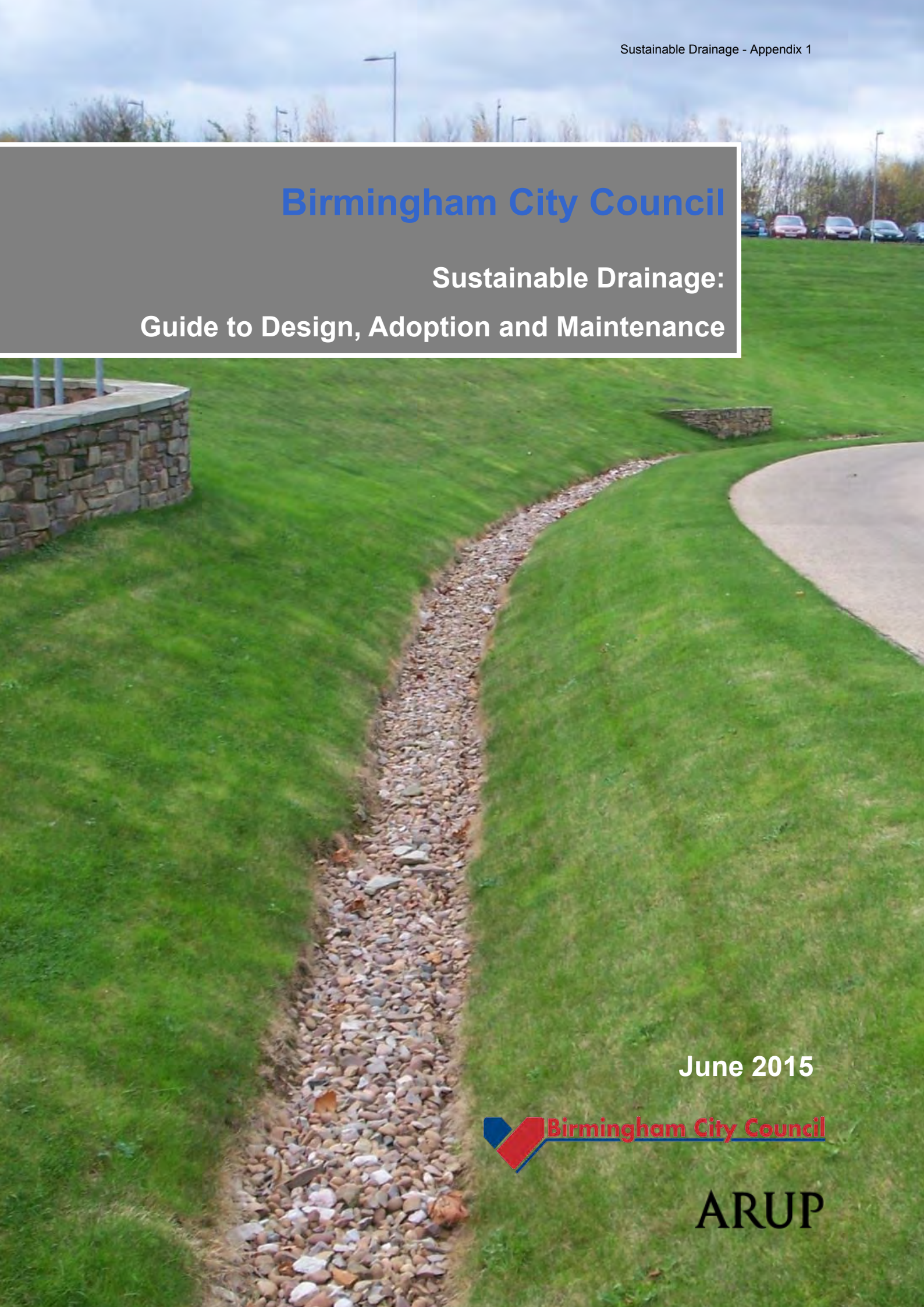
Birmingham City Council

Sustainable Drainage:

Guide to Design, Adoption and Maintenance



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Birmingham City Council

ARUP

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This document has been developed by Birmingham City Council and Arup for the purpose of providing guidance to all persons involved in the design, construction, operation and future maintenance of all SuDS features within Birmingham City Council jurisdiction.

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Foreword

I am pleased to be launching this version of the Birmingham City Council, Sustainable Drainage: Guide to Design, Adoption & Maintenance. This document is a significant step towards a more resilient approach to water management for Birmingham.

Birmingham is a thriving city, with an expected population growth of over 150,000 by 2031, which will result in increased pressure on our land resources. We recognise that this will place additional stress on our aging infrastructure, particularly our watercourses and surface water assets.

Recent significant changes to legislation surrounding Sustainable Drainage Systems (SuDS) include the expectation that SuDS will be implemented on all major development, with provision for operation and maintenance of SuDS features for the lifetime of development. SuDS will be realized through the planning process, with technical support from the Lead Local Flood Authority (LLFA).

The most significant change is the transfer of responsibility for surface water management from the Environment Agency to the LLFA, resulting in the LLFA undertaking assessment of the impacts of development on surface water, working in partnership with Severn Trent Water to align a unified approach within Birmingham.

I am most impressed with the embracing attitude to SuDS across all stakeholders, uniting in agreement that SuDS present a great opportunity to enhance the resilience of Birmingham. This approach responds to changes in climate and the need to manage the pressures between the city's watercourses, ground conditions and our urbanised environment.

This guide aims to provide support to all involved in the design, construction, operation and future maintenance of SuDS, including designers, planners, prospective owners and maintainers, developers and others. It targets the proactive management of surface water through the use of SuDS, thereby transforming water into an asset; provides tailored, local guidance with supporting maps; and clearly outlines the expectations and requirements of development in Birmingham.

It is for this reason Birmingham City Council is adopting this Sustainable Drainage: Guide to Design, Adoption & Maintenance, within which we aim to proactively manage surface water, enhance water quality and provide additional amenity space and biodiversity value across the city.

Councillor Tahir Ali

Cabinet Member for Development, Transport and the Economy

Birmingham City Council

List of Abbreviations

BDP	Birmingham Development Plan
BGS	British Geological Society
BRE	Building Research Establishment
BS	British Standard
CAA	Civil Aviation Authority
CDM	Construction, Design and Management
DCLG	Department of Communities and Local Government
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EIA	Environmental Impact Assessment
EU	European Union
F&WMA	The Flood and Water Management Act
GLSP	Green Living Spaces Plan
LFRMS	Local Flood Risk Management Strategy
LHA	Local Highways Authority
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
SPZ	Source Protection Zone
STW	Severn Trent Water
SuDS	Sustainable drainage systems
SWMP	Surface Water Management Plan
VPHC	Victoria Park Health Centre
WFD	Water Framework Directive

Introduction

As the Lead Local Flood Authority (LLFA) and Local Planning Authority (LPA), Birmingham City Council have provided this guidance to support the efficient planning, design and delivery of Sustainable Drainage Systems (SuDS) on all developments within Birmingham

Since April 6th 2015, all major developments should '*ensure that sustainable drainage systems for the management of runoff are put in place.*[1]' Major developments are defined within 'The Town and Country Planning Order 2015[2]', and may be summarised as the following:

- 10 or more dwellings are to be provided;
- Number of dwellings is unknown and the site area is 0.5ha or more;
- Provision of floor space created by the development is 1,000m^2 or more;
- Development site area is 1ha or more;
- Development associated with the working of minerals or the use of land for mineral-working deposits; or
- Waste development.

The guide aims to identify and provide support in local situations and clarify the information sought by the LPA, having regard to the nature and scale of the development.

The guide is structured around the non-statutory technical standards for SuDS[3] in conjunction with the National Planning Policy Framework and practice guidance[4], with local requirements to meet local policy identified.

It is a living document and will be updated periodically as the council's and key stakeholder experience evolves.

Guide Users

This guide is to be used by all involved in the design, construction, operation and future maintenance of SuDS for guidance on the implementation of SuDS specific to Birmingham. This includes developers, designers, planners, prospective SuDS owners & maintainers and others involved in the planning and design of the built environment in Birmingham.

The LLFA and LPA expects this guidance to be used for all types of residential, commercial and industrial development.

A Sustainable Drainage Assessment and a Sustainable Drainage Operation and Maintenance Plan will be required for all major development in Birmingham.

Whilst these documents are required for major developments only, Birmingham City Council, advocate the consideration of SuDS on all developments.

1 http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/

2 http://www.legislation.gov.uk/uksi/2015/595/pdfs/uksi_20150595_en.pdf

3 https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

4 http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

1.0 LEGISLATION & KEY STAKEHOLDERS

Legislative Drivers

The following sections provide an overview of current legislation driving surface water management.

National Legislation

The Flood and Water Management Act 2010[5]

The Flood and Water Management Act 2010 (F&WMA) was introduced to address the concerns and recommendations raised in the Pitt Review (2007)[6]. The Act imposes many duties on all upper tier councils, such as Birmingham City Council as the LLFA, including coordinating local flood risk management within its area, including smaller 'ordinary' watercourses, surface and ground water.

Some of the F&WMA has not been implemented, including Schedule 3. This would have required LLFAs to determine applications for drainage systems against national standards and then adopt those SuDS serving more than one property.

National Planning Policy

In December 2014, the government announced[7] that from 6th April 2015 they will strengthen existing planning policy by also making SuDS a material consideration for major development.

'Local planning policies and decisions on planning applications relating to major development[8] *are to ensure that sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate.*

The sustainable drainage system should be designed to ensure that the maintenance and operation requirements are economically proportionate.[9]*'*

The National Planning Policy Framework (NPPF) sets out the expectation that new development is sustainable and requires that LPAs should avoid flood risk to people and property and should manage any residual risk. The NPPF states that *"when determining planning applications, development [must be] appropriately flood resilient and resistant*".

Paragraph 103 states that all new developments in areas at risk of flooding should give priority to the use of sustainable drainage systems.

The NPPF also sets out other key priorities for planning to address including climate change, water quality and biodiversity – all challenges that SuDS help to address.

Planning practice guidance supports the use of SuDS. It emphasises that generally the aim should be to discharge surface run off as high up the hierarchy of drainage options as reasonably practicable, with infiltration to the ground the most preferred and connection to a combined sewer the least.

In March 2015, the Government laid a statutory instrument[10] making the LLFA a statutory consultee by adding the

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[5] http://www.legislation.gov.uk/ukpga/2010/29/contents

[6] http://webarchive.nationalarchives.gov.uk/20100807034701/http:/archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html

[7] https://www.gov.uk/government/speeches/sustainable-drainage-systems-drainage-systems

[8] Developments of 10 dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2015)

[9] http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/

[10] http://www.legislation.gov.uk/uksi/2015/595/pdfs/uksi_20150595_en.pdf

consultation requirement to Schedule 4 of the Development Management Procedure Order. This will come into effect from 15 April 2015.

Non-Statutory Technical Standards for Sustainable Drainage[11]

The technical standards provided by government relate to the design, construction, operation and maintenance of SuDS and have been published as guidance for those designing schemes.

