run-off away from urban areas quicker than natural, vegetated conveyances.



This can cause disruption to the natural water cycle as flows in downstream waterways can peak faster and in greater quantities than pre-developed conditions. This can exacerbate, or create new, surface water flood risks and can also increase pollution in our waterways.



SuDS aim to manage rainfall and surface runoff by allowing rainfall to be intercepted or absorbed into the ground through vegetation and specially designed landscape features. SuDS also convey any additional flows to the nearest surface waterbody (for example, groundwater, stream, river or drain) where it is discharged at the same rate and, where feasible, the same volume as would occur if the site was undeveloped. SuDS can also be used to provide biodiversity improvements to developed areas.



There are several proven benefits which can be derived from employing SuDS components, for both new and existing built environments. These include water-management benefits, such as temporary storage during a storm event to reduce flooding, improved run-off water quality and removal of sediments (an accumulation of sediments can reduce storage capacity and contribute to flooding).

SuDS can also have indirect social benefits for an area and community. SuDS components can be designed to create green areas used for recreation which also enhance the aesthetic qualities of the locality. In turn, these measures can improve the appeal of the area, and may also encourage investment in an area leading to economic benefits such as increased prices in the property market.

The implementation of SuDS within new developments may have the following benefits:

Management of increased water quantity / extreme events

- Increased precipitation, as climate change occurs, is likely to lead to wetter winters and therefore more water within the drainage system

Management of more frequent extreme rainfall events

- SuDS can help reduce surface water discharge rates and therefore prevent drainage systems being overwhelmed

Management of brownfield sites

- SuDS can provide betterment to drainage at brownfield sites and improve a particular problem or enable re-development (e.g. reduced extents of hardened surfaces)

Assistance with the protection of all water bodies from the effects of pollution and enabling the implementation of law, policy and management

- The Water Framework Directive (WFD) (Directive 2000/60/EC)
- North West River Basin Management Plan 2009
- Environment Agency 2013: North West River Basin District: Challenges and Choices

Increase in green spaces and vegetated areas and general improvement of landscapes and townscapes

- SuDS can provide an array of biodiversity benefits and help to reduce the urban heat-island effect, and provide key links in Green Infrastructure networks
- To improve visual amenity
- SuDS can contribute to the aesthetic improvement of the landscape by softening man-made environments with more naturalistic features.

Increase recreational areas and improve social wellbeing

- Planning policy encourages the provision of opportunities for access, outdoor sport, and recreation and SuDS can contribute to the quality of that outdoor leisure opportunity
- SuDS can be designed as community assets to support social cohesion and enhance communities' quality of life e.g. wetlands can be wildlife parks with stepping stones and islands.

Understanding about sustainability and functionality of SuDS

- Education of the public about the environmental importance of SuDS and the positive impact they have on the environment and people's wellbeing

Perceived improvement of an area

- The visual attractiveness of a development can help to increase developer confidence and the value people place on the area in terms of quality of life and sense of community
- SuDS can link public open spaces with green infrastructure and provide habitat corridors, helping to make areas feel more accessible and walkable

3

INCORPORATING SUSTAINABLE DRAINAGE

3 Sustainable Drainage Design Process

3.1 SuDS design - the need for a holistic approach

Until now, SuDS have often been designed in parallel with, rather than as an integrated part of urban and landscape design. Along with other positive aspects of place quality, such as GI and natural features, the place making has been secondary to commercial and other technical considerations. This has led to very few examples where SuDS have genuinely added to and enriched the place.

A more creative and joined up approach to SuDS design is essential, as advocated in national policy and guidance. This requires a much more collaborative design philosophy to ensure SuDS are integrated into the wider design to add to the quality of place. Land promoters and developers need to ensure SuDS potential is considered from the outset, and a collaborative design team is brought together from inception of the project.

Alongside this, engagement with communities and the local planning authority and drainage teams will be fundamental as part of early place-shaping work. SuDS design needs to be inbuilt into the process and timeline for community engagement, pre-application discussion and planning performance agreements (where they are entered into).

Early consideration of SuDS is is essential in the preparation of development briefs, masterplans and design codes.

3.2 Design Team for SuDS

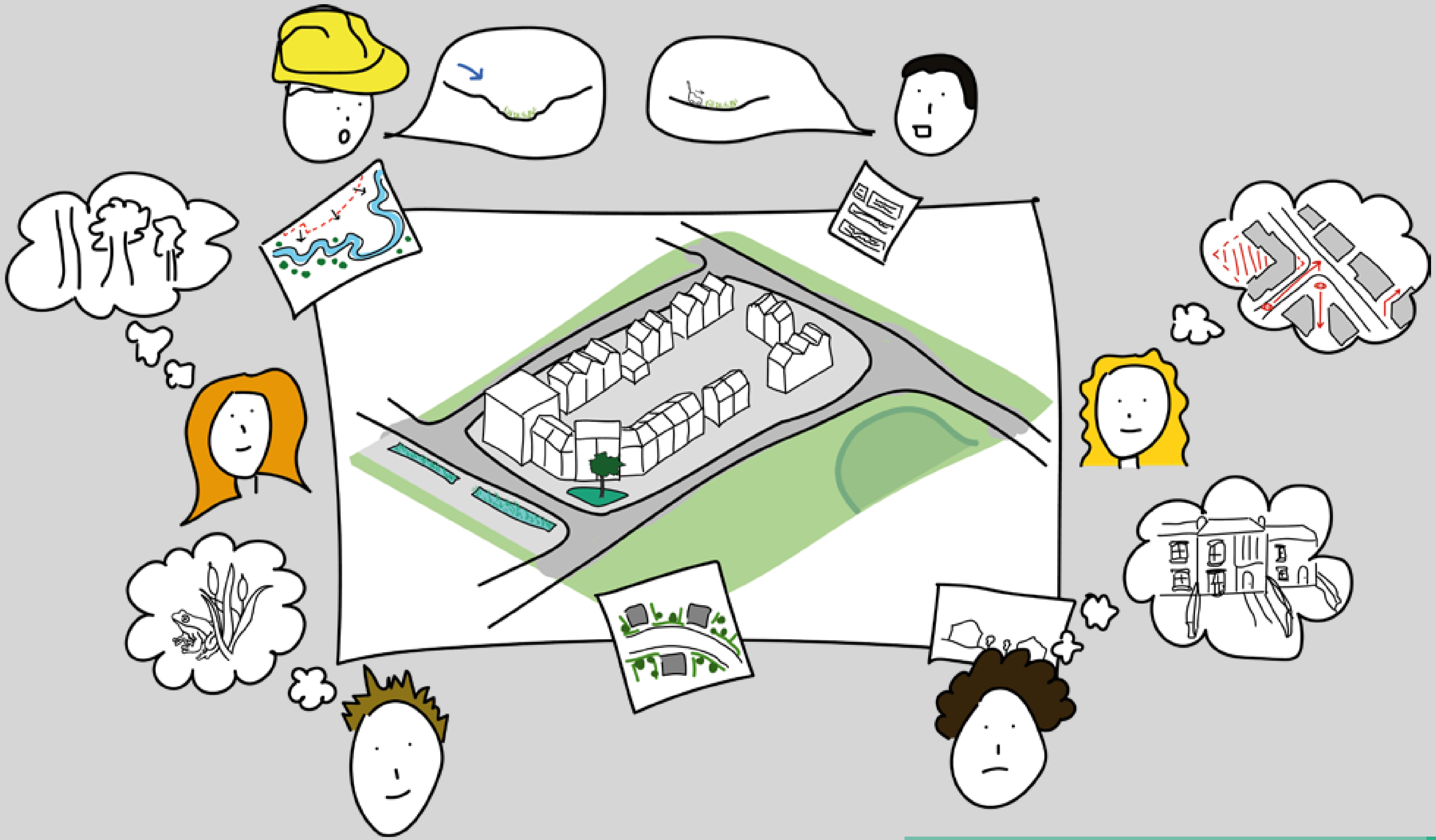
A SuDS design team should be multidisciplinary to promote a holistic approach to the design process. Identifying considerations for SuDS early on will avoid potential delays and budget issues.

Your design team should have experience of designing SuDS and should include:

- Drainage Engineer
- Landscape architect
- Ecologist
- Arborist
- Urban designer
- Architect
- Maintenance Engineers
- Town planner
- Highways Engineer
- Land developer

The Construction, Design and Management Regulations (CDM) (HSE, 2007) must be applied to the planning, design, construction, and long-term maintenance of SuDS. CDM regulations apply to all construction projects, though the scale of the project and duration of its construction period will determine whether the project is notifiable to the Health and Safety Executive.

Image:SDS Water Infrastructure systems



3.3 The SuDS Design Process

The SuDS Design Process can be broken down into the following four Stages:

1. Strategic Objectives 2. Concept 3. Outline Design 4. Detailed Design

The flowchart diagrams that follow describes best practice for the SuDS design process based on the **CIRIA SuDS Manual**.

Figure 3-1: Design Stage 1. Set Strategic Surface Water Management Objectives Discharge Hierarchy

Figure 3-2: Design Stage 2: Conceptual Design – Initial Design and Layout

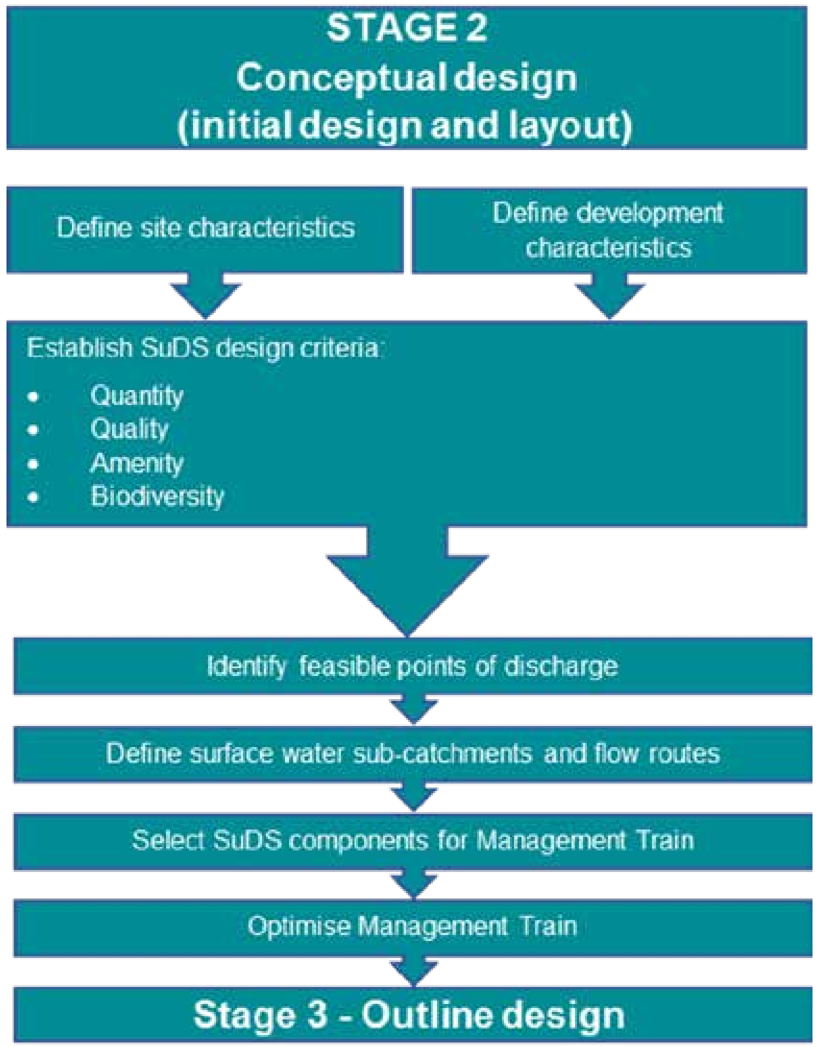


Figure 3-3: Design Stage 3: Outline Design – Including Sizing and Optimisation

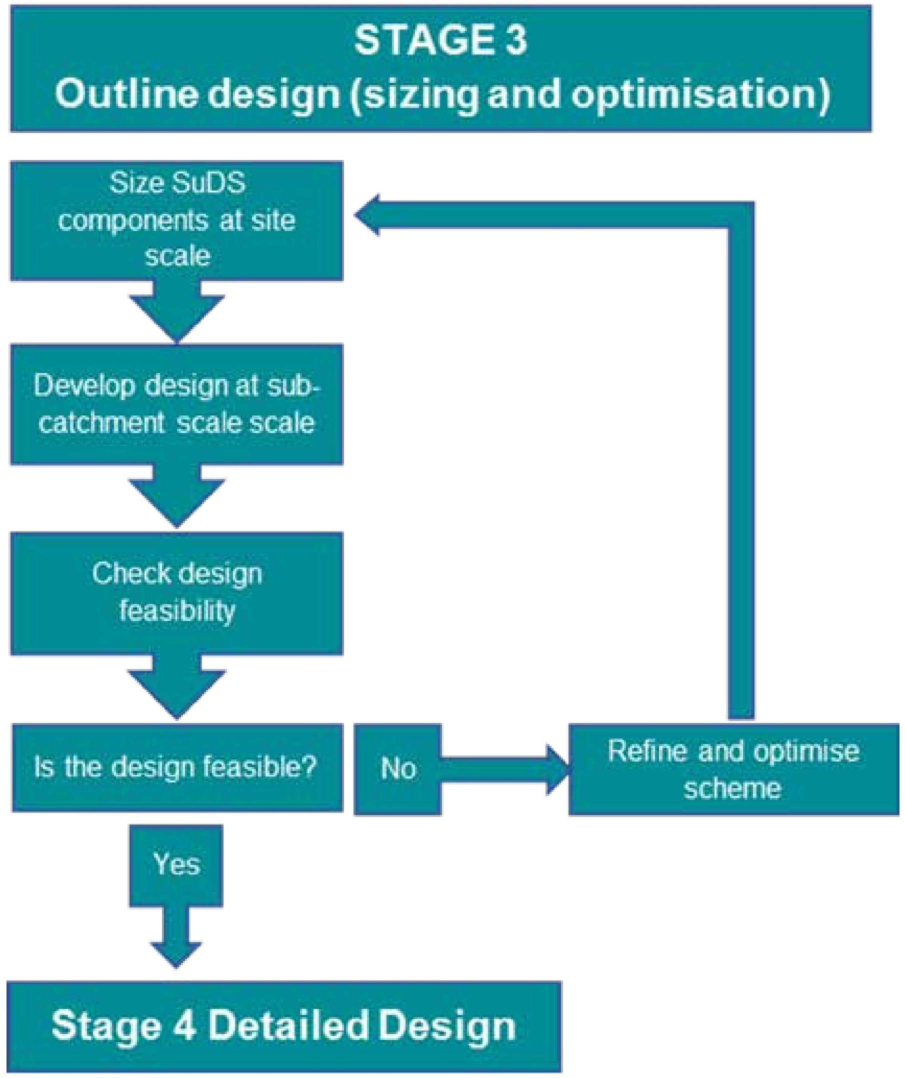
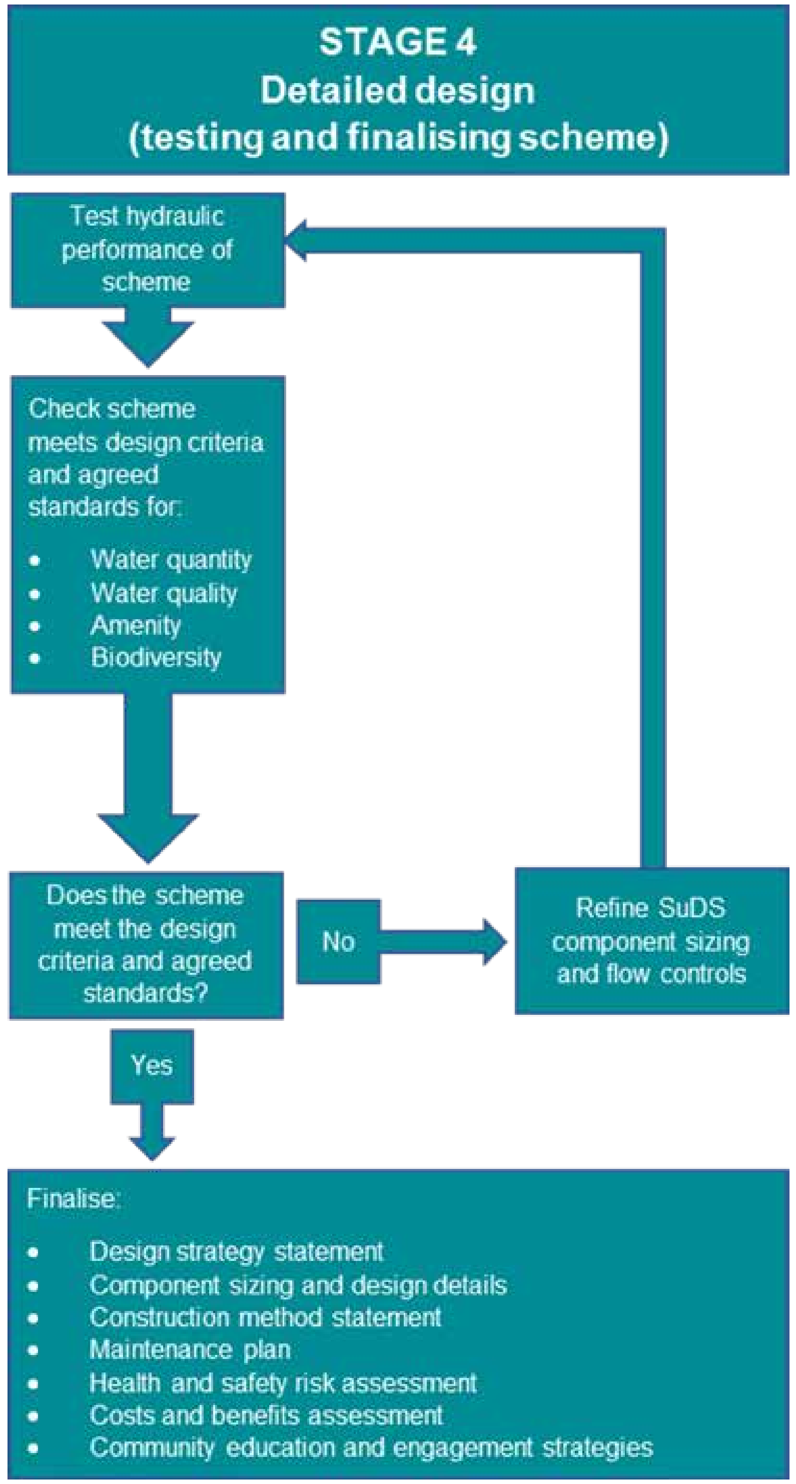


Figure 3-4: Design Stage 4: Detailed Design - Including Testing and Finalisation of the Scheme



3.4 Design considerations

There are a variety of SuDS components which may be used independently or as a combination to fit into a SuDS management train.

The list below summarises the actions and considerations which should be made when designing SuDS.

- Plan SuDS at development proposal inception,
- Enhance landscape through SuDS design,
- Ensure access and maintenance is feasible,
- Promote and encourage biodiversity,
- Reduce waste produced from SuDS,
- Replicate natural drainage and avoid pipes / pumps,
- Promote water re-use,
- Maximise benefits and multi-use features,
- Ensure iterative design process.

3.5 The Sustainable Drainage System Management Train

Sustainable drainge systems for both public and private areas should utilise a management train of components to follow and reinforce the natural pattern of drainage. The train of components should be designed to reduce the adverse effects that additional runoff from a development would have on land and watercourses.

The SuDS Management Train follows a hierarchy of techniques:

- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent run-off and pollution
- **Source control** – control of run-off at, or very near, its source
- **Site control** – management of run-off within the site
- **Regional control** – management of run-off in the locality

All developments must give priority to prevention to reduce the need for mitigative structures. **The requirements for drainage should be considered whilst determining the overall layout of the development because the site's natural features; geology, topography, soil types and existing habitats, will dictate some aspects of the drainage system design.**

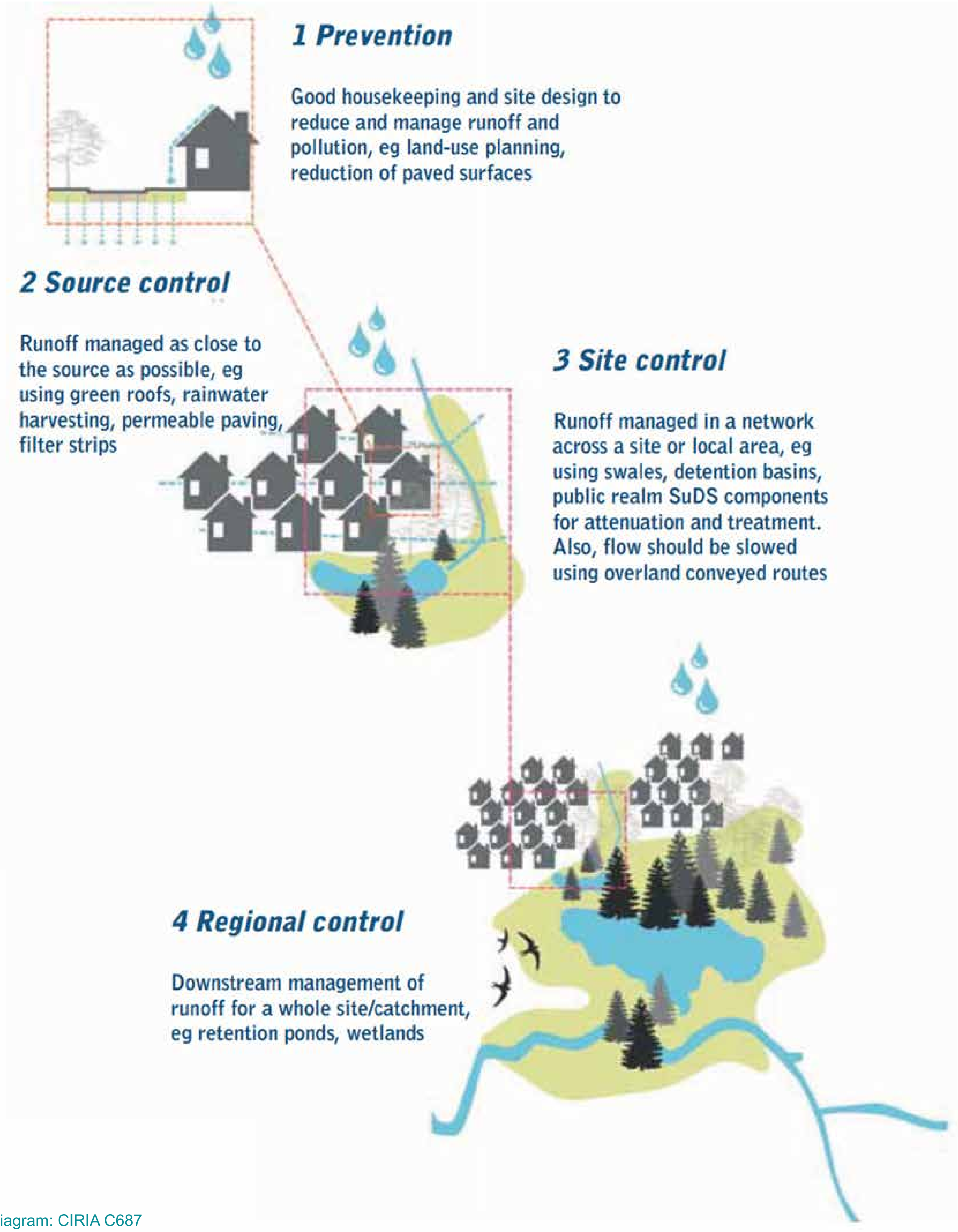


Diagram: CIRIA C687

3.6 Types of Drainage Control

3.6.1 Prevention

Preventing adverse impacts is the first priority when considering the sustainability of any development.

The first consideration for improving the sustainability of a drainage system for your site is preventing surface-water run-off is.

Preventing surface run-off reduces the pressure on water catchments, and on the sewerage system in times of flood. Prevention also reduces the need for SuDS components within your site.

To prevent or reduce surface-water run-off:

- **Assess and understand the natural drainage of your site and plan your layout to integrate with it**
- Minimise footprints for buildings - floor area should be a true reflection of need
- Utilise green roofs - technology is widely available and can also provide insulation, carbon absorption and visual integration
- Minimise the extent of hard-surfacing, e.g. use soft centrelines within wheel-strips for driveways and reduce paved-patio sizes
- Utilise softer surfacing, e.g. reinforced grass and grid-type vehicular surfacing
- Retain the maximum extent of natural soils
- Manage soils to preserve & improve their depths, porosity and permeability and long-term health
- Retain the maximum scale of existing vegetation on site
- Increase vegetation where possible and appropriate, e.g. hedges rather than fenced boundaries, trees where space allows, climbing plants and living walls

Figure 3-5

SuDS design teams should assess your site, integrate your development with its environment and maximise run-off prevention measures

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Directory link here for

Flood Consultants.

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Masterplanning with SuDS

https://www.kent.gov.uk/__data/assets/pdf_file/0007/23578/Masterplanning-for-SuDS.pdf

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Landscape Architects are trained in physical landscape assessment for all situations:
urban, peri-urban or rural
and can create an integrated masterplan for your site.

For masterplanning guidance refer to:
https://webarchive.nationalarchives.gov.uk/20110118111818/http://www.cabe.org.uk/files/creating-successful-masterplans.pdf

To find a Landscape Architect search the Landscape Institute directory:
https://my.landscapeinstitute.org/directory

Key Prevention Measures for All Sites:

Manage Soils: The effects of poor soil-management include death of soil-ecology and loss of soil-structure, which lead to waterlogging and flooding and an inability to support health vegetation.

Retain Vegetation: hedgerows and trees take decades to establish and develop as habitats and are essential elements of the natural drainage system, improving soil structure for infiltration and absorbing and transporting water

(downtoearth.co.uk)

Minimise Hard Surfaces:

To avoid and reduce the adverse impacts of hard surfaces, the scale of built development must be the minimum required, including roofs, approach roads, parking & turning areas and pedestrian paving.

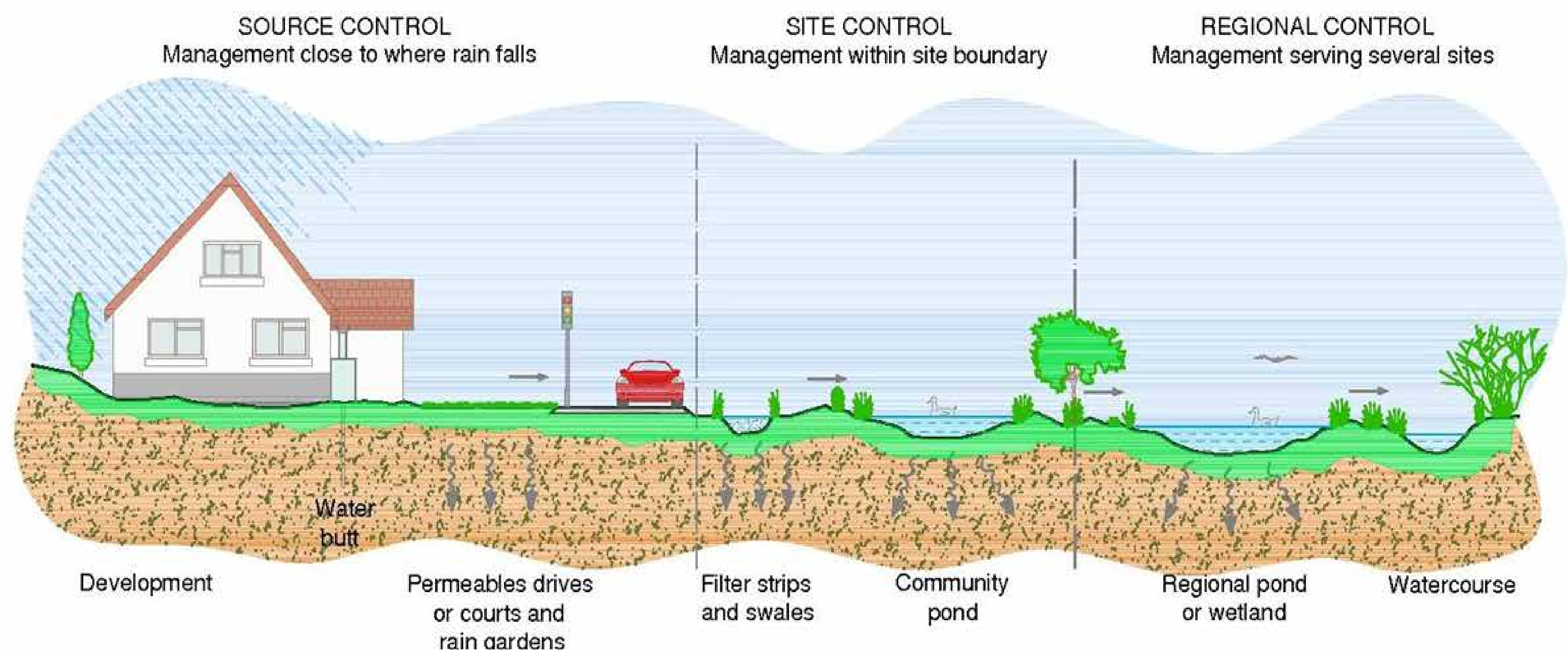
Royal Horticultural Society Research Project:
Greening Great Britain / RHS Gardening

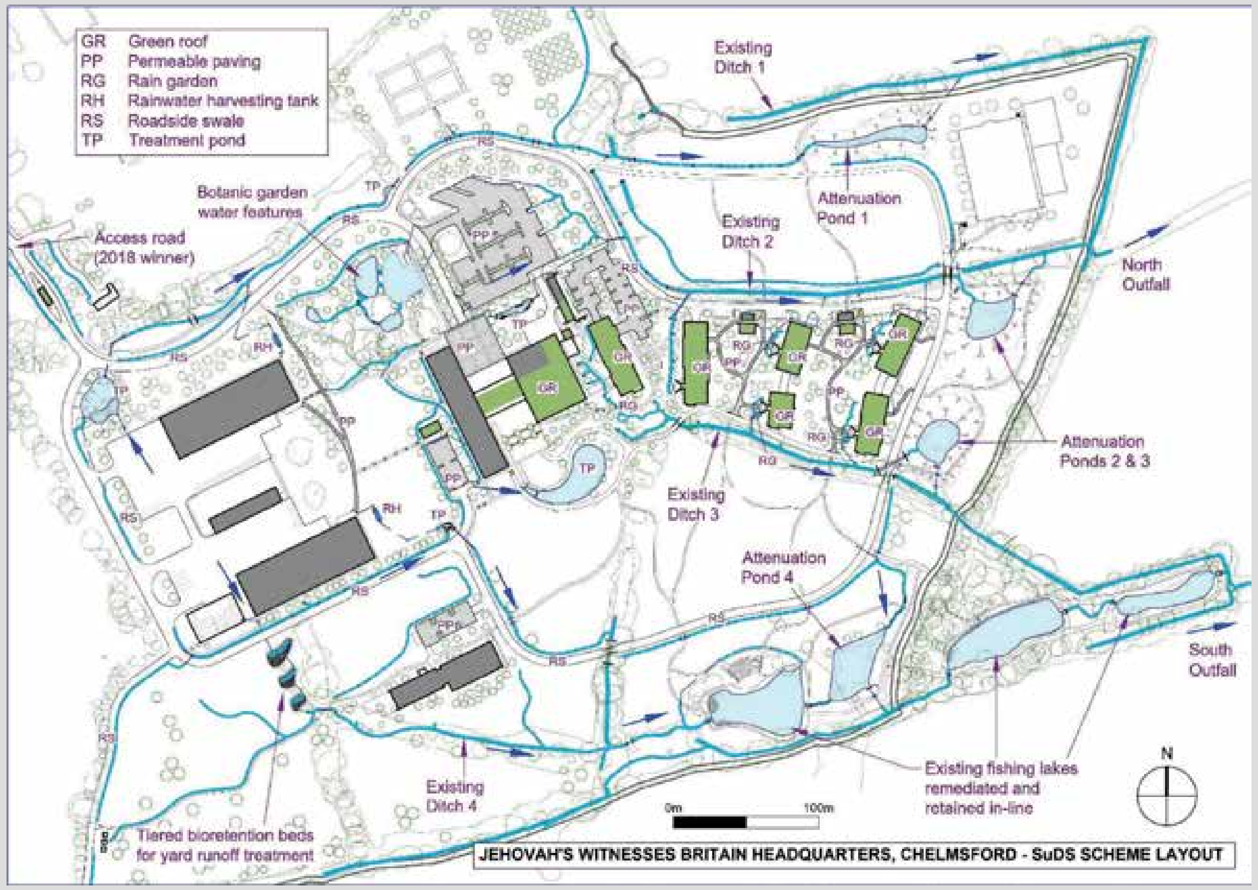
Scott Mitchell, Bridgehampton
'Ribbon driveways' and access roads reduce hard-surfacing by 60-70%

Maximise soft-surfaces: retain soft ground and utilise alternative design, new materials and green technologies

Figure 3-6 Control Zones

Once all prevention opportunities have been explored and incorporated into your development's design, there are 3 zones of water control to consider: *Source*, *Site* and *Regional.*





An example of a SuDS Train scheme (Image: susdrain.org)

3.6.2 Source control

Source control uses sustainable drainage system components to manage your site's rainwater close to where it falls. Source control components effect the speed of run-off by helping to **intercept, capture and temporarily store water close to its fall-point**.

Source control components can also **reduce run-off quantity** and **improve run-off quality**.

Examples of source control components include:

- green roofs
- living walls
- permeable surfaces
- rainwater harvesting

Many source control components can be utilised for both new developments and retro-fitting to existing development.