National Flood and Coastal Erosion Risk Management Strategy for England[12]

The national strategy produced by the Environment Agency (EA) in 2011 identified SuDS as being of significant importance in mitigating the potential impacts of flood risk and in helping to provide multiple benefits within catchments.

The national strategy specifically recommends '*Using SuDS in new developments and redevelopments to manage surface water flood risk.' A*nd '*Use of public space and the multifunctional use of open space could be considered as part of preparing local flood risk management strategies to reduce the potential land take from SuDS for new developments.'*

Water Framework Directive[13]

The Water Framework Directive – 2000/60/EC (WFD) is European Union (EU) legislation that was enacted into UK law in December 2003. The legislation requires the UK to make plans to protect and improve the water environment, and applies to all surface freshwater bodies, including lakes, streams, rivers and canals; transitional bodies such as estuaries; groundwater; and coastal waters.

The WFD provides an opportunity to plan and deliver a better water environment, focussing on ecology, through river basin management planning.

A significant contributor of the pollution is '*diffuse'* pollution i.e. pollution that runs off large areas. In many cases, SuDS can be an effective means to reduce this type of pollution and can therefore help to meet the WFD requirements.

Biodiversity[14]

Local authorities have a duty to have regard to the conservation of biodiversity in exercising their functions. This duty was introduced by the Natural Environment and Rural Communities Act and came into force on 1 October 2006. The duty affects all public authorities and aims to raise the profile and visibility of biodiversity, to clarify existing commitments with regard to biodiversity, and to make it a natural and integral part of policy and decision making.

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[11] https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

[12] https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england

[13] http://ec.europa.eu/environment/water/water-framework/index_en.html

[14] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69311/pb12585-pa-guid-english-070516.pdf

Local Policies and Supporting Evidence

There are a number of local policies and evidence that support the implementation of SuDS, flood risk management and green infrastructure in Birmingham.

(Emerging) Local Flood Risk Management Strategy (LFRMS)

Birmingham City Council, as the LLFA, is required to develop a local strategy for management of flood risk in its area, aligning with the national strategy. The emerging strategy sets out the objectives and vision for managing flood risks in the city, and how Birmingham City Council seek to work with the community and partner authorities. The strategy encourages and promotes investment in flood risk management with additional benefits. SuDS play a significant role in achieving many of the objectives.

Strategic Flood Risk Assessment (SFRA)[15]

In 2012, SFRAs Level 1 & 2[16] were completed in accordance with the NPPF, to inform Birmingham City Council of the nature and extent of flood risk in the area. These SFRAs aim to provide clear guidance on appropriate risk management measures for adoption on potential sites within areas at risk of flooding, primarily focussed on those sites found in Flood Zones 2 and 3 (fluvial flood zones provided by the EA).

The Level 1 SFRA (April 2012) for Birmingham assesses and maps known sources of flood risk, including fluvial, surface water, sewer, groundwater and impounded water bodies, taking into account future climate change predictions, and to allows Birmingham City Council to locate future development primarily in low flood risk areas. The Level 2 SFRA (April 2012) facilitates application of the Sequential and Exception Tests to specific sites.

(Emerging) Surface Water Management Plan

The emerging Surface Water Management Plan (SWMP) identifies a SuDS strategy as a key catchment-wide action for Birmingham. SuDS for new developments and retro-fitting for existing developments has been identified as a key measure in managing the surface water flood risk.

(Emerging) Birmingham Development Plan 2031

Birmingham has a vision *to be* '*renowned as an enterprising, innovative and green City that has delivered sustainable growth meeting the needs of its population and strengthening its global competitiveness.*[17]

The City's population is projected to grow by an additional 150,000 people over the period to 2031 which will require a response that ensures the homes are provided, the jobs are created and the quality of environment secured for both residents and businesses. Tackling this will need an innovative and far sighted approach.[18]'

The emerging Birmingham Development Plan (BDP) sets out the statutory framework to guide decisions on development and regeneration in Birmingham up to 2031. Within the emerging plan, there are several policies of relevance for SuDS.

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15 http://www.birmingham.gov.uk/cs/Satellite?c=Page&childpagename=Development-Planning%2FPageLayout&cid=1223418817006&pagename=BCC%2FCommon%2FWrapper%2FWrapper

16 http://www.birmingham.gov.uk/cs/Satellite?c=Page&childpagename=Development-Planning%2FPageLayout&cid=1223418817006&pagename=BCC%2FCommon%2FWrapper%2FWrapper

17 http://consult.birmingham.gov.uk/portal/ps/bp/birmingham_plan_2013?pointId=d686774e581

18 http://consult.birmingham.gov.uk/portal/ps/bp/birmingham_plan_2013?pointId=2720715

Policy TP6[19] focuses on the management of flood risk identifying that it is '*essential that future development is planned appropriately.'*

'To minimise flood risk, improve water quality and enhance biodiversity and amenity all development proposals will be required to manage surface water through Sustainable Drainage Systems (SuDS).

Wherever possible the natural drainage of surface water from new developments into the ground will be preferred. Where ground conditions are not suitable for infiltration, then expected and direct flows into sewers and watercourses will be controlled in order to lessen the impact of flash floods and decrease the risk of flooding.

All SuDS must protect and enhance water quality by reducing the risk of diffuse pollution by means of treating at source and including multiple treatment trains.

All SuDS schemes should be designed in accordance with any relevant national standards and the long-term maintenance arrangements must be agreed.'

Policy TP7[20] notes that '*New developments will be expected to address green infrastructure issues in an integrated way and to take advantage of new opportunities such as green and brown roofs.*'

Policy PG3[21] states that '*New development should…* [amongst other things] *Ensure that private external spaces, streets and public spaces are attractive, functional, inclusive and able to be managed for the long term.* [and] *Take opportunities to make sustainable design integral to development, such as green infrastructure, sustainable drainage and energy generating features.'*

Green Living Spaces Plan (GLSP) [22]

The Green Living Spaces Plan (GLSP) aims to enhance and ensure the effective long term maintenance of the city's natural green and water spaces. Under Principle 2, 'The City's Blue Network' it is recommended to;

'*Seek integrated solutions for Sustainable Urban Drainage Schemes (SuDS), rain water harvesting, flood risk, water management and habitat (wetland) creation, with WFD and water sensitive urban design*.'

[19] http://consult.birmingham.gov.uk/portal/ps/bp/birmingham_plan_2013?pointId=d686774e2641

[20] http://consult.birmingham.gov.uk/portal/ps/bp/birmingham_plan_2013?pointId=d686774e2709

[21] http://consult.birmingham.gov.uk/portal/ps/bp/birmingham_plan_2013?pointId=d686774e1054

[22] http://birmingham.gov.uk/greenlivingspaces

Key Stakeholders

Many stakeholders are key to the successful provision and implementation of SuDS. These stakeholders and their roles in relation to surface water drainage have been outlined below.

Local Planning Authority

The role of the LPA is undertaken by Birmingham City Council.

All planning applications are submitted to the LPA and dependent upon the type of application varying periods of review apply:

- minor and other applications are reviewed in 8 weeks
- major applications are reviewed in 13 weeks
- Environmental Impact Assessment (EIA) development applications are reviewed in 16 weeks

Application validation will now include the local list planning application requirements of:

- a sustainable drainage assessment
- a sustainable drainage operation & maintenance plan

As of April 6th 2015, the LPA will '*consult the relevant lead local flood authority on the management of surface water; satisfy themselves that the proposed minimum standards of operation are appropriate and ensure through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.*'[23]

Lead Local Flood Authority

Birmingham City Council, as the LLFA have the overall responsibility for managing local flood risk.

As of April 15th 2015, the LLFA must be consulted on all '*major development with surface water drainage*.'[24]

The LLFA will assess surface water drainage including sustainable drainage and provide a consistent source of technical advice for the LPA. The developer should not rely on the LLFA technical advice in order to ensure the suitability or otherwise of a particular drainage system.

The LLFA will provide pre-application advice (charges will be applied on a cost-recovery basis) for surface water and encourages developers to understand the constraints that drainage may pose from the outset of the design and planning process.

Local Highways Authority

Birmingham City Council, as the Local Highways Authority (LHA) have the responsibility for all the publicly maintained highways and associated assets in Birmingham, other than Trunk Roads, un-adopted roads and private roads.

Birmingham City Council may adopt roads and footways with associated infrastructure (including traffic signals, street lighting and highway drainage) by different methods as stated in the Highways Act 1980, undertaking the responsibility for ongoing maintenance.

Where SuDS are proposed within the extents of the publically maintained highways, the LHA may adopt these features, pending an agreement between the developer and the LHA.

23 http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/

24 http://www.legislation.gov.uk/uksi/2015/595/pdfs/uksi_20150595_en.pdf

Water Companies

Birmingham's surface water and combined public sewer networks are all serviced by Severn Trent Water (STW).

The LPA will consult STW where proposed drainage systems will discharge to the adopted sewer network to ensure that development does not cause increase flood risk from the development, mostly by agreeing discharge conditions.

STW continue to encourage early and direct dialogue with developers with regard to any intention to connect to the sewerage system.[25]

Environment Agency

The EA will no longer comment on surface water matters.

The EA will continue to act as a statutory consultee in areas at high risk of flooding[26] from rivers and the sea and designated critical drainage areas (except for non-residential extensions with a footprint of less than 250 sq. metres or a domestic extension).[27]

Developers

As of April 6th 2015, SuDS are expected to be put in place for the management of run-off on all major developments. It is the responsibility and duty of the developer to ensure that SuDS are provided in all developments, where appropriate.

Birmingham City Council recommend that developers consider SuDS at the earliest opportunity seeking pre-application advice where required, as this will aid in mitigating the risk of design conflicts, allow for ease in implementation of SuDS and the greatest cost savings.

Land and Property Owners and Occupiers

Where SuDS service a single property it is anticipated that this feature will be operated and maintained by the owners and occupiers.

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[25] http://www.stwater.co.uk/developers/
[26] http://apps.environment-agency.gov.uk/wiyby/37837.aspx

[27] https://www.gov.uk/government/consultations/planning-application-process-statutory-consultee-arrangements

2.0 PRINCIPLES OF SUSTAINABLE DRAINAGE

Principles of Sustainable Drainage

What are SuDS?

SuDS is a hierarchical approach to drainage design seeking to ensure that the most sustainable range of drainage techniques are used on a site by site basis.

It is more than just a number of drainage techniques, systems or devices. It aims to drain a site in a sustainable way with consideration to water quantity and water quality, biodiversity and amenity.

SuDS focus on three key areas; controlling surface water quantity (flood risk management), improving surface water quality (water quality management) and providing added development amenity (including biodiversity) benefits.

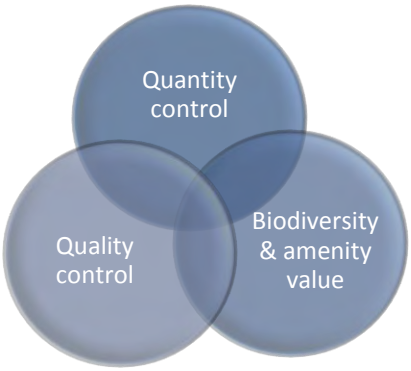
What are the benefits of SuDS?

Well-designed SuDS provide effective surface run-off drainage, and provide opportunities to reduce the causes and impacts of flood risk, remove pollutants from urban run-off at source, and combine water management with green space with benefits for amenity, recreation and wildlife.

When considered at an early stage, evidence shows that generally the cost of constructing SuDS is cheaper than conventional drainage methods. The cost of providing run-off attenuation storage by above ground SuDS is considerably cheaper than sewers, and underground storage, when integrated into the urban realm or other land use.

Key SuDS Design Principles

The following three key design principles have been identified as critical for the implementation of SuDS:



Quantity Control

Achieved by controlling the quantity of surface water runoff reaching a watercourse, drainage system or sewer. Controlling runoff can aid in mitigating the risk of flooding. The benefits to quantity control include:

- Less surface water entering watercourses, thereby offsetting peak flows and reducing fluvial flood risk
- Less surface water entering sewers, thereby freeing capacity and reducing flood risk
- Allows for adaption to climate change
- Allows for recharge of underground aquifers

Quality Control

Achieved by improving the quality of surface water reaching a watercourse, drainage system or sewer. The benefits to quality control include:

- Reduces of pollution levels in surface water bodies
- Protects groundwater resources from contamination
- Enables compliance with the WFD

Biodiversity and Amenity Value

Achieved by introducing SuDS that enhance the existing biodiversity of the area and/or add amenity value to the community. The benefits include:

- Contributes to community health & wellbeing by providing green spaces with value in terms of landscape, recreation and walking routes
- Provides opportunities for multifunctional areas
- Provides wildlife habitat and ecological benefits
- Increases property values

These key design principles should be considered in all aspects of SuDS selection and design. All SuDS should aim to achieve each of these principles.

Key SuDS Design Practices

SuDS use a series of drainage techniques. These techniques are applied progressively from prevention, source control, site control through to catchment control. This "management train" includes:

Prevention – which involves good site design to reduce and manage runoff though land-use planning.

Source Control – which involves managing run-off as close to source as possible including the use of green roofs, rainwater harvesting, permeable paving and filter strips.

Site Control – which involves managing runoff through a network or components such as swales and detention basins. Flows for exceedance events should be controlled and directed using overland exceedence routes.

Catchment Control – which involves downstream management of site runoff such as retention ponds and wetlands.

The following design practices have been identified to be used throughout the design process. These design practices should be considered in all aspects of SuDS selection and design:

Drainage Hierarchy (Page 18)

A prioritised order of methods for management of surface water, which is to be considered at all stages of design.

Wherever possible the natural drainage of surface water from new developments into the ground will be preferred. Surface water runoff should be managed as close to its source as possible in line with the following drainage hierarchy

Treatment Train (Page 18)

*A s*ystem of treatments desired to achieve the desired water quality improvements in surface water runoff. The treatment train can be designed to have multiple or singular SuDS features working to obtain the required treatment levels. There are three categories of treatment that may be achieved through the application of a treatment train.

Each development should include an appropriate treatment train, taking account of existing and proposed conditions.

Drainage Hierarchy (Ref (Emerging) Birmingham Development Plan 2013 Policy TP6)

Treatment Train - including treatment processes and typical SuDS features

Why and when should SuDS be implemented?

National and local policy requires a sustainable approach to drainage and evidence suggests that where SuDS are appropriately designed, constructed and maintained, they provide a more sustainable drainage system that conventional approaches.

Birmingham City Council recommend that a SuDS approach should be implemented on all development sites. However, Birmingham City Council also understand that each site may present constraints and may limit the potential for a solution to achieve maximum benefits for all functions.

Designing SuDS to deliver more than just surface water management is not necessarily difficult or costly but it does often depend on early consideration at the master planning stage, creativity, consultation and partnership. It can deliver benefits for the whole community in terms of biodiversity, climate regulation, regeneration, learning, health and recreation, and a cost effective way of delivering sustainable, resilient communities in urban areas.

3.0 SuDS AND BIRMINGHAM

SuDS and Birmingham

Birmingham comprises of approximately 26,800 hectares of predominantly urban landscape.

This section provides a high level summary of Birmingham's key characteristics that influence SuDS implementation.

History

In the 18th century the population of Birmingham expanded dramatically during the industrial age, where a concentration of manufacturing centred in Birmingham. This has had a long-standing impact on the water landscape across Birmingham, having most significant impact on watercourses and groundwater conditions.

Topography

Birmingham is situated just to the west of the geographical centre of England on the Birmingham Plateau - an area of relatively high ground, ranging around 150-300 metres above sea level. With the Clent, Waseley and Lickey Hills towards the south-west of the city, Birmingham slopes gently to the east of the conurbation.

Climate

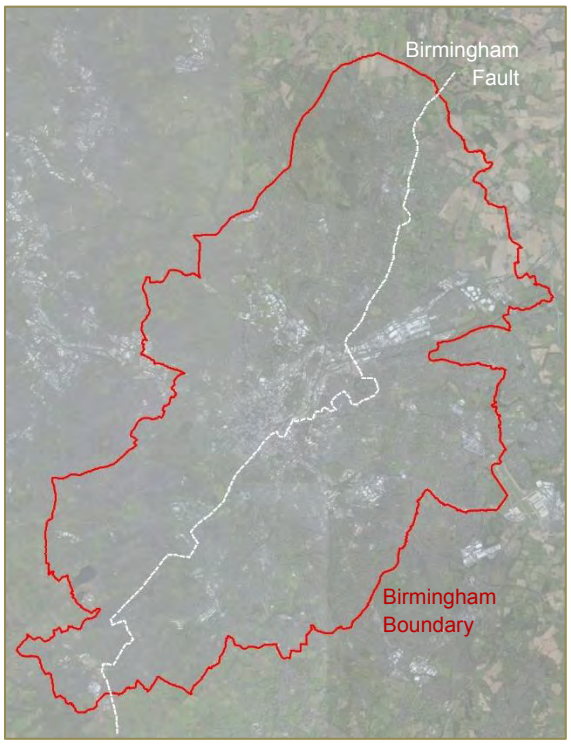
Birmingham has a temperate maritime climate, with summer temperatures reaching over 20°C dropping to winter temperatures of 0°C, and annual mean rainfall of 660mm.

Climate change has already seen in the UK are consistent with the UKCP02 scenarios. These suggested that winters would become wetter over the whole of the UK, by as much as 20% by the 2050's. The latest UK Climate Projections (UKCP09) show that in the West Midlands there is a 90% chance that winter mean precipitation will increase by 38%, and summer mean precipitation will increase by 67%, by the 2080's[28].

Ground Conditions

Due to the extents of Birmingham City Council's jurisdiction, there is significant variation in ground conditions across the council's boundary.

The geology beneath Birmingham is divided into two due to a fault, known as the Birmingham Fault, running approximately north east to south west and consists of Permian and Triassic sandstones and mudstones. To the west of the fault line the rock strata predominantly consists of red and red-orange sandstones, and to the east the rock strata predominately consists of red and red-brown mudstones, which are inter-bedded by several silt and sandstone bands.



28 http://ukclimateprojections.metoffice.gov.uk/21708?projections=23754

The existing ground conditions are heavily influenced by the Birmingham Fault, with predominantly free-draining, mixed flow soils to the north west and poorly draining, fracture flow soils to the south east.

Within the SuDS discharge hierarchy, infiltration is advocated as the first route of disposal of surface water runoff, to be considered when developing runoff management options. Infiltration should be used where conditions allow and only where it is safe[29]. The infiltration potential of a drainage system is governed primarily by the permeability of the surface geology.

British Geological Survey (BGS) infiltration SuDS mapping[30] provides a preliminary indication of the suitability of the ground for infiltration SuDS. The mapping is not for local assessment and does not provide specific subsurface data or state the limitations of the subsurface with respect to infiltration.

Site specific assessment should be undertaken, as required, to determine the infiltration potential. This should be in the form of soakaway tests conforming to the procedure established in BRE Digest 365 – Soakaway design[31], or various other permeability assessment techniques.

Groundwater

Due to the presence of the Birmingham Fault, and the resultant geological conditions (impermeable clays to the south and sandstone to the north), there is variation in groundwater depths across the city.

Current depth to groundwater is, typically, greater than 5m below ground level (bgl), however in the areas surrounding watercourses this drops to less than 3m bgl.

Due to a recent fall in the abstraction of groundwater, as a result of a decline in manufacturing, the groundwater levels in the city are expected to rise.

Groundwater contamination is considered to be a significant risk in areas of shallow groundwater, typically southeast of the fault.

Overall, the majority of Birmingham does not fall within a shallow groundwater area or a Source Protection Zone (SPZ) however this should be verified on a site specific basis.

Under the F&WMA, Birmingham have developed a (emerging) LFRMS to consider the impact and consequences of local flood risk generated by the main rivers and other sources. The (emerging) LFRMS defines groundwater flooding as:

> ***'Groundwater flooding occurs when water levels in the ground rise above surface levels or into the basement of buildings. It is most likely to occur in areas underlain by permeable rocks, called aquifers. These can be extensive regional aquifers, such as chalk or sandstone; or may be more local sand or river gravels in valley bottoms underlain by less permeable rocks.'***

Groundwater flood risk is concentrated in the area immediately surrounding major and minor watercourses. While there is localised areas of groundwater flood risk, there is over-arching low groundwater flood risk in the area to the north west of the fault, with wide variation from low to very high risk to the south east of the fault.

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29 www.susdrain.org/files/resources/SuDS_manual_output/paper_rp992_19_infiltration_assessment_checklist.pdf

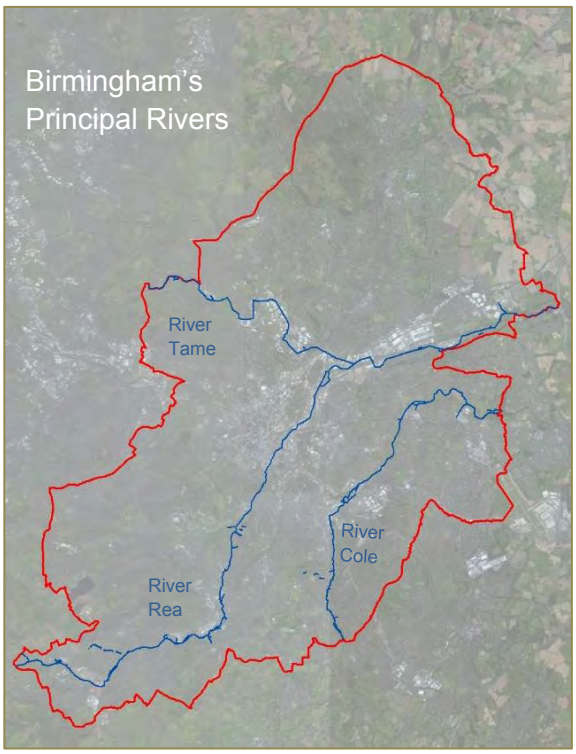
30 http://www.bgs.ac.uk/products/hydrogeology/infiltrationSuds.html

31 BRE Digest. (2007). Soakaway Design. Bracknell: IHS BRE Press

Rivers and Fluvial Flooding

There are three principal rivers in Birmingham; River Tame, River Rea and River Cole.