Aberyswth University (Singleply.co.uk)

Green roof technology reduces run-off by retaining some infiltration, evaporation and plant-transpiration over the footprint of the building

Image courtesy of K. Swindells (2021)

Permeable paving reduces run-off by allowing infiltration on what would be an otherwise impermeable surface

3.6.3 Site control

Site control components can further **reduce run-off** from your site, **temporarily store excess water** and **guide the flow of any remaining run-off**. Site controls are also needed to **manage any run-on from neighbouring land**.

There are a variety of SuDS components which act as site controls and can be incorporated in any drainage system. SuDS components should be selected for their appropriateness in the context of your SuDS management train and should integrate with your site's context, considering land character and availability, maintenance needs and adoptability.

To reduce and control development run-off within your site, infiltration systems are encouraged. The following are examples of site control components:

- **swales and filter strips**
- **canals, rills and channels**
- **raingardens**

Where infiltration does not provide sufficient reduction of run-off, water-storage components should be incorporated in your SuDS management train. Subject to site constraints and the results of a risk assessment, ponds can provide the most effective water treatment. Underground storage does not provide water quality benefit and can only be used in conjunction with other SuDS.

In order of preference, storage components include:

- **attenuation basins**
- **underground storage**

3.6.4 Regional control

Regional control components **gather run-off from multiple local sites, guide the flow of regional run-off** and **temporarily store regional run-off.**

Regional controls also affect run-off **quality**, through sedimentation, filtration or sewage treatment. Regional control components include:

- **detention ponds**

Large-scale regional controls can have multiple benefits, including providing resources for wildlife and recreation

Larger-scale regional control components can become biodiverse habitats, including temporary or permanent waterbodies, wet woodland such as alder carr, extensive wet grassland, bogs and fens. Such habitats can benefit many priority species in local biodiversity action plans

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For further advice regarding providing resources for biodiversity and recreation, refer to the Royal Society for the Protection of Birds (RSPB) and Wildfoul and Wetlands Trust (WWF) publication 'SuDS: Maximising the potential for People and Wildlife'

https://www.rspb.org.uk/our-work/our-positions-and-casework/our-positions/land-use-planning/sustainable-homes-and-buildings/

The design of SuDS components for source, site and regional controls is described in Chapter 4.

3.7 Discharge and Run-off Considerations

The preference for the discharge of surface water run-off is to the ground via infiltration. However, this may not be entirely possible for all sites due to soil-permeability, contaminated land, topography of the area or quantity of sediments and contaminants within the surface water.

As shown in the run-off destination diagram (Figure 3-7), other options of discharging to a surface water body, to a surface water sewer, or a combined sewer (in that order of preference) should be explored where infiltration is not fully possible. Surface water should never be discharged to the foul sewer. Connections from developments are not permitted onto highway drainage unless they comprise solely water from highway gullies.

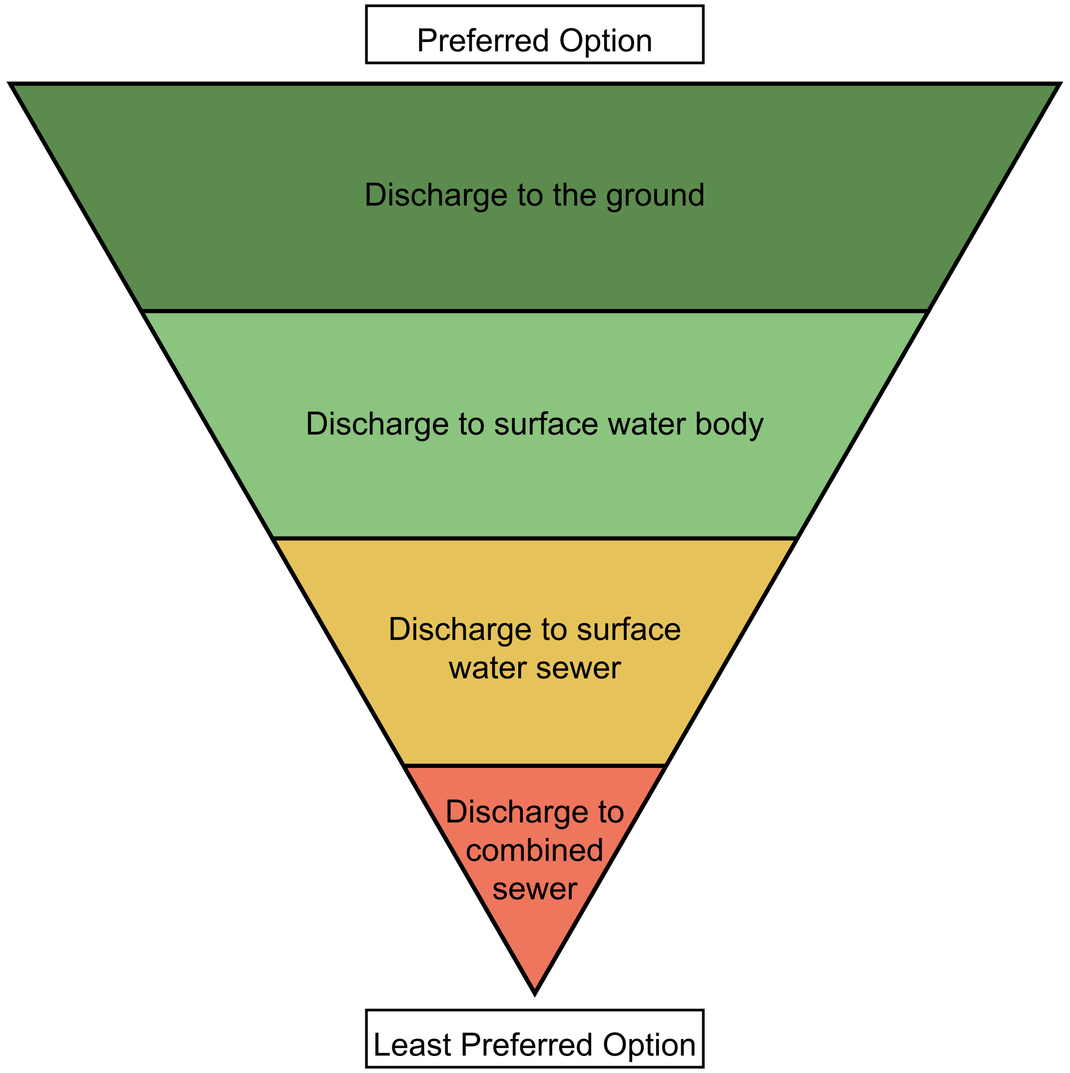
Considerations and actions that should be undertaken include:

- Calculations of pre- and post-development run-off rates to ensure a neutral or better impact as appropriate.
- Consideration of the method of attenuation.
- Identification of whether the site lies within the coastal / tidal, fluvial or surface water (pluvial) flood outlines, or affected by groundwater.
- Consideration of the effects of climate change upon surface water volumes and flow pathways.
- Consultation with the relevant bodies depending on the location to which surface water is to be discharged:
    1. To the ground - consultation (where relevant) with the Environment Agency, National Coal Authority, British Geological Survey, Cheshire Brine Subsidence Compensation Board
    2. To surface water bodies - consultation (where relevant) with the Environment Agency or Council or Lead Local Flood Authority or Canal and River Trust for near / to canals or appropriate navigation authority
    3. To a surface water sewer or combined sewer - consultation (where relevant) typically with United Utilities, Dwr Cymru Welsh Water or the Highways Authority (for highway drainage only).

Once the preferred method of discharge has been decided, the following details are required to be included as identified on the **SuDS Checklist** detailed in **Appendix A** of this guidance:

- Peak run-off flows calculations and results to demonstrate pre- and post-development run-off rates in relation to greenfield run-off rates. For re-development sites, existing brownfield rates will be taken into consideration (See Section 3.8).
- Discharge volume calculations and results
- Simulation modelling of runoff (major applications)
- Flood risk (from surface water, coastal, river and groundwater sources)

Figure 3-7: Discharge Hierachy



Traditional Discharge to stream (Image: LLong)

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The **SuDS Submission Application and Approval Checklist (the SuDS Checklist)**

Checklists can be found on the Susdrain website below:

https://www.susdrain.org/resources/SuDS_Manual.html

This **SuDS Checklist** identifies the requirements for SuDS to be submitted as part of a planning application to the Council in line with the National Standards, Local Policy and these guidance documents.

3.8 Site challenges for Designing SuDS

Attenuating flood flows and volumes

Addressing surface water runoff

- Proximity to sites with existing surface water issues
- Proximity to homes and other urban features
- Runoff caused by adopted highways and other impermeable surfaces

Consideration of groundwater

- Potential entry of pollutants to groundwater through infiltration of surface runoff
- High groundwater levels
- Additional restrictions of Groundwater Protection Zones

Topography

- Conveying water on ground without a gradient
- Conveying water on ground with a steep gradient

Conditions of the ground

- Highly cohesive soils restricting infiltration
- Contamination

Constrained space

- Limitations of space within site area

Existing / buried infrastructure

- Buried utilities - particularly water pipes that could come into contact with SuDS
- Predominantly impervious sites

An important criterion for all sites is the quantity of run-off. Storm flows can trigger combined sewer overflows, causing foul pollution and they can also overload wastewater treatment works, reducing treatment efficiencies. In exceptional circumstances the water authority might request that the run-off is detained completely and released only at night.

Brownfield sites

On uncontaminated brownfield sites, the water quality design criteria will depend on the existing sewerage infrastructure. If the water is discharged to a separate surface water sewer or directly to a watercourse, the site should be treated as an undeveloped site and the quality criteria will relate to the proposed land use.

If the site drains to a combined sewer that is unlikely to be converted to a separate system, the surface water should be treated with a single stage of treatment to remove grit and coarse solids. Foul sewage should be drained separately within the site.


(Image: LLong)


(Image: LLong)

Contaminated land

Where a contaminated land site is proposed for redevelopment, SuDS may still be used for drainage of surface water. However, the design of the drainage system will be site-specific and dependent upon the contaminants at the site, the remediation strategy and the risks posed by any residual contamination, in addition to normal design considerations.

The developer will need to consult with the planning authority and demonstrate that the proposed drainage system will not cause re-mobilisation of contaminants resulting in exposure to the wider environment. Infiltration systems may not be appropriate without remedial measures, and most techniques will require the use of liners. Remediation and redevelopment of contaminated land is a complex subject that requires specialist knowledge. The CIRIA publication SP164 (Harris et al, 1998) should be referred to for further information.

WAYMARKER

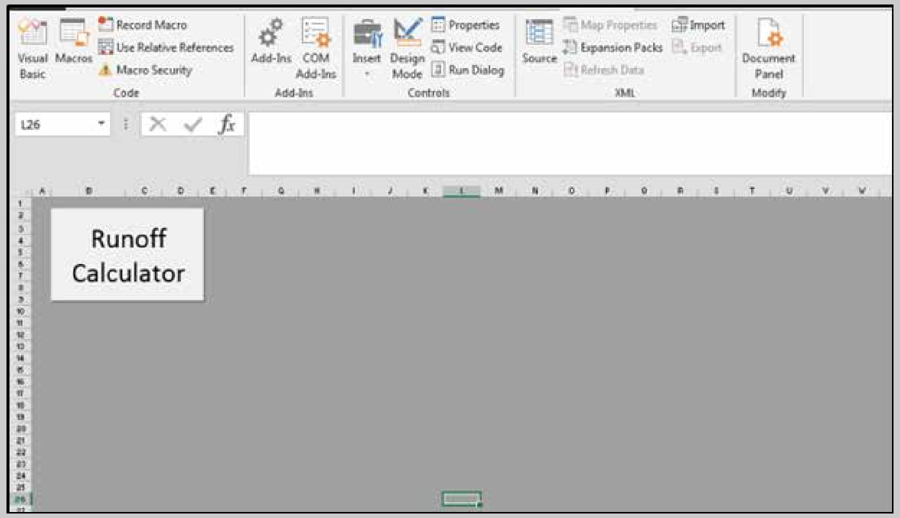
The gov.uk webpages contain extensive guidance regarding Brownfield and Contaminated Land. Here is a starting point for finding-out the condition of your land:

Performance standard for laboratories undertaking chemical testing of soil - brief guide for procurers of analytical services (publishing.service.gov.uk)

Run-off Calculator Guide

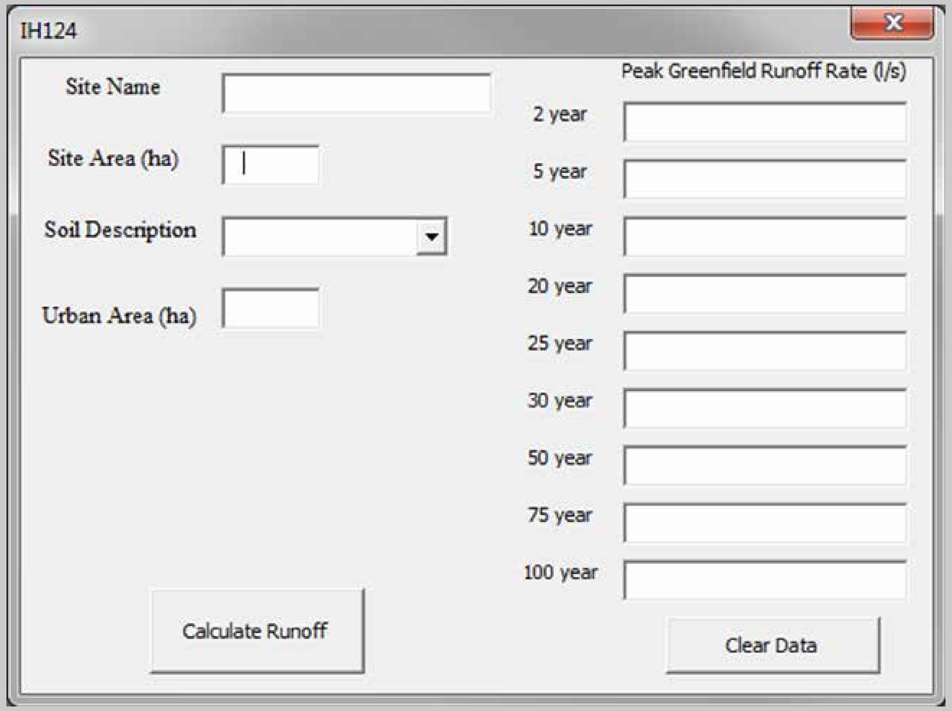
The Run-off Calculator is a programme constructed in Microsoft Excel. The run-off calculator can be downloaded from XXAdd URLTo use the programme, open the file “Run-off Calculator.xlsm” and ensure macros are enabled. When open, the file should look similar to Figure B-1.

Figure B-1



To use the Calculator, press the “**Run-off Calculator**” button. A window should be displayed similar to Figure B-2.

Figure B-2



This window in Figure B-2 should be completed as follows:

Site Name:	A name for the Site.
Site Area:	The area of the site in hectares.
Soil Description:	Select the best description of the prevailing ground conditions for the Site.
Urban Area	The area of impermeable surface within the site in hectares.

Once these have been completed press the “**Calculate Run-off**” button to calculate the peak Greenfield Run-off Rate in litres per second for the displayed return periods.

Effects of excess run-off: Landslip (Image: LLong)

Effects of excess run-off: Soils Erosion (Image: LLong)

4

COMPONENT DESIGN

4 Component Design

WHAT THIS SECTION WILL COVER:

- Choosing SuDS components
- The SuDS selection matrix
- Considerations for discharge
- Local SuDS zones
- Types of Permitted SuDS and technical requirements

4.1 Choosing SuDS components

SuDS design should focus on easy and efficient maintenance, to achieve low operation and maintenance costs and provide a safe operating environment for residents, visitors and the maintenance operatives.

One of the key elements of designing a site with SuDS is the decision about which components to use. As described in the previous chapter, there are a variety of SuDS components but not all will be suitable for all sites. It is therefore vital to have a comprehensive understanding about the nature of the site, particularly if there is contaminated ground and to ensure that a constant review is undertaken from project inception to SuDS operation. **Figure 4-2** describes the best practice for this decision-making process based on the **CIRIA SuDS Manual**.

Indicative schematic design layouts for the SuDS components described are included in **Appendix C**. Source control options are detailed in the SuDS Suitability Selection Matrix as detailed at the end of **Section 4.**

When undertaking a SuDS design using this guidance, developers should be mindful of the following:

- Pumping stations are not covered in this document
- If your surface-water drainage strategy requires a pumping station, you will need to gain approval from Cheshire East's Lead Local Flood Authority

Example of SuDS from urban to rural

Incorporating Amenity and Recreation

When designing SuDS solutions as part of place-making, there is an opportunity to celebrate water, to educate and engage both new and existing communities, to create opportunities for people of all ages to interact with water, to be playful.

Water can bring nature, movement, light, noise, drama, mark the changing seasons, add to the richness of a place and offer a more immersive experience to the user. People are drawn to water: looking at it, being near it, or even dipping fingers or toes into it. It can ignite the imagination, the senses, offer a sense of freedom and exhilaration or create places of calm reflection and playfulness. Its fluidity presents opportunities for self-initiated creative play and inclusion or creation of public art features.

As with all design, consideration of how people might use and respond to SuDS is a key consideration which should be taken into account from the outset of development planning. All ages benefit from a more creative, thoughtful integration of water and of SuDS into their environment, though particular consideration must be given to more vulnerable adults and children.

The CDM (Construction Design and Management) Regulations help all project managers, clients and designers to ensure all foreseeable risks are assessed. Any unacceptable risk should then be removed through design (designed-out) and where this is not achievable, remaining risks must be mitigated and managed. A Health and Safety file must be produced and a copy submitted to the Local Planning Authority.

SuDS should positively contribute to the amenity of developments and, whilst there are risks involved with water, with careful design, risk management and appropriate maintenance, SuDS could incorporate opportunities for community recreation, fun, and add distinctiveness and character.

Currently, the majority of drainage solutions proposed for residential developments in Cheshire East comprise pipes to detention basins. This solution can present a high risk in terms of amenity and recreation due to their potential flow-rates and depths of water and, as a consequence, these areas are often fenced off.

Image:J.Taylor

One of the objectives of this SuDs guide is to help developers move away from a 'one component fits all' solution, towards the design of an integrated, site-wide SuDS train of that combines a number of components to negate or mitigate the need for large detention-basins.

In emulating the way the natural environment absorbs water, the SuD System should naturally reduce the risks associated with recreation and spreads it across the site. Thoughtfully-designed and well-managed solutions should open-up opportunities to include safer amenity and recreational elements for all sectors of our communities to enjoy. It should be supported by engagement with new and existing communities, by materials that creatively explain their purpose and presence and be clear about the required and specific maintenance they will receive.

Increasingly, water-play opportunities are incorporated into urban play-schemes, however the most common route has been through the use of mains-fed features such as jets, fountains or paddling pools.

Mains water is an expensive and unsustainable resource. Mains-fed play features tend to be seasonal and predictable, simply spraying or wetting people during the summer months. These could be considered as part of larger public realm schemes where the increased installation costs, management and maintenance are sustainable and the use of an increasingly important resource justified. Using rainwater and SuDS for play offers more diverse opportunities. It can also be simple, cost effective and easy to implement provided it is designed-in from the outset and as part of a well-considered masterplan.

SuDS must remain safe and accessible for the life-time of the developments they serve. Cheshire East Council will only approve and adopt SuDS where the risks have been formally assessed by a suitably-qualified person, taking into account future amenity and maintenance requirements of all components of the system.

"A paddling pool, even if shallow, involves a low but inevitable risk of drowning but this [risk] is normally tolerable. The likelihood is typically extremely low, the hazard is readily apparent, children benefit through the benefit of water play and finally, further reduction or management of risk is not practicable without taking away the benefits" - *Health and Safety Executive*

Water can provide formal and informal play and learning opportunities, ranging from naturalistic exploration akin to the understanding of risk taught at forest schools, to more contained experiences, such as dipping hands in rills and channels. SuDS systems and nature ponds should be considered within every new school or educational facility where the learning opportunity is maximised.

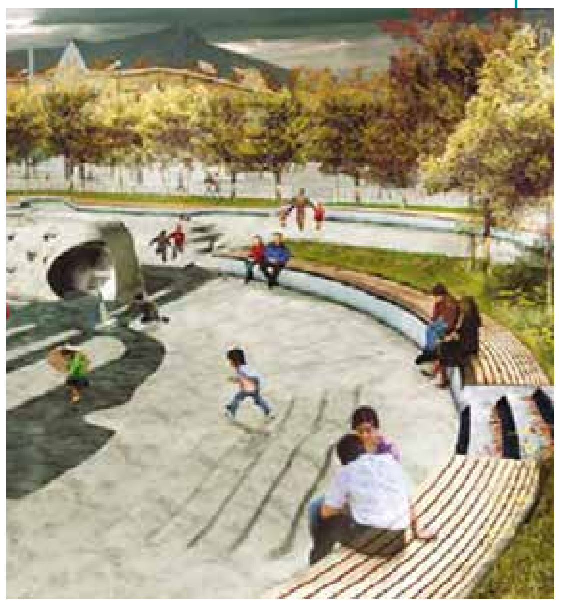
WAYMARKER

Further advice regarding designing-out and managing risk should be sought from current national guidance which includes:

hyperlink to HSE

hyperlink to ROSPA

hyperlink to CDM Regulations



Green roofs consist of a multi-layered system including an impermeable layer, a drainage layer and a growing medium. They are designed to mimic predevelopment hydrology by intercepting and collecting precipitation; attenuating peak flows and decreasing surface water run-off. The main advantages of green roofs are high value local biodiversity, treatment of rainwater, increase in local air quality, and increased economic and aesthetic value of development (for full list of benefits please see page 233 of CIRIA SUDS Manual).

WAYMARKER

SEE MATRIX ID 9

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**

Key Characteristics

- Green roofs and walls are very effective as part of a comprehensive SuDS approach
- Potential to add significantly to ecological framework for a development
- Vaiety of options to create living surfaces
- Loadings upon structures for living roofs, need to be purpose designed
- Certain types of living wall need specialist design to enable maintenance and irrigation

Main Considerations

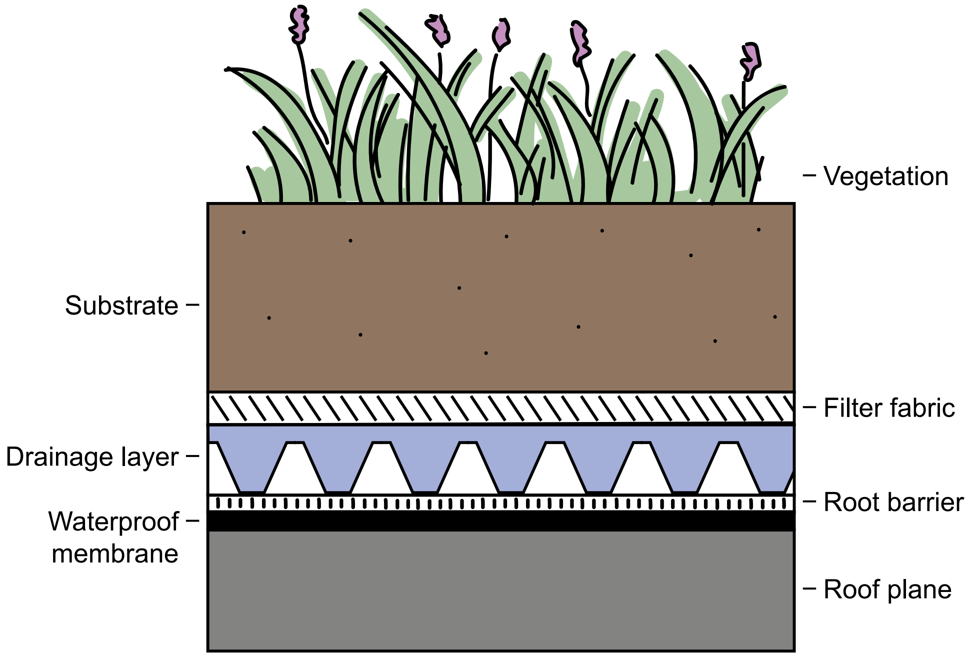
- Solar aspect important for determination of planting specification
- Choice of growing mediums will effect water storage capacity and planting choices

Key Benefits

- Can significantly reduce run-off and improve biodiversity for all types of new built developments
- Can be retro-fitted to existing built development
- Multi-functional: also providing the amenity and place-making benefits of additional living surfaces
- Scope for these to be included within functional structures associated with development and within the public realm (e.g. bus stops, toilet-blocks etc.)
- Green-roofs and living-walls are also supported in the CEC Design Guide Volume 2 Chapter 4 (p.63)

https://www.urbanplanters.co.uk/blog/new-breeam-scheme-set-reward-addition-green-roofs-walls/

Image: S.Cottle



Example Green Roof Cross-section (not to scale)

Technical Requirements: Green Roofs

There are two key categories of green roof available for installation:

Extensive Green Roofs - These generally have low loadings on the building structure due to shallow substrate depths. They typically feature a 20-150mm thick growing medium. They include resilient, slow growing, low maintenance plants e.g. succulents, herbs, mosses and grasses.

Intensive Green Roofs – These generally have deeper substrates and therefore heavier loadings on the building structure. They typically feature a deeper substrate (150mm plus). They can support an advanced landscape environment that can provide high quality amenity and biodiversity benefits.

Siting: can be suitable for:

- Residential (including high-density residential)
- Commercial
- Retrofit (providing there is sufficient structural capacity for the roof to support them).
- Contaminated Land
- Vulnerable groundwater

Design Considerations

Hydraulic design of green roofs should be focused on two aspects of performance:

- How the roof is expected to perform during an extreme rainfall event.
- How the roof is likely to perform throughout the year and during both summer and winter rainfall periods when the roof is likely to be saturated.

May need to provide an additional outfall/overflow pipe into site wide surface water drainage infrastructure for these extreme events).
Exceedance flows should be safely accommodated for onsite when events larger than those designed for may occur.

Pre-treatment, Inlets and Outlets

There is no requirement for pre-treatment or inlet, unless there are plans to use water for irrigation purposes.
Outlets – Outlets should be signed in order to reduce the possibility of blockages. They can include flow control devices to dictate downpipe flows and deliver attenuation capacity.
Outlets must be separated from the growing medium to prevent plant root obstructions and free gravel blockages.

Maintenance requirements

- The most intensive maintenance is required within the first 12 to 15 months during the establishment phase.
- Maintenance schedules should always be specific to the individual green roof design.

See Table 12.5 (pg.252 of CIRIA Report C753) for example maintenance schedule.

Safety

- All maintenance arrangements at roof level must be in full compliance with the appropriate health and safety regulations.
- Access routes to the roof must be safe and should be clear of obstruction at all times.

See p.g. 251 of CIRIA Report C753 for further guidance.

Landscaping and Amenity

- Significantly improves roofscape for local communities.
- Delivers natural environments for people to use or visit, improving their health and wellbeing.
- Can be combined with Rainwater Harvesting to provide a source of water for non-potable uses.

If designed effectively they can help deliver of key amenity principles; such as;
Improved air quality – via the increased absorption of CO_2 and various air pollutants found in dense cities.

Climate Resilience - Has the possibility to significantly reduce energy demand if designed correctly due to increased thermal efficiency.

Helps to reduce Noise Pollution.

Economic Benefits

High aesthetic value increases property/rental prices.

Reduced energy costs due to increased heat conservation.

4.2.2 Source Control - Rainwater Harvesting

Rainwater harvesting is the collection of rainwater runoff from impermeable surfaces via interception which can be used as a sustainable water supply, whilst also reducing the volume of surface water run off on site and in turn reducing flood risk. Rainwater harvesting supports SUDS systems and helps to provide interception storage.

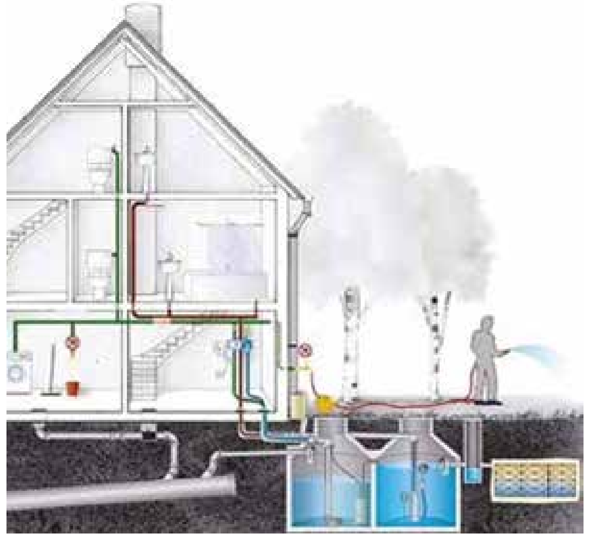
Rainwater can be collected in water butts for watering gardens or more complicated systems can be installed for re-using water to flush toilets or for supplying water for outside use.

WAYMARKER

SEE MATRIX ID 10

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**



Rainwater harvesting can take on many forms in a variety of situations:

Within a residential context this may include the provision of individual water butts to collect rainwater from roofs.

A commercial application could be the use of storage ponds to accumulate water for reuse as an alternative water supply for a garden centre.

https://www.renewableenergyhub.co.uk/main/rainwater-harvesting-information/large-scale-commercial-rainwater-harvesting/

Key Characteristics

- In its simplest form this could be provided to every new property as a water butt(s)
- More complex harvesting systems provide benefits within and outside of buildings
- It can be part of a combined system that also includes ‘grey’ water
- Applications can be for residential and non-residential development

Main Considerations

- Controlling contaminants and managing flow into the tank are important parts of the design
- Ground/hydrological conditions need to be suitable if below-ground tanks are proposed
- Excavation proposals must include appropriate soils’ management and re-use
- The more complex the system, the greater the purchase and management cost
- System type should be designed to suit the nature and context of the development
- More complex systems require water quality monitoring, depending on use

Key Benefits

- Many new developments are taking place in the Borough, where even simple harvesting could make a significant cumulative impact
- There are a number of large-scale commercial sites where harvesting systems could be utilised
- Rainwater harvesting is already discussed as part of Chapter 5 Volume 2 of the CEC Design Guide
- In many areas ground conditions should be favourable for more complex systems (tanks below ground)

Technical Requirements: – Rainwater Harvesting

There are three key types of RWH system; composite systems, gravity-based systems and pumped systems.
Gravity systems are designed so that the rainwater is collected by gravity and stored at elevation (e.g.in roof space or just below gutters) so that it can also be supplied by gravity.
Pumped systems tend to store water at ground level or underground, where it is then pumped out for supply purposes.
Composite systems use both gravity and pumped features in their design
The primary parameters used for calculating the size of the storage are:

- The rainfall volume that is to be captured.
- Average annual rainfall (AAR)
- Daily need for non-potable water
- Building occupancy number
- Contributing surface area

Hydraulic and water quality design criteria

There are various methods available to design a RWH system; the most accurate is via modelling.

Selection and siting

Rainwater harvesting is a SUDs component that can be used in a variety of development settings e.g. residential, commercial or industrial development.

- Storage tanks should be placed in secure locations and are commonly fitted underground, on roofs and adjacent to buildings.
- Geotechnical ground investigations are needed to establish site selection for RWH units (tanks should not be placed on made ground).
- Careful consideration should be given to the ground water table when using underground units as flotation issues may arise, if the ground water level is shallow on site.
- Structural considerations (e.g. depth of building foundations) should be given to RWH tanks sited parallel to buildings.

Pre-treatment, inlets and outlets

Primary screening devices are used to avoid leaves and from entering the tank. Primary screening devices often have a wire mesh screen installed near the downspout.
First flush devices can be designed to divert the first part of the rainfall away from the main storage tank; this normally contains the largest amount of dirt, debris and contaminants. This must then be safely treated and managed downstream.
RWH systems need either an inlet valve that closes flow into the container when it is full, or an overflow arrangement that conveys excess surface water runoff away from the building without causing damage.
Landscaping and Amenity

- Support the resilience of developments and their landscape to variabilities in climate and water resource availability.
- Create opportunities for learning in educational and community settings.

Safety

RWH systems should be installed using safe construction methods and manufacturers guidelines should be adhered to.

Operation and Maintenance

- Access to RWH components should be safe and easily accessible to ensure regular maintenance and inspection can be carried out.
- Maintenance requirements are specific to each individual RWH system.
- Routine inspection of the filter system should be carried out every 3 months.

Any property with an RWH system installed should be provided with appropriate information as to what equipment as been installed. This information should include:

- Its purpose
- Its maintenance requirements
- The actions required to rectify any potential failure
- The expected performance of the system.

https://www.escofet.com/en/products/walking/permeable-paving/checkerblock

Permeable paving allows water to infiltrate through its surface into a sub-base below. Water then either infiltrates into the ground or passes through to an outfall.

Permeable pavements can be very effective at controlling surface-water run-off.

It is now a legal requirement in England that new and refurbished driveways in front gardens must be designed to be permeable.

WAYMARKER

SEE MATRIX ID 11

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**

Key Characteristics

- A variety of permeable surfacing is available
- Allows infiltration into the sub-base where water is stored and released gradually either to the ground or to an outfall (usually another SuDS component)
- Permeable surfacing is effective at slowing run-off and can help remove pollution
- Cross-construction permeability is required i.e. base layers and membrane permeability as well as wearing course
- Permeable surfacing can add water-storage capacity

Main Considerations

- Extent of any artificial surfacing should be minimised to promote natural drainage, preserve soils and promote vegetation
- Excavation proposals must include appropriate soils' management and re-use
- Construction materials should avoid landscape impacts of quarrying virgin rock by utilising appropriate re-used or recycled materials in preference to new. Any new materials should be locally-sourced where possible
- Any stone used should reflect local geology where possible.
- Ensure any new stone is certified as ethically-sourced & supplied
- Permeable paving is not presently adopted as CEC Highway
- Incorporate outflow components to manage excess

Key Benefits

- Usable for parking areas, vehicular hard-standings, pedestrian walkways, driveways, patios and other non-adoptable surfaces
- Can substantially reduce run-off at source
- Can be retro-fitted to existing development
- In many areas, ground conditions should be favourable for infiltration, however, areas with poor soil-infiltration can consider permeable surfacing as an attenuation component

WAYMARKER

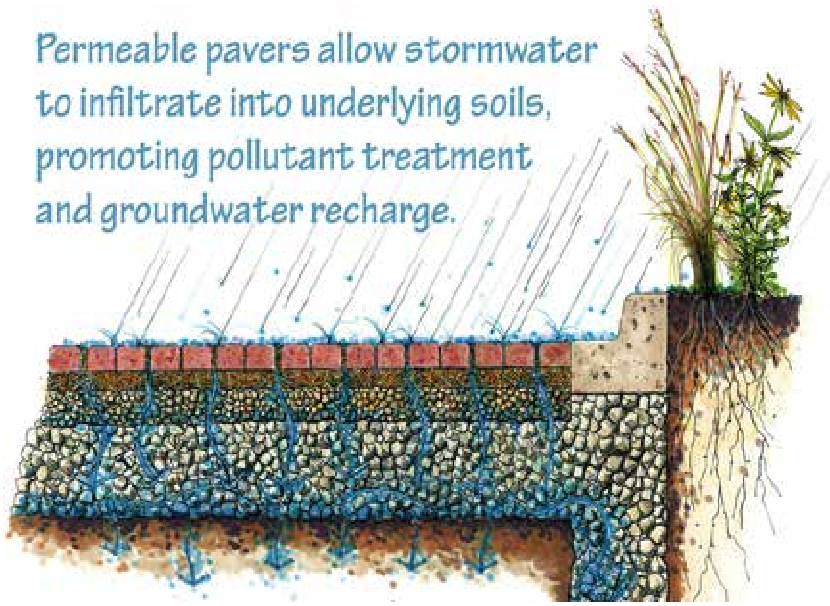
Porous and permeable surfaces:

Adoptable standards will be required for public highways.

https://www.cheshireeast.gov.uk/pdf/highways/policies-and-standards-documents/highway-surface-water-policy.pdf

The Paving Expert website contains information and inspiration for available materials and commercially-tested techniques:

https://www.pavingexpert.com/



https://specificationproductupdate.com/2019/05/01/permeable-paving-by-interpave/

Technical Requirements: Porous / Permeable Surfacing

Porous Pavements: infiltrate water through their whole surface.
Permeable pavements: have a surface that is formed of material that is itself impermeable to water. The materials are positioned to provide void space through the surface towards the sub-base.
Concrete block permeable paving must be designed in relation to British standard BS 7533-13:2009.
Materials commonly used include: porous asphalt, reinforced grass, gravel, concrete or clay block permeable paving.

Hydraulic and water quality design criteria

There are three surface water management methods which can be adopted:
1) All surface water run off infiltrates through the structure and permeates into the ground. An overflow pipe may be required to manage surface water run off flows during extreme rainfall events.
2) Surface water run off which exceeds the infiltration capacity of the subsoils discharges to the receiving drainage system e.g. watercourse or sewer.
3) No infiltration to the subsoils occurs, instead water drains through the subbase and is then carried through perforated pipes to an outfall.
There are four features to the hydraulic design of pervious pavements to consider:
1) Calculation of the infiltration rate through the permeable pavement structure.
2) Calculation of the storage volume necessary to accommodate flows up to 1 in 100yr (plus percentage for climate change).
3) Calculation of the discharge rate to the outfall (l/s).
4) Exceedance design layout so that all surface water run off flows are contained and managed safely onsite without causing any increased flood risk.

- In order for the system to have a positive outfall for associated surface water run off, the infiltration rate of the soils onsite should be significantly greater than the design rainfall intensity.
- Stormwater calculations for a range of rainfall durations up to 1 in 100yr + CC event should be carried out to accurately determine the capacity of the storage volume required.
- Surface water flow paths during exceedance events should be planned for within the overall surface water drainage layout. This should ensure that flooding to property is avoided and safe access and egress from the development site is maintained.
- Where adjacent areas drain into the surface, the ratio of impermeable to pervious should be limited to 2:1 to prevent clogging.
- A minimum value of 2500mm/h is considered reasonable for a pavement surface to be considered pervious in relation to surface water management.
- It is advised that a factor of safety of 10 is applied to the surface infiltration rate of all permeable structures, to account for potential clogging of the pavements surface area over its design life.

Selection and siting

- Permeable paving is a suitable SUDs feature for a variety of sites.
- Pervious pavement should be limited to low traffic areas (unless permeable paving materials designed to withstand pressures from heavy loading vehicles can be installed).
- Within 10 feet of building foundation that is above proposed pavement location or 100 feet from a building foundation that is below the proposed pavement location.
- Within four feet water table's highest level.
- Ground investigations and infiltration testing should be carried out onsite inline with BRE 365 guidelines to determine the infiltration rate of underlying soils.
- Permeable paving should be avoided where there is a high risk of silt loads on the surface (unless regular maintenance can be guaranteed).
- Unlined pavements should not be used on brownfield sites unless it has been demonstrated that the risk of leaching of containments is managed within acceptable levels (this may need to be agreed with appropriate environmental regulatory bodies e.g. Environment Agency and LLFA).
- Permeable paving should not be used on sites where groundwater pollution is suspected.
- Unlined pavements are not suitable for use in areas which are susceptible to slope instability or close to building foundations unless a full risk assessment has been carried out by a geotechnical engineer.

Landscaping and Amenity

- Extent of any artificial surfacing should be minimised to promote natural drainage, preserve soils and promote vegetation
- Excavation proposals must include appropriate soils' management and re-use
- Construction materials should avoid landscape impacts of quarrying virgin rock by utilising appropriate re-used or recycled materials in preference to new. Any new materials should be locally-sourced where possible
- Wearing course must be in-keeping with local geology and landscape character
- Ensure any new stone is certified as ethically-sourced & supplied

Safety

Permeable pavements should be fitted using safe construction methods and in strict accordance with manufacturers guidelines.

Operation and Maintenance

- Require regular inspection and maintenance to preserve their infiltration capacity.
- The frequency of required maintenance is site specific but many of the maintenance activities can be undertaken as part of a general site cleaning contract.
- Maintenance plans and schedules should be submitted to Cheshire East's Local Planning Authority and Lead Local Flood Authority for review during the design phase.
- Table 20.15 (pg 430) of the CIRIA report C753 includes an example of a maintenance schedule.

Canals, rills and channels are hardscape open surface water channels used to store run-off within a constructed container. They can be integrated into public realm areas with a more urban character. They could be above or below ground and should be sized to the storage need, having regard to safety considerations. Often they are designed as linear features as part of a system including small pools to add significantly to the townscape and landscape quality, assisting the management of water flow and cleansing. Planting within the features creates the potential for distinctive, aquatic landscape and biodiversity enrichment. They are usually designed as linking components between other components within the SuDS train.

WAYMARKER

SEE MATRIX ID 21

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**

Key Characteristics

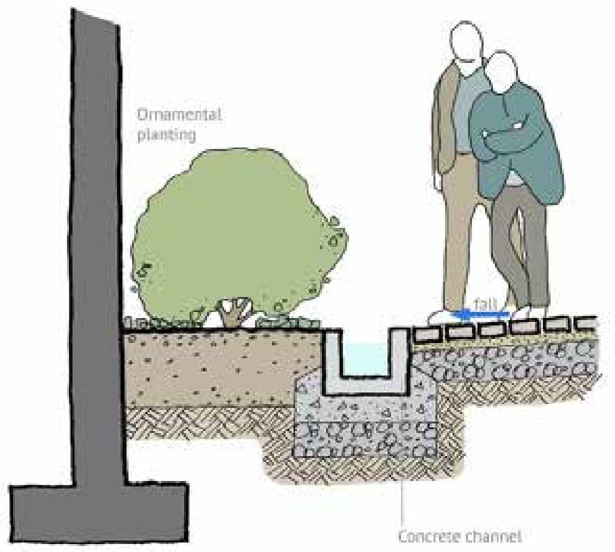
- Should be designed as an integral part of a SuDS system
- Can act as pre-treatment
- More complex storage and conveyance systems provide benefits within and outside of buildings
- Applications can be for residential, non-residential and public realm

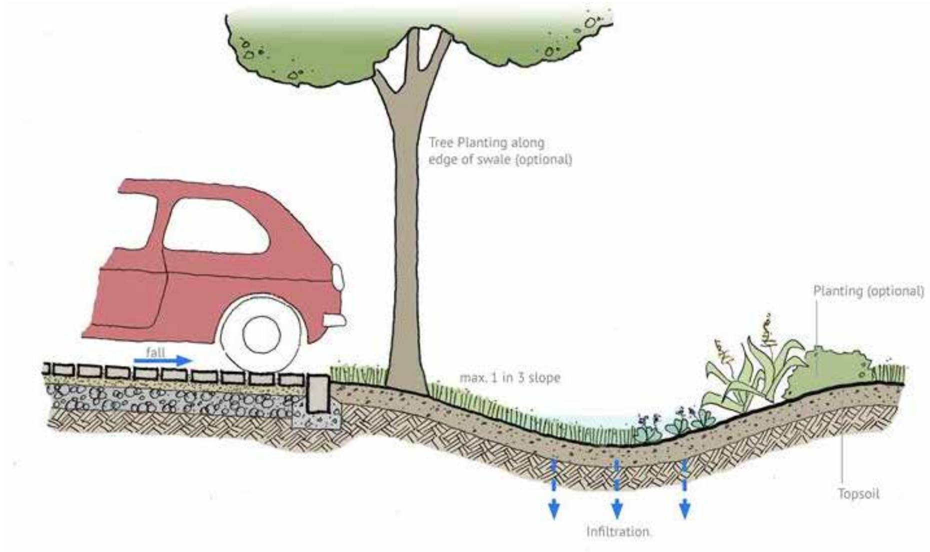
Main Considerations

- Easy to construct and manage as part of the public realm
- Excavation proposals must include appropriate soils' management and re-use
- Construction materials should avoid landscape impacts of quarrying virgin rock by utliseing appropriate re-used or recycled materials in preference to new. Any new materials should be locally-sourced where possible
- Choosing appropriate planting to prevent silt build up
- Need to give careful consideration to crossing points and people with mobility and visual impairment
- Potential complexities around adoption

Key Benefits

- Provision of above-ground solutions within higher density, space constrained contexts - predominantly urban
- Can be visually appealing and add to sense of place
- Amenity value and informal play potential for local communities





Images: susdrain.org

Technical Requirements: Canals, Rills and Channels

Canals, rills and channels are open surface water channels, usually crafted with hard edges. Their cross-sections can be adapted to suit topography, the scale of the scheme and to enable safe access for informal recreational use and management. Crossings and bridges can be incorporated to enable access to buildings and spaces and to encourage alternative views of the features and the feeling of crossing water. They should be designed so as not to require any safety railings or fencing to maximise the social benefits. Specific risk assessment will be required as part of the design process. Materials commonly used are concrete, reconstituted and natural stone. Planting needs to be tolerant to varying hydrological conditions.

Hydraulic and water quality design criteria

- Stormwater calculations for a range of rainfall durations up to 1 in 100yr + CC event should be carried out to accurately determine the capacity of the storage volume required.
Surface water flow paths during exceedance events should be planned for within the overall surface water drainage layout. This should ensure that flooding to property is avoided and safe access and egress from the development site is maintained.
- Treatment channels collect water, slow it down and provide storage for silt and oil that is captured. The outlet is designed to act as a mini oil separator thus the channel is very effective at treating pollution. They can provide excellent pre-treatment value to larger SuDS, as they are able to remove contaminants such as silt and oil before the water is conveyed into downstream SUDs features. However, it is important that they are managed effectively to prevent contaminant/sludge build up that affects their physical efficiency and the flora that assists the cleansing process.
- Depending on their placement in the SuDS management train, species selection needs to be designed based on the hydrological conditions to ensure that planting flourishes in either permanently wet, semi wet, or predominantly dry conditions

Selection and siting

They are an effective SuDS measure in more dense, urban developments where space constraints are a common challenge. Rills and canals can be used to collect water straight from hard surfaces or they can be used to convey water, for example where it has been collected via a permeable pavement structure. They can be designed as integral parts of the landscape scheme, or as more incidental elements as part of a wider SuDS/landscape scheme. They can also be used as threshold definition between private and public spaces. Consequently they are suited to a variety of scenarios:

- Public realm and parks/open spaces
- Residential development
- Commercial/industrial development
- Contaminated sites (providing they use impermeable lining)

Landscaping and amenity

All built components should be purposely designed to be in-keeping with the design philosophy for the scheme, having regard to local character, and materials and construction should be of high quality to help build a strong sense of place and character. Where stone is used then it should reflect local geology.

Bridges and crossing points can provide more dramatic linear views of the features, especially where well integrated into townscape to draw the eye to feature buildings or landscape. The potential for these features to be close to homes or commercial premises, and as part of the public realm, means potentially high levels of amenity benefit, particularly where they are designed to enable more direct access. Well designed, appropriate planting can help enrich the feel and quality of the development, bring people closer to nature and enhance the sense of community.

Operation and maintenance

Routine maintenance is required, involving removal of debris and litter, whilst more intensive maintenance work, such as removing silt, is only required intermittently (e.g. every 5 years). Repair of the structure, including grouting etc. will also be required during the lifetime of the feature. The initial cost of installation should be no greater than an equivalent underground solution, but routine maintenance cost will be higher. However, the cost of more fundamental repair is likely to be no greater given they are surface based components.

Although quite straightforward to design, problems have occurred due to a lack of attention during design and construction including silt build up due to inappropriate landscape and treatment of adjacent areas, and the landscape quality being poor due to the frequency and type of planting, both of which are easy to address at the design stage.

4.3.2 Site Control - Filter trench / Infiltration trench

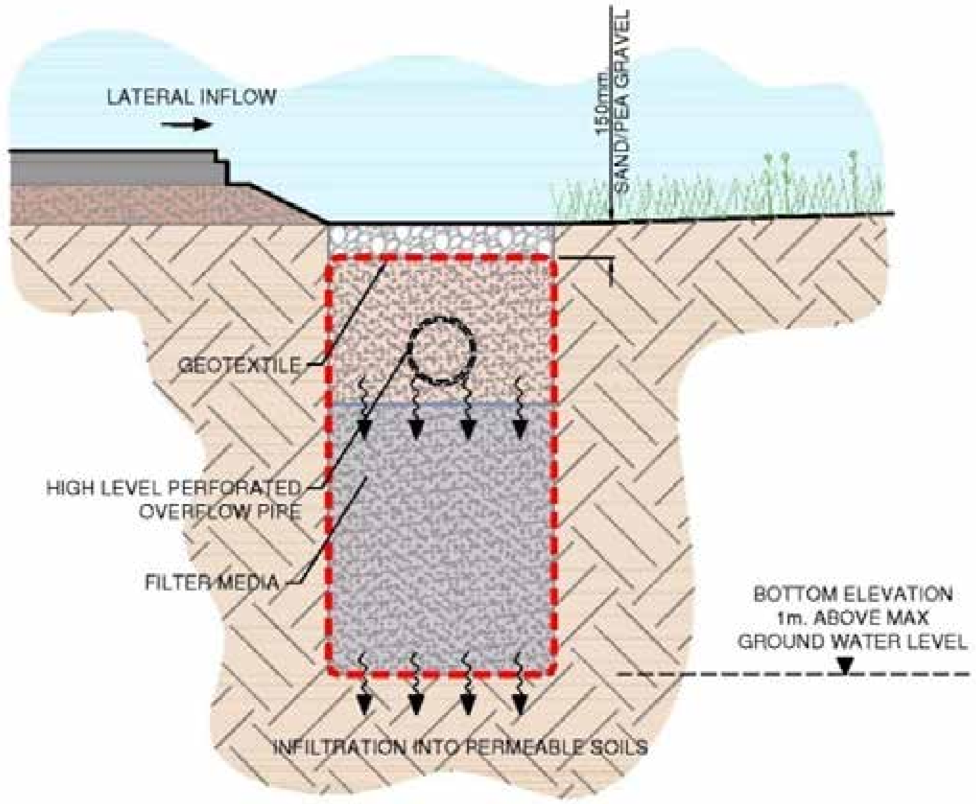
Gravel or rubble filled trench that creates subsurface storage for infiltration, or filtration of surface water runoff. Trenches can be used to filter, attenuate and dissipate storm water into the ground through the base and sides of the trench and/or provide a level of treatment prior to reaching a secondary SuDS feature.

WAYMARKER

SEE MATRIX ID 19 & 12

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**
- **Design Manual for Roads and Bridges HA 103/06**



SHEET INFLOW
SECTION A-A
INFILTRATION TRENCH SCHEMATICS

Key Characteristics

- The location of the filter trenches should be carefully considered to avoid interaction with people, vehicles, or exiting rootzones.
- Work best with SuDS components which provide attenuation of storm flows.
- Use in combination with effective pre-treatment.
- Separate filter media from surrounding ground with a geotextile where infiltration is desirable, or a membrane where infiltration is not permitted.
- Include a geotextile layer within the upper gravel and incorporate observation wells and rodding points for maintenance.
- Use a distribution pipe in combination with point discharges.
- Consider the impacts of stone scatter.

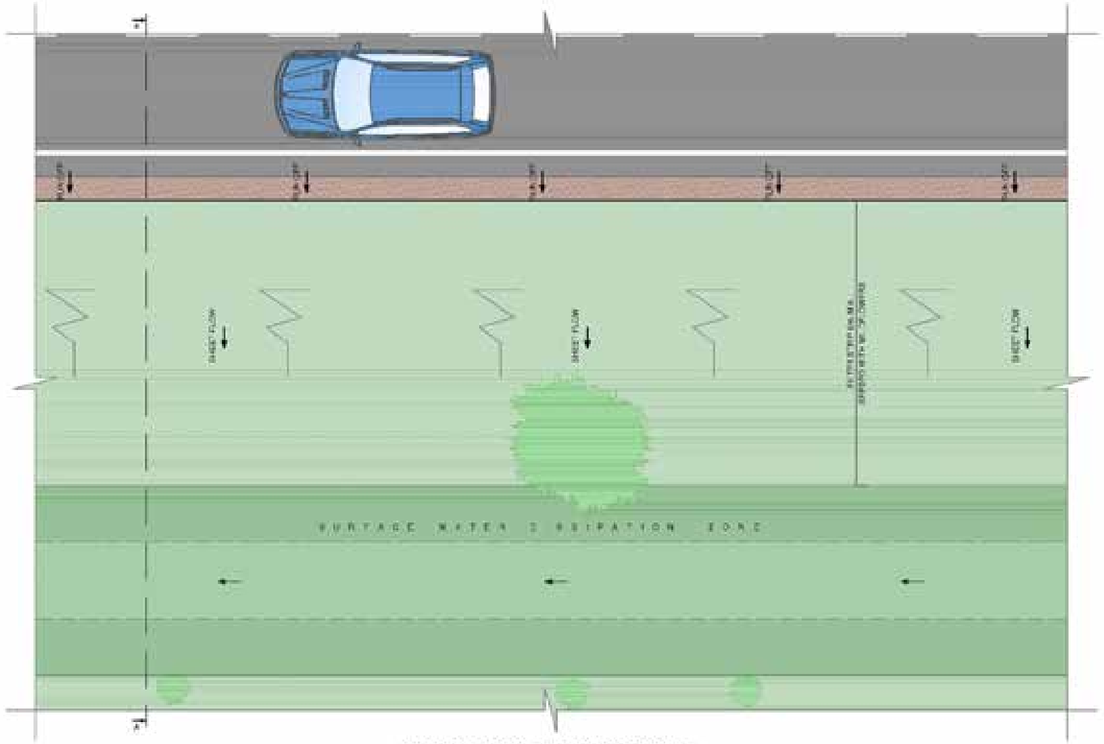
Main Considerations

- Can be prone to blockage and work best in combination with pre-treatment such as filter strips to reduce sediment load.
- Excavation proposals must include appropriate soils' management and re-use
- Features to help inspection and maintenance are critical.
- Can be expensive to replace the filter material if poorly designed or neglected maintenance.
- Difficult to identify pollution and maintenance issues underground.
- Must be sited to avoid impacts on existing hydrologically-sensitive ecological habitats
- BRE365 Percolation testing will need to be reviewed by LPA

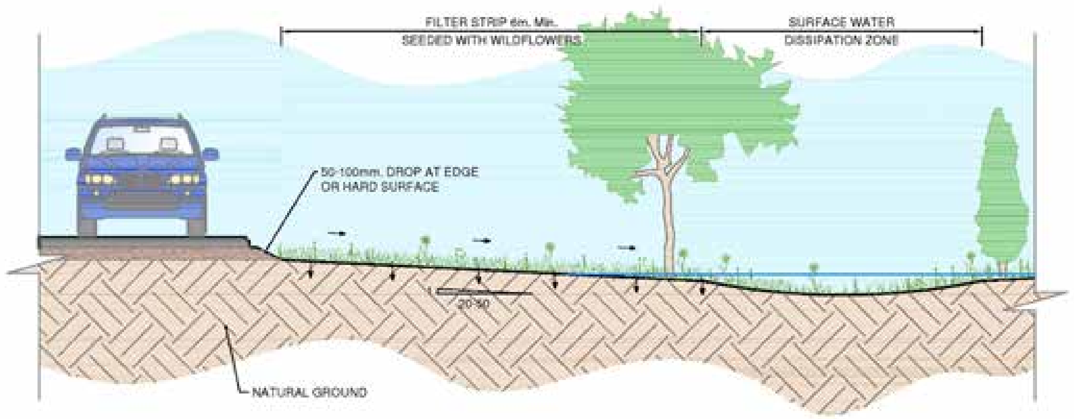
Key Benefits

- Ideal for use with small contributing areas.
- The land-take is usually moderate, with a slope not exceeding 1 in 20.
- Moderate water quality treatment.
- Can be easily incorporated into site landscaping and alongside roads.
- Can be enhanced using grass/ wildflower seed mixes.
- Can link green areas.
- Low cost and maintenance.

New native hedge thriving alongside filter trench (Crewe, University Way)



BIORETENTION / FILTER STRIP PLAN



SECTION A-A

Technical Requirements – Infiltration Trenches & Filter Strips

Configuration and Dimensions of Infiltration Trenches & Filter Strips

- Filter / Infiltration Trenches should be used as source controls only.
- Filter / Infiltration Trenches should not be designed as sediment traps.
- Filter / Infiltration Trenches should be designed to the requirements of the **Design Manual for Roads and Bridges Volume 4, Section 2, Part 5, HA40/01 - Determination of Pipe and Bedding Combinations for Drainage Works, Drawing F2, trench Type H, the requirements of this document and Appendix D - Figure D1 and D2**.
- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- Filter / Infiltration Trenches should not exceed 3m in depth.
- It is preferred that storm water inflow be sheet flow from drainage areas. Where this is not practical point flow inputs will be acceptable.
- Where point flows are used, a pre-treatment stage be installed that will effectively remove particulate matter present in the water and prevent clogging of the trench.
- Point flow inputs should be connected to a slotted high level distributor pipe. The pipe should be capable of conveying the design flow.
- The stone filter material should be wrapped in geotextile to the diagram as shown on **Appendix D**, **Figure D1**, with a minimum 150mm overlap at all joins. The geotextile should meet the requirements of the **Specification for Highway Works Series 500**.
- Filter / Infiltration Trenches should be provided with a high-level overflow to accommodate design exceedance.

Hydraulic and Water Quality Design Criteria

- The trench design should be checked for design exceedance and modelled explicitly and holistically to demonstrate the impact to the downstream drainage components.
- Infiltration trenches should be designed to half-empty in 24 hours to allow for incoming flows from subsequent storms.
- The base of the trench should be at least 1m above the highest seasonal or permanent groundwater table.

Selection and Siting

- A risk assessment shall include all relevant safety and environmental issues associated with siting a filter / infiltration trench.
- The trench shall be designed for easy maintenance.
- Infiltration trenches should be sited on stable ground, soil and groundwater conditions should be assessed to verify ground stability.
- Design of infiltration trenches must comply with **groundwater protection regulations and with EA policy on infiltration**.
- Must not direct water towards existing dry habitats or direct nutrient-rich water towards existing habitats with a low nutrient status. If the trench directs water towards high value habitat, the pH of the water discharged must be comparable with that of the existing habitat.

Safety

- Risk assessment shall include risks associated with scatter of filter material.

Operation and maintenance

- All maintenance access points shall be clearly visible and documented in the Operation and Maintenance plan.

A vegetated shallow channel or depression designed to treat, filter, store and convey run-off. Swales can be either ‘dry’ (where water is stored beneath the ground in a gravel layer) or ‘wet’ where run-off is stored above the surface in the channel so may be permanently wet. Lining can be added to enable infiltration even when there are known contaminants in the water.

WAYMARKER

SEE MATRIX ID 22 & 23

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**
- **Design Manual for Roads and Bridges HA 103/06**

Image: COrton

Key Characteristics

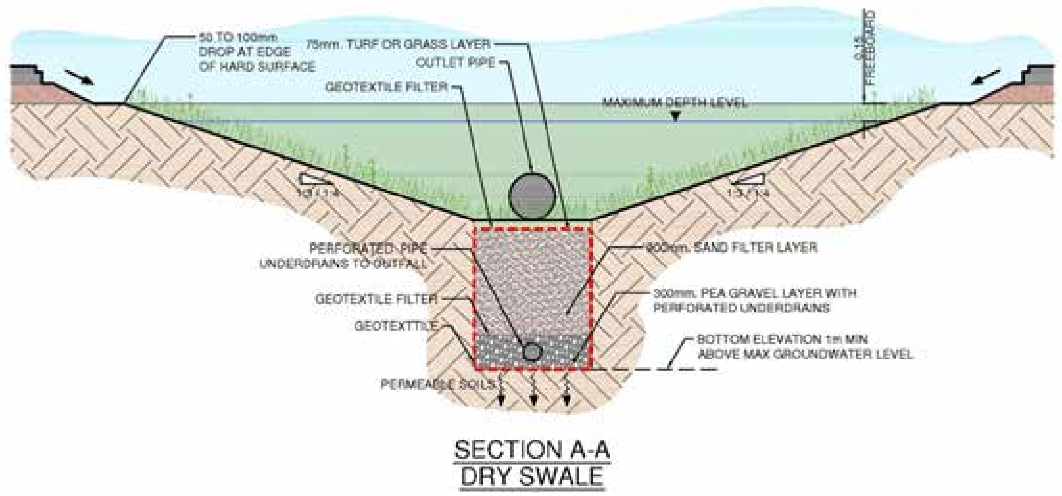
- Conveyance swales are suited to directing flow
- Dry swales provide additional filter treatment
- Wet swales encourage filtering and attenuation through wet and marsh-like conditions
- Parts of a swale designed to hold water permanently can be planted up with a range of native aquatic or marsh plant species. Other parts of the swale which may only be wet temporarily can be seeded with a pond-edge type mixture which will include species tolerant of both drier and damper soil conditions.

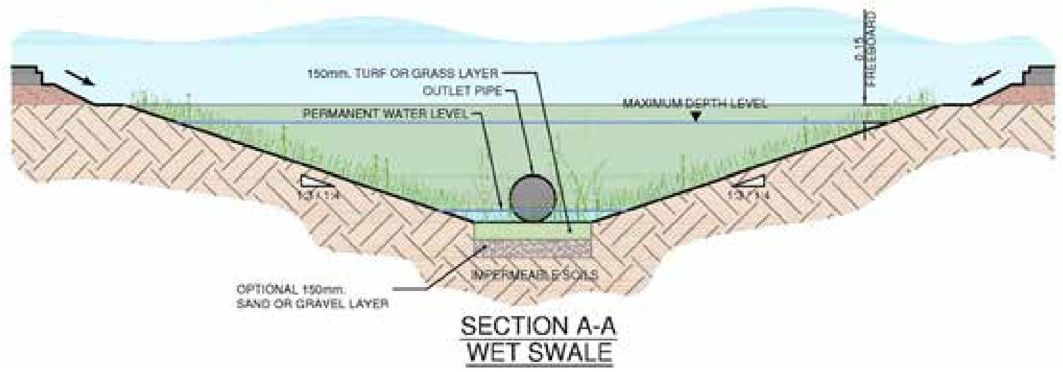
Main Considerations

- Should enhance and integrate with site’s topography
- Must be planned into layout early in design process, particularly for residential developments due to access crossings
- Relatively moderate land-take
- Checkdams may be needed for steeper sites
- Needs to be shaped to attenuate or significantly reduce peak flow or volume
- May require lining on contaminated sites

Key Benefits

- Ideal for use with linear contributing areas like roads
- Good for pre-treatment
- The land-take is usually moderate, minimum of 4m wide
- Excavation proposals must include appropriate soils’ management and re-use
- Good water quality treatment
- Can be incorporated into site landscaping and alongside roads
- Can be enhanced using grass/ wildflower seed mixes
- Can be linked to create green corridors
- Can provide biodiversity enhancement
- Low/Medium cost and maintenance





Technical Requirements – Swales

Configuration and Dimensions of Swales

- Swales should be used as source controls only.
- Swales should be designed to the requirements of **CIRIA C753 The SuDS Manual, the requirements of this document and Appendix D - Figure D3**.
- Swales should be:

  a. Trapezoidal or parabolic in cross section.

  b. The side slopes of a swale shall be a maximum of 1 vertically to 4 horizontally.

  c. The base of the swale shall be a minimum of 0.5 m and a maximum of 2 m wide and designed to avoid the formation of rills.

  d. The depth of the swale shall be between 400 mm to 600 mm deep and achieve a freeboard of 150 mm during design flow conditions.

  e. Swales shall be no less that 30m in length.

  f. The longitudinal slope of the swale shall not exceed 1 vertically to 40 horizontally without the use of checkdams and shall not exceed 1 vertically to 10 horizontally.

Hydraulic and Water Quality Design Criteria

- Swales should be designed so that the flow arising from a 1 in 1 year 30-minute storm event does not exceed 0.3m/s or 100mm in depth.
- The average velocity should be calculated using Manning's equation with a roughness coefficient of 0.025 for flows up to the grass height. Grass height in the channel should be assumed to be 100-150mm height. At depths of flow above the grass height the friction factor can be reduced to 0.01 for the analysis of design exceedance storm events.
- Storage volumes for the 1 in 1 year design event should dissipate within 24 hours, so that subsequent storms can be accommodated in terms of storage and treatment.
- Where practical, swales should form part of a wide blue/green network, designed for the temporary storage and conveyance of design exceedance storm events 30 to 100 year storm event. The maximum flow velocity should be below 1.0m/s. Higher velocities up to 2.0m/s may be permissible if erosion, soil stability and safety aspects can be demonstrated to the satisfaction of Council.

Selection and Siting

- Swales should be:

  a. Positioned as close to the source of receiving runoff as possible.

  b. In a location that is easily and safely accessible by maintenance machinery.
- On stable ground and where groundwater will not occur within 1 m of the base of the swale.
- Infiltration swales shall not be positioned adjacent to building foundations without a design certificate from a suitably qualified geotechnical engineer.
- Infiltration swales shall not dissipate water directly to ground without a suitable groundwater risk assessment.

Pre-treatment, inlets, and outlets

- Sheet flow is desirable to minimise erosion and increase treatment potential. Other options to provide an approximate to sheet flow, such as flush kerbs, shall be considered on a site by site basis.
- Point flow outlets such as road gullies and pipes shall flow into a flow spreader to minimise the risk of erosion and silting.
- A drop of 50 to 100mm shall be included at the edge of the hard surface to prevent the formation of a sediment lip.
- Conveyance swale discharge pipes and underdrain pipes shall be provided with a hydraulically designed outlet structure that is resistant to erosion.
- Swales shall include a suitably designed overflow to safely convey flows arising from design exceedance events. Overflows shall be incorporated within the development strategy for managing exceedance events and routed to planned temporary storage areas.

Landscaping

- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- Swales shall be overlaid with soil at depths appropriate for the proposed vegetation. Proposed vegetation shall comprise native species tolerant of the anticipated soil-types, water tolerance requirements and microclimate.
- To increase the biodiversity of swales specialist SuDS Turfs are also available which include a range of plant species to produce habitats tolerant of both drought conditions and periodic flooding.

Safety

- A risk assessment shall include all relevant safety and environmental issues associated with siting a swale

Operation and maintenance

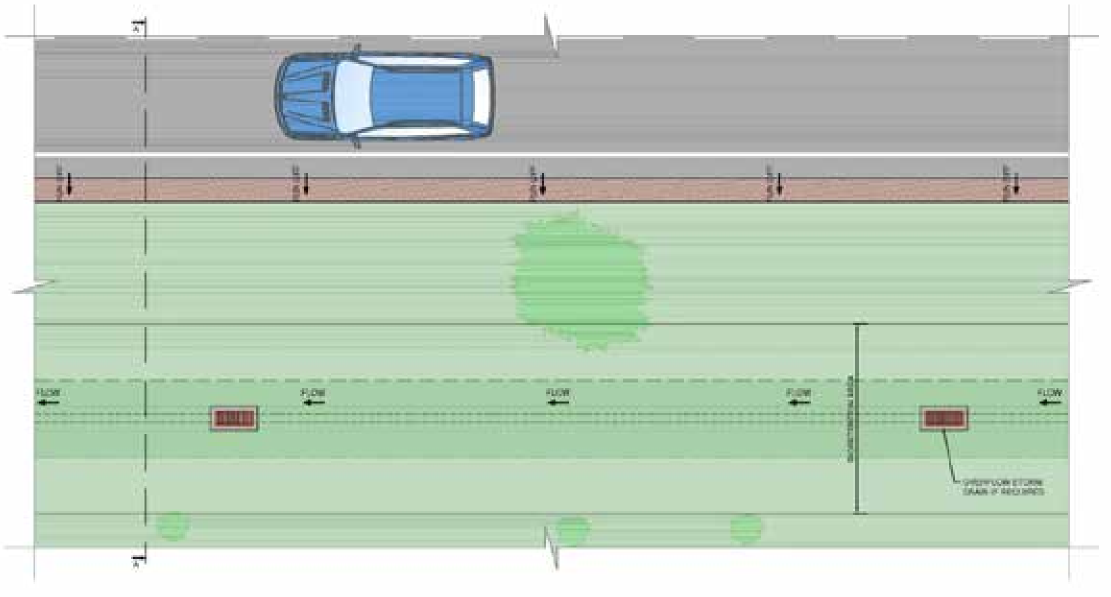
- Access shall be provided to all areas of the swale for inspection and maintenance. All maintenance assess points shall be clearly visible and documented in the Operation and Maintenance plan.