- River Tame: Flows through Perry Barr, Witton, Gravelly Hill, Bromford and Castle Vale
- River Rea: Flows from Frankley through Longbridge, Northfield, Kings Norton, Stirchley, Selly Park to Highgate, Digbeth, Duddeston and Nechells
- River Cole: Flows through Yardley Wood, Billesley, Hall Green into Sparkhill, Yardley, and Stechford

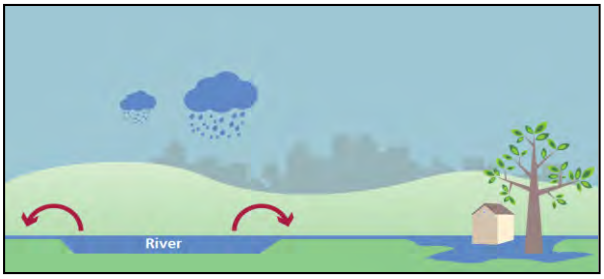


In addition to the principal watercourses, Birmingham has numerous main rivers[32] and ordinary watercourses, with countless unnamed streams, brooks and ditches, which have the potential to impact on fluvial flood risk. Parts of all of these rivers may be classified as 'heavily modified water bodies'[33]' and generate significant fluvial flood risk in the immediately surrounding areas. Each of these river catchments are considered to be highly responsive to the urban environment, and all exhibit flashy responses to all events.

Birmingham's urban environment has a real impact on fluvial flooding, with increases in upstream impermeable areas leading to faster run-off rates.

The (emerging) LFRMS defines fluvial flooding as:

> ***'Flooding from rivers, called fluvial flooding, occurs during heavy or prolonged rainfall, or rapid snow melt, when a watercourse cannot cope with the water draining into it from the surrounding land.'***



Birmingham City Council believe that all future development should be planned appropriately to mitigate and manage the risk of flooding[34].

Surface Water

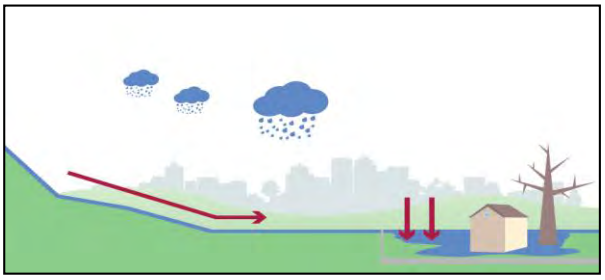
The urban nature of Birmingham with significant impermeable areas across the city generates significant surface water runoff which places extreme pressure on the existing drainage systems. Birmingham has a history of surface water flooding, where heavy rainfall overwhelms drainage systems

[32] http://apps.environment-agency.gov.uk/wiyby/151293.aspx
[33] European Environment Agency defines HMWB as 'HMWB are bodies of water which as a result of physical alterations by human activity are substantially changed in character and cannot, therefore, meet "good ecological status" (GES). In this context physical alterations mean changes to e.g. the size, slope, discharge, form and shape of river bed of a water body,' under the WFD. (www.eea.europa.eu)
[34] Birmingham Development Plan 2013, Policy TP6

and watercourses. In 2009, Birmingham was estimated to have 22,900 properties at risk of surface water flooding, making Birmingham the highest ranked settlement of properties at risk from surface water flooding outside of London.

The (emerging) LFRMS defines surface water and surface water flooding as:

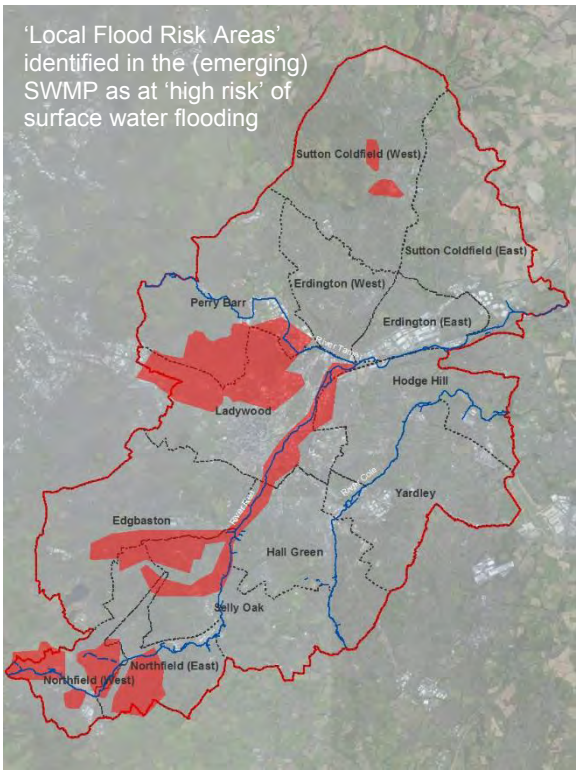
> ***'Surface water is rainwater which is on the surface of the ground and has not entered a watercourse, drainage system or sewer. Surface water flooding occurs where high rainfall exceeds the drainage capacity in an area. Surface water cannot then enter the system or the drainage network overflows, with manholes surcharging.'***



The (emerging) SWMP[35], created through collaboration with key stakeholders, establishes the long-term action plan to manage and mitigate the risks associated with surface water.

The (emerging) SWMP identifies 14 'Local Flood Risk Areas' that have a 'high risk' of surface water flooding.

The (emerging) SWMP, SFRAs Level 1 & 2 and the (emerging) LFRMS have identified surface water to be a major contributor to flood risk.



Landscape and Townscape Character

Birmingham currently ranks as '*one of Britain's greenest cities with more than one fifth of its area consisting of parks, nature reserves, allotments, golf courses and playing fields, many of which are linked by rivers, watercourses and a significant number of canals*.'[36]

The BDP states that future development should be supported by green infrastructure, and '*opportunities to make sustainable design integral to development, such as green infrastructure, sustainable drainage and energy generating features'* should be undertaken (Policy PG3).

Sustainable drainage solutions can aid this vision.

[35] (Emerging) Surface Water Management Plan for Birmingham, Final Report – May 2014

[36] http://bigcityplan.birmingham.gov.uk/wp-content/uploads/2013/01/Pre_Submission_Part_1.pdf

Nature Conservation, Ecology and Biodiversity

Birmingham boasts of a thriving nature and wildlife community; home to a National Nature Reserve (Sutton Park), 10 local nature reserves and 156 other local designated nature conservation sites.

The European Water Framework Directive (WFD) came into force in December 2000 and became part of UK law in December 2003. The WFD provides an opportunity to plan and deliver a better water environment, focussing on ecology, through river basin management planning. We know that the WFD is already at the forefront of Birmingham City Council thinking and SuDS will aid in further progressing this vision.

There can be challenges in delivering SuDS in some developments, however an integrated approach to design will unlock pragmatic solutions.

4.0 DESIGN PROCESS

Design Process

The following design process has been identified and should be applied to all proposed developments in Birmingham:

STAGE 1 : Understand the current requirements of SuDS

Utilise previous guide sections plus additional national and supplementary gudiance to understand BCC and other drainage/SuDS requirements.

STAGE 2 : Evaluate existing site conditions and constraints

Confirm all relevant Authority requirements and understand site specific opportunities, risks and constraints - Utilise BCC zoning maps, (emerging) SWMP, SFRA and (emerging) LFRMS information etc.

STAGE 3 : Understand the primary design considerations of the respective zone

Utilise BCC zoning maps and understand the primary design considerations aplicable to the site and as outlined on page 30 of this guide to aid the development of an appropriate SuDS strategy.

STAGE 4 : Complete a Sustainable Drainage Evaluation and seek pre-applicaiton advice where required

Prepare a 'Sustainable Drainage Evaluation' to ensure an appropriate undertanding of the requirements and site conditions has been obtained and seek advice where required/suggested.

STAGE 5 : Select appropriate SuDS features for the site

Select the apropriate SuDS features, understanding key SuDS design principles and practices. Section 5.0 Feature Design Considerations of this guide provides feature specific requirements to be considered also.

STAGE 6 : Develop a design (including a Sustainable Drainage Assessment) comensurate with the level of planning required

Select the appropriate system type, location, and size. Consider all apsects of SuDS design including landscaping, bioiversity and health and wellbeing benefits. Section 6.0 of this guide provides examples to aid in desgin development and Section 7.0 provides landscape and biodiversity considerations.

STAGE 7 : Prepare an Operation and Maintenance Plan

Develop an Operation and Maintenance Plan to meet the requirements outlined in Section 8.0 of this guide.

STAGE 8 : Submit planning applictaion and obtain planning permissions and permits

Submit all final plans and operation & maintenance plan, as part of planning application, to the LPA/LLFA for review.

STAGE 9 : Construct, operate & maintain for the lifetime of the development

Once design plans are approved and permitted, the developer should be ensured that the system is constructed in accordance wiith the project plans and specifications, and operated and maintained as previously outlined.

STAGE 1: Understand the current requirements of SuDS

The previous sections of this guide summarise national policy requirements and guidance, and detail complimenting local drivers specific to Birmingham.

Anyone developing in Birmingham should ensure that they understand the national and local requirements for SuDS respective of their proposed development.

In March 2015, updated Non-statutory technical standards for sustainable drainage systems[37] were published. Birmingham City Council have elaborated on these standards, with Birmingham Specific requirements. These are available in Appendix A.

STAGE 2: Evaluate existing site conditions

There are various conditions that will impact on the selection and design of SuDS, and a good understanding of the existing conditions for any proposed site is required before a drainage/SuDS strategy can be developed.

Zoning Maps

Birmingham City Council has developed a series of zoning maps that provide high level information on SuDS considerations, including infiltration potential information compiled from BGS data. These zoning maps should be used as a starting point for site evaluation, and are available in Appendix B.

These zones mirror the Birmingham constituencies and reflect zones that have been used within other supporting documents, e.g. SFRA.

There are 13 zones for Birmingham; Edgbaston, Erdington (West), Erdington (East), Hall Green, Hodge Hill, Perry Barr, Ladywood, Northfield (West), Northfield (East), Selly Oak, Sutton Coldfield (West), Sutton Coldfield (East) and Yardley.

Each of the zones has been reviewed and zone specific primary design considerations have been assigned.

As this assessment has been undertaken at a high level, developers must test assumptions using site specific characteristics/testing as appropriate. For example, if the zoning maps suggest infiltration is possible, site specific infiltration testing in accordance with BRE-365 would be required to validate the BGS data.

Surface Water Risk Mapping

Use of Risk of Flooding from Surface Water mapping available from the EA[38] should be used to determine if the development is at

Very low risk

- ***Less than 1 in 1000 (0.1%) chance of surface water flooding***

Low risk

- ***Between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of surface water flooding***

Medium risk

- ***Between 1 in 100 (1%) and 1 in 30 (3.3%) chance of surface water flooding***

High risk

- ***Greater than 1 in 30 (3.3%) chance of surface water flooding***

[37] https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

[38] http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

risk from surface water flooding. This risk is categorized from very low to high risk, which is defined as:

It should be noted that surface water flooding *'can be difficult to predict, much more so than river or sea flooding as it is hard to forecast exactly where or how much rain will fall in any storm.*[39]*'*

Birmingham Specific Documents

In addition to the zoning maps, additional Birmingham specific documents, should be evaluated to ensure a thorough understanding of the existing conditions.

Other Supporting Information

Every effort should be made to determine existing site conditions through the use of all relevant available information. This information may include, but is not limited to EA mapping, historic records and local knowledge. If appropriate, the local sewer capacity and any infrastructure improvements to accommodate the flows should also be investigated through a development enquiry to STW.

STAGE 3: Understand the primary design considerations of the respective zone

A number of primary design considerations have been identified in relation to SuDS and for each zone the top three primary design considerations have been identified.

[39] http://watermaps.environment-agency.gov.uk/wiyby/WiybyMapQueryResults.aspx?lang=_e&scale=11&cx=370198&cy=314746&topic=ufmfsw&layerid=0&x=369533&y=314997

Fluvial Flood Risk

- This area has been identified to be at significant risk of fluvial flooding. Whilst SuDS will not remove the risk of fluvial flooding, the design of the proposed SuDS features must not increase, and should seek to reduce, this risk.
- SuDS features should prioritise surface water quantity control measures.

Surface Water Flood Risk

- This area has been identified to be at significant risk of surface water flooding. Whilst SuDS may not remove the risk of flooding, surface water control measures must be integral to the design of the proposed SuDS features to not increase, and should seek to reduce, this risk.
- SuDS features should prioritise surface water quantity control measures.

Soil Permeability / Infiltration

- This area has been identified to have low soil permeability leading to poor natural infiltration.
- SuDS features should be designed and constructed appropriately to accommodate low infiltration levels.

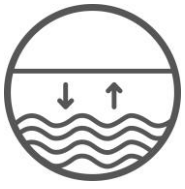
Groundwater Contamination

- This area has been identified to be highly susceptible to groundwater contamination.
- SuDS features should be designed and constructed appropriately to mitigate the risk of contamination.

Groundwater Flood Risk

- This area has been identified to be at significant risk of groundwater flooding. Whilst SuDS will not remove the risk of groundwater flooding, quantity control measures and attenuation should be integral to the design of the proposed SuDS features to mitigate this risk.
- SuDS features should prioritise surface water quantity control measures and water quality.

Depth to Water Table



- This area has been identified to have a high water table, which may result in poor infiltration rates and high risk of groundwater contamination.
- All SuDS features should be designed and constructed appropriately to accommodate the depth to water table.

Water Quality

- This area has been identified to contribute to poor water quality in natural watercourses and waterbodies.
- SuDS features should prioritise water quality mitigation measures.

STAGE 4: Complete a Sustainable Drainage Evaluation and seek pre-application advice where recommended

Surface water drainage should be considered at the start of the design process to ensure drainage systems can be delivered as effectively as possible.

To ensure early consideration, development of a **Sustainable Drainage Evaluation** is recommended at the pre-planning application stage in order to pre-empt and highlight issues that could later arise and conflict with the ability of a development to incorporate SuDS.

Development proposals progressed without undertaking this early consultation stage risk the possibility that the proposed layout would not be capable of being drained in a sustainable way to meet national and local policy.

The Sustainable Drainage Evaluation stage looks to gather all relevant data to ensure the site of any proposed development is adequately understood, alongside all relevant opportunities, risks and constraints, from which an adequate SuDS strategy can be developed.

A Sustainable Drainage Evaluation should consist of:

- A location plan
- An existing conditions plan[40], which should include:
  - Identification of existing overland flow paths and blue corridors
  - Topography (high and low points)
  - Existing land drainage features
  - Existing drainage network
  - Existing flood risk
  - Existing ground conditions, infiltration rates/potential, groundwater depth and contamination as appropriate
  - Existing services
  - Existing habitats and species
  - Physical restrictions (e.g. existing development/drainage)
- A preliminary surface water strategy, which should include:
  - Proposed overland flow paths and blue corridors
  - Infiltration and contamination potential
  - Discharge restrictions[41], (e.g. 1 greenfield runoff rate[42] or 1 in 100yr discharge or (emerging) TP6 1 in 100 year + climate change)
  - Hydraulic considerations (e.g. capacity for 1 in 30 year event)
  - Identified appropriate SuDS features
  - Maintenance restrictions
  - Access issues
  - Potential for amenity, biodiversity and landscaping

Birmingham City Council encourage developers to develop a Sustainable Drainage Evaluation that is agreed in principle by all key stakeholders, to meet national and local policy.

Seeking Pre-Application Advice

Pre-application advice will reduce the risk of subsequent design conflicts and later issues that may arise due to the proposed implementation of SuDS. Development proposals progressed without undertaking a Sustainable Drainage Evaluation and seeking pre-application advice run the risk that the proposed layout may not be capable of being drained in a sustainable way.

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[40] BCC will accept use of publically available data, in absence of site specific data

[41] The current discharge restrictions should align with the Sustainable drainage Systems, Non-statutory technical standards for sustainable drainage systems (March 2015) until such times as the (emerging) TP6 policy comes into effect.

[42] http://www.uksuds.com/greenfieldrunoff_js.htm

Pre-Application Advice Matrix

The following pre-application advice matrix suggests where pre-application advice is to be requested.

	Within an area at risk of Surface Water flooding[43]	Within 250m of a site that has flooded historically	Within a 'Local Flood Risk Area' as identified by the (emerging) SWMP	Within Flood Zone 2 or 3	Within 8m of an Ordinary Watercourse	All other areas
10 dwellings or more, or provision of dwellings on a site of 0.5 hectares or more	Pre-app Consultation recommended	Pre-app Consultation recommended	Pre-app Consultation recommended	Pre-app advice available	Pre-app advice available	Pre-app advice available
Buildings with a floor space 1000 square metres or more	Pre-app Consultation recommended	Pre-app Consultation recommended	Pre-app Consultation recommended	Pre-app advice available	Pre-app advice available	Pre-app advice available
Development site of 1 hectare or more	Pre-app Consultation recommended	Pre-app Consultation recommended	Pre-app Consultation recommended	Pre-app advice available	Pre-app advice available	Pre-app advice available
All other sites	Pre-app advice available	Pre-app advice available	Pre-app advice available	Pre-app advice not necessary	Pre-app advice not necessary	Pre-app advice not necessary

With reference to pre-application advice the following points should be noted:

- Pre-application advice is to be charged on a cost recovery basis.
- The EA will continue to provide pre-application advice for developments within Flood Zone 2 or 3.
- The developer should identify, at a pre-application stage, if they propose the use of conditions or a section 106 agreement. This will ensure that early discussions may take place and the most suitable mechanisms, respective to the developers' choice, can be determined, taking into account the particular circumstances of the development.

[43] (updated Flood Map for Surface Water or (emerging) Surface Water Management Plan 1 in 100 year outline)

Viability

Evidence on the whole life costs of SuDS considers the performance, construction and maintenance costs[44]. The findings of this research, with regard to enhancing the viability of SuDS systems, are outlined below:

- Capital costs for SuDS are generally less than traditional drainage systems. The larger the site the bigger the differential.
- Maintenance costs can be higher, but SuDS are often multifunctional and the combined cost of maintenance activities may be reduce, for example, SuDS incorporated as part of public space have the potential to be maintained as part of the landscape requirements.
- Early consideration of SuDS in the design process is likely to reduce long term maintenance costs.
- Stakeholder involvement enhances the successful management of surface water and its integration with the development.

Every effort should be made to enhance the viability of SuDS systems, and approaches to reduce construction and maintenance include:

- Use of simple, surface, vegetated systems, avoiding deep excavation and engineered structures where possible.
- Development of cost-effective construction programmes which protect drainage (including SuDS).
- Designing for low ongoing maintenance, integrated within general landscaping.
- Effective community engagement, with the possibility of involving local people in SuDS maintenance.
- Enhancing the potential benefits of SuDS systems; reducing flood risk, enhancing water quality, increasing amenity and biodiversity (section 2.0).

[44] http://www.susdrain.org/resources/evidence.html

STAGE 5: Select appropriate SuDS features for the site

Based on the site specific requirements, identified and the understanding gained of what should be the main considerations regards SuDS (Sustainable Drainage Evaluation) the next stage is to select appropriate SuDS for the site.

When selecting appropriate SuDS features for implementation within a development, consideration must be given to:

- Key SuDS design principles (section 2.0) aiming to achieve each principle, as far as reasonably practicable
    - Quantity Control
    - Quality Control
    - Biodiversity and Amenity Value
- Use of Birmingham specific documents to prioritise the key SuDS design principle to be achieved, for example use of the SFRAs may indicate where quantity control should take highest priority.
- Achieving the highest level of the drainage hierarchy (section 2.0)
- Selection of the most suitable level of treatment (treatment train) (section 2.0) taking account of existing and proposed water quality conditions.
- SuDS feature design specifications (section 5.0), which include:
    - Hydraulic design considerations
    - Structural & geometrical design considerations
    - General design considerations
    - Biodiversity & landscape design considerations (further expanded in Section 7.0)
    - Maintenance requirements
- Balancing multiple land use demands; e.g. affordable housing, park space, SuDS.

STAGE 6: Develop a design (including a Sustainable Drainage Assessment) commensurate with the level of planning required

Following selection of site specific SuDS, the site-specific design should be developed. This design should incorporate a **Sustainable Drainage Assessment,** which consists of:

- A location plan
- Sustainable Drainage Evaluation (see Stage 4)
- Proposed Surface Water Management Strategy, including:
  - Assessment of drainage hierarchy
  - Level of treatment train achieved
  - Proposed overland flow paths and exceedance corridors
  - Infiltration and contamination potential
  - Allowable discharge rates from drainage system, (e.g. greenfield runoff rate)
  - Hydraulic considerations (capacity of drainage system to accommodate a particular rainfall event, e.g. 1 in 100 year event)
  - Identified appropriate SuDS features
  - Maintenance restrictions and access issues
  - Potential for amenity, biodiversity and health and wellbeing benefit including consideration for landscaping
- Results of site-specific testing (where applicable)
- Summary of selected SuDS features

In addition to the Sustainable Drainage Assessment outlined above, the following information is required for specific planning applications.

It should be noted that the following requirements are also applicable to renewal planning applications.

Outline Planning

A concept design is required at outline planning, appropriate to the consent being sought[45], which may include:

- Sustainable Drainage Evaluation (see stage 4)
- Proposed surface water management summary, which should include:
  - Proposed conditions
  - Proposed overland flow paths
  - Anticipated discharge conditions and restrictions, (e.g. discharge to watercourse at greenfield runoff rate)
  - Anticipated maintenance restrictions and access issues
  - Potential for amenity, biodiversity and landscaping

Full Planning (including Reserved Matters)

A detailed design is required for full planning, which should include:

- Full Sustainable Drainage Assessment
- Supporting design report & drawings, documenting:
  - Hydraulic calculations (e.g. network capacity required)
  - Maintenance restrictions and access issues
  - Additional consents approved/to be applied for.