Areas of shallow vegetated open water with specially selected plant species and varying water levels and treatment areas. Water flows horizontally and is gradually treated prior to discharge; flow control is required.

Example:Raingardens

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**
- **Design Manual for Roads and Bridges HA 103/06**



BIORETENTION / FILTER STRIP PLAN

Key Characteristics

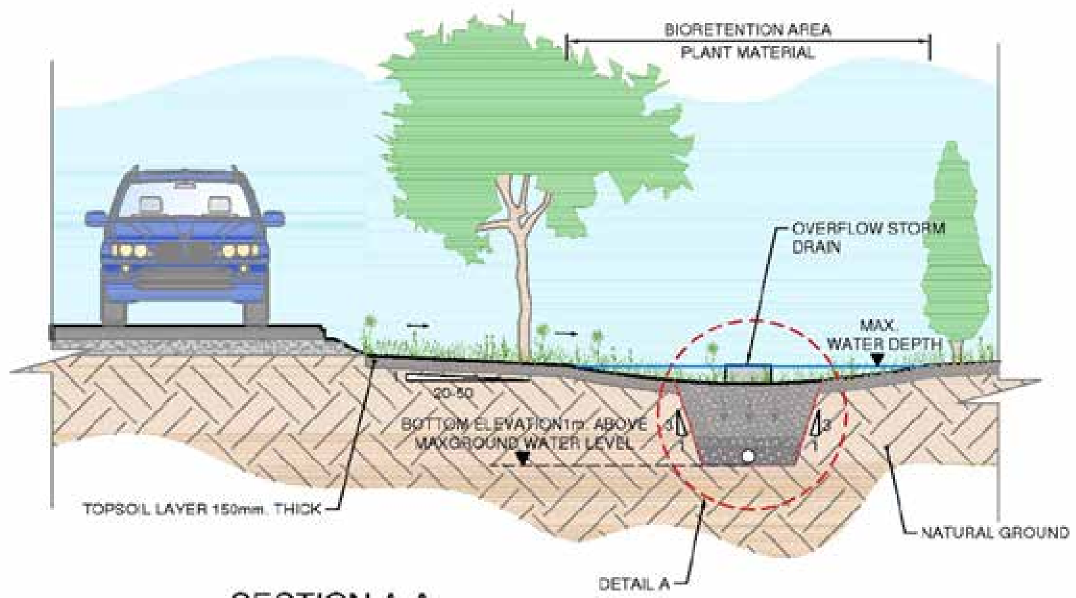
- Generally applied to small catchmnts and are typically 5%-10% of the contributing area
- Bioretention should be lined where infiltration could cause slope stability or foundation problems
- Groundwater table must be 1m below the base of the feature
- Suggested width of 3m and a 2:1 length to width ration to allow random planting of vegetation
- Standard landscape mulch should be used for the top dressing not exceeding 75mm
- Plants must be able to withstand pollution and extended dry and wet periods

Main Considerations

- Construction materials should avoid landscape impacts of quarrying virgin rock by utilising appropriate re-used or recycled materials in preference to new. Any new materials should be locally-sourced where possible
- Requires plant species with appropriate water-tolerances

Key Benefits

- Suitable for a variety of urban and rural environments
- Good retrofit solutions
- Works well in low permeability soils
- Can be very compact and used within streetscaping, or in larger landscaping areas
- Good water quality treatment and volume reduction with infiltration
- Can be adapted into a rain garden feature



SECTION A-A

4.3.5 Site Control - Bioretention Units: Rain Gardens

Rain Gardens
can offer localised strage and attenuation

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**

Image: susdrain.org

Key Characteristics

- Potential to enhance biodiversity and create more visually appealing streets
- Assists in cleansing of water of contaminants

Main Considerations

- Can be part of a SuDS train or stand alone
- Applicable to private and public land, such as driveways or highway verges
- Potentially low installation cost

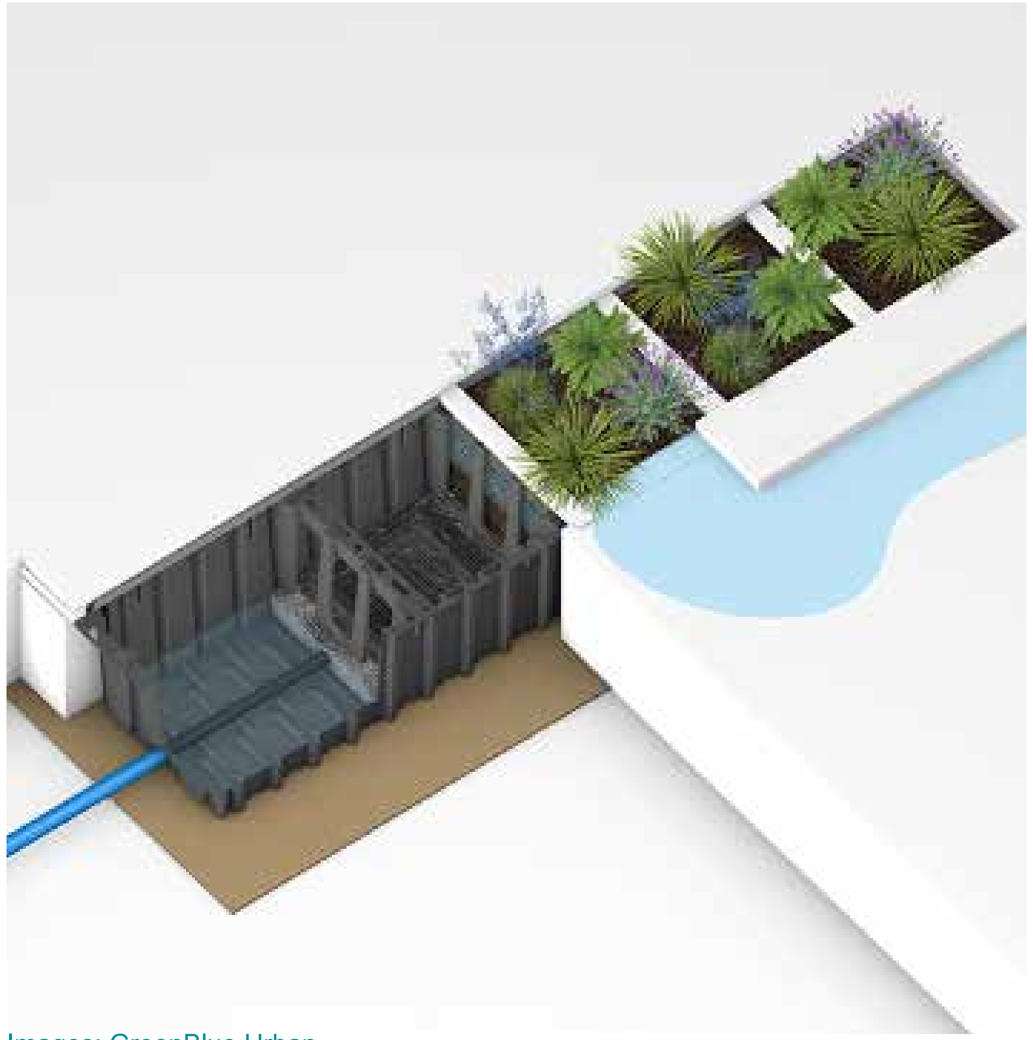
Key Benefits

- Significant retrofit opportunities in urban and rural contexts, including individual householders
- Easy to retrofit to existing development
- A highly visible SuDS component that can help educate and inform
- Can be planted to reinforce local landscape character
- Reduces maintenance compared to regular mowing
- Adds water-storage capacity and filtration

https://www.next.cc/journey/design/rain-gardens

Cellular planting offers enhanced bioretention storage capacity

For best practice refer to:
- **CIRIA C753 The SuDS Manual Part D.**



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Images: GreenBlue Urban

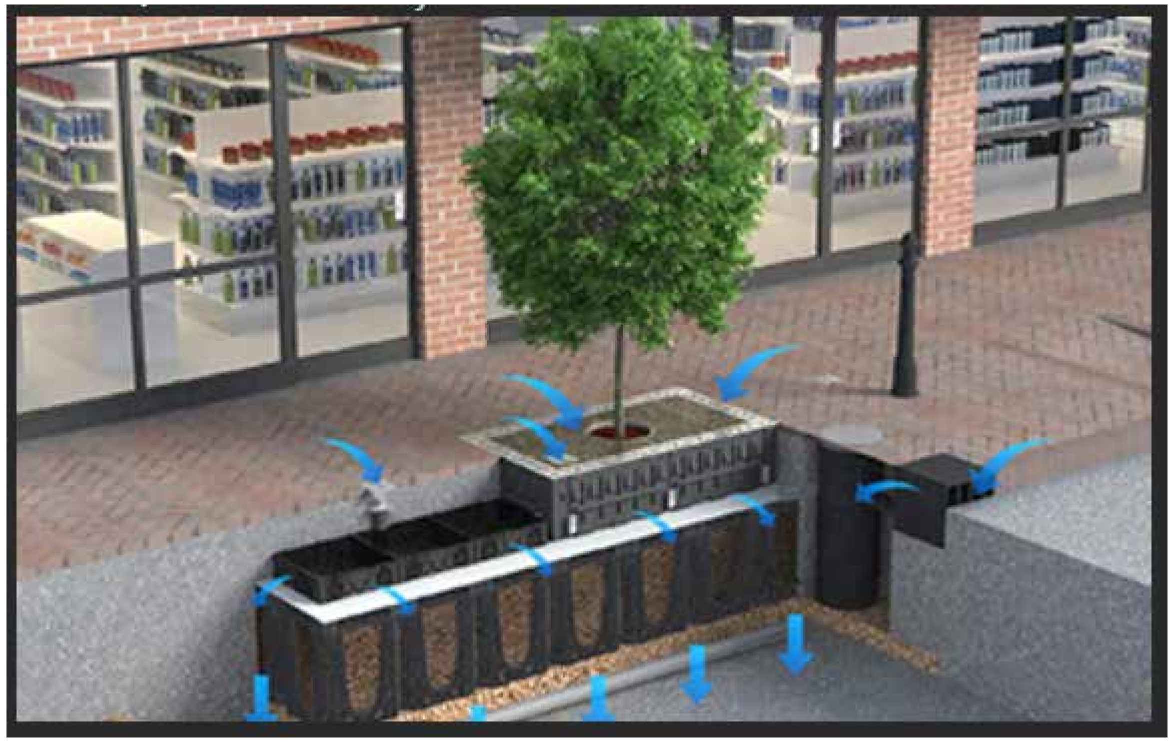


Image: GreenBlue Urban

Tree-trenches with suspended pavement facilities can offer water storage, water-cycling and attenuation, and help reduce pollutants through filtration, absorption, microbial action and tree uptake.

For best practice refer to:

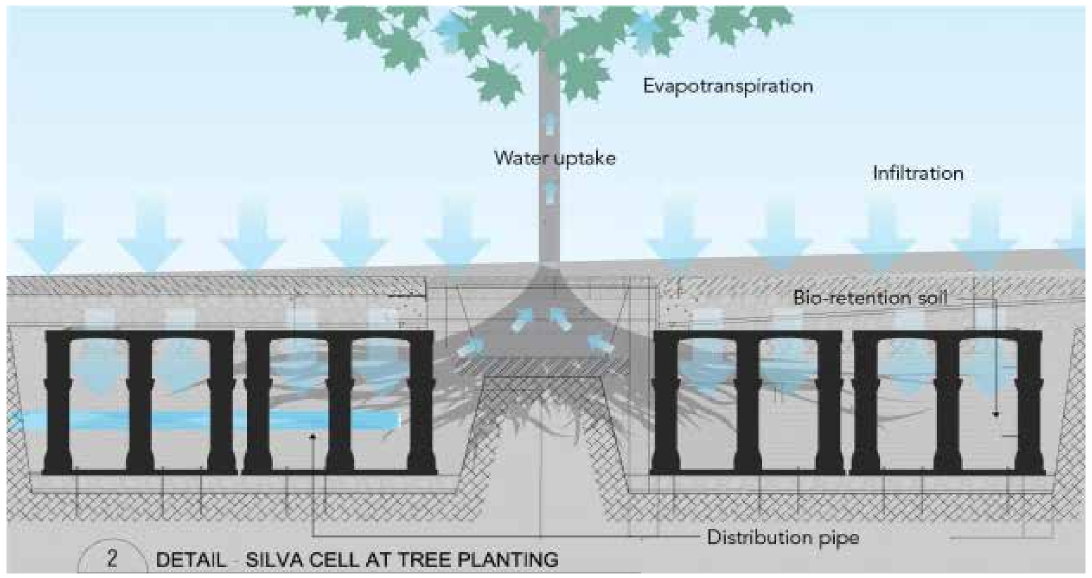
- **CIRIA C753**
- **Appendix D - Figure D4**
- **Specification for Highway Works Series 500**

Key Characteristics

- Significant retrofit opportunities in urban and rural contexts including householders
- Adaptable to different situations
- Can be installed in a variety of soil types from clay to sand
- Can be part of a SuDS train or act as a stand-alone component

Main Considerations

- Siting and trench shape should be adapted to suit existing constraints, such as underground cables etc.
- Applicable to private and public land, such as driveways of highway verges
- Tree species choice must be suited to anticipated soil, water and site conditions



Key Benefits

- Significant water-cycling through tree-growth and transpiration
- Increases water-storage capacity
- Increases attenuation periods for run-off
- Assists in cleansing water of contaminants
- Form significant landscape enhancement features
- Tree-species choices can build or reinforce local character
- Enhances biodiversity
- Creates more visually appealing places
- Helps with longer-term flood mitigation through climate change mitigation, including reducing heat-island-effect in urban areas and contributing to carbon-capture

Tree-trenches as Storage, Water-Cycling and Attenuation Components

Suspended-pavement tree-trenches were originally designed to help street-trees to thrive in urban environments by ensuring against soil compaction, but recent adaptations now offer excellent innovations for bioretention units.

Research undertaken by The University of Manchester and City of Trees for Salford City Council, the Environment Agency and United Utilities has demonstrated that street trees can have a significant positive impact on managing water.

Street-trees can be planted in specially-adapted tree-trenches which receive rainwater run-off from the adjoining road and pavement. As run-off flows along the trench, it soaks into the soil and is extracted by the trees for growth and transpiration, leaving only excess water to drain out of this SuDS component.

Results from two years' monitoring showed 3 street trees and the soil they were planted in were able to reduce the amount of water running off a street into the sewer by approximately 75%, and that remaining excess water was attenuated by up to 3 hours.

Cheshire East is looking to encourage use of multifunctional technology, such as 'box-crate' planting-pits, which could provide key components for Sustainable Drainage Systems.

'Box-crate' Tree-planting as a Storage, Water-cycling and Attenuation SuDS Component
(images courtesy: DeepRoot UK)

https://www.deeproot.com/blog/blog-entries/multi-agency-green-infrastructure-streetscape-silva-cell-case-study

Technical Requirements – Bioretention Units

Configuration and Dimensions of Bioretention

- Bioretention units should be designed to **CIRIA C753 The SuDS Manual, the requirements of this document and Appendix D - Figure D4**.
- The use of proprietary bioretention units is permitted and shall be considered on a case-by-case basis.
- Performance of the bioretention units is independent of shape. Any shape can be used successfully subject to its practicality for the proposed planting and required maintenance.
- A mulch layer shall be maintained over the planting area to reduce erosion and help retain more consistant moisture levels for plants.
- The soils shall be suitable to sustain the selected plants and to achieve a permeability of 250 to 1000mm per hour under design conditions. The depth of soil will vary depending upon the selected planting scheme, but shall be a minimum total depth of 1m deep,
- The soils, transition sand layer and coarse bedding material shall be wrapped in geotextile to avoid migration, as shown on **Appendix D, Figure D4**, with a minimum 150mm overlap at all joins. The geotextile shall meet the requirements of the **Specification for Highway Works Series 500**.

Hydraulic and Water Quality Design Criteria

- Ponding in bioretention units should not be able to exceed 150mm depth.
- The bioretention unit should be checked for design exceedance and modelled explicitly and holistically to demonstrate the impact on its downstream drainage components.
- The bioretention unit should be designed to be able to half-empty within 24 hours to allow for incoming flows from subsequent storms.
- The base of the bioretention unit shall be at least 1m above the highest seasonal or permanent groundwater table.
- The underdrain pipe design should follow standard hydraulic design methods. Bioretention units shall be provided with high level overflows and sub-surface collection pipe(s) to accommodate design exceedance.
- A maintenance pipe for cleaning the underdrain should be provided and secured against vandalism.
- The transition layer below the soil filter media shall consist of 100mm of coarse sand with a grain size of 0.5 to 1mm.
- The gravel around the perforated underdrain shall be 5 to 20mm size.

Selection and Siting

- A risk assessment shall include all relevant safety and environmental issues associated with siting bioretention units. This should be carried out by a qualified Engineer or Geologist where infiltration systems are proposed.
- The bioretention unit shall be designed for easy monitoring and maintenance.
- Bioretention units should be sited on stable ground: soil and groundwater conditions should be assessed to verify ground stability.
- Design of bioretention units must comply with groundwater protection regulations and with Environment Agency policy regarding infiltration.

Pre-treatment, inlets, and outlets

- Sheet flow is desirable to minimise erosion and increase treatment potential. Other options to provide an approximation of sheet flow, such as flush kerbs, shall be considered on a site-by-site basis.
- Point flow outlets such as road-gullies and pipes shall flow into a flow-spreader to minimise the risk of erosion and silting.
- To prevent the formation of a sediment lip around the boundary of the retention unit, a drop of 50 to 100mm shall be included at the hard-surface's edge.
- Bioretention units shall include a suitably designed overflow to safely convey flows arising from design exceedance events. Overflows shall be incorporated within the development strategy for managing exceedance events and routed to planned temporary storage areas.

Landscaping

- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- Bio-retention units shall utilise types and quantities of soils appropriate for the proposed vegetation and sufficient for plants' potential stature at maturity.
- Proposed vegetation shall comprise appropriate species suitable for the anticipated soil-types, water tolerance requirements and microclimate, and in-keeping with site character and wider landscape character.
- Confirmation of planting management responsibility, planting establishment schedule and long-term maintenance are required.
- All components should be in-keeping with local landscape character and any new stone should reflect local geology.

Health and Safety

- A risk assessment shall include all relevant safety and environmental issues associated with siting bioretention units.

Operation and maintenance

- Access, monitoring and maintenance requirements shall be incorporated into design and siting of the bioretention unit.
- All maintenance access points shall be clearly visible and documented in the Operation and Maintenance plan.

4.3.8 Site Control - Detention Basins

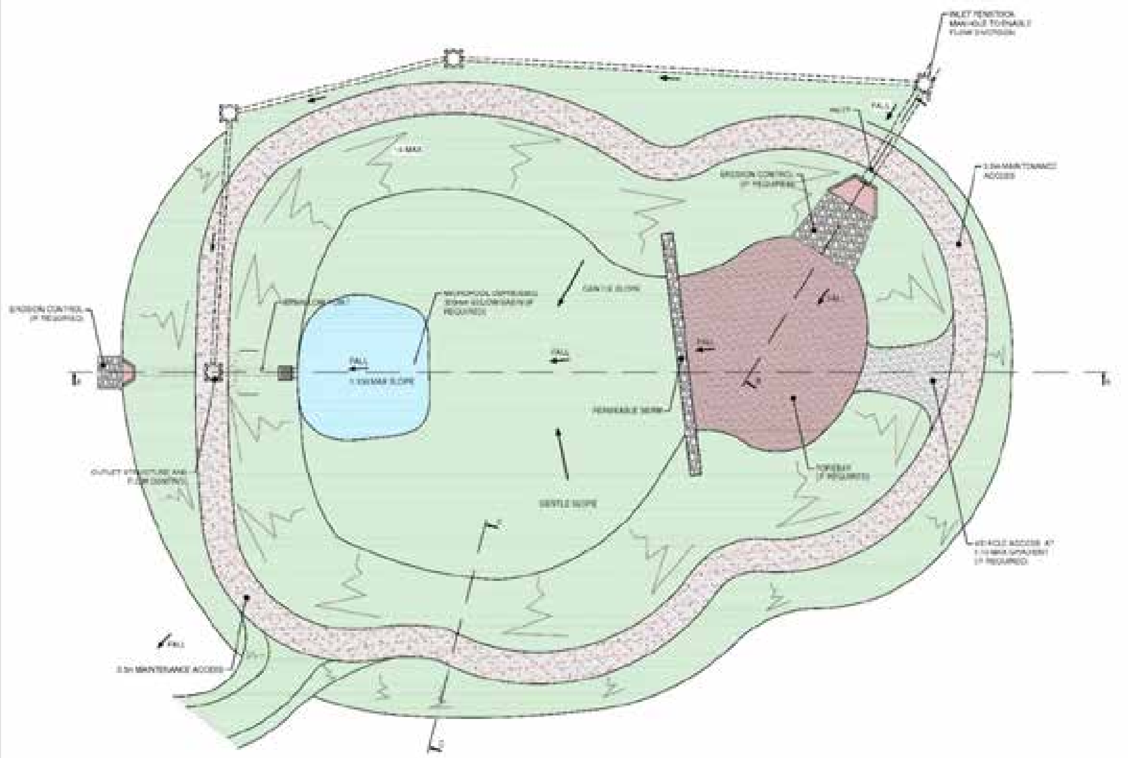
Dry vegetated depressions in the ground that have been designed to attenuate storm water flows, provide temporary storage and some pollution removal through settling of particulates. They can also be designed to function as recreational areas.

WAYMARKER

SEE MATRIX ID 20

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**
- **Design Manual for Roads and Bridges HA 103/06**



DETENTION BASIN PLAN

Key Characteristics

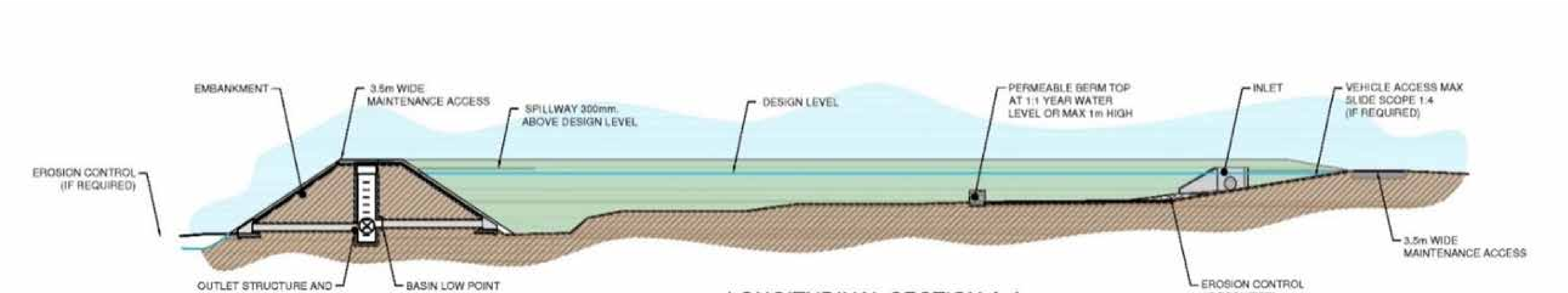
- Maximum water depth should not exceed 3m although local safety considerations may reduce this further
- Length/width ration should be between 1:2 and 5:1
- Contouring inside the basin can assist with defining areas likely to be inundated
- Maximum side slopes of 1 in 4 to allow easy access
- Sediment forebay or pre-treatment option will improve the water quality
- Surface water bypass and drawdown is required to facilitate safe maintenance
- Can be enhanced to improve ecological value
- Large outlet pipes should be screened

Main Considerations

- Low volume and pollution reduction
- Should enhance and integrate with site's topography
- Excavation proposals must include appropriate soils' management and re-use
- Requires landscaping and management
- To enhance their ecological value detention basins should be designed to retain a proportion of permanent open water habitat.

Key Benefits

- Can be applied to large contributing catchments
- Works well in low permeability soils
- Can be incorporated into larger landscaping
- Good flow control
- Easy to design, build and maintain
- Can have amenity value if designed carefully



LONGITUDINAL SECTION A-A

Technical Requirements – Detention Basins

Configuration and Dimensions of Detention Basins

- Detention basins should be designed to CIRIA 753 The SuDS Manual, the requirements of this document and Appendix D - Figure D6.
- An irregular shape should be used for maximising the aesthetic aspect of the detention basins. Angular shapes should be avoided as far as practical in the design of basin elements and details.
- As a minimum detention basins should contain the following sections:
  a. The sediment forebay if expected sediment loading is significantly high
  b. The main basin
  c. A part of the main basin depressed to form a micropool
- Additional elements to be included in the design of basins should be an inflow structure, an emergency overflow structure, bypass sewer piping and outlet with flow control device. The sedimentation forebay shall be separated from the permanent pool by a permeable berm.
- Detention basin bases shall be designed with gentle inner slopes (1 to 100 maximum) towards the centre.
- Embankment inner slopes shall be less than 1 to 4.
- The maximum design water depth of the basins shall be 3m.
- The length to width ratio for online detention basins shall be between 5:1 to 2:1.
- The maximum volume of the detention basins shall be 5000m^3

Hydraulic and Water Quality Design Criteria

- The drain down time should be a minimum of 24 hours, to allow for sedimentation to take place.

Selection and Siting

- A risk assessment should include all relevant safety issues associated with siting a basin.
- Siting of detention basins should follow a multicriteria analysis to provide the widest benefits to the public.
- The 100yr +Climate Change water level in any detention basin shall be at least 600mm below the finished floor level of any adjacent properties.
- Consideration should be given to the potential failure of any embankment and the subsequent flood flows through, and downstream, of the site.
- The maximum 1-year return period event basin water level shall be higher than the appropriate return period event water level of the adjacent watercourse, as specified by the Local Authority as part of its flood prevention duties. Appropriate hydraulic checks on the implications of high watercourse levels should be made, where appropriate.
- At sites of high groundwater table, the basin bottom level shall be built 500mm above the annual maximum groundwater level.
- At sites with contaminated soil, detention basins shall be designed water tight. Unlined detention basins should not be used on brownfield sites unless it has been clearly demonstrated that there is no risk of groundwater pollution.

Pre-treatment, inlets, and outlets

- Energy dissipation and erosion protection should be provided at the basin inlets. Basin inlets to be at least 300mm higher than the base of the basin.
- Safety grilles should be provided in all pipe inlets diameter greater than 350mm. During extreme events, operatives should be able to access safely the inlet pipe for cleaning.
- Detention basins should be designed with a slight depression in the inlet structures to encourage the water quality benefits of bioretention processes.
- A manhole and a flow control device should be provided at the outlet of the basin. Discharge from the basin should be limited to the allowable Council limit. The flow conditions in the receiving stream downstream of the basin should be modelled to the satisfaction of the Council.
- An overflow structure should be provided at the outlet. A spillway shall also be provided for an emergency. The spillway should be designed as a controlled overtopping of the embankment. It should not be designed to pass through the embankment. Emergency overflows should be routed back to the receiving watercourse to protect downstream properties.
- The top of embankment at the spillway should be 300mm above the 100 year + climate change allowance storm event.
- The outlet structure should be designed to operate and discharge the design discharge flow rate up to the 1 in 100 year + climate change 24-hour storm event. Appropriate hydraulic checks on the implications of high watercourse levels shall be performed, where applicable.

Landscaping

- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- Detention basins shall be overlaid with soil at depths appropriate for the proposed vegetation. Proposed vegetation shall comprise native species tolerant of the anticipated soil-types, water tolerance requirements and microclimate.
- Consideration should be given to the suitable aesthetic design of the detention basin and its surrounds to enhance the visual amenity of the site and to reflect the landscape character of its location.
- Suitable native planting should be selected to maximise the ecological value of the detention basin and surrounds.
- To increase the biodiversity of detention basins specialist SuDS Turfs are available which include a range of plant species to produce habitats tolerant of both drought conditions and periodic flooding.

Amenity

- Suitable native planting should be selected to maximise the ecological value of the detention basin and surrounds.
- The dual use of the detention basin as passive public open space for recreation activities should be considered where the area is subject to flooding from events less frequent than the 1-year return period and where it can be clearly distinguished from the area providing flood storage for frequent events.

Safety

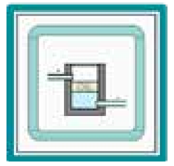
- A safety risk assessment shall examine all relevant safety issues for both operatives and the public.
- The maximum cross slope of the embankment shall be 1:4 to allow to provide safe working conditions for grass cutting.
- Dense vegetation around the external perimeter of the detention basin is discouraged to allow high levels of visibility of the area. Detention basins should not normally require to be fenced.

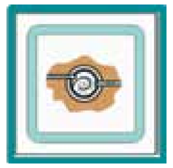
Operation and Maintenance

- Access road for maintenance of 3.5m minimum width access road shall be provided.
- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- Design should be carefully considered to ensure it:
  - is permeable,
  - incorporates reused or recycled materials in its construction
  - utilises appropriate wearing-course materials which reflect local landscape character
- A summary of the maintenance activities is provided below and shall be considered for basin accessibility design:
  a. Removal of litter, debris and grass cutting.
  b. Removal of unwanted plant species and dead plant growth.
  c. Removal of aquatic plants if present.
  d. Bank vegetation cutting and removal.
  e. Sediment removal from forebays and micropools.
  f. Reseeding of areas with poor vegetation growth.

4.3.9 Site Control: Pre-Treatment - Oil and Sediment Separators

Oil and sediment separators can be used as pre-treatment, or as a last resort, site treatment for the removal of sediment, litter, and oil from surface water run-off. These systems can be installed in a standard size manhole. Captured pollutants are retained within the separator, providing a single point of maintenance.





Key Benefits

Design Standards

- Require designing so that regular maintenance can be undertaken
- As the vortex separator requires a velocity to function, a filtration chamber or detention basin should be used for small flow events

Best Practice

- Most effective for removal of heavy particulate matter rather than solids or dissolved pollutants

Key Benefits

Design Standards

- **Must comply with BS EN standards for separating systems**
- Require maintenance to prevent re-suspension of pollution
- Should be situated close to the pollution source

Best Practice

- Depending on the location to which the water is to be drained and the type / severity of pollutants, different classes of separators should be used

Technical Requirements – Oil and Sediment Separators

Configuration and Dimensions of Oil and Sediment Separators

- Oil separators used for the removal of oil and grease present in storm waters operate on the flotation principle. Separated oils are floating on the water surface inside the unit.
- The use of proprietary units is permitted and shall be considered on a case by case basis.

Hydraulic and Water Quality Design Criteria

- Facility design shall be in accordance with BS EN 858-1:2002 Separator systems for light liquids (e.g. oil and petrol). Principles of product design, performance, and testing, marking and quality control.

Selection and Siting

- Oil separator units should be installed underground. The installation site shall be within passive open space accessible by a vacuum tanker for cleaning and maintenance.

Health and Safety

- A risk assessment shall include all relevant safety and environmental issues associated with siting the oil separators.

Operation and maintenance

- Regular inspection of the unit in accordance with the manufacturer’s maintenance requirements but no longer than every six months. The volumes of bottom sludge and the floating layer shall be estimated and cleaning of the unit should be scheduled.
- Cleaning of the oil separator shall be performed by a licenced waste management company to ensure appropriate disposal of the collected oils, floatables and sediment.
- Following cleaning the separator shall be filled with clean water, ready to fully operate with the first rainfall.

4.3.10 Site Control - Underground Storage Structure

Underground structures with capacity to store water below ground.

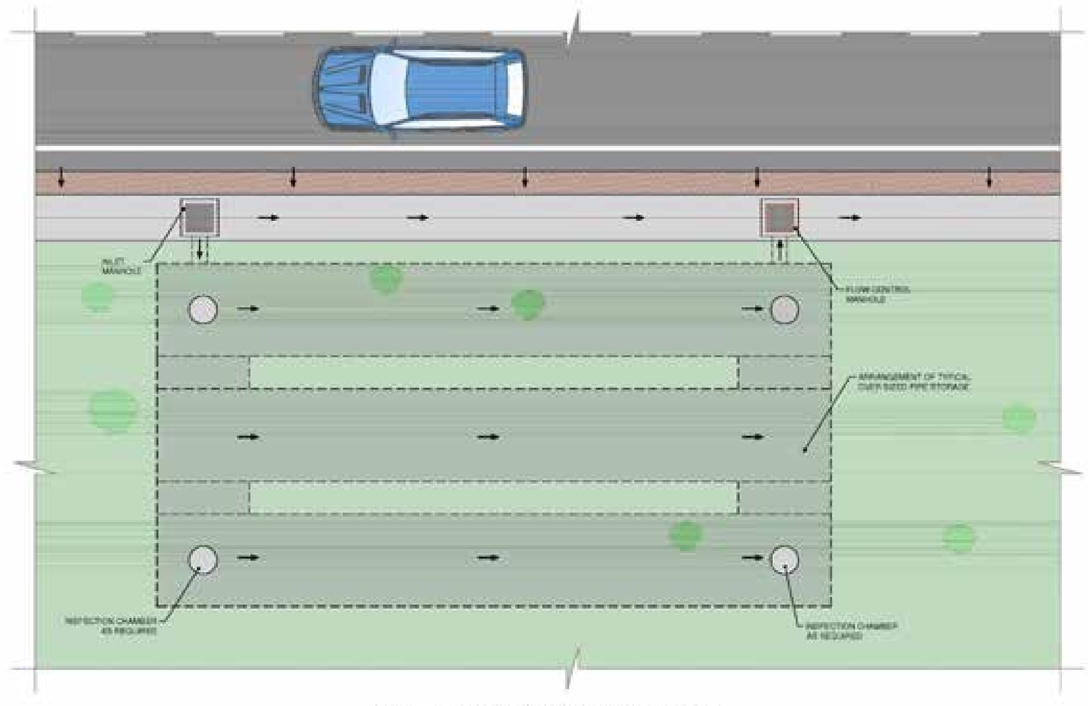
These structures only provide water-attenuation and not water-treatment therefore cleaning of the water is required prior to release.