[45] For example, if a developer seeks outline consent with all matters reserved (including reserving design details such as layout for consideration in a reserved matters application at a later stage) it may not be possible to provide all aspects of the concept design. The developer should demonstrate an understanding of existing conditions and anticipated proposed conditions.

- Site layout and detailed design of the surface water network, including selected SuDS features

It should be noted that where discharge of water is directed to an area with a conservation designation, an ecological impact assessment may be required.

What calculations do I need to provide for my development?

The following hydraulic calculations are required for all developments:

- Proposed discharge rates

Greenfield runoff rate calculations should be provided for the 1 in 1 year rate, 1 in 30year rate and 1 in 100yr plus climate change.

These calculations may be provided through use of appropriate industry standard drainage design software, use of the EA Guidance[46] or use of a greenfield runoff calculator[47].

Where greenfield runoff rates are not being applied, further justification of proposed discharge rates is required (e.g. STW correspondence, evidence that development is unviable with greenfield runoff rates)

- Proposed storage requirements

Attenuation storage calculations should be provided for the 1 in 30yr and the 1 in 100year plus climate change event. These calculations may be provided through the use of appropriate industry standard drainage design software, use of the EA Guidance or use of a stormwater storage calculator[48], and should include the design criteria, calculated storage required and details of proposed storage features

Where the proposed development contains 50 dwellings or more; provision of dwellings on a site of 2 hectares or more; buildings with a floor space of greater than 5,000 square metres or development site of 2 hectares or more, the following information is also required:

- Existing and proposed drainage network details

Where there is an existing drainage network, details should be provided of the existing network dimensions (diameter/width/length), slope and roughness (e.g. STW records & survey drawings).

The proposed drainage network details should be provided, including dimensions (diameter/width/length), slope and roughness for all drainage features, with a layout plan and catchment area summary

- Evidence of proposed network performance

Verification of the performance of the proposed drainage network is required under the 30 year and 100 year plus climate change events.

Evidence of this should include details of design criteria, water level, surcharged depth, flooded volume, pipe flow, flow/overflow capacity, status of network and outfall details under each event, and may take the form of software simulation results. Network performance should be evaluated for storm durations of 15, 30, 60, 120, 240, 360, 480, 960 & 1,440 minutes.

It should be noted that Birmingham City Council consider 30% to be an acceptable allowance for climate change, and that for all development (greenfield & brownfield) surface water discharge rates shall be limited to the equivalent site-specific greenfield runoff rate for all return periods up to the 1 in 100 year plus climate change event, unless it can be demonstrated that the cost of achieving this would make the proposed development unviable.

[46] Rainfall Runoff Management for Developments
[47] http://www.uksuds.com/greenfieldrunoff_js.htm
[48] http://www.uksuds.com/surfacewaterstorage_js.htm

How do I present my calculations?

In addition to the guidance noted above, Birmingham City Council has created a 'Surface Water Management, Drainage Pro-forma' to support the user in development of a Sustainable Drainage Assessment. This pro-forma can be found in Appendix C.

What is the difference between a Sustainable Drainage Assessment and a site-specific Flood Risk Assessment?

NPPF footnote 20 explains that a site specific Flood Risk Assessment (FRA) is required for developments of 1 hectare or greater in Flood Zone 1; all developments in Flood Zones 2 and 3, or in an area within Flood Zone 1 notified as having critical drainage problems; and where development or a change of use to a more vulnerable class may be subject to other sources of flooding. The FRA should, amongst other things, help demonstrate that priority is being given to sustainable drainage systems in areas at risk of flooding.

A Sustainable Drainage Assessment is a Birmingham specific requirement for all major applications. It should include the detailed design, management and maintenance of surface water management systems including SuDS.

STAGE 7: Prepare an Operation and Maintenance Plan

Due to the variation in the operation and maintenance requirements of different SuDS features, early consideration of the long term maintenance of these features is critical to ensure that maintenance of the selected SuDS feature is achievable for the lifetime of the development.

An operation and maintenance plan must be developed and submitted with all major development planning applications, refer to Section 5.0 for SuDS feature specific requirements and Section 8.0 for details of the requirements for relevant planning applications.

Birmingham City Council has created an 'Operation & Maintenance Pro-forma' to support the user in development of an Operation & Maintenance Plan. This document can be found in Appendix D.

Birmingham City Council has provided a number of typical maintenance schedules (available in Appendix E) to provide guidance on the appropriate levels of operation & maintenance by SuDS feature. It should be noted that all maintenance schedules should be tailored to consider site-specific aspects of SuDS features, including location and access points.

STAGE 8: Submit Planning Application and obtain planning permissions and permits

Once completion of the design (including a Sustainable Drainage Assessment), including an appropriate Operation and Maintenance Plan and an agreement on future adoption of the drainage system (including SuDS) have been completed, the developer should submit this under the relevant planning application. It should be noted that the council may choose to use planning conditions or section 106 agreements, taking into account the particular circumstances of the development.

The LLFA maintains an asset register of all SuDS and flood mitigation assets which includes location, size, discharge, maintenance requirements and owner. In order to maintain a current register information received respective to SuDS, as part of a planning application, will be added to this register. The developer must provide the LLFA with the final 'as-built' plans & drawings, with accompanying operation and maintenance plan (including adopting party agreement) to be added to the asset register.

STAGE 9: Construct, operate & maintain for the lifetime of the development

Following the approval of the planning application, it is the responsibility of the developer to ensure that the drainage system is constructed in accordance with the submitted plans, and operated and maintained as previously outlined by the approved adopting party.

5.0 SuDS FEATURE DESIGN CONSIDERATIONS

Selection of Suitable SuDS Features

A number of typical SuDS features have been identified that are applicable to the Birmingham area. The following section explores these SuDS features indicating the key design criteria to be considered. It is acknowledged that the identified SuDS within this section may not be applicable to every development, and elements of the key design principles can be adapted by a competent engineer/designer and applied in bespoke SuDS systems.

Alongside feature specific design considerations all SuDS should be designed to:

- Mitigate flood risk to people and property as far as reasonably possible, and must not exacerbate or increase flood risk elsewhere.
- Provide a satisfactory level of protection to natural watercourses and surface water bodies.
- Be effectively designed to allow for appropriate levels of operation & maintenance, clearly defined within a management plan, to allow the system to operate efficiently for the lifetime of the development.
  Birmingham City Council has provided a number of typical maintenance schedules (available in Appendix E) to provide guidance on the appropriate levels of operation & maintenance by SuDS feature. It should be noted that all maintenance schedules should be tailored to consider site-specific aspects of SuDS features, including location and access points.
- Maximise the aesthetic appeal and amenity value of the drainage system, enhancing biodiversity.
- Preserve or enhance existing landscape design quality and amenity value to allow the continued recreational use of open space.
- Adhere with national policy, relevant design guidance and Birmingham City Council requirements relevant to the non-statutory Technical Standards for Sustainable Drainage Systems[49]' which are available in Appendix C.

All SuDS feature design should be completed in accordance with the SuDS Manual (CIRIA C697) with consideration of CIRIA C609B, Sustainable drainage systems: hydraulic, structural and water quality advice.

[49] https://consult.defra.gov.uk/water/delivering-sustainable-drainage-systems/supporting_documents/20140912%20SuDS%20consult%20doc%20finalfinal.pdf

Safety and Access

Consideration should always be given to safety in design and appropriate consideration of access during the design of SuDS. The design of SuDS should consider:

- All drainage systems should be designed for safe access for maintenance.
- Designs should minimise the risk of falls. Where a person could fall a significant height (~greater than 2m), the provision of a fence should be considered.
- Access around ponds (safety shore) which is suitable for maintenance vehicles and pedestrians should be provided (subject to local requirements) with cross-falls of 1:15 and width of 3.5m.
- Aquatic benches should be at least 1 m wide, with the design taking into account the results of a risk assessment for the site. Gradients in the pond beyond the aquatic bench, if designed to be steeper than 1:3, should have a minimum transitional width of 1 m at a maximum gradient of 1:3.
- Gradients between the safety bench and the lower “aquatic bench” (see Section 5.0) should be less than 1 in 3 (and preferably a minimum of 1:4) to reduce risks of the public slipping into the water and ensuring easy access from it.
- Where risks are considered to be significant, education boards should be used to inform the public and encourage them to take personal responsibility, and lifesaving equipment should be provided where this is thought necessary.
- Where ponds are located within eight miles of an airport, guidance provided by the Civil Aviation Authority (CAA) should be applied in designing ponds which minimise the risk of inappropriate types of birds (swans etc.) colonising the area. This reduces the risks of aircraft bird strikes causing accidents.

CDM Regulations 2015 must also be considered and applied to the planning, design and construction and long term maintenance of SuDS systems.

Soakaway

Soakaways are excavations, filled with rubble or lined with brickwork, pre-cast concrete or polyethylene rings/perforated storage structures surrounded by granular backfill that store surface water and allow it to soak into the ground. The use soakaways in many areas of Birmingham will be limited because of the presence of clay soils and high groundwater levels. However, where conditions are suitable they can be used to manage surface water runoff from roofs, driveways and patios.

Hydraulic Design Considerations

- Design in accordance with current standards[50]
- Site infiltration rate assumed for design should be based on appropriate site investigations and in accordance with national standards
- Infiltration testing should be carried out in accordance with BRE-365
- Minimum distance of 1m from the base of the soakaway to the seasonally high groundwater table
- Outlets must be provided for excess stormwater if considered necessary

Structural & Geometrical Design Requirements

- Fill material must provide 30% or more void space
- Geotexile material is to be used to separate the granular materials and the surrounding soil to prevent clogging and migration of fine soil

General Design Requirements

- Minimum distance from structural foundations of 5m
- Soakways that have a depth greater than 4m require approval from the EA
- Pre-treatment is required where appropriate
- Not to be used in areas where risk of contamination in the runoff could lead to pollution of groundwater
- Where used in areas at risk of groundwater contamination, geotexile membrane liner should be used
- Design in accordance with the SuDS Manual (CIRIA C697) with consideration of CIRIA C609B, *Sustainable drainage systems: hydraulic, structural and water quality advice*.