WAYMARKER

SEE MATRIX ID 2

Refer to:

- **CIRIA C753 The SuDS Manual Part D.**
- **Design Manual for Roads and Bridges HA 103/06**



TYPICAL UNDERGROUND STORAGE PLAN

Key Characteristics

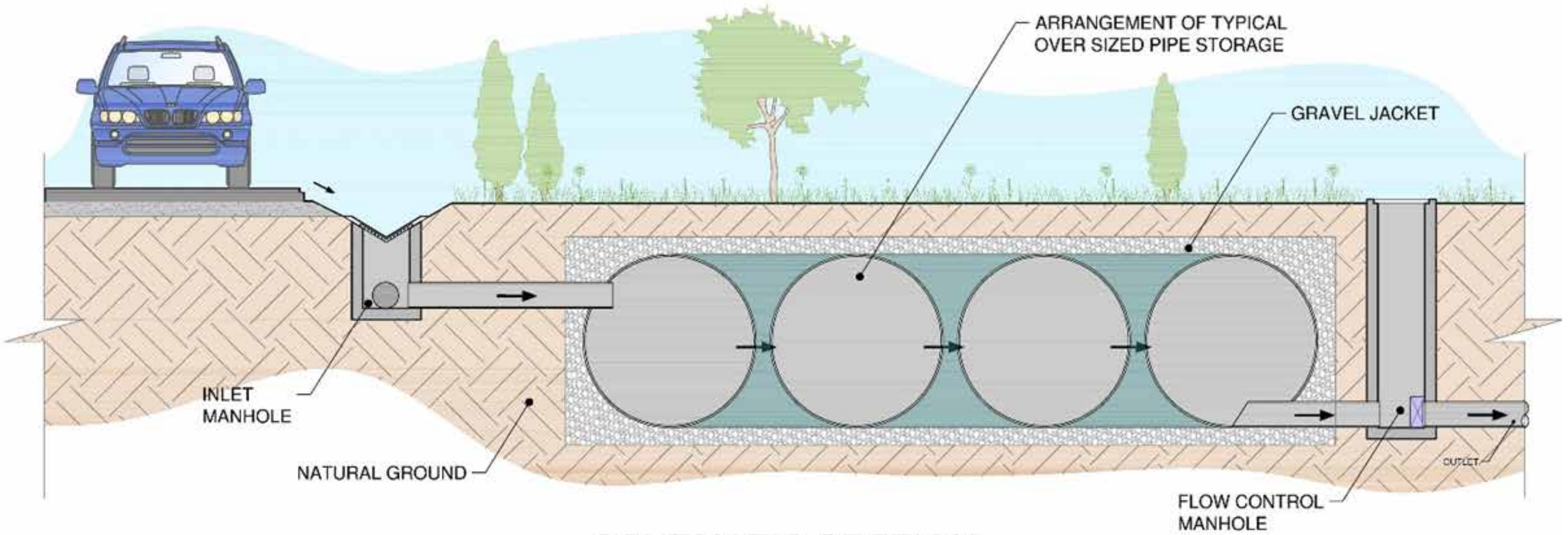
- Use underground storage structures only where above ground space is not available
- Underground storage structures must be part of a wider SuDS Management Train
- Storage requires suitable internal void ration of the structure (>90%)
- Structure requires regular silt removal
- Outflow may require pollution treatment

Main Considerations

- The storage structure must fit into a planned SuDS Management Train to provide the required silt removal and pollution treatment
- Excavation proposals must include appropriate soils' management and re-use
- Examine possibility of enabling infiltration through geotextile-lined layers
- Designs should consider expected and potential loading to ensure avoidance of structural failure and collapse
- Stable ground is required
- monitoring and maintenance of underground structures must be safe, programmed, practical and viable

Key Benefits

- Can be designed to attenuate stormwater where no surface space available



SCHEMATIC SECTION

Technical Requirements – Underground Storage

Configuration and Dimensions of Underground Storage

- The use of underground storage (which provides no surface water treatment) shall only be allowed where the use of other SuDS methods are inappropriate.
- The design of the underground storage shall aim to minimise sedimentation. Underground storage should be designed to the **CIRIA C753 The SuDS Manual Part D, the requirements of this document and Appendix D - Figure D7**.
- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- Larger underground storage structures shall permit man-entry to enable inspection and maintenance activities to be carried out within the storage chambers. This shall include suitable clear opening and internal step irons for safe access/egress. Smaller underground storage structures should have suitable access points to permit remote cleaning and inspection to be readily carried out. Covers should be large enough to allow man-entry with breathing apparatus. Entry points should be on level ground to permit the erection of man-entry safety tripods.
- Design options that shall be acceptable for public areas are pre-fabricated structures, oversized pipes or cast in-situ concrete structures.
- The maximum water level in any underground storage structure shall be at least 600mm below the lowest floor level of any adjacent premises.
- Underground storage should normally be designed as off-line storage and should be sized in accordance with the hydraulic design requirements.
- Low-flow channels should be provided.
- The minimum gradient for storage systems should be 1:100 for off-line tanks and 1:200 for on-line tanks to minimise sedimentation.

Selection and Siting

- Underground storage should not be located beneath public areas or roads.
- Existing and proposed tree root zones must be avoided or appropriately accomodated, including allowance for growth, appropriate backfill soils for local soil-type
- Ecological constraints must be accounted for such as possibility of leakage, locally-appropriate backfill soils and leaching potential
- Access route to components requires careful integration with site features

Pre-treatment, inlets, and outlets

- The outlet structure should be designed to operate and discharge the design-limiting discharge rates. Appropriate hydraulic checks on the implications of high downstream water levels should be made, where appropriate, and take account of the receiving watercourse or downstream sewer capacity.
- Flow controls shall be designed to the requirements of **Sewers for Adoption 7th Edition**. The minimum size of any orifice should be 75mm diameter.
- The outlet structure should have an overflow provided.

Safety

- A risk assessment should cover all aspects of safety, including access, for operatives during maintenance operations.
- A minimum of two access points (upstream and downstream) should be provided with maximum intervals between access points of 50m.
- Ventilation should be provided to minimise the risk of build-up of dangerous gases.

Operation and maintenance

- Operation and maintenance of underground structures must be integrated in their design.
- Monitoring and maintenance responsibility must be confirmed.
- A programme of safe, practical and viable monitoring and maintenance is required.
- All maintenance access points shall be clearly visible and documented in the Operation and Maintenance plan.

4.4 Regional Control - Retention Pond

Retention ponds are structures that provide both retention and treatment of contaminated storm water run-off. Retention ponds include a permanent pool of water into which storm water run-off is directed and outflows are controlled to reduce flow rate. A well-designed retention pond provides a community asset and opportunities for new habitats. The pond's physical, biological, and chemical processes work to remove storm water pollutants. Sedimentation processes remove particulates, organic matter and metals, while dissolved metals and nutrients are removed through biological uptake. In general a higher-level storm water quantity control can be achieved as well providing positive amenity benefits.

WAYMARKER

SEE MATRIX ID 1

For best practice refer to:

- **CIRIA C753 The SuDS Manual Part D.**
- **ROSPA Safety at Inland Water Sites - Operational Guidelines.**

Key Characteristics

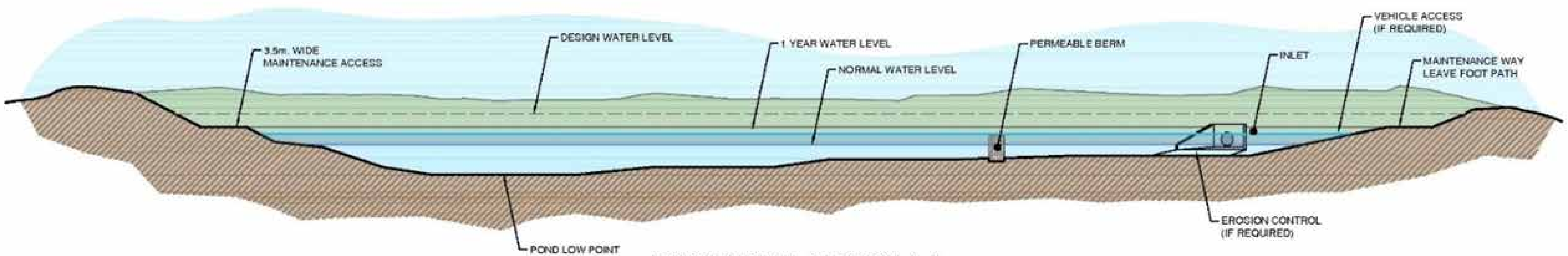
- The pond should have 4 zones - sediment forebay, permanent pool, temporary storage volume and shallow, wetland-type zone
- Located outside the floodplain
- Water quality treatment levels required should determine design
- Depth should be <2m to prevent stratification
- A liner may be required to prevent infiltration if the water is polluted or if the pond is near an aquifer
- Maintenance should account for invasive species
- Health and safety should be considered to restrict proximity of the public to the pond

Main Considerations

- Large area of land required
- Not suited to sloping sites
- Should enhance and integrate with site's topography
- Excavation proposals must include appropriate soils' management and re-use
- Perceived safety risks need to be managed
- Ecological advice must be sought regarding existing potentially high value habitats
- Whilst they have some nature conservation value, retention ponds should not be promoted as compensation for any proposed loss of existing wetlands or ponds.

Key Benefits

- Can be applied to large contributing catchments
- Works well in low permeability soils and permeable soils with a liner
- Good flow control
- Easy to design, building, maintain
- Can be used for amenity use
- Can incorporate a drawdown zone to reduce run-off volume



LONGITUDINAL SECTION A-A

Technical Requirements – Retention Ponds

Configuration and Dimensions of Retention Ponds

- Retention ponds should be designed to **CIRIA 753 The SuDS Manual and the requirements of this of this document and Appendix D - Figure D5**.
- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- The aesthetic element should prevail in the design of ponds. Angular shapes and symmetry should be avoided in the design of pond layout and details. All ponds should contain several zones:
  a. The sediment forebay
  b. The permanent pool
  c. The temporary storage volume
  d. An aquatic bench
- Additional elements to be included in the design of ponds include:
  a. A 3.5m wide maintenance route, suitable for vehicles.
  b. An inflow structure.
  c. A bypass sewer,
  d. An outlet with flow control and drain down chamber.
  e. An emergency overflow structure,
- The sedimentation forebay should be separated from the permanent pool by a permeable berm and have an average width of 5 to 10 times the inlet pipe diameter and a length of 10m or four times the width, whichever is greater.
- Inlets and outlets shall be placed at the maximum distance to maximise flow paths.
- The flow path length to width ratio shall be 3:1 minimum to avoid short circuiting.
- A maximum depth of 2m should be used for the permanent pool to prevent anoxic conditions and water stratification. The minimum water depth of the permanent water zone shall be 1.2m to prevent plant growth.
- The maximum depth of attenuation storage should not exceed 2m.
- The aquatic bench should be a minimum of 2m continuous around the pond, except at inlets and should range in depth up to 450mm below the design permanent pool level.
- The top level of the permeable berm shall be 150mm below the permanent pool water level.
- Energy dissipation should be provided at the inlet and outlet to the pond
- Ponds should be designed to hold a permanent volume of water equivalent to the treatment volume, also referred to as Vt.
- The treatment volume (Vt) should be calculated using the fixed depth method of 15mm of rainfall from impermeable (including paved and roofed) surfaces draining to the pond.
- The volume of the sediment forebay should be approximately 10% of the pond's permanent volume (Vt).
- The maximum volume of any retention pond should be 5000m3
- The Sedimentation forebay should be designed to provide efficient deposition of sediment and should be accessible for cleaning and maintenance operations in its entire area.
- The floor of the sedimentation forebay should be a minimum of 300mm above the main pond bottom
- The design should include a safe and efficient means of draining the lowest point in the detention pond.

Hydraulic and Water Quality Design Criteria

Ponds hydraulic design

- The top of the embankment should be 600mm above the maximum design water level.
- The outlet structure should be designed to operate and discharge the design discharge flow rates up to the 100yr + climate change 6-hour storm event.
- Ponds should provide a minimum permanent pool volume equal to one times the treatment volume for paved surfaces.
- Pond liners should be finished at a height 150mm below the outlet control unit, where appropriate, to encourage infiltration and to minimise discharges to the receiving water for small events. However, they should not be lower than the invert level if used on a site with a sensitive underlying groundwater zone or if used to treat runoff from a potential pollution hotspot.
- The by-pass sewer network should be designed for flows equal to the incoming flows.
- The hydraulic capacity of the draw down facility for emptying the pond should consider the geotechnical stability of the pond and associated embankments.

Selection and Siting

- The risk assessment should include all relevant safety issues associated with siting a pond.
- A detailed analysis and impact assessment of a flood exceedance event indicating flow paths shall be undertaken and submitted to Council. Where ponds are impounded behind engineered embankments, the unlikely scenario of embankment failure should be examined and potential impacts downstream of the pond assessed.
- The siting of retention ponds should follow a multicriteria analysis to provide the widest benefits to the public.
- The highest design water level in retention ponds should be at least 600mm below the floor level of any adjacent premises.
- The maximum 1-year return period event pond water level should be higher than the appropriate return period event water level of the adjacent watercourse, as specified by the Lead Local Flood Authority. Appropriate hydraulic checks on the implications of high watercourse levels should be made, where appropriate.
- In sites containing contaminated soils or contaminated groundwater, ponds should be fully contained within an impermeable liner to prevent cross contamination of surface water.

Pre-treatment, inlets, and outlets

- Bypass structures shall be provided at both the inlet and outlet chambers. The risk to the embankment stability shall be kept to a minimum.
- A man entry chamber shall be provided at the inlet of the pond.
- The invert level of the incoming sewers to the inlet structure shall be at or above the 1-year water level in the pond.
- A man entry chamber shall be provided for the pond outlet equipped with a flow control device. Minimum diameter of the control device shall be 75mm.
- Bypass structures shall be provided at both the inlet and outlet chambers. The risk to the embankment stability shall be kept to a minimum.

Landscaping

- Ponds should be designed to enhance the visual amenity of the site and to reflect the landscape character of its location.
- Existing site subsoils and site topsoils are to be reserved and re-laid in accordance with DEFRA's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Should existing site soils prove unsuitable (due to contamination for example) or insufficient then any relocated or imported subsoil must meet BS 8601:2013 Specification for Subsoil and Requirements for Use and relocated or imported topsoils must meet BS: 3882:2015 Specification for Topsoil.
- Ponds should be planted and seeded with native species to promote variation in the physical habitat value of the pond.
- Trees shall not be planted within the pond or embankments needed to retain water.

Ecology

- In order to maximise their ecological value retention ponds should be designed with scalloped sinuous edges to maximise their shore-line and a variety of depths with extensive areas of shallow water. The incorporation of gently sloping sides will ensure that shallow water in provided regardless of the depth of water retained.

Images: K.Swindells

Safety

- A safety risk assessment shall examine all relevant safety issues for both operatives and the public.
- The maximum side slope between the maintenance access path and the aquatic bench shall be 1:4 to allow easy egress from the pond.
- The aquatic bench should be planted with appropriate species to achieve a high-density barrier when they mature which effectively dissuades people from trying to get access to the open water. Dense or tall vegetation (bushes and trees) around the external perimeter of the ponds is discouraged to provide high levels of visibility of the whole pond area.
- Barrier fencing must be provided at all retention ponds. All access gates must be lockable. The locks must be childproof. The minimum height of the fence shall be 1.1m and shall be constructed in such a manner that there are no step-ups to reduce the 1.1m minimum height. The form of the fence should not detract from the aesthetic value of the local environment.
- All exposed pipe inlets or outlets, which are larger than 350mm, should normally have safety grilles. However, where grilles can be avoided by the use of appropriate design to restrict human access into the structures, this is preferred. Grille designs should be suitable to minimise the risk of blockage, have safe access for clearing during extreme events and prevent unauthorised access particularly by children and dogs. A typical outfall safety grille is illustrated in **Appendix D, Figure D6**.
- Bar spacing should not exceed 150mm and should not be less than 75mm to avoid trapping small debris.
- Consideration should be given to the potential failure of any embankment and the subsequent flood flows through, and downstream, of the site.
- Warning signs should be erected providing information on pond function, basic data, and prohibition of swimming.
- The perimeter of the pond 1m inside and outside the water's edge (water level during dry periods) should have a gradient of less than 1:10. This shall provide a margin which is attractive to flora and fauna and is a disincentive for people to enter the pond. Other areas (above and below the pond) shall have gradients of less than 1:4.

Operation and maintenance

- The pond shall be accessible to cleaning equipment by an access road 3.5m minimum width.
- A summary of the maintenance activities is given below and shall be considered for pond accessibility design.
  - a. Removal of litter, debris and grass cutting.
  - b. Removal of nuisance plant species and dead plant growth.
  - c. Removal of submerged and emergent aquatic plants if present.
  - d. Bank vegetation cutting and removal.
  - e. Sediment removal from forebays and main pond body.
  - f. Re-seeding and re-planting as required.
- Pond outlet design shall provide for removal of blockages.

4.6 Component Selection Matrix

The types of SuDS should be chosen to suit the local conditions. To assist in the selection of appropriate SuDS, the following page includes a **SuDS Suitability Selection Matrix** which identifies the various benefits and constraints of common SuDS techniques.

This matrix table compares the various SuDS techniques against the following criteria:

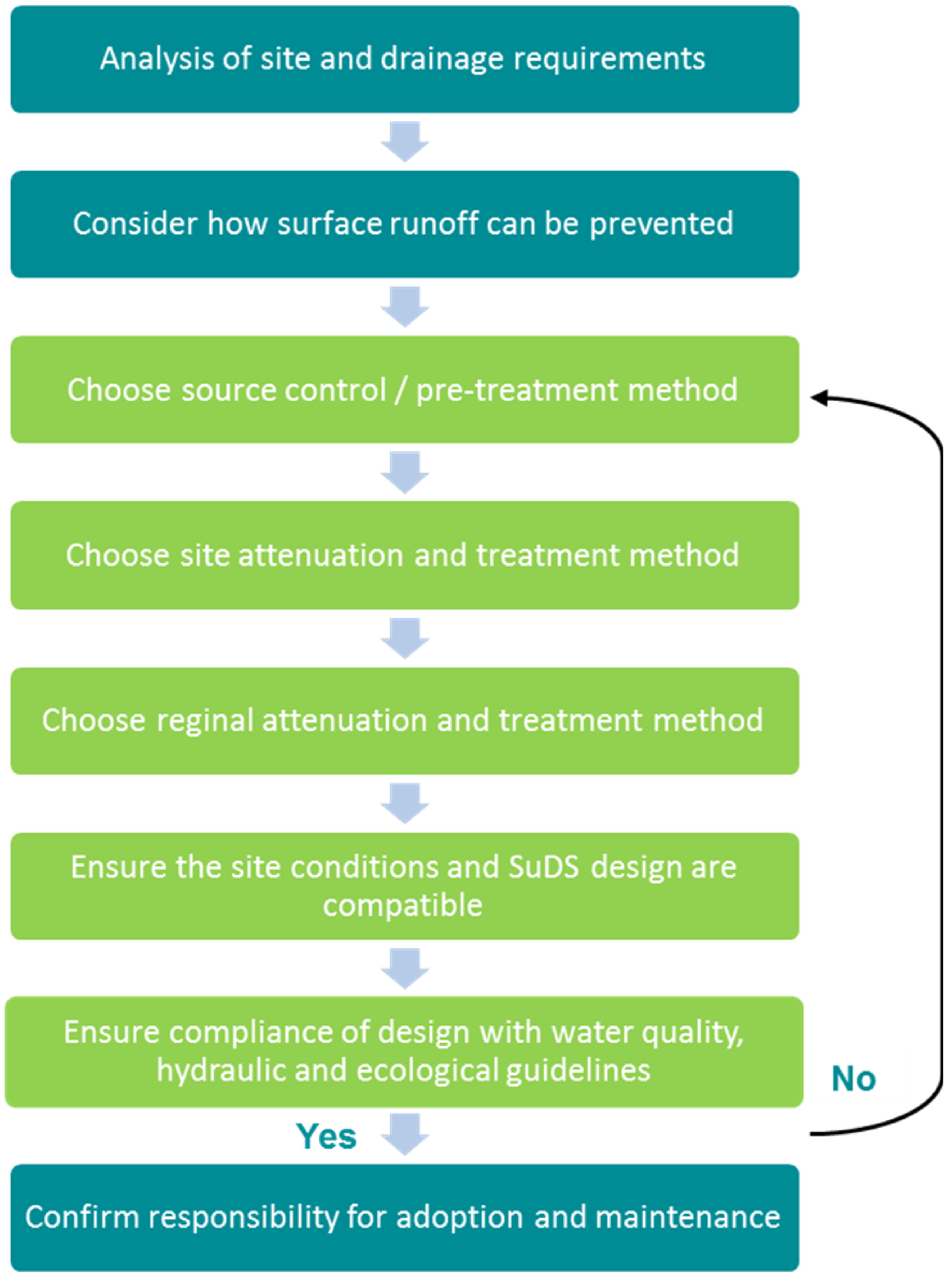
- Land use suitability
- Water quantity suitability
- Water quality suitability
- Environmental benefits
- Cost suitability

4.8 Development Tools for SuDS

Development tools can also be used to help design SuDS Trains which effectively respond to the unique characteristics of an individual site. This can be useful when considering how SuDS components work together and the impact these features can have in mitigating flood risk.

An example of such a tool is https://www.innovyze.com/en-us/products/drainage-design though there are a variety of tools available which offer the same service.

Figure 4-2: How to Select SuDS Components



SuDS Suitability Selection Matrix

General Suitability					Landuse Suitability								Water Quantity Suitability	Water Quality Suitability								Environmental Benefits		Cost Suitability	
																Removal Treatment Potential								
SUDS Group	ID	Technique	Suitability Conditions	Management Train Suitability	Low Density (1)	Residential (1 to 2)	Local Roads (2)	Commercial (2 to 3)	Industrial (2 to 3)	Construction Site (1)*	Brownfield (1)	Contaminated Land		Water Quality Removal Technique	Pollutants Removed	TSS	Heavy Metals	Nutrients	Bacteria	FSSDP	Community Appeal	Habitat Creation Potential	Maintenance	Capital
Retention	1	Retention pond	A, F	Site control, regional control	Y	Y	Y	Y	Y	Y	Y	Y	Detention, infiltration*, water harvesting	Sedimentation, filtration, adsorption, biodegradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	M	M	H	$H^!$	H	M	M
Retention	2	Subsurface storage		Conveyance, site control	Y	Y	Y^1	Y^1	Y^1	Y	Y	Y^1	Conveyance, detention	Sedimentation*, filtration*	Nutrients, sediments, metals, hydrocarbons	L	L	L	L	L	H	L	L	M
Wetland	3	Shallow wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y	Y	Y	N	Y	Y	Conveyance*, detention, infiltration*, water harvesting	Sedimentation, filtration, adsorption, biodegradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	$H^!$	H	H	H
Wetland	4	Extended detention wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y	Y	Y	N	Y	Y	Conveyance*, detention, infiltration*, water harvesting	Sedimentation, filtration, adsorption, biodegradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	$H^!$	H	H	H
Wetland	5	Pond / wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y	Y	Y	N	Y	Y	Conveyance*, detention, infiltration*, water harvesting	Sedimentation, filtration, adsorption, biodegradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	$H^!$	H	H	H
Wetland	6	Pocket wetland	B, D, H	Conveyance*, site control, regional control	Y	Y	Y	Y	Y	N	Y	Y	Conveyance*, detention, infiltration*, water harvesting	Sedimentation, filtration, adsorption, biodegradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	$M^!$	H	H	H
Wetland	7	Submerged gravel wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y	Y	Y	N	Y	Y	Conveyance*, detention, infiltration*, water harvesting	Sedimentation, filtration, adsorption, biodegradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	L	M	M	H
Wetland	8	Wetland channel	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y	Y	Y	N	Y	Y	Conveyance*, detention, infiltration*, water harvesting	Sedimentation, filtration, adsorption, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	$H^!$	H	H	H
Source control	9	Green roof	G, H	Prevention, pre-treatment, source control	Y	Y	N	Y	Y	N	Y	Y^1	Detention	Filtration, adsorption, volatisation, precipitation, uptake by plants, de-nitrification, biodegradation	Sediments, hydrocarbons, metals, pesticides, chlorides, cyanides, organic matter, BOD, nutrients	N/A	N/A	N/A	N/A	H	H	H	H	H
Source control	10	Rain water harvesting	H	Prevention, conveyance*, source control	Y	Y	N	Y	N	N	Y	Y^1	Conveyance*, detention*, infiltration, water harvesting*	Sedimentation*, filtration*, adsorption*, biodegradation*, volatisation*, precipitation*, uptake by plants*, de-nitrification*	Chlorides, sediments, hydrocarbons, metals, pesticides, chlorides, cyanides, organic matter, BOD, nutrients	M	L	L	L	N/A	$M^!$	L	H	H
Source control	11	Pervious pavement	C, D	Prevention, source control, site control*	Y	Y	N	Y	Y	N	Y	Y*	Detention, infiltration, water harvesting*	Sedimentation, filtration, adsorption, biodegradation, volatisation	Sediments, hydrocarbons, metals, pesticides, nutrients, cyanides, organic matter, BOD	H	H	H	H	H	M	L	M	M
Infiltration	12	Infiltration trench	C, H, J	Conveyance*, source control, site control	Y	Y	Y	Y	N	N	Y	Y^{1*}	Conveyance*, detention, infiltration	Filtration, adsorption, biodegradation, volatisation	Sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	M	L	L	L
Infiltration	13	Infiltration basin	C, F, J	Site control, regional control	Y	Y	Y	Y	N	N	Y	Y^{1*}	Detention, infiltration	Filtration, adsorption, biodegradation, volatisation	Sediments, hydrocarbons, metals, pesticides, cyanides, nutrients, organic matter, BOD	H	H	H	M	H	$H^!$	M	M	L
Infiltration	14	Soakaway	C, H, J	Source control	Y	Y	Y	Y	N	N	Y	Y*	Infiltration	Filtration, adsorption, biodegradation	Sediments, hydrocarbons, metals, nutrients, pesticides, organic matter, BOD	H	H	H	M	H	M	L	L	M
Filtration	15	Surface sand filter	C, D, F, K	Pre-treatment, site control, regional control*	N	Y	Y	Y	Y	N	Y	Y	Detention, infiltration*	Filtration, adsorption, biodegradation, volatisation, precipitation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	L	M	M	H
Filtration	16	Sub-surface sand filter	C, D, H, K	Pre-treatment, site control, regional control*	N	Y	Y	Y	Y	N	Y	Y	Detention, infiltration*	Filtration, adsorption, biodegradation, volatisation, precipitation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	L	L	M	H
Filtration	17	Perimeter sand filter	C, D, H	Pre-treatment, site control, regional control*	N	N	Y	Y	Y	N	Y	Y	Detention, infiltration*	Filtration, adsorption, biodegradation, volatisation, precipitation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	L	L	M	H
Filtration	18	Bioretention / filter strip	C, D, F, H	Pre-treatment, source control	Y	Y	Y	Y	Y	N	Y	Y	Conveyance*, detention*, infiltration*	Sedimentation, filtration, adsorption, biodegradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD,	H	H	H	M	H	H	H	H	M
Filtration	19	Filter trench	A, C, D, H	Conveyance, source control, site control*	Y	Y	Y	Y	Y	N	Y	Y	Conveyance, detention	Filtration, adsorption, biodegradation, volatisation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	M	L	M	M
Detention	20	Detention basin	A, C, F, K	Site control, regional control	Y	Y	Y	Y	Y	Y	Y	Y	Detention	Sedimentation, filtration*, adsorption*, biodegradation, uptake by plants*	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	M	M	L	L	L	$H^!$	M	L	L
Open channels	21	Conveyance swale	C, E, F, H, J	Conveyance, pre-treatment, site control	Y	Y	Y	Y	Y	Y	Y	Y	Conveyance*, detention*, infiltration*	Sedimentation, filtration, adsorption, uptake by plants*, biodegradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD	H	M	M	M	H	$M^!$	M	L	L
Open channels	22	Enhanced dry swale	C, E, F,H, J	Conveyance, pre-treatment, site control	Y	Y	Y	Y	Y	Y	Y	Y	Conveyance*, detention*, infiltration*	Sedimentation, filtration, adsorption, uptake by plants*, biodegradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD	H	H	H	M	H	$M^!$	M	L	M
Open channels	23	Enhanced wet swale	B, E, F, H, J	Conveyance, pre-treatment, site control	Y	Y	Y	Y	Y	Y	Y	Y	Conveyance*, detention*, infiltration*	Sedimentation, filtration, adsorption, uptake by plants*, biodegradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD	H	H	M	H	H	$M^!$	H	M	M

Item	Description
Blue outline	Infiltration-dependent components; will only work with permeable soil
	Not suitable / not applicable
	Potentially suitable providing that design prevents mobilisation of contamination
	Suitable
Y	Yes
N	No
L	Low
M	Medium
H	High
A	Liner is required for permeable soil
B	Surface base flow may be required
C	Minimum depth to water table shouldn't be less than 1 m
D	Slope should not exceed 5%
E	Follows contours for slope greater than 5%
F	Only suitable for large spaces
G	A roof has to be able to support 2 KN/m2 for extensive, 7 KN/m3 for semi-intensive and 10 KN/m3 for intensive configurations.
H	Not suitable if area draining into SUDS is more than 2 ha
I	Only suitable where high flows are diverted around SUDS component for area of more than 2 ha
J	Only if available head is less than 1 m
K	Only if available head is between 1 and 2 m
1	One treatment train stage may be sufficient
*	Some opportunities, subject to design
*	Will require draw-down and rehabilitation following construction activity, prior to use as a permanent drainage system.
(...)	Number of treatment train stages required.
!	There may be some public safety concern associated with open water which needs to be addressed at the design stage.
FSSDP	Fine Suspended Sediments and Dissolved Pollutants

5

SuDS MAINTENANCE & MANAGEMENT

5 SuDS Maintenance & Management

WHAT THIS SECTION WILL COVER:

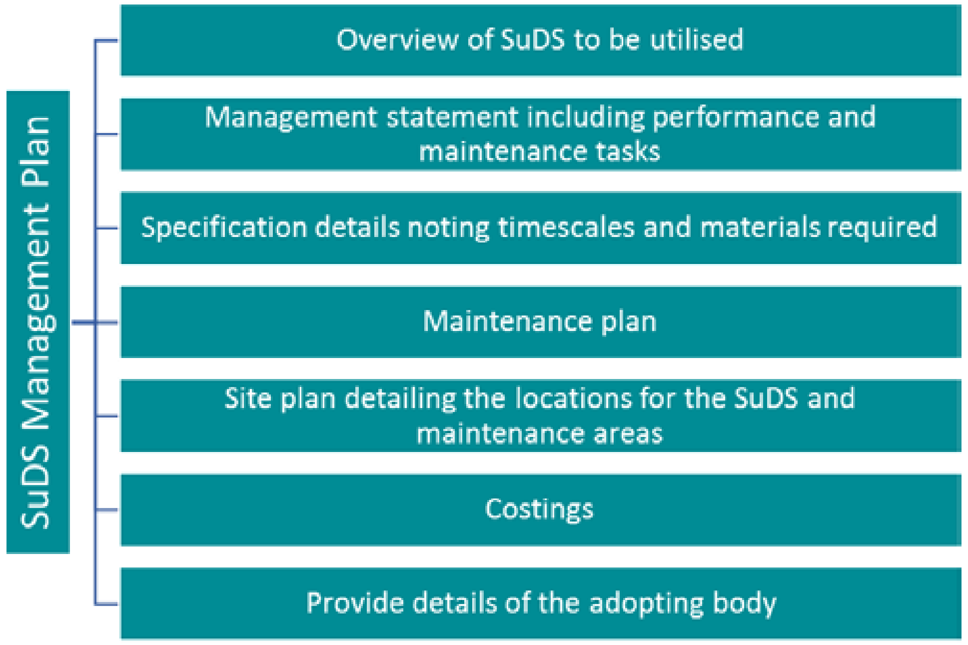
- SuDS maintenance and management plan
- Who should undertake maintenance?
- Maintenance activities and frequency

Unlike more conventional drainage systems, SuDS should be designed to be visible and function under anticipated loading conditions over the design life of the development. This will enable those who are responsible for maintenance to easily identify and remediate problems as they occur. When systems are properly designed, operated, and maintained, SuDS performance can be easily monitored against the expected performance.

5.1 SuDS Maintenance and Management Plan

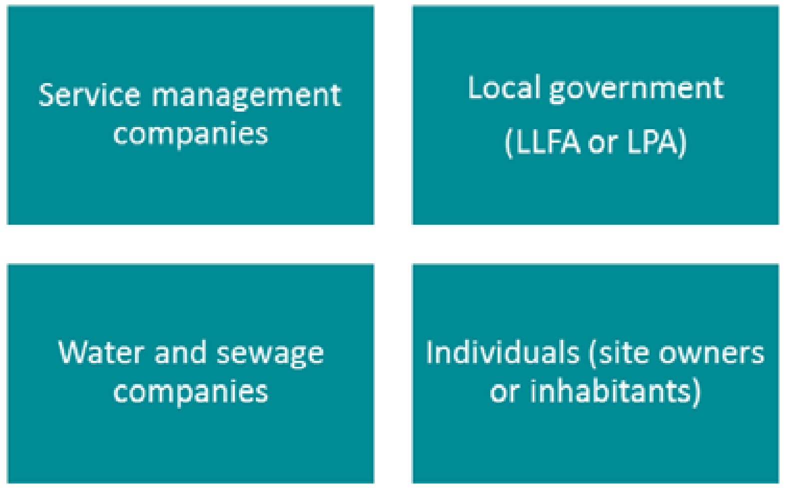
The maintenance and management of SuDS should be recorded within a SuDS Management Plan which should form part of the information submitted by the Developer at the planning application stage.