Landscape/Biodiversity Design Requirements

- Use of locally native, or otherwise appropriate, plant species, requiring little or no aftercare once established

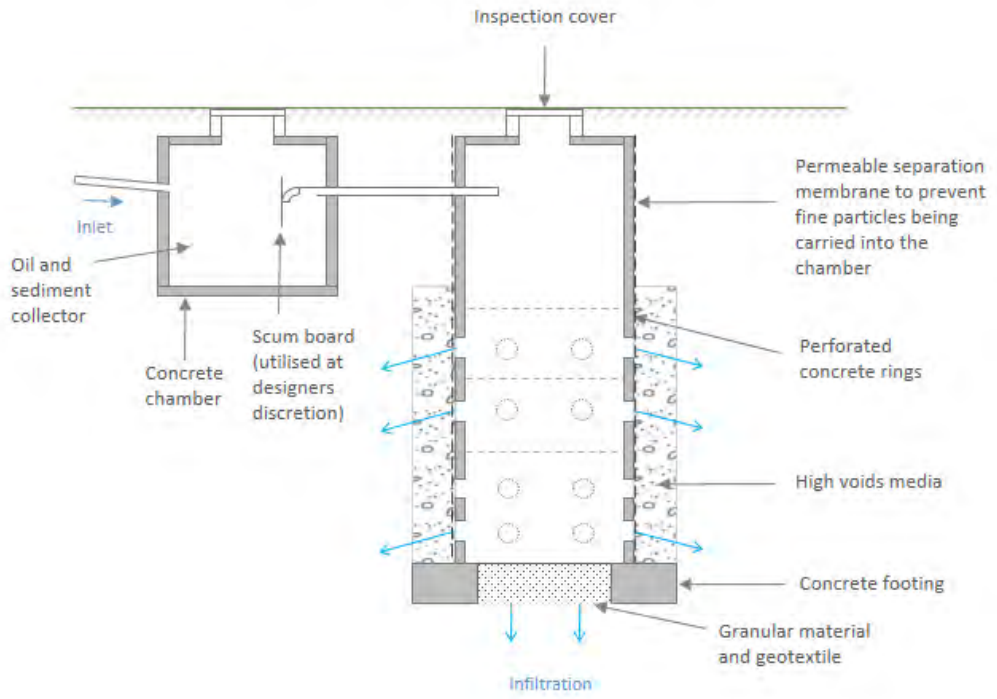
Maintenance Requirements

- Provide access to allow for maintenance
- Not to be used to drain landscaped or similar areas due to risk of sediment blockage and clogging of the soils surrounding the device.
- Regular Monitoring performance (using observation well) is advised

[50] https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards The current discharge restrictions should align with the Sustainable drainage Systems, Non-statutory technical standrds for sustainable drainage systems (March 2015) until such times as the (emerging) TP6 policy comes into effect

SOAKAWAY (Including pre-treatment device)

Modified from CIRIA C697 Figure 6.5



Example of Good Practice

Elvetham Heath, Fleet, Hampshire

63ha development including residential units, a school, village centre, large retail outlet, park and ride and sports pitches.

The drainage strategy provides a soakaway systems to drain the areas of high ground, using swales/linear ponds for conveyance in the flattest areas with small detention basins scattered through the site to provide attenuation storage and encourage infiltration to reduce the volume of runoff.

The scheme is designed to limit discharge to the 50 year return period greenfield rate of 7l/s/ha and to function without flooding up to the 30 year return period event.

Example of a soakaway

Image source: Arup

Green/Brown Roofs

Green/Brown roofs have a thin layer of soil-like material known as substrate that is planted with species appropriate to the local conditions and visual amenity considerations.. Varying substrate depths are best from visual and biodiversity points of view with thicker areas located over stronger points in a roof such as columns.

Hydraulic Design Requirements

- Hydraulic design should follow guidance in BS EN 12056-3:2000
- Attenuate 1 in 2 year storm event

Structural & Geometrical Design Requirements

- Roof pitch : Minimum slope of 1 in 80, Maximum slope of 1 in 3
- Roof must withstand full additional load of saturated green roof elements
- Discharge outlets should adhere to relevant guidance - BS 12056-3:2000 and keep separate from growth medium
- Provide greater than two (preferably multiple) outlet locations to reduce the risk of blockage
- Substrate/Soil should contain less than 20% organic matter
- Minimum soil thickness of 100mm

General Design Requirements

- 1m wide gravel or slab fire break every 40m
- Provide a raised grid structure to secure the plant growing substrate
- Provide a shallow layer of gravel over a width of approximately 400mm from the outside perimeter of the roof
- Provide adequate access to allow for maintenance
- Water capacity should not exceed 65% by volume in order to avoid water logging
- Where used in areas at risk of groundwater contamination, geotexile membrane liner should be used
- Design in accordance with the SuDS Manual (CIRIA C697) and with consideration to from Building Greener, published by CIRIA, and the EAs Green Roof Tool Kit

Landscape/Biodiversity Design Requirements

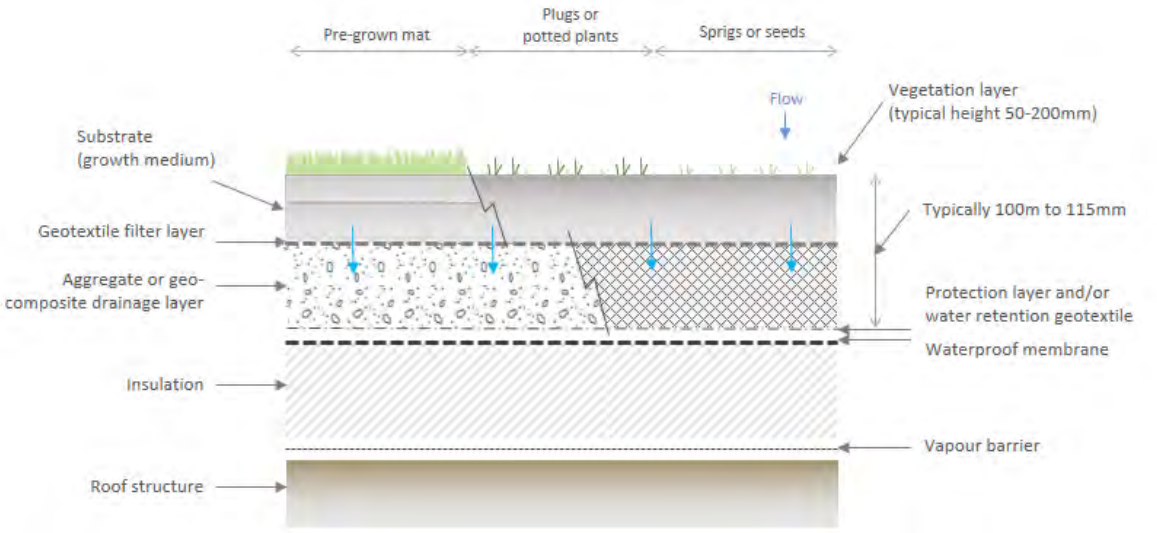
- Use of locally native, or otherwise appropriate, plant species, requiring little or no aftercare once established
- A roof top can be an inhospitable place for plants and plant species should be self-sustaining, able to withstand heat, cold and high winds and able to tolerate poor soil and mildly acidic conditions
- 10-15% of bare ground on roof tops to be accommodated in areas where mitigation for Black Redstarts is a priority.

Maintenance Requirements

- Consideration should be given to:
  - Irrigation during establishment of vegetation
  - Inspection for non-designed bare patched and replacement of plants
  - Litter removal

GREEN ROOF

Modified from CIRIA C697 Figure 6.2



Example of Good Practice

Triton Street, Regent's Place, London

This mixed-use office and residential development, found close to Regent's Park, is set within a dense urban location.

Green roofs extend along three different building blocks of various heights and amount to a total area of 2,500m^2.

This SuDS system provides added value in biodiversity, health and wellbeing, enhances the urban environment.

Example of a green roof

Image source: Arup

Filter Drain

Filter drains are gravel filled trenches that collect, store and move water. They also treat pollution. The trench is filled with free draining gravel and often has a perforated pipe in the bottom to collect the water. They are widely used to drain roads and are often seen along the edge of main roads. There is frequently a geotextile just below the surface that is used to trap silt and stop it clogging the gravel deeper in the trench. A small filter strip before the trench is also a good way of stopping silt clogging the trench.

A filter strip is an area of vegetated land designed to accept runoff, located between an impermeable area and a receiving water course or drainage system.

Hydraulic Design Requirements

- Run off from adjacent impervious areas must be evenly distributed across the filter strip with a water depth less than 50mm for the water quality treatment event.
- Conveyance routes for runoff should be identified, with a slope of 1 in 300 minimum, to encourage flow under gravity. These should be predominantly lateral inflow, point flows may be acceptable on a site-specific basis
- Low level outlets to be used when designed for conveyance, high level overflows to be used when designed for infiltration.

General Design Requirements

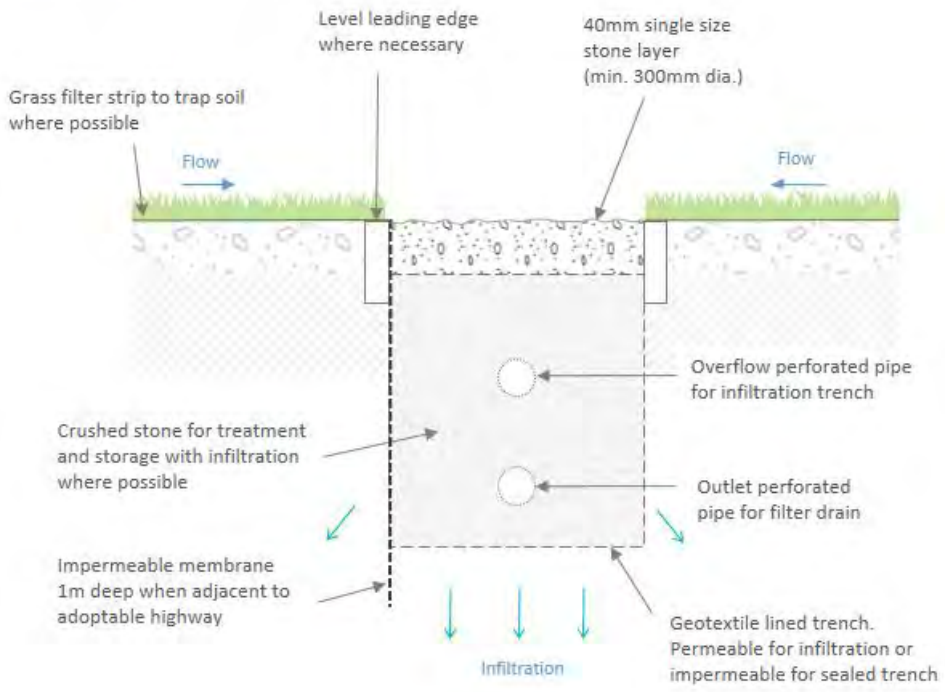
- Maximum width of 50m of impermeable area that runs off onto filter strip
- Slopes must not excess 1 in 20
- Minimum Slope of 1 in 50
- Where used in areas at risk of groundwater contamination, geotexile membrane liner should be used
- Effective upstream pre-treatment to remove sediment and fine silts.
- Filter drains can be used in conjunction with swales to create enhanced swales and act as a pre-treatment system.
- A minimum void ratio of 0.3 to be used for the fill material.
- Design in accordance with the SuDS Manual (CIRIA C697) with consideration of CIRIA C609B, Sustainable drainage systems: hydraulic, structural and water quality advice.