The approved Maintenance and Management plan must include information on the safe operation, design assumptions, maintenance of SuDS components and how SuDS components interact. The Maintenance and Management Plan must include an estimate of the ongoing maintenance costs. Where appropriate the management plan must make provision for a warning system and contingency arrangements. If undertaken correctly, the design of SuDS will ensure that day to day and long term maintenance is feasible, cost-efficient, and easy to undertake. Most the SuDS components are features of the landscape and so should be managed according to existing landscape practices. Maintenance fits into the management plan as follows:



5.2 Responsibility for Maintenance?

It is the responsibility of the developer to establish a maintenance agreement that ensures the drainage system is maintained and continues to function as designed in perpetuity for the lifetime of the development. National guidance indicates that this maintenance should be undertaken by any of the following bodies:

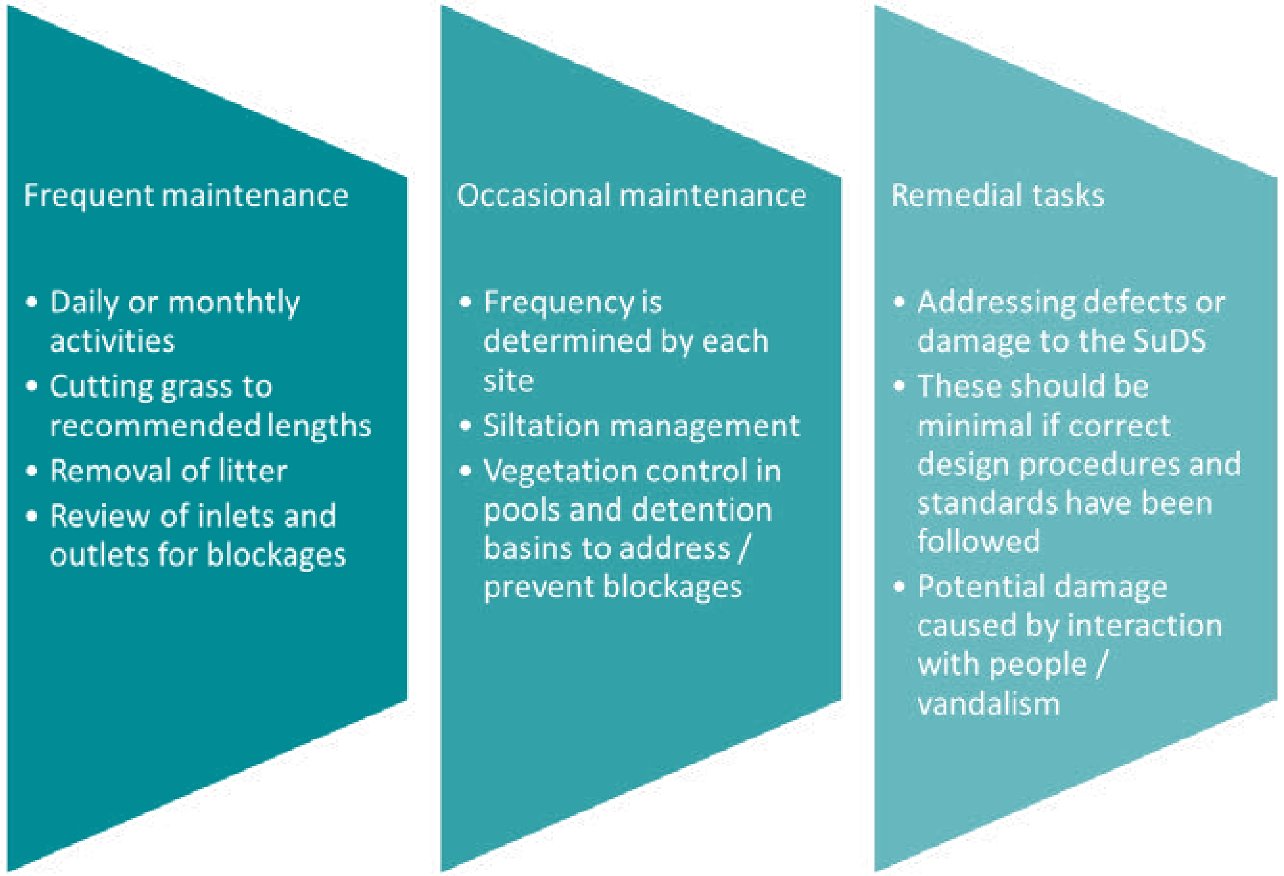


It should be noted that the Councils are currently not formally adopting or maintaining SuDS schemes but, alongside developing this strategy and in advance of having a final position in relation to the adoption and maintenance of different types of SuDS, the Council will endeavour to be flexible in the consideration of SuDS proposals provided appropriate management systems are put in place and the Council's position in terms of future management liability is protected.

In instances where the Council take on the responsibility for maintenance of SuDS, a commuted sum will be payable to the Council for maintenance and management. Commuted payments will be determined on a case by case basis based upon the nature and design of the SuDS scheme.

5.3 Maintenance of SUDS Components

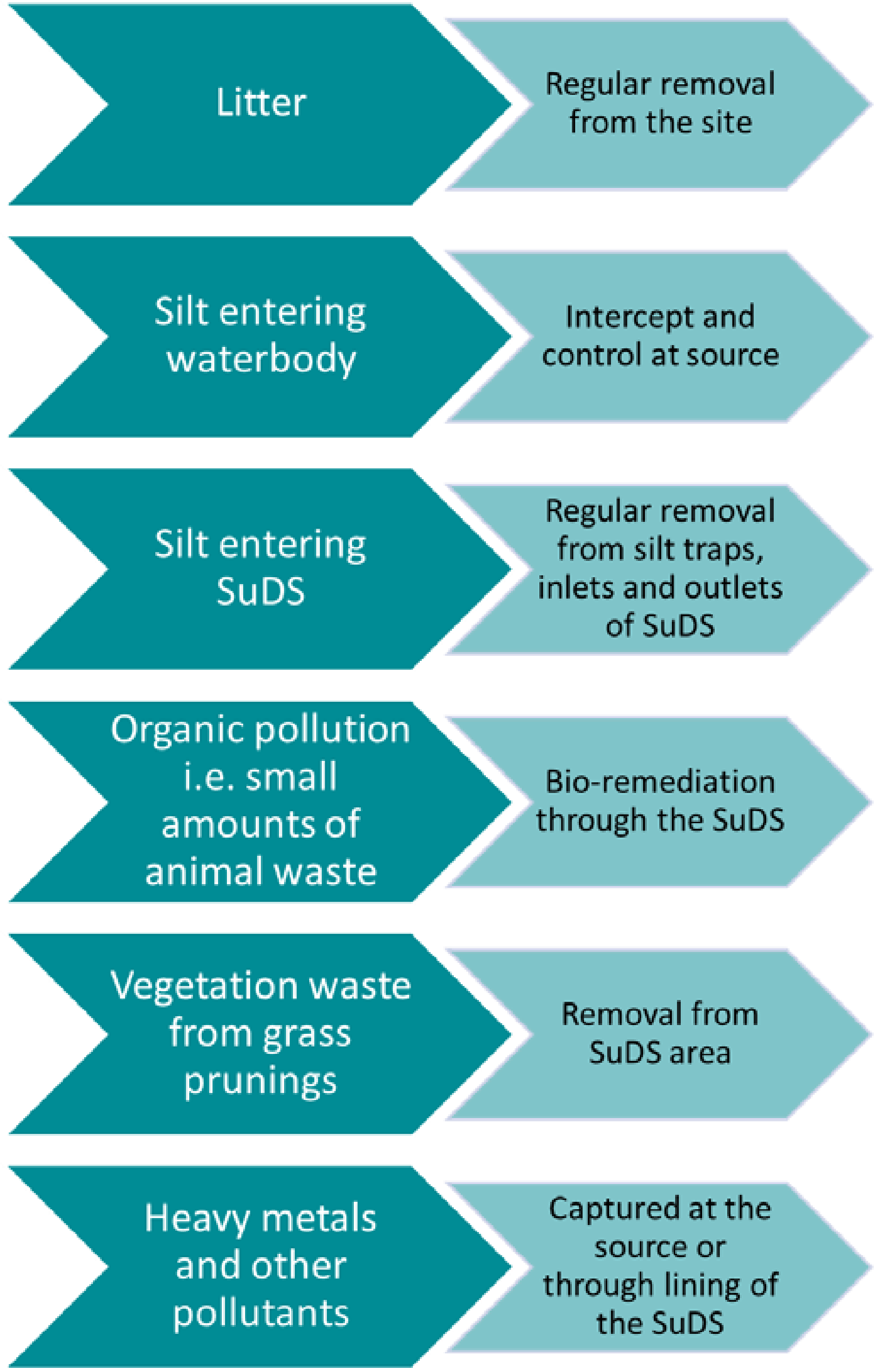
Maintenance of SuDS components is important to ensure their ongoing effectiveness. The tables below identifiy the principal "Frequent", "Occasional" and "Remedial" maintenance works for a range of SuDS components.



	Activity	Green roof / wall	Filter Drain	Filter Strips	Cannels, rills and channels	Swales	Bio Retention	Detention Basin	Underground Storage	Pond	Vortex Separator	Oil Separator
Frequent	Removal of litter / debris	•	•	•	•	•	•	•		•	•	•
	Pruning grass and SuDS vegetation	•	•	•		•	•	•		•	•	•
	Maintenance of surrounding plants				•		•	•		•		
	Clearance of inlets / outlets		•	•	•	•		•	•			
	Silt removal						•			•	•	•
	Removal of compost					•						
	Replenish mulch						•					
	Surface scarification						•					
	High powered wash / suction sweep											
Occasional	Silt removal / review of silt levels		•	•	•			•		•	•	
	Replenish mulch											
	Excess vegetation removal	•			•	•		•		•	•	•
	High powered wash / sweep of paving											
Remedial	Review of erosion				•	•						
	Review / repair of inlets and outlets		•		•	•	•	•		•	•	•
	Replace filter stones		•	•								
	Readjust retention levels						•					
	Replace geotextile layer		•	•								
	Silt removal		•	•	•	•			•		•	

5.4 Waste management for SuDS

A maintenance programme should also include plans for addressing waste produced by SuDS:



WAYMARKER

Maintenance standards required for public highways:

https://www.cheshireeast.gov.uk/pdf/highways/policies-and-standards-documents/highway-surface-water-policy.pdf

6

PLANNING APPROVAL AND ADOPTION

6 Planning Approval & Adoption

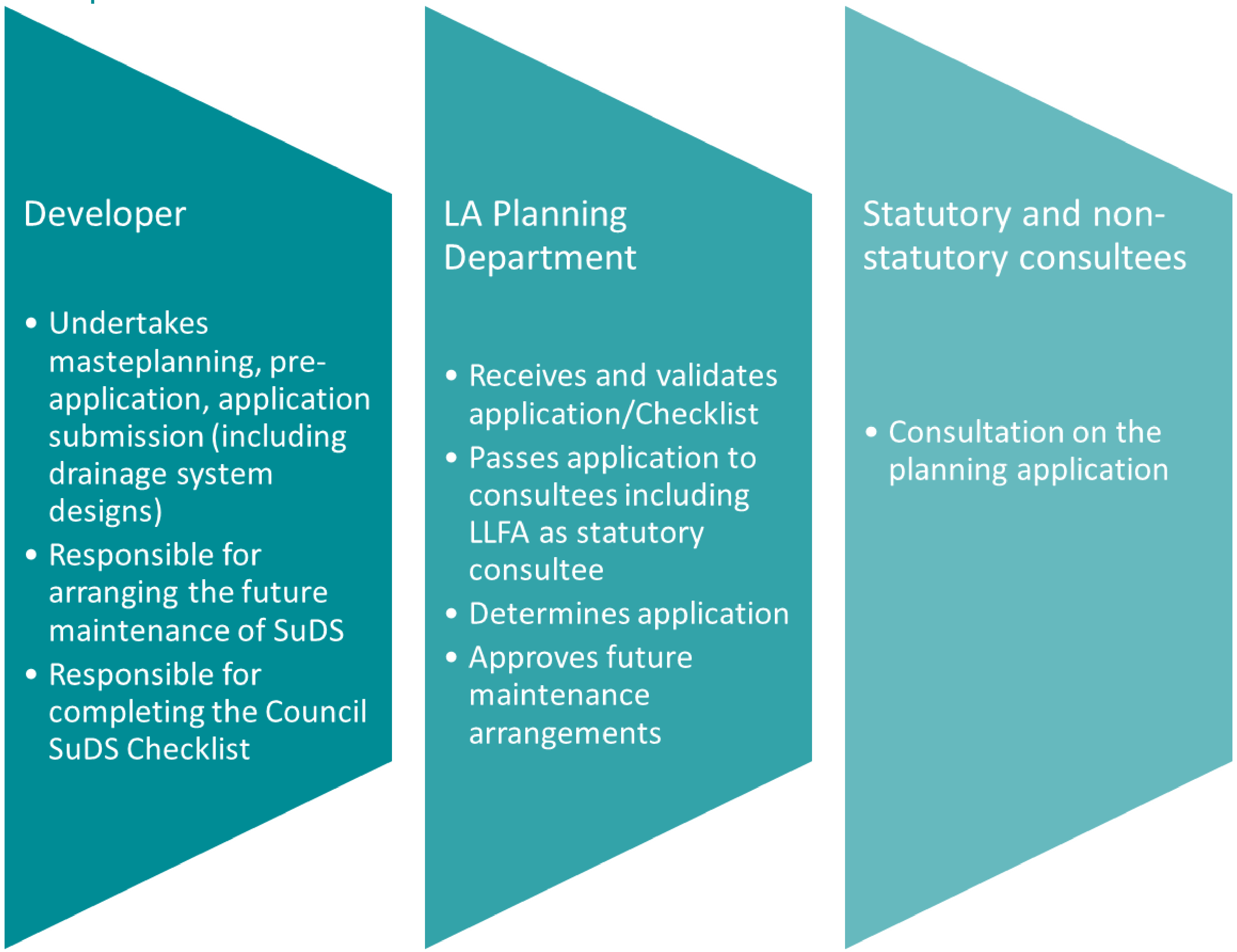
WHAT THIS SECTION WILL COVER:

- Responsibilities - who does what?
- Introduction to the planning application process
- Requirements for different types of planning applications
- Consultation requirements
- The SuDS Application Submission and Approval checklist

6.1 Responsibility Designation

This Section details the approval process for implementing SuDS. SuDS proposals form part of planning applications and should adhere to both the **National Planning Practice Guidance** and the **Defra Non-Statutory Technical Standards for SuDS**. **Figure 6-1** outlines the responsibilities of the three key groups involved in SuDS from inception to implementation. Whilst in Part 2 of this Manual, the future Technical Design Manual will explain this process in more detail as part of the detailed design guidance for SuDS.

Figure 6-1: Responsibilities

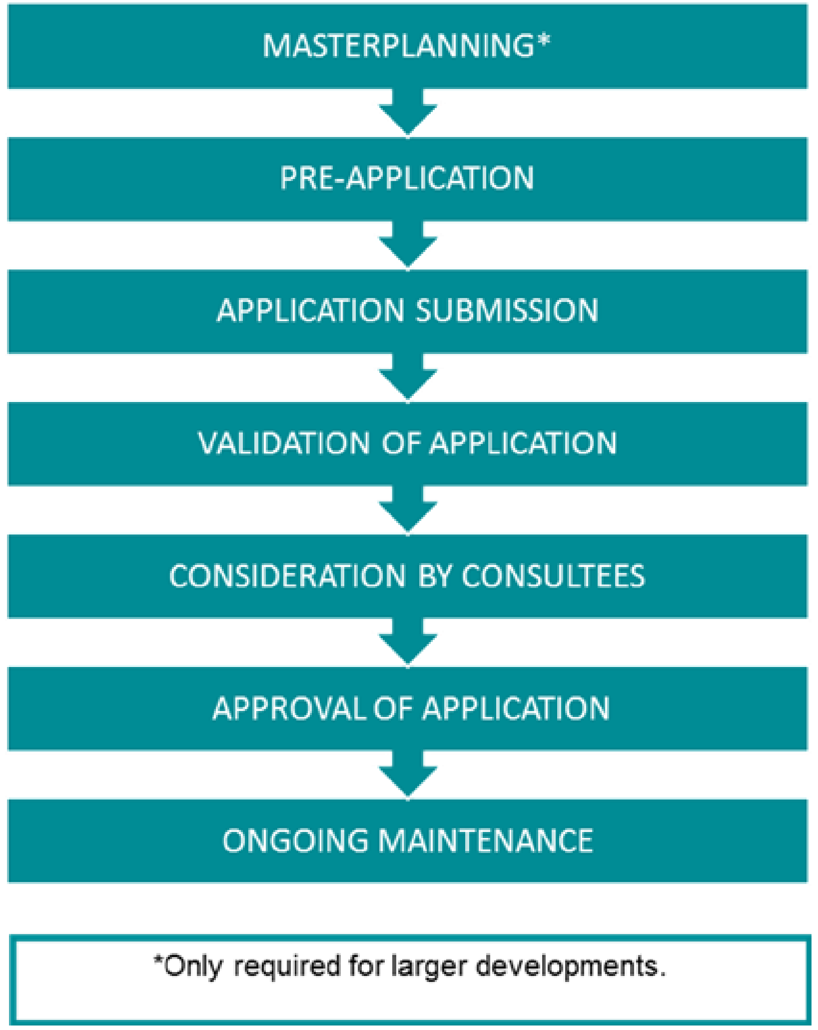


6.2 Planning Application Process

The **Figure 6-2** below illustrates the stages involved in the submission of a Planning Application.

Cheshire East Council operates a paid pre-application service and enters into Planning Performance Agreements (PPAs) to provide developers with pre-application advice and in the case of PPAs with an enhanced, managed approach to the various stages of the planning process. As stated previously, the Councils are keen to promote a collaborative approach to place design, engaging meaningfully with stakeholders and communitites, thus requiring a partnership approach to place-making from inception of the scheme to implementation. The Council is also keen to encourage design review on major schemes and therefore, in future, this should form part of the pre-application and application stages of the planning process.

Figure 6-2: The Planning Application Process



The following Sections describe the considerations and actions which should be undertaken at each stage of the SuDS submission as part of a Planning Application.

For those cases where the developer is uncertain as to whether the application should be submitted as Permitted Development Application, Outline Application or a Full Planning Application, early consultation should be undertaken with the Councils Planning Department and Lead Local Flood Authority.

6.2.1 Masterplanning

Masterplanning is necessary for larger developments, where a full planning application is required. At the masterplanning stage it is useful to establish design codes and principles and layout of development proposals.

In Cheshire East, the CEC Residential Design Guide sets out the requirements for Design Coding and design information required for different types of applications. This is summarised in figure iii/02 of the Design Guide (Figure 6-3). Coding is required for all schemes of 150 dwellings or more, including for component schemes for a site totalling 150 units and for smaller, sensitive sites.

At the outline stage, in developing illustrative masterplans, the Design Guide encourages the submission of testing layouts, as often conceptual masterplanning leads to unrealistic assumptions at the outline stage which creates issues for detailed design. This can lead to conflict between useable open space, SuDS and ecology. Moving forward, these aspects need to be planned collectively to achieve a place structure that prevents such conflicts with testing of layout at the earliest possible stage, even at outline.

Consequently, at this stage the Developer or landowner should consult with the Local Planning Authority to understand the requirements for SuDS. The Developer should plan the SuDS layout with regards to the flows, topography and geology of the area in order to mitigate flood risk, taking account of established industry standards - **CIRIA SuDS Manual C753 and BS8582:2013 Surface Water Management**. With regards to a phased development, developers should provide a coherent drainage strategy for the entire development. This stage also allows an initial costing of the process.

6.2.2 Pre-application

Undertaking early consultations with the Statutory consultees can avoid delays and misunderstandings, increasing flood risk and issues with enforcement or adoption. The management of surface water flood risk is important for SuDS planning. The Council offers a Pre-Application Advice Service involving a multi-disciplinary team advising on urban and landscape design, ecology, flood risk management delivery, asset management and planning.

6.2.3 Application Submission

Full applications and outline planning (where layout is applied for) applications, will require applicants to include a draft Section 106 agreement / or head of terms (or Community Infrastructure Levy (CIL) levy details were an adopted CIL charging scheme is adopted) to deal with future maintenance and management of SuDS as part of the management of highways and open spaces. Calculations of peak flow rates and discharge volumes should also be submitted electronically. When the application is submitted, the Council Planning Department will check to ensure that all the details have been provided (as noted in Way Marker 6.3) by reviewing the provided SuDS Checklist and associated supporting information. If all details have been provided to a satisfactory level the application will be validated. The application will then be passed to the Statutory Consultees for review.

WAY MARKER 6.1
Checklist for masterplanning:

- Requirements are identified in the **SuDS Submission Application and Approval Checklist** provided in **Section 1** Appendix XXX of this guidance.
- Review of key evidence flood risk base documents
- Pre and post developments, including any phasing
- Review of geology, hydrology, green infrastructure, flood risk
- Initial costing and maintenance

WAY MARKER 6.2
Checklist for pre-application:

- Consult with statutory and non-statutory consultees
- Seek advice from the Council via the Pre-Application Advice Service using the **SuDS Submission Application and Approval Checklist** provided in **Section 1** of this guidance to provide the relevant information to inform discussions.

WAY MARKER 6.3
Checklist for Application Submission

- The **SuDS Submission Application and Approval Checklist** is provided in **Section 1** of this guidance and is designed to be completed by developers, validated by the LPA and reviewed by the LLFA.
- For larger developments where a masterplan is required, a detailed drainage layout, post development and pre-development layouts and development phasing will be required.

Figure 6-3

Documents to be submitted with the application:	Nature of Application:					
	Outline:		Reserved Matters:		Full:	
	less than 150 homes	150 homes & more	less than 150 homes	150 homes & more	less than 150 homes	150 homes & more
Design & Access Statement	✓	✓	✗*[1]	✗*[1]	✓	✓
Spatial Design Code	✗	✓	✗	✗	✗	✗
Detailed/Character Area Code	✗	✗	✗	✓	✗	✗
Comprehensive Design Code	✗	✗	✗	✓*[2]	✗	✓

Note:
1. *[1] Whilst a Design & Access Statement is not required, a supporting design statement is recommended, explaining how the reserved matters application accords with the D&As submitted at the outline stage.
2. *[2] A comprehensive design code or elements of a comprehensive design code may be required to accompany a reserved matters application, if a spatial code was not prepared at the outline application stage.
3. The final decision on the need for a Design Code shall be determined by the planning case officer.
4. It is recommended that the content and form of all design documents be agreed with CEC prior to submission.
5. All documentation will need to be validated by CEC, on formal submission of the application.

Figure iii:02 - Planning Application Requirements for Supporting Design Documents

6.3 Submission Requirements

6.3.1 Acceptance of Design Submissions

Design Submissions will include the information identified in the **SuDS Checklist** and follow the standards as described in the following sections.

SuDS located in public areas shall be limited to infiltration/filter trenches, filter strips, swales, bio-retention, detention basins, and underground storage and retention ponds. These SUDS techniques should be appropriately considered, for the best overall performance of the drainage systems and the water quality of the receiving water body.

A Planning Application that deviates from the following design standards must include specific data and information on the proposed design to prove that it is a more appropriate solution for that site. The Council will assess the evidence and if in agreement they will confirm in writing the acceptance of the proposal. The developer may be asked to provide additional information supporting their proposal.

SuDS shall be located in passive public open space or road side verges (if highway drainage), so that SuDS can be accessed for maintenance purposes. The Developer must tell the Planning Authority who will take on future maintenance of the SuDS.

6.3.2 SuDS Design & Submissions - General Requirements

The Developer is responsible for the design of SuDS. The design shall be supported by a risk assessment to ensure risks to both the local community and operators of the drainage system are minimised. The Developer and/or his designer shall certify that their design complies with this design guide and accept liability for compliance through their professional indemnity insurance. These responsibilities/liabilities shall not be discharged to Council or their representatives through the planning consent process.

SuDS designs shall be carried out in accordance with this Guide and the best practice principles in current UK drainage guidance.

Where, as a last resort, the Water Authority permits both surface and foul water to discharge to a combined sewer system, the surface water sewer drainage shall be attenuated to the requirements of the water authority. The developer shall support their planning submission with written discharge consent from the water authority.

The developer should take cognisance of the Councils Land Drainage Byelaws and Environment Agency Main River designations paying particular attention in their masterplanning to the requirement for no obstructions typically within 8 meters of the edge of the watercourse. Flood Defence Consent and Land Drainage Consent information is required as part of the submission, including distance of construction from watercourses etc. Easements for work adjacent to watercourses and culverts, drains, private sewers should be indicated and assumed to be 8m. It is the Developers responsibility to obtain all required discharge permits and evidence of this should be provided.

SuDS are not to be located adjacent to or within the adopted highway, carriageway or footway.

Design submission requirements to the Council (calculations, drawings and construction details) for private SuDS and pipe drainage, are presented in the **SuDS Checklist** and forms part of the audit for the design of the proposed system.

The complete surface water drainage system for a development (sewers and SuDS) could be partly private, partly adopted by the relevent Water Company and partly owned and maintained by a third party but not the Local Authority.

6.3.3 Drawings, Calculations, and Manhole Records

Drawings and calculations of the complete drainage system should be supplied with the SuDS application. Separate drawings of private systems should be supplied for record purposes only.

All drawings and calculations submitted should be in metric units.

The drawings should show all the necessary detailed information required by the the **SuDS Checklist**, this Guidance and **Appendix VI of Sewers for Adoption 7th Edition**.

Location and layout plans, sections and details should show the proposed SuDS and drainage system in full, including private SuDS. Plan scales should be those in common use, i.e. 1:20, 1:50 and 1:100 as appropriate.

Longitudinal sections should generally be to an exaggerated scale, with the horizontal scale the same as the plan (but no less than 1:500) and the vertical scale 1:100.

Record drawings shall contain the "as-built" information to 300mm accuracy in the horizontal plane, with dimensions related to fixed Ordnance Survey features or Ordnance Survey co-ordinates to 1m accuracy (12-digit accuracy, e.g. 123456, 123456).

6.4 Surface Water Drainage Design

6.4.1 Hydraulic Design

The surface water drainage system shall be designed according to **Part C5 Hydraulic Design of Sewers for Adoption 7th Edition**, so that flooding does not occur in any part of the site in a 1-in-30 year return period design storm flood frequency.

Appropriate software shall be used to simulate the system and provide expected performance data. For all developments which utilise SuDS, the use of appropriate analytical tools are needed to demonstrate the required level of flood protection performance. For developments of fewer than ten houses, the procedure presented in **Part C3 Hydraulic Design of Sewers for Adoption Small Developments Version – September 2013** shall be followed.

Representation of SuDS in simulation software should be explicit, where possible. A copy of the model and results should be submitted to Council for acceptance. All hard surfaces draining to the network should be accurately allocated to the drainage network and represented in the model. All connecting manholes should be included in the model. Representation of the hard surfaces draining to the network should be accurately allocated to the drainage system and all manholes should normally be included in the model.

Surface water drainage should be designed for run-off from roofs and subject to the agreement of the Undertaker, roads (including verges) and other hard-standing areas. For these areas, an impermeability (runoff coefficient) of 100% shall be assumed.

An additional increase in the paved surface area of 10% shall be assumed for all areas to allow for future urban expansion (extensions and additional paved areas) unless this would produce a figure greater than 100% of the site.

Design event rainfall should be based on the use of the most recent version of the 'Flood Estimation Handbook' specific to the location of the development. An allowance for climate change in accordance with Environment Agency Guidance (by factoring the rainfall intensity hyetograph values) should be applied.

WAY MARKER 4.3
Climate Change & Peak Rainfall Intensity Allowance

Increased rainfall affects river levels and land and urban drainage systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments. For design, assess both the central and upper end allowances to understand the range of impact.

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Defra Climate Change Guidance
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

During severe wet weather, the capacity of the surface water drainage systems may be inadequate, even though they have been designed in accordance with this Guide and Sewers for Adoption 7th edition. Examples of different weather conditions which cause flooding include:

a. High-intensity rainfall events bypassing gully inlets;
b. High-intensity rainfall events resulting in sewer surcharging and surface water escaping where the ground level is below the hydraulic gradient;
c. High-intensity rainfall events on areas adjacent to the development site (urban or rural) from which overland flooding can take place;
d. Long-duration rainfall which may result in the top water level in storage systems becoming full, resulting in overflow;
e. Extended periods of wet weather which may result in high receiving watercourse water levels affecting the hydraulics of the drainage system.

Checks shall be made for the 1-in-100+ climate year return period to ensure that properties on and off site are protected against flooding for all these scenarios. The design of the site layout, or the drainage system should be modified where the required flood protection is not achieved. This is particularly relevant on undulating and steeply-sloping catchments and adjacent to watercourses. Developers should also demonstrate flow paths and the potential effects of flooding resulting from these storm events. Access roads into and through the site for emergency vehicles must be ensured for these events.

Where it is proposed to connect to an existing adopted drainage network, the developer shall consult with the Undertaker and the Lead Local Flood Authority regarding acceptable discharge criteria. Hydraulic performance modelling of the receiving drainage system may be required.

Where it is proposed to connect to other existing drainage networks (including but not limited to culverts, privately owned systems, open drainage ditches, or constrained watercourses) the developer shall consult with owner of the drainage network and the Lead Local Flood Authority to agree acceptable discharge criteria. Hydraulic and structural assessment of the receiving drainage network is likely to be required.

6.4.2 Attenuation Storage

The limiting discharge rates from the site should normally be assessed using the '**Flood Estimation for Small Catchments**' **(Institute of Hydrology 1994)**. For application sites, smaller than 50ha it should be applied for 50ha and linearly interpolated to the development area. Values should be determined for the 1-year, 1-in-30 year and 1-in-100 years as a minimum. A tool for assessing greenfield runoff rates is provided in **Appendix B** using the calculation described in **Way Marker 4.4**.

The maximum 1-year water level in attenuation storage should not cause significant backing up of flows in the incoming sewer and a 1-year, 1-hour duration event should not surcharge the drainage network.

Simulation modelling of the contributing development area considering the head-discharge relationship of the proposed SuDS discharge outlet is required to calculate the attenuation storage volume. The model may be based on either the fixed percentage run-off of 100% run-off from all impermeable surfaces, or the UK variable run-off model (see **CIRIA document 'Drainage of Development Sites – A Guide' (2004)** for the run-off from the whole site. Appropriate allowance in the reduction in run-off should be made for infiltration systems serving any impermeable areas.

WAY MARKER 4.4
Calculation for greenfield run-off peak flows
(Institute of Hydrology Report 124)

$$QBAR_{rural} = 1.08(AREA/100)^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$$

$QBAR_{rural}$ = Mean annual run-off for rural (greenfield) areas (litres/second)

AREA = area of the site (hectares)
If the site is smaller than 50 hectares, the calculations should be undertaken using 50 hectares and then amended (by dividing by the actual site area) at the end of the calculation.

SAAR = Standard Average Annual Rainfall (mm)

SOIL = Predominant soil type
The most suitable soil type should be selected from the table below:

Soil Description	Soil value for calculation
Peat (waterlogged)	0.50
Clay	0.50
Clayey loam	0.45
Loam	0.40
Sandy Loam	0.30
Sand	0.15

6.4.3 Peak flow rate and volume

Peak flow rate and volume does not apply to any surface run-off that is discharged:

- By infiltration; or
- To a coastal or estuarial water body; or
- To an alternative water body where the LLFA considers it appropriate to do so.

Developers will need to demonstrate that Consent to discharge and 3rd party land ownership issues/crossing have been agreed prior to planning application and detail these in the relevent sections of the SuDS Checklist.

6.4.4 Low rainfall

There should be no discharge to a surface water-body, or sewer that results from the first 5mm of any rainfall event. In low-permeability soils where this is not achievable, the developer shall demonstrate to the Council that infiltration has been encouraged through the SuDS management train.

6.4.5 High rainfall

Either of the two approaches below must be used to manage the surface discharge:

Approach 1: Restricting both the peak flow rate and volume of runoff

The peak flow rates for the:

- 1 in 1 year rainfall event; and
- 1 in 100+ climate year rainfall event;

must not be greater than the equivalent greenfield run-off rates for these events. The critical duration rainfall event must be used to calculate the required storage volume for the 1 in 100+ climate year rainfall event.

The volume of runoff must not be greater than the greenfield run-off volume from the site for the 1 in 100+ climate year, 6-hour rainfall event.

Climate change should be considered in attenuation storage calculations by increasing the rainfall depth using a climate change factor. Current Environment Agency guidance should be referenced to apply the appropriate climate change factors relevant to the location and design life of the proposed development.

Approach 2: Restricting the peak flow rate

The critical duration rainfall event must be used to calculate the required storage volume for the 1 in 100+ climate year rainfall event. The flow rate discharged:

For the 1 in 1 year event, must not be greater than either:

- The greenfield runoff rate from the site for the 1 in 1 year event, or
- 2-5 l/s per hectare. This should be agreed with the Lead Local Flood Authority within the planning process;

And for the 1 in 100+ climate year event, must not be greater than either:

- The greenfield mean annual flood for the site, or
- 2 litres per second per hectare (l/s/ha).

6.4.6 Previously developed land

Where the site is on previously developed land and neither Approach 1 or 2 is reasonably practicable then:

a. An approach as close to Approach 1 as is reasonably practicable must be used (the Councils are seeking runoff from brownfield sites to mimic greenfield run-off rates wherever possible);

a. The flow rate discharged from the site must be reduced from that of the actual modelled pre-development rate, in accordance with the criteria set out in Section 2A-2C:

- The 1 in 1 year event; and
- The 1 in 100+ climate year event.
- The volume of run-off may only exceed that prior to the proposed development where the peak flow rate is restricted to 2 l/s/ha.

6.4.7 Exceedance

The design of the drainage system must consider the impact of rainfall falling on any part of the site and also any estimated surface run-off flowing onto the site from adjacent areas.

Drainage systems must be designed so that, unless an area is designated for flood management in the Local Flood Risk Management Strategy, flooding from the drainage system does not occur:

a. on any part of the site for a 1 in 30 year rainfall event; and

b. during a 1 in 100+ climate year rainfall event in any part of:

- a building (including a basement); or
- utility plant susceptible to water (e.g. pumping station or electricity substation); or
- on neighbouring sites during a 1 in 100+ climate year rainfall event.

Flows that exceed the design criteria (i.e. 1 in 100+ climate year rainfall event) must be managed in flood conveyance routes, preferably in green networks, that minimise the risks to people and property both on and off the site. Evidence of those conveyance routes must be submitted to the LLFA.

6.4.8 Water quality

The treatment train process described in Section 3.5, should be used to assess storm water quality requirements.

WAYMARKER

Run-off Hazard Levels

Hazard	Level of hazard
Low	Roof drainage
Medium	Residential, amenity, commercial, industrial uses. Includes car parking and roads
High	Areas used for handling and storage of chemicals and fuels, handling and storage of waste. Includes scrap yards as well as lorry, bus or coach parking or turning areas

WAYMARKER

Treatment stages for discharge to groundwater

Groundwater Discharge Location		Minimum number of treatment stages		
	Runoff Hazard Level	Low	Medium	High
G1	Source Protection Zone, within 50m of a well, spring or borehole that supplies potable water	1	3	Consult the Environment Agency
G2	Into or immediately adjacent to a sensistive receptor that could be influenced by infiltrated water. Includes designated nature conservation, heritage and landscape sites - including Biodiversity Action Plan (BAP) habitats and protected species.	1	3	
G3	Source Protection Zone II or III or Principal Aquifer	1	3	
G4	Secondary Aquifer	1	2	

Surface run-off from roof drainage must be isolated from other sources where it is discharged to G1 and G2.

Infiltration may only be used to discharge to G1 and G2 where a risk assessment has been undertaken and the SuDS design effectively addresses these risks.

Research undertaken by Portsmouth University, showing water quality improvement by vegetated SuDS components

Image:Wildflower Turf Ltd (TBC)

WAYMARKER

Treatment stages for surface water bodies

Hazard	Normal surface water	Sensitive surface water
Low	0	1
Medium	2	3
High	Consult the Environment Agency	

Where discharged to a sensitive surface water body (defined as any catchment smaller than 50km; any catchment with less than 20% urbanisation; any catchment with an environmental designation or national or international recognition, or any catchment where good ecological status is at risk), one extra treatment stage must be added.

6.4.9 Record Information for the completed Works

Upon completion, the following items should be supplied to Council.

a. Two sets of as-built record drawings in electronic format and compatible with AutoCAD Release 14 in *.DWG or *.DXF format;

b. Where appropriate, closed circuit television (CCTV) survey of underground systems by a qualified contractor in accordance with Clause E7.6 of Sewers for Adoption 7th Edition in CD or DVD format with a hard copy of the written report. CCTV at completion is at the discretion of the Developer. The Developer is responsible for checking that the CCTV survey shows no defects or debris within the infrastructure.

c. Health & Safety File prepared in accordance with the Construction (Design & Management) Regulations 2015.

6.5 Development and Flood Risk

When considering new development, Developers will need to consider flood risk and development in accordance with the requirements of the **National Planning Policy Framework (NPPF)**.

Figure 3-3 summarises the process.

Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk of flooding. Where development is necessary, it should be demonstrated to be safe and should not result in an increase in flood risk elsewhere.

The **NPPF** sets of the aims of the Sequential Test, to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The **Council's Strategic Flood Risk Assessment (SFRA)** will provide the basis for applying this test although the most recent Environment Agency flood maps should also be reviewed. A sequential approach should be used in areas known to be at risk from any form of flooding.
A site-specific **Flood Risk Assessment (FRA)** will be required and this will need to demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere. Where possible overall flood risk should be reduced.

On brownfield sites the existing drainage systems should be modelled to demonstate actual pre-development surface water runoff. Appropriate consideration of the existing system operation, including number and frequency of gullies, and existing attenuation whether natural or artificial.

Appropriate reductions of surface water runoff should be achieved in accordance with Section 6.4

A site-specific flood risk assessment is required for development proposals:

- of 1 hectare or greater in Flood Zone 1;
- all proposals for new development (including minor development and change of use) in Flood Zones 2 and 3;
- or within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency);
- and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

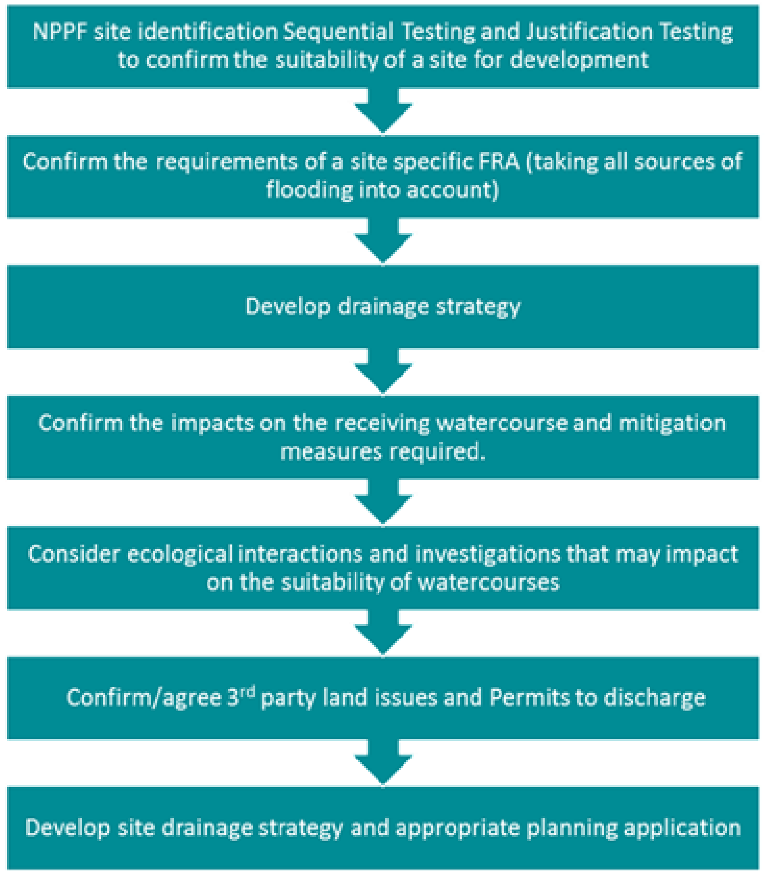
Drainage strategies will need to take local flooding into account. Interactions with receiving ditches and watercourses (including culverts) will need to be fully appraised in order to ensure that surface water runoff is effectively managed without increasing flood risk elsewhere.

Proposals will need to include assessment of surface water interactions with other sources of flooding including fluvial and tidal interactions. This will need to including consideration of, for example, climate change, blockage scenarios and hydraulic capacity of for example, bridges and culverts during design flood events.

Developers will need to demonstrate that all land ownership and long-term maintenance issues have been resolved as prior to submitting a full planning application. Developers will also need to obtain relevant Permits to discharge, and include information on pollution control measures where required.

It is recommended that Developers consult with the Local Planning Authority and the Environment Agency to determine the requirements for a site specific FRA.

Figure 5-4: Development & Flood Risk Assessment

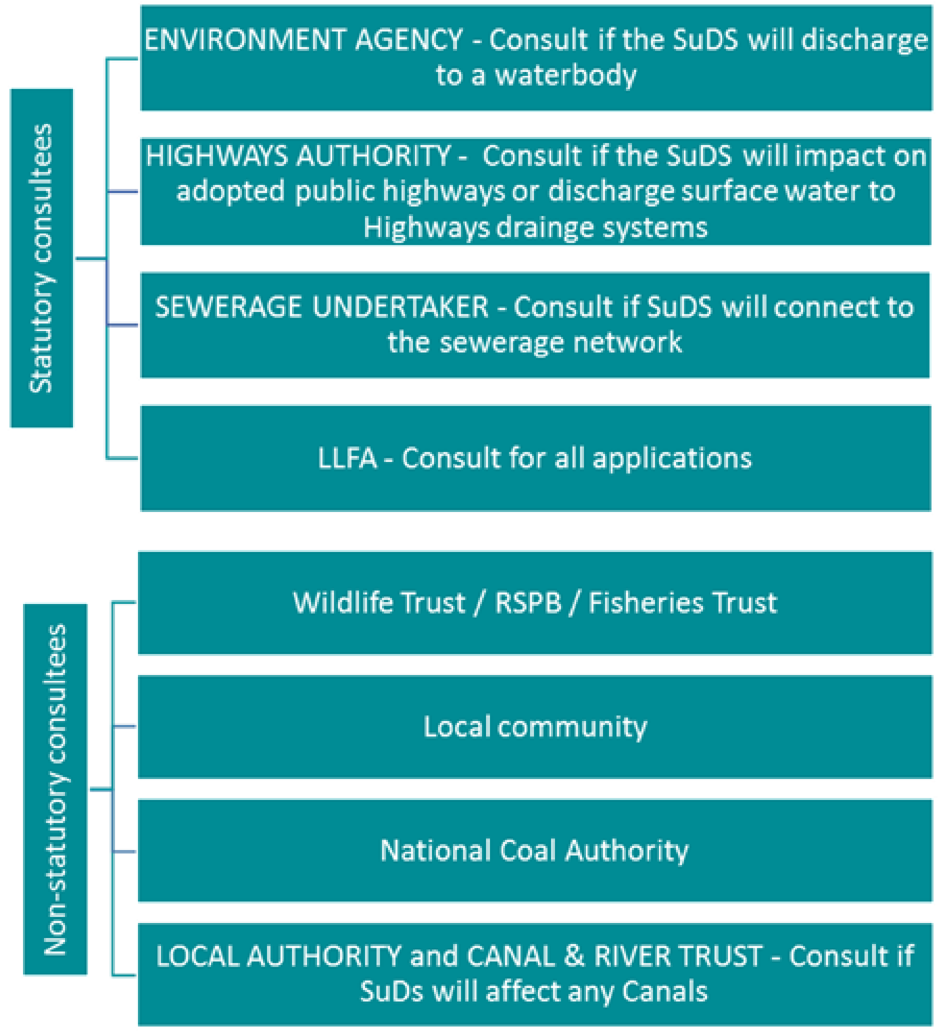


6.6 Consultation

Under the **Flood and Water Management Act 2010,** the Council are a Lead Local Flood Authority (LLFA) and according to the Defra Planning Practice Guidance, LLFA's should be consulted at the planning consultation stage to gain advice for surface water drainage. As each Council is well placed in terms of existing strategic policy and flood risk evidence base, being at the forefront of the SuDS approval process will positively affect local decisions on planning and drainage and will make a significant contribution to the vision of the local plan core strategy.

Whilst not compulsory, it is beneficial to consult to gain further understanding of the implications and considerations which should be made when planning for SuDS

Figure 5-5: Consultees



6.7 Approval

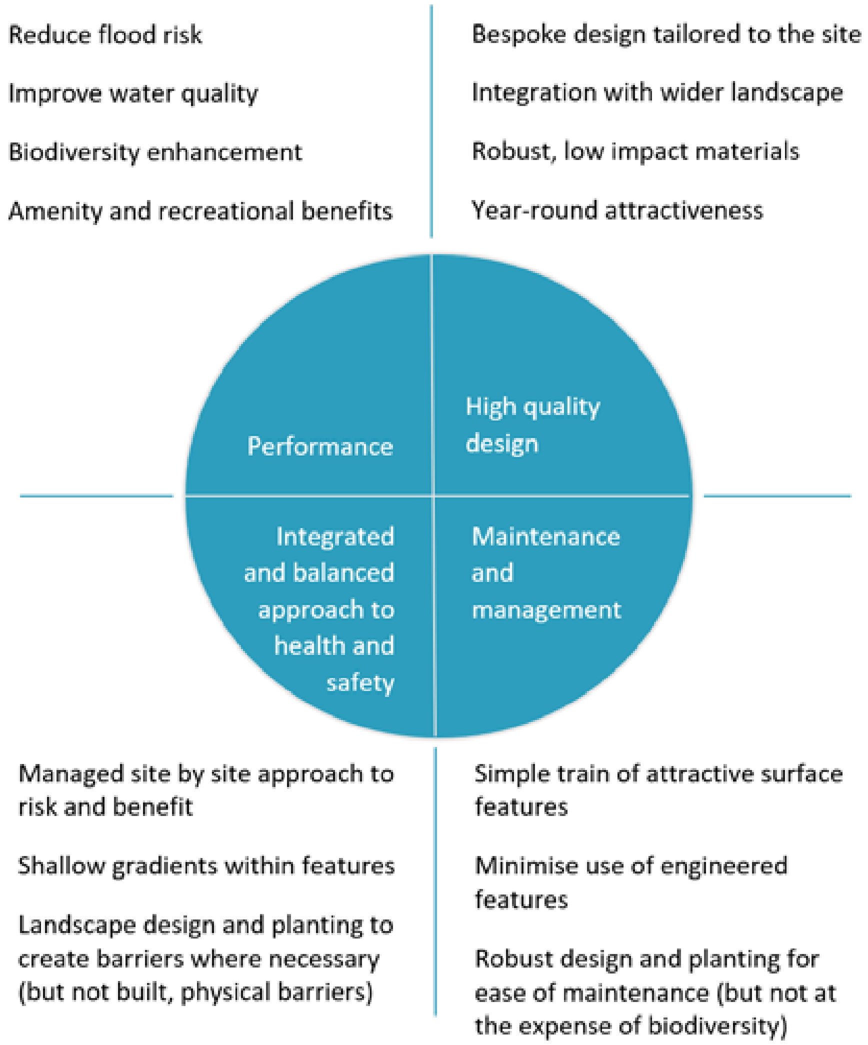
The approval of SuDS within an application will be determined by the Council Planning Department, who will base their decision on the recommendations made by the LLFA and the other consultees. This may take the form of planning conditions.

The Planning Department will also take into consideration the extent to which the proposal has complied with National Standards (general compliance will have been ensured at the Validation stage of the process through ensuring appropriate completion of the **SuDS Checklist**), the understanding of local requirements and the Local Plan. Larger developments and those which have met with objections will be determined by planning committees within the Council Planning Department.

6.8 Adoption Process

The adoption process technically begins once SuDS approval has been granted and includes the physical construction and subsequent maintenance of the SuDS.

However, to ensure that the proposed SuDS will be adopted and maintained to a high standard and ensure long term benefits, this stage of the planning application process should be considered before submission.



Adapted from the Cambridge SuDS Design and Adoption Guide

The **SuDS Checklist** has been designed for use by Planners, LLFA and Developers to ensure that the various requirements of adoption and maintenance have been carefully planned before submission. If sufficient provision has not been made, then absence of these details will be flagged and the planning application will be recommended for refusal by the LLFA.

National guidance allows the developer to arrange for the adoption and maintenance to be undertaken by any one of four bodies:

- Service management companies
- LLFA or LPA (**Note that the Councils are not currently adopting SuDS schemes**)
- Water and sewerage companies (United Utilities and Dwr Cymru Welsh Water)
- Individuals (site owners or inhabitants)

Evidence of an agreement in principle with the body who will adopt the SuDS, connecting sewer networks and storm drainage is likely to be required at the submission stage together with a plan of the maintenance schedule and the likely activities to be involved.

Further details of SuDS Maintenance and Management requirements can be found in **Section 5** of this guidance document.

This table summarises the various processes, including adoption running in parallel from inception to implementation.

Planning Stage		Development process required information (from the SuDS Guide)	Drainage design process (from the SuDS Guide)	Adoption process
Pre-application discussions and submission of FULL application	Pre-application discussions and submissions of outline application	Submission of FRA and drainage strategy in line with PPS25. Identification of likely SuDS methods to satisfy planning policy	Conceptual drainage design flow routes through the site and storage locations. Outline drainage design and drainage impact assessment. Demonstrate storage areas and volumes, conveyance routes and controls.	Initial consultation on adoption - locations and design requirements
Negotiation of Full submission and Section 106 discussions	Negotiation of Outline submission and Section 106 discussions	Submission of any amendments (if necessary)	Submission of any amendments (if necessary)	Agreement of outline drainage design and agreement to adopt in principle (or option to adopt in principle)
	Planning permission granted and Section 106 agreed			
	Design coding	Principles of the detailed design agreed site wide	Principles of the detailed design agreed site wide	Agreement that the detailed design is compliant with adoption guide and S106 agreement
	Reserved matters applications	Detailed plans in line with agreed design code	Final submitted design with location and size, depth, etc. compliant with approved detail above	Submitted design compliant with adoption guide
Full approval/ S106 approval	**Reserved matters approval**			
Construction of development	Construction of development	Discharge of any outstanding conditions	Construction of drainage system	Verification of construction to agreed design and specification
Formal adoption of SuDS and monies paid as per the trigger/amount agreed in the S106				

Adapted from the Cambridge SuDS Design and Adoption Guide

6.10 Other Consents

In addition to planning approval, developers may also need to obtain further consents to discharge. The LLFA will normally require evidence of compliance from the responsible authority, as outlined in the table below.

Consent	Responsible Authority
Land Drainage Consent (Ordinary Watercourse) (Land Drainage Act, 1991, Section 23)	LLFA
Flood Risk Activity Permits (Main River) (The Environmental Permitting (England and Wales) Regulations 2010)	Environment Agency
Environmental Permits for Waste or Emissions	Environment Agency
Adoption of a sewer (Water Industry Act, 1991, Section 104)	Water and Sewerage Companies (United Utilities or Dwr Cymru Welsh Water)
Connection to a sewer (Water Industry Act, 1991, Section 106)	Water and Sewerage Companies (United Utilities or Dwr Cymru Welsh Water)
Building over or close to a sewer (within 3m) (Building Regulations, 2015, Document H)	Water and Sewerage Companies (United Utilities or Dwr Cymru Welsh Water)
Connection to an existing highway drain or adoption of highways drainage (Highways Act, 1980, Section 38)	Highway Authority
Highways Technical Approcal Category D	Highway Authority
Third party landowner permissions	Third party landowner
Local Authority Land Drainage Byelaws	Lead Local Flood Authority

6.11 The SuDS Submission Application Process

The **SuDS Submission Application and Approval Checklist** (the **SuDS Checklist**), included as **Appendix A**, identifies the SuDS-related information which should be provided by the Developer in support of a Planning Application. The requirements, and level of detail needed, is dependent on the stage of application, as well as the scale of the proposed development.

The **SuDS Checklist** includes for:

- **Pre-Application**
- **Minor Developments**
- **Major Developments**
- **Outline Application**
- **Reserved Matters**

The Developer is required to provide all the information identified in the Checklist including specific links to key plans, calculations and supporting documents where required.

> **WAY MARKER**
> **Definition of "Major Development":**
>
> "Major Development" (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010) means development involving any one or more of the following:
>
> α. the winning and working of minerals or the use of land for mineral-working deposits;
>
> β. waste development;
>
> χ. the provision of dwelling houses where:
>
> i. the number of dwelling houses to be provided is 10 or more; or
>
> ii. the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the development falls within sub-paragraph (c)(i);
>
> δ. the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or
>
> ε. development carried out on a site having an area of 1 hectare or more.
>
> Changes to the National Planning Policy Framework (NPPF) came into effect on 06 April 2015 which made Lead Local Flood Authorities (LLFA) statutory consultees in planning applications for "**Major Development"** in relation to SuDS and Drainage.
>
> The Development Management Procedure Order was also amended, designating Councils as the Lead Local Flood Authority, and therefore each Council is now a statutory consultee within the planning process on the management of surface water.

The **SuDS Checklist** identifies the information required as a series of questions and includes references to this Guidance where further information can be found. The checklist is in five sections:

1. **Application Details**
2. **General Details and SuDS Proposals**
3. **Hydraulic Assessment of SuDS Proposals**
4. **SuDS Discharge Proposals and Agreements**
5. **SuDS Maintenance and Management Proposals**

> **WAY MARKER**
> **How to Complete the SuDS Submission Application and Approval Checklist (the SuDS Checklist)**
>
> The **SuDS Checklist** is in the form of an Excel spreadsheet which is included in **Appendix A** of this guidance document and can be downloaded here. **TO BE ADDED AT LATER DATE**
>
> The Checklist is designed for the Applicant to provide a response to each indicated questions appropriate to the stage and type of planning application.
>
> The Applicant's response should include references to their submitted reports, drawings and calculations where information to support their answer can be found. **Developers are to submit all SuDS information as a package (hard & soft copy).**
>
> The Applicant will be required to confirm that the SuDS documentation submitted complies with the Council's SuDS Guidance Documentation, Local Planning Policies and all relevant National Legislation, Policies and Guidance.

> **WAY MARKER**
> **Defra SuDS Non Statutory Technical Standards**
>
> Non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems.
>
> https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

6.11.1 Submission Validation & Assessment

Planning applications may be made either as a, **Minor Application**, an **Outline Application** (with one or more matters reserved for later determination) **or as a Full Application**. The level of information which would need to be submitted for each type of application or stage within the planning process will vary depending on the size of the development, flood risk, constraints and proposed sustainable drainage system.

The Developer shall be wholly responsible for the design and construction of SuDS systems. The Developer and/or their designer shall certify that their design complies with Council Guidance and accept liability for compliance through their professional indemnity insurance. These responsibilities/liabilities shall not be discharged to Council following a satisfactory audit of their design.

The Council will assess SuDS applications to ensure proposed minimum standards of operation are appropriate and, through the use of planning conditions or planning obligations, that there are clear arrangements in place for ongoing maintenance of SuDS over the lifetime of the development.

Sustainable drainage systems may not be practicable for some forms of development (for example mineral extraction). The decision as to whether a sustainable system would be inappropriate in relation to a particular development proposal is a matter of judgement for the Local Planning Authority. The judgement of what is reasonably practicable will be by reference to the SuDS technical standards published by the Department for Environment Food and Rural Affairs and take into account design and construction costs.

It should be noted that the Councils have no duty to adopt SuDS (**and are not currently adopting new SuDS**) and provision for the disposal and maintenance of run-off remains the responsibility of the Developer.

A satisfactory audit by a Council does not authorise any activities by the Developer which may be in contravention of any enactment or any order, regulation or other instrument made, granted, or issued under any enactment, or in contravention of any rule, byelaw or in breach of any agreement or legal rights.

APPENDICES

Appendix A SuDS Checklist

Checklist to be added

Appendix B Additional Relevant Policies

National

The National Planning Policy Framework (NPPF)

The framework presumes in favour of sustainable development, i.e. development that meets interdependent social, environmental and economic objectives, as set out in its various chapters.

Chapter 8 Promoting Healthy and Safe Communities – requires that planning processes seek to promote healthy, inclusive and safe places through a positive approach to design, including by creating the opportunity for social interaction via mixed uses and high quality public realm, making places safe and accessible for all, and supporting healthy lifestyles, including through provision of a high quality network of accessible spaces and access to sport and recreation.

Chapter 14 Conserving and enhancing the natural environment – promotes a positive approach to the management of the natural environment including valued landscapes, biodiversity, geodiversity, soils and the best quality and most versatile land, whilst recognising the intrinsic value of the countryside. It requires minimising ecological impact and promotes biodiversity net gain and ecological networks resilient to future change. A tiered approach to protection is provided, with a general presumption against ecological harm. In regard to Development Management, it sets out a process to protect important natural assets from development, including international, national and locally protected assets including ancient woodland and veteran trees. It also promotes supporting development aimed principally at conserving the natural environment or that would positively secure measurable biodiversity net gain.

The National Planning Practice Guidance (NPPG) provides guidance for implementing the NPPF (but not set out here).

Local

Cheshire East (including that part of the Peak District National Park within its area)

Cheshire East Local Plan Strategy (CELPS)

Principal Policy

SE3 Biodiversity and Geodiversity – seeks to protect nationally and locally important designated sites from inappropriate development, whilst securing appropriate mitigation in regard to non-designated assets or sites. In respect to all forms of development, the objective should be to positively contribute to the conservation and enhancement of biodiversity and geodiversity

SE 4 Landscape – requires that all development should seek to conserve the landscape character and quality of the Borough, comprising both built and natural features, that contribute to its local distinctiveness. This is to achieved by incorporating appropriate landscaping, preserving and promoting local distinctiveness, avoiding the loss of habitats of landscape importance and protecting historical and ecological character.

SE5 Trees, hedgerows and woodlands – stipulates that proposals that would threaten the heath of trees (including veteran trees), woodland or hedgerow, that provide a significant contribution to amenity, biodiversity and landscape and historic character should not be allowed unless there is a clear overriding justification. Where such development is allowed, there should be net environmental gain through mitigation, compensation or offsetting and the new development should provide for the sustainable management of woodland, tree and hedgerows as well as ensuring planting of large trees within structured landscape schemes to maintain canopy cover.

SE6 Green Infrastructure –sets out the Councils ambitions to deliver high quality, accessible and connected GI across the Borough, providing for healthy recreation and biodiversity, and building on the varied characteristics of the GI across the Borough by protecting and enhance existing GI and ensuring that new development includes high quality new green spaces that integrate with the wider GI framework.

SC3 Health and wellbeing – promotes health and wellbeing through the planning process including by ensuring that new developments provide opportunities for healthy living and to improve health by creating well connected, walkable and cyclable neighbourhoods, cohesive and inclusive communities, enabling social interaction and access to quality open space, green infrastructure and sport and recreation.

Emerging Policy

Cheshire East Site Allocations and Development Management Policies (SADPD) Draft

ENV 1 Ecological Network and ENV 2 Ecological implementation – these elaborate on policy SE3 of the CELPS in terms of setting out the approach that new development should deliver proportionate opportunities to protect, conserve, restore and enhance the ecological network including setting out the approach to ecological net gain and the need for developments to be ecologically positive, both where ecological assets are impacted and to generally improve biodiversity within new development.

ENV 3 Landscape Character, ENV 4 River Corridors and ENV 5 Landscaping – collectively these policies seek to reinforce the landscape character of the Borough by ensuring that the landscape approach within new development seeks to protect and enhance landscape character and green and blue infrastructure, the incorporation of place relevant planting, an appropriate balance between space and built form, and by providing for climate change mitigation and adaptation (including SuDS) within new development

ENV 6 Trees, hedgerows and woodland implementation – requires the retention of existing landscape features and the need to compensate for any loss. Trees, woodland and hedgerow should be sustainably integrated and new planting should be integrated into proposals as part of a comprehensive landscape scheme.

ENV 7 Climate Change - sets out a number of requirements for new development, both in the design of buildings and spaces in accommodating climate change adaptation and resilience, including within retrofit situations.

Cheshire East Design Guide SPD volumes 1 and 2 (the Design Guide)

The Design Guide includes a number of chapters that are important in considering the design of SuDS.

Volume 1 sets out in detail the local context and what makes Cheshire East distinctive, and the required approach to improving design quality, including processes such as Design Coding. Volume 2 sets out the specific considerations for designing new development and delivering place quality, sustainable design and improved health and wellbeing through high quality design. The relevant chapters are:

Chapter 1 working with the grain of the place – which aims that designers and developers establish a broad understanding of the site, its context and the opportunities to create a place specific and sustainable development based on a strong vision for the scheme.

Chapter 2 urban design – builds on chapter 1, setting out the means to create a strong structure for new development, identifying the important layers (including green and blue infrastructure at the top of the hierarchy) necessary to create a well-conceived and integrated development that responds positively to the place to ensure a sustainable, functional and attractive development.

Chapter 4 Green Infrastructure and Landscape Design - provides detailed guidance relating to GI and BI, and detailed aspects of landscape design, including the importance of maintaining existing landscape features and the appropriateness of new landscape design. It also provides a concise introduction to sustainable drainage systems and their value in terms of quality of place, providing the design context for this SuDS manual.

Chapter 5 Sustainable Design Principles – identifies spatial, active and passive aspects of sustainable design of buildings and spaces, including the role of trees and landscape in terms of passive design and adaptation, as well as considering how active approaches at source can contribute to water management as part of an integrated approach to SuDS.

Chapter 6 Quality of Life – identifies the importance of good quality and attractive homes and neighbourhoods including access to high quality open and green space and public realm, the promotion of community health and wellbeing and the specific wellbeing benefits of a sense of identity derived from the local character of places (a sense of belonging).

NB there are also a number of 'saved' policies from the legacy Local Plans but these are intended to be superseded in the near future by the SADPD. The intention of this SPD is not to provide further guidance on these policies, and so, they are not listed here.

Appendix C SuDS Schematic Indicative Design Layouts

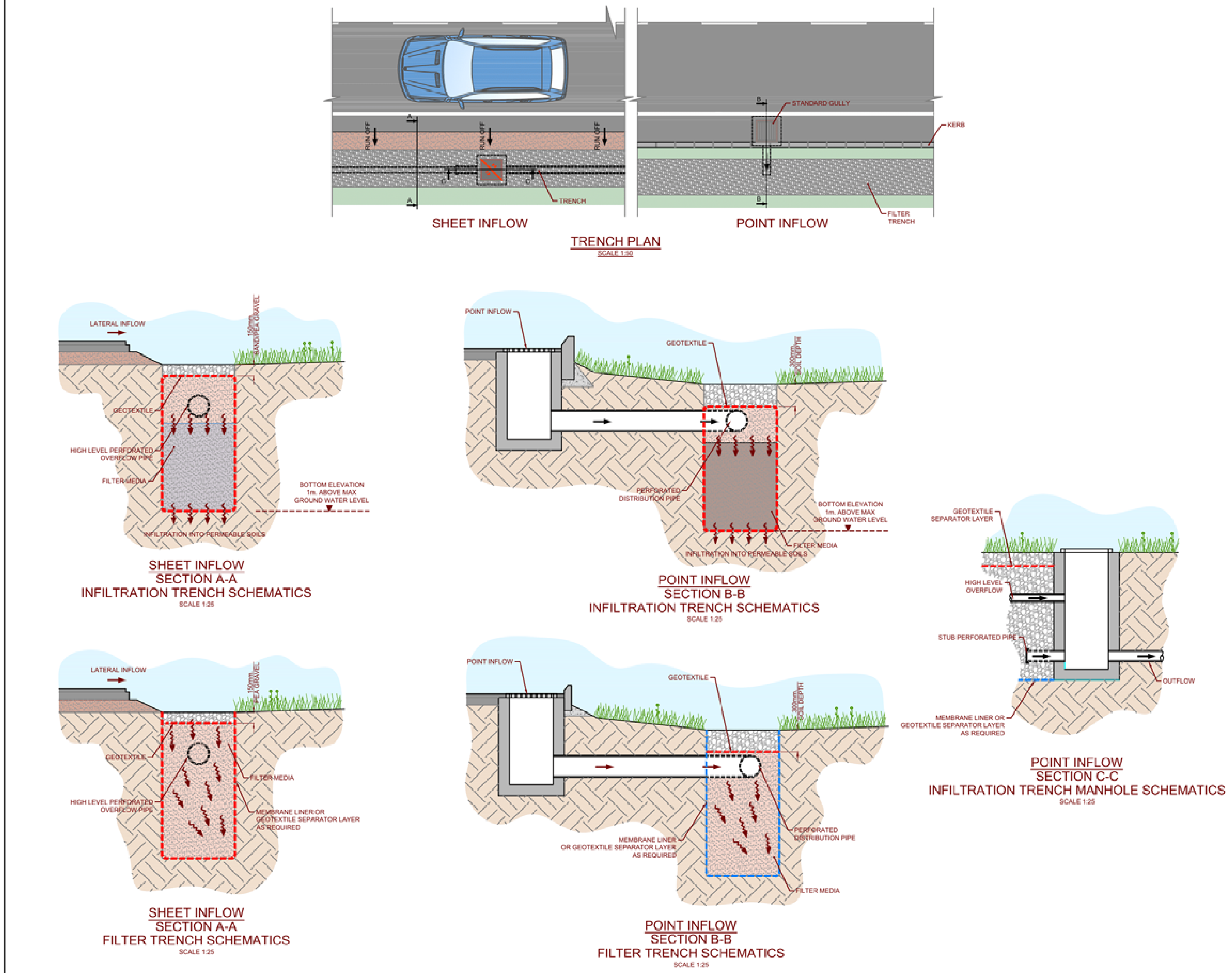
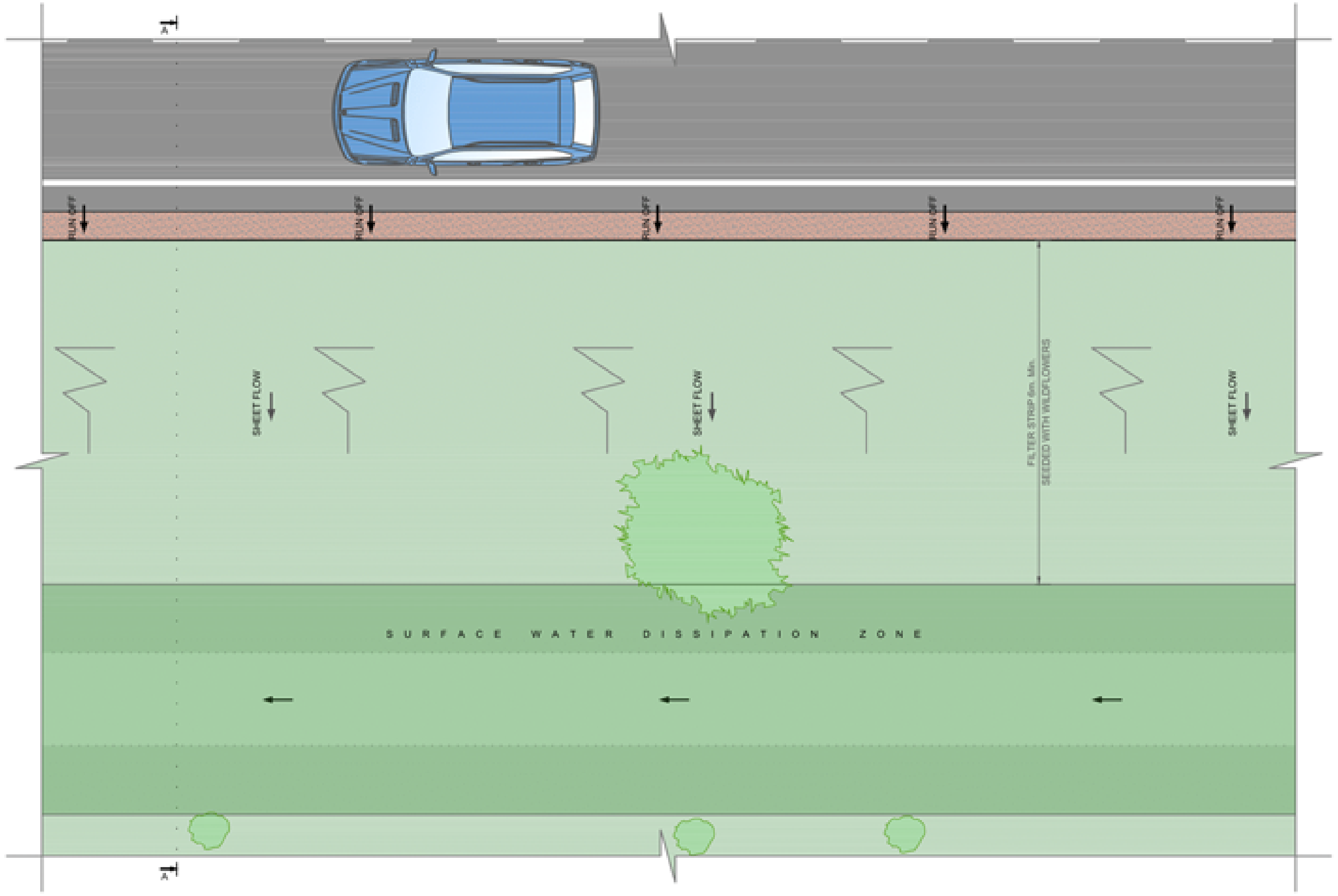


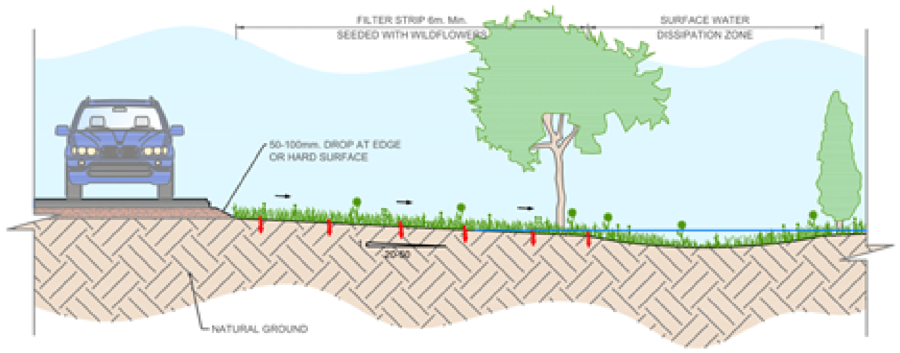
FIGURE D1

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF INFILTRATION FILTER TRENCH



BIORETENTION / FILTER STRIP PLAN

SCALE 1:50



SECTION A-A

SCALE 1:50

FIGURE D2

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF DETENTION FILTER STRIP

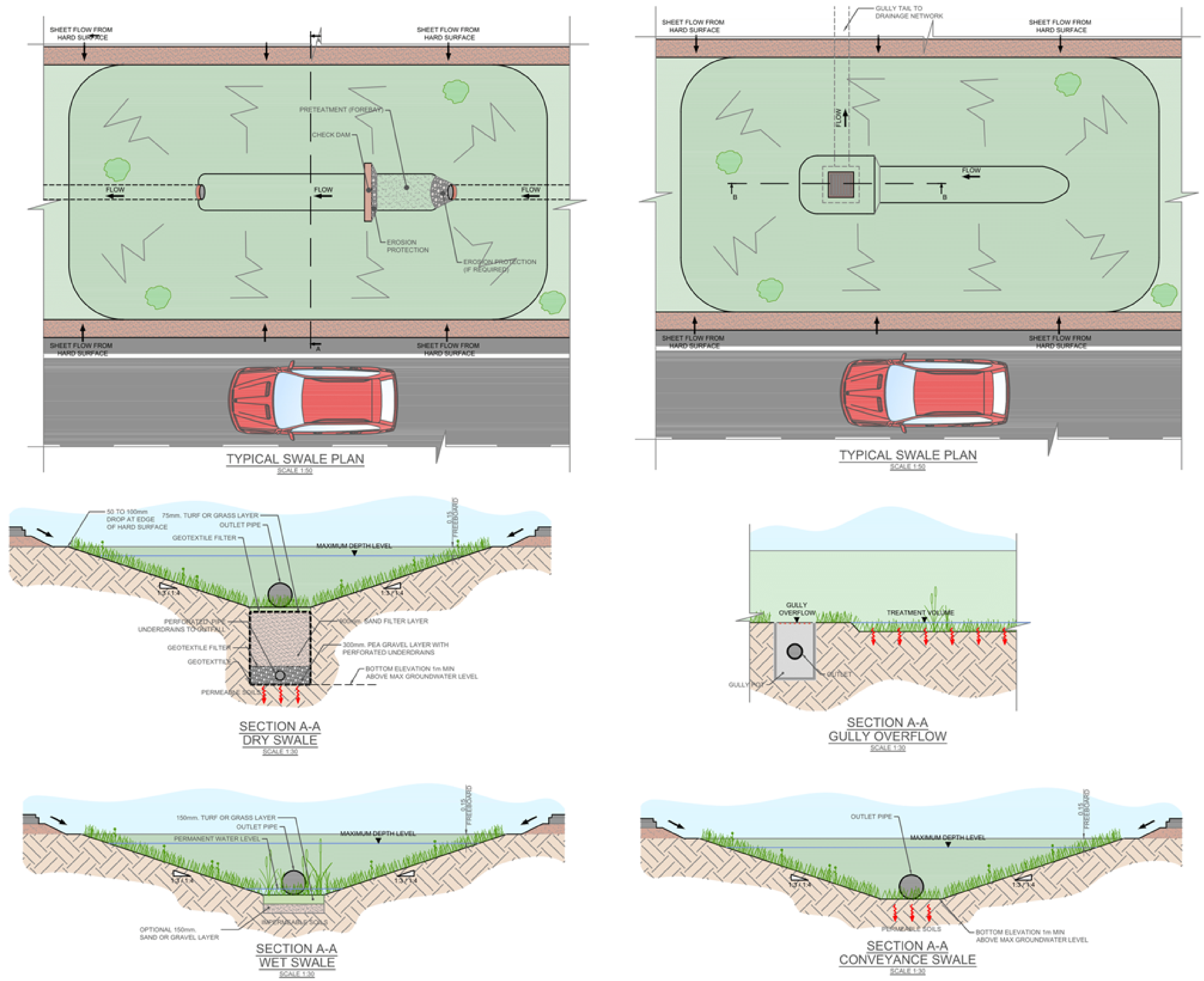
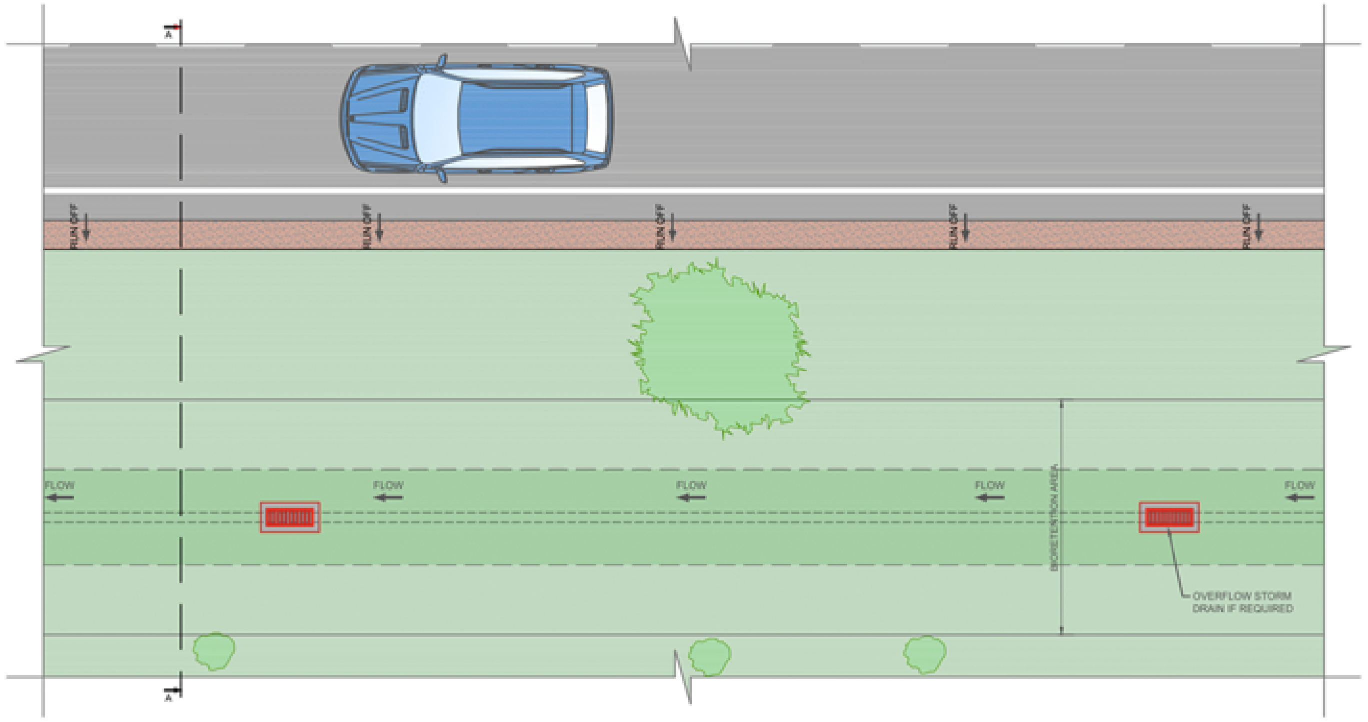


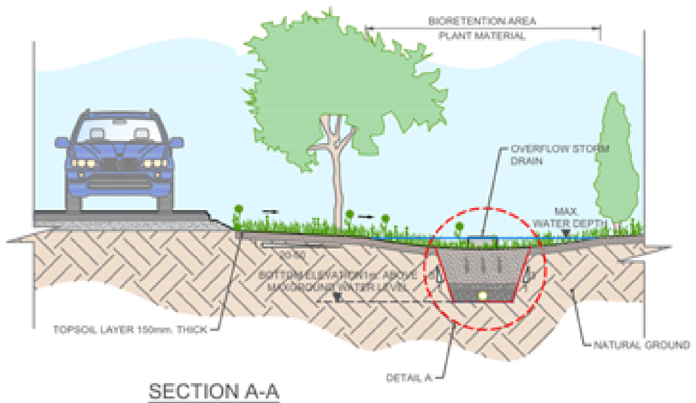
FIGURE D3

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF SWALES



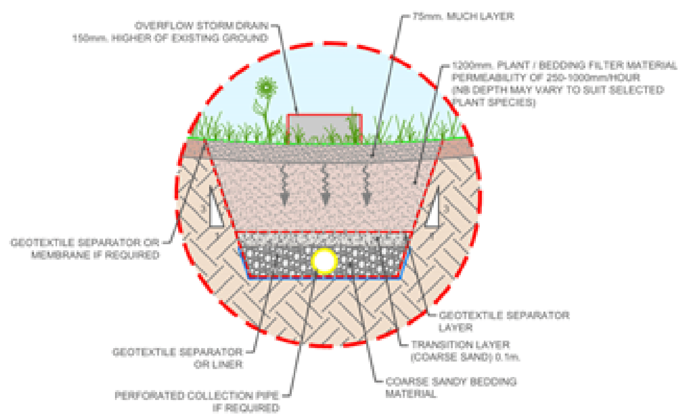
BIORETENTION / FILTER STRIP PLAN

SCALE 1:50



SECTION A-A

SCALE 1:50



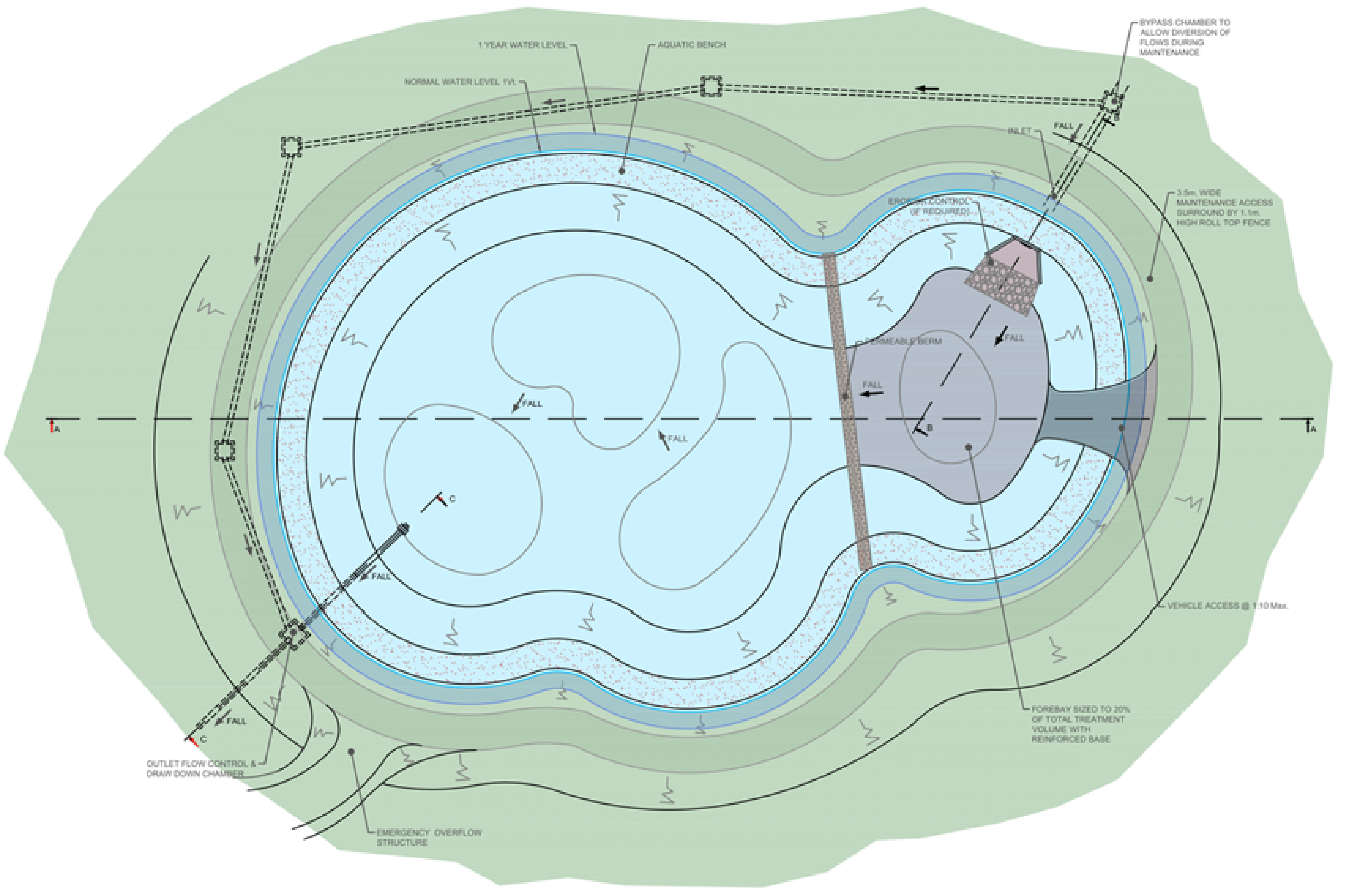
DETAIL A

SCALE 1:20

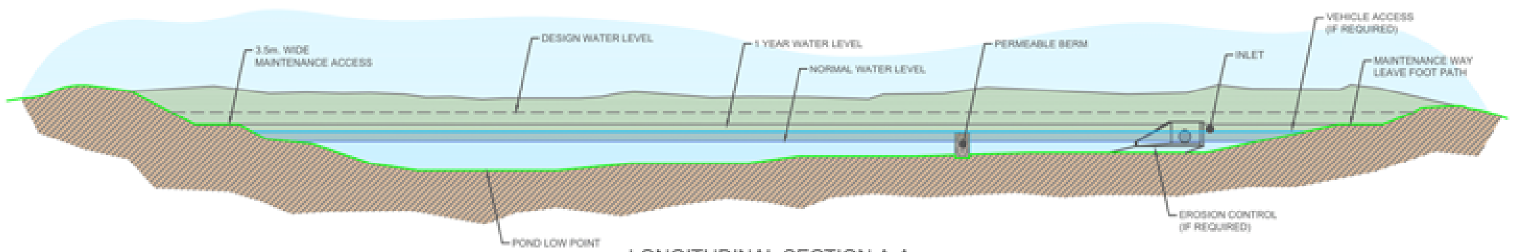
JBA

FIGURE D4

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF BIORETENTION



RETENTION POND PLAN
SCALE 1:200

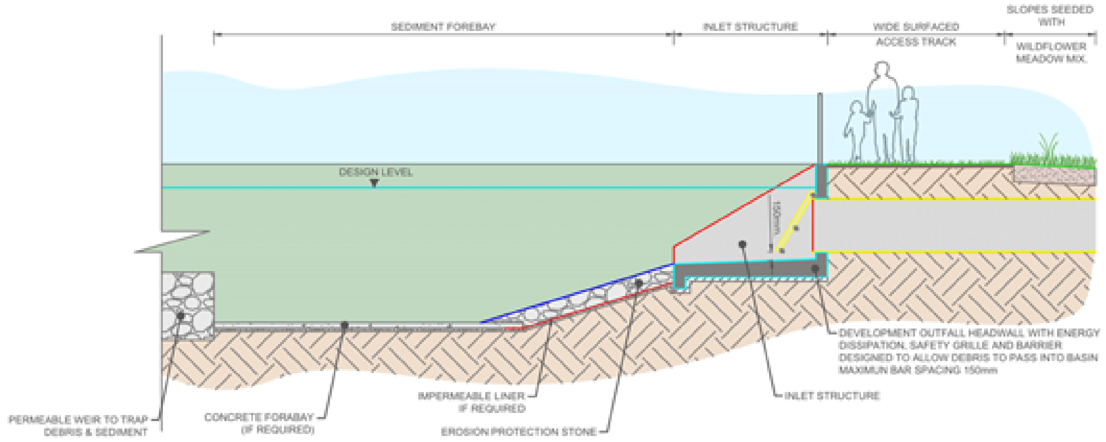


LONGITUDINAL SECTION A-A
SCALE 1:200

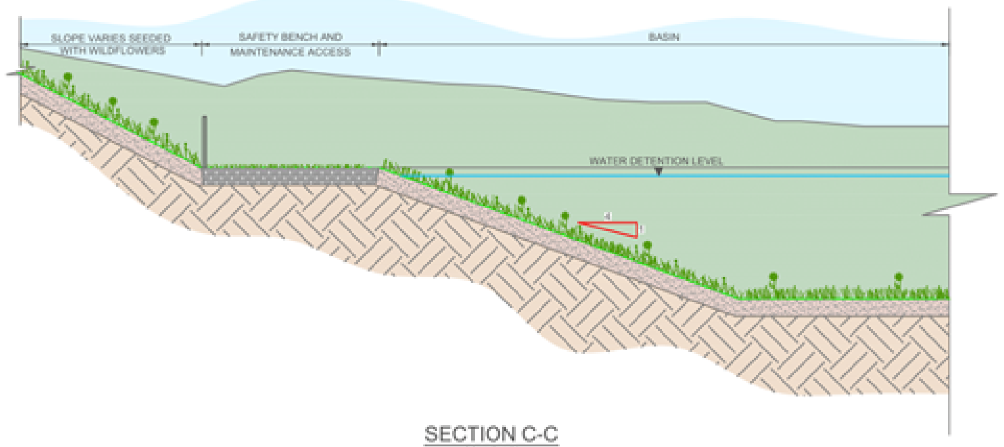
JBA

FIGURE D5

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF POND



SECTION B-B
INLET DETAIL
SCALE 1:50

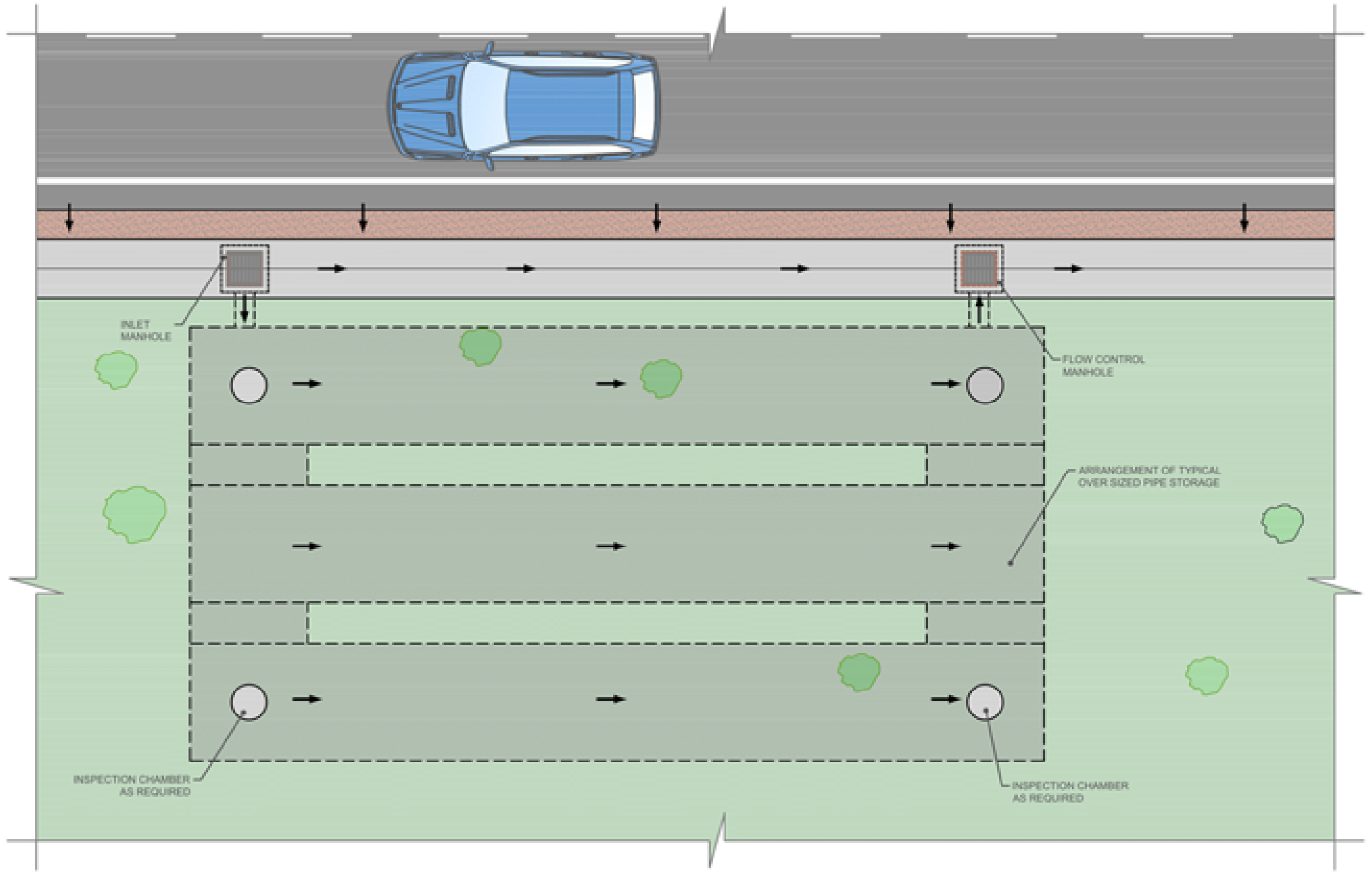


SECTION C-C
SCALE 1:50

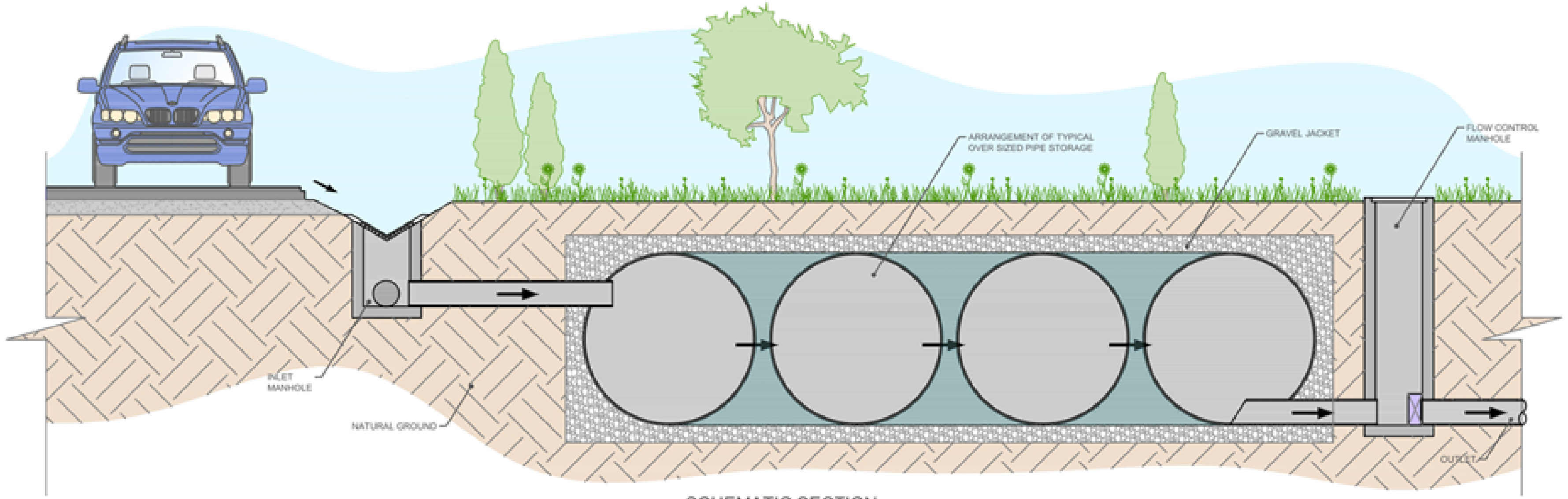
JBA

FIGURE D6

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF DETENTION BASIN



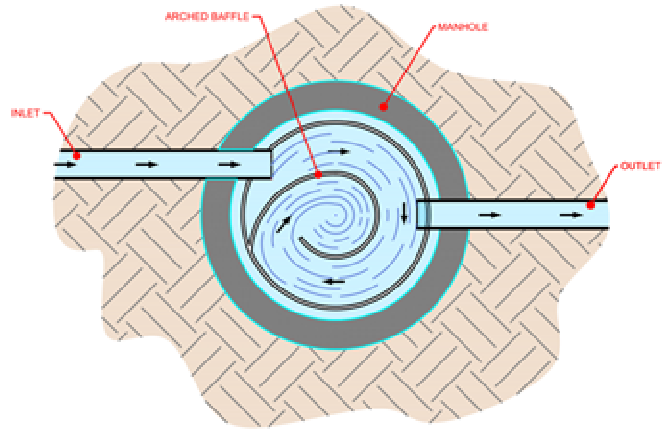
TYPICAL UNDERGROUND STORAGE PLAN



SCHEMATIC SECTION

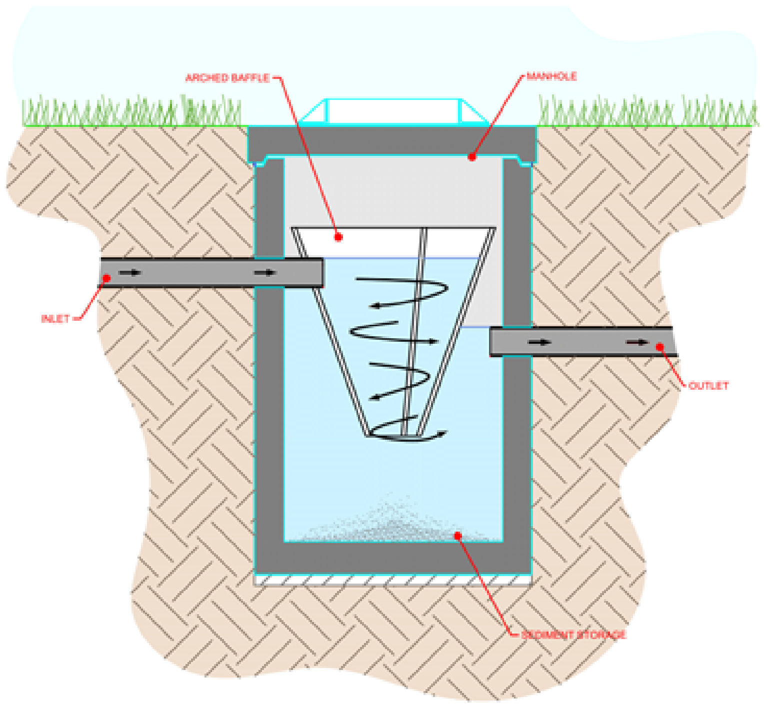
FIGURE D7

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF UNDERGROUND STORAGE



VORTEX SEPARATOR PLAN

SCALE 1:20



SECTION A-A
VORTEX SEPARATOR

SCALE 1:20

JBA

FIGURE D8

SCHEMATIC LAYOUT SHOWING TYPICAL FEATURES OF VORTEX SEPARATOR

Appendix D Useful Resources

Masterplanning and Concept Design

CIRIA (2010) Guidance on water cycle management for new developments (WaND) (C690)
http://www.ciria.org/ItemDetail?iProductCode=C690&Category=BOOK
CIRIA (2010) Planning for SuDS: Making it Happen (C687)
http://www.ciria.org/Resources/Free_publications/Planning_for_SuDS_ma.aspx
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Glossary

Attenuation – The process of slowing and temporarily storing run-off to enable a more controlled rate and volume of discharge

Brownfield – Land that has been previously developed

Catchment – The area of land drained by a river and other water bodies along that river's route

Environmental Permit - A permit which allows certain activities which have the potential to impact the environment and human health, following specific restrictions.

Flood Risk Assessment (FRA) - is an assessment of the risk of flooding from all flooding mechanisms i.e. fluvial, pluvial, tidal, groundwater, sewer systems.

Greenfield – Natural or agricultural land that is vacant of existing buildings or infrastructure

Impermeable – Not allowing passage (as of a fluid) through its matter.

Impervious – A material that prevents penetration or passage of another substance

Infiltration - The process by which surface water passes through the soil.

Interception – The disruption of the movement of water by vegetation cover.

Land drainage Consent - Is a requirement of the Land Drainage Act 1991, for any developer who plans to carry out any construction work that might affect the flow of an ordinary watercourse and subsequently increase the flood risk to the surrounding area.

Main River - Usually consists of larger streams and rivers, but some of them are smaller watercourses of local significance. Main Rivers indicate those watercourses for which the Environment Agency is the relevant risk management authority.

Manning's Equation – Is an empirical equation that relates the velocity (V) of water flowing through a stream to its slope (s), the hydraulic radius of the stream (R), and its approximate bed roughness (n). $V = (R^{2/3}s^{1/2})/n$..

National Planning Policy Framework (NPPF) – A strategic document which aims to address the Government's economic, environmental and social planning policies for England. The policies set out in this framework apply to the formation of local and neighbourhood plans and to decisions on planning applications.

Ordinary Watercourse – Includes every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than public sewer) and passage through which water flows which does not contribute to part of a Main River. The Lead Local Flood Authority, District/Borough Council or Internal Drainage Board is the relevant risk management authority.

Outline Application - An application which allows for a decision on the general principles of how a site can be developed. Outline planning permission is granted by the Local Planning Authority on the basis that additional details of the development are conditioned to ensure they are submitted within a subsequent reserved matters application.

Permeable – A material which is able to be easily passed-through by a liquid

Porous – A material that is able to easily absorb fluids into its pores

Reserved Matters – Regards certain elements of a proposed development which an applicant can choose not to submit details of with an outline planning application, such as access details

Riparian Owner - An owner of land with a watercourse adjoining, above or running through it, who has specific rights and responsibilities, i.e. maintenance of the watercourse to prevent restrictions which have the potential to cause fluvial flooding. https://www.gov.uk/guidance/owning-a-watercourse

Strategic Flood Risk Assessment (SFRA) – Is a requirement of the local planning process, as set out in Planning Policy Statement 25, produced by the Department for Communities and Local Government. It's overall aim is to ensure that requires local authorities to demonstrate that due regard has been given to the issue of flood risk as part of the planning process. Please see Strategic Flood Risk Assessment for further details on Cheshire East Council's SFRA.

Topography – The contours, gradients, levels and features formed on a terrestrial surface

Urban heat-island effect – the effect hard-surfaces in an urban environment have in raising built-environment temperatures above those of surrounding natural land