Maintenance Requirements

- Consideration should be given to the requirement for litter/debris removal, mowing and repair of eroded or damaged areas
- Jetting pipes every 10 - 15 years, or as required
- Replacing blocked stones/geotextile every 10-15 years, or as required

FILTER DRAIN

Modified from CIRIA C697 Figure -



Example of Good Practice

Bognor Regis Sports Centre, West Sussex

2ha site comprising of a sports centre, synthetic sports pitches, multi-use games area and 136 car parking spaces.

The SuDS system comprises of porous paving in the car park area which allows blanket infiltration into the subgrade and a network of filter drains servicing the sports pitches which connect to an infiltration trench.

This system attenuates site runoff to a limited discharge of 7 l/s.

Example of a filter drain

Image source: Arup

Swale

Swales are vegetated shallow channels designed to store and/or convey runoff. They are source control element of SuDS and may be used as conveyance structures to pass the runoff to the next stage of the treatment train. The grass/vegetation slows the water down and traps some allowing it to infiltrate into the ground. In addition, the plants help evaporate some water and filter out pollutants. Swales can be incorporated into larger greenspaces and make significant contributions to landscape, biodiversity and sense of place.

Hydraulic Design Requirements

- Maximum velocities during extreme events of 2m/s, soil dependant - promoting low flow velocities to allow suspended particulate load to settle out, providing effective pollutant removal.
- Maintain flow height of water during frequent events below the top of the vegetation (typically 100mm)
- Pre-treatment is recommended to remove sediment and fine silts prior to infiltration
- Check dams to be used where longitudinal slopes are steep to maximize storage and minimize land use where appropriate

Structural & Geometrical Design Requirements

- Maximum side slopes of 21 degrees (where soil conditions allow)
- Minimum base width normally 0.5m where water treatment is required, may be reduced to 0m to maintain suitable bank slopes in constrained sites.
- Minimum Freeboard of 150mm

General Design Requirements

- Where used in areas at risk of groundwater contamination, geotexile membrane liner should be used
- Design in accordance with the SuDS Manual (CIRIA C697) with consideration of CIRIA C609B, *Sustainable drainage systems: hydraulic, structural and water quality advice.*

Landscape/Biodiversity Design Requirements

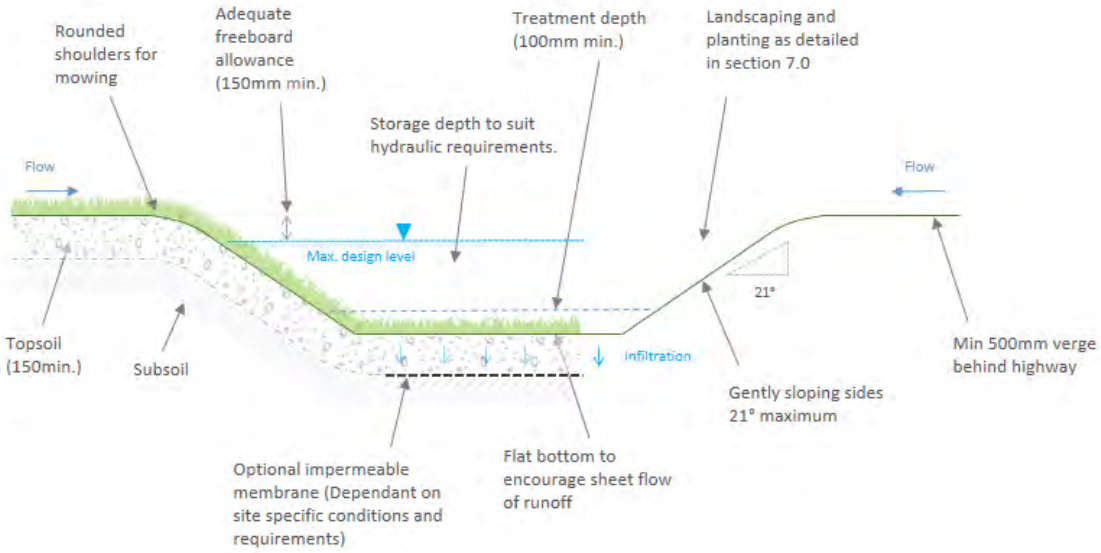
- Use of locally native, or appropriate, plant species, for swale base or on slopes to enhance biodiversity, requiring limited management
- Aim to provide a green setting for new developments, contributing to a ‘local sense of place’
- Create a connected network of green existing and proposed spaces

Maintenance Requirements

- Consideration should be given to:
  - Litter removal
  - Grass cutting and removal of cuttings
  - Clearing inlets, culverts and outlets from debris and sediment
  - Repairing of eroded or damaged areas

SWALE

Modified from CIRIA C697 Figure 10.1



Example of Good Practice

Lamb Drove, Residential SuDS scheme, Cambourne

A residential development of 35 affordable homes on a 1Ha site. A number of SuDS features have been applied across the site, comprising of water butts, permeable paving, green roofs, swales, filter strips, detention and wetland basins and a retention pond.

Example of a swale

Image source: Arup

Permeable Paving

Permeable paving consist of blocks or porous concrete/asphalt that is suitable for pedestrian and/or vehicular traffic, while allowing water to infiltrate through the surface where it can be discharged to another system or attenuated before infiltrating into the ground.

Hydraulic Design Requirements

- Selection of appropriate permeable paving system following assessment of site infiltration; total infiltration, partial infiltration or no infiltration.
- Design surface infiltration rate should accommodate the design rainfall intensities taking into consideration the limiting impact of surface material clogging, geotextile membranes and sub-soil on infiltration rates; typically the design surface infiltration rate is significantly larger than the design rainfall intensity
- Seasonal high groundwater table must be greater than 1m below the sub-base for total and partial infiltration systems; and must be below the geotextile membrane liner for no infiltration systems
- Maximum designed water depth must not exceed the top of the subbase

General Design Requirements

- Base of the paving system to be laid flat to maximise storage, or if installed on a sloping site, baffles should be considered to slow flows and promote maximum infiltration.
- Subsurface storage volume should meet site-specific requirements for infiltration and/or discharge requirements
- Adequate outflow piping must be provided for sealed systems, using appropriate geotextiles to prevent clogging
- Emergency overflow points should be included in the system to accommodate events in excess of the design event
- Appropriate use of geotextiles meet treatment requirements and prevent clogging
- In areas at high risk of contamination, sealed systems may be used for treatment and attenuation purposes only
- Sealed systems must include an appropriate geotextile membrane should be selected to prevent infiltration from the system to the surrounding sub-soil
- Structurally designed to accommodate proposed loading, taking into consideration the impact of loading on the sub-surface system and design infiltration rates e.g. vehicular loading

Landscape/Biodiversity Design Requirements

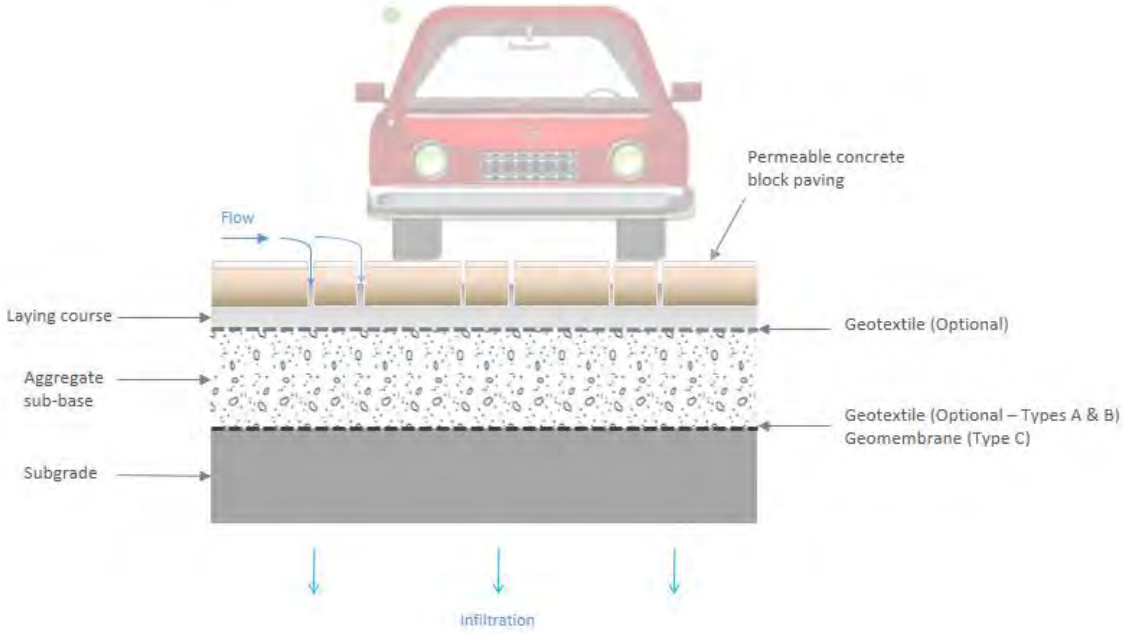
- Use of paving materials appropriate to local context

Maintenance Requirements

- Regular sweeping and vacuuming

PERMEABLE PAVING

Modified from CIRIA C697 Figure 12.6



Example of Good Practice

Riverside Place, Riverside Court, Stamford

Riverside Court was the re-development of an electricity sub-station to create high density urban housing, with 72 units in 0.69ha. This redevelopment increased runoff.

A system of permeable paving, rills, canals and shallow geocellular storage has been used to capture, clean and store runoff in a very confined space with no land take. Roof water is collected through silt traps that flow into diffuser boxes within the voided stone sub-base or directly to planted rills.

This system ultimately discharges a controlled flow of clean water to the River Welland.

Example of permeable paving

Image source: Arup

Infiltration Basin

Infiltration basins are vegetated depressions in the ground designed to store surface water runoff on the surface. They should be dry most of the time except in periods of heavy rain. Infiltration basins should be designed as landscape features that act as visual enhancement and habitat creation. When dry, they can be used for social space, and habitat creation.

Hydraulic Design Requirements

- Site specific infiltration tests should be completed; infiltration basins are not appropriate in areas of negligible infiltration, or areas where there is a high risk of groundwater contamination
- Seasonal high groundwater table must be greater than 1m below the sub-base
- Conveyance routes for runoff to be identified, with a minimum slope of 1 in 300. to encourage flow under gravity
- Erosion control measures should be installed at inflow and outflow points,
- Basins should be designed to infiltrate fully, no long term standing water is permitted.
- Design should allow for 50% of the basin to infiltrate within 24 hours
- Basin floor should be as flat as possible to maximise infiltration rates.
- Rate of water inflow and rise in water levels should be sufficiently slow as not to present a hazard

General Design Requirements

- Emergency overflow points should be included in the system to accommodate events in excess of the design event,
- Pre-treatment to reduce accumulation of silt is recommended
- Side slopes to be a maximum of 21 degrees, with adequate access points to allow for maintenance, e.g. mowers
- Embankment design to allow for water to be impounded; fill material must be inert
- Adequate access must be provided to allow for inspection & maintenance
- Where used in areas at risk of groundwater contamination, geotexile membrane liner should be used

Landscape/Biodiversity Design Requirements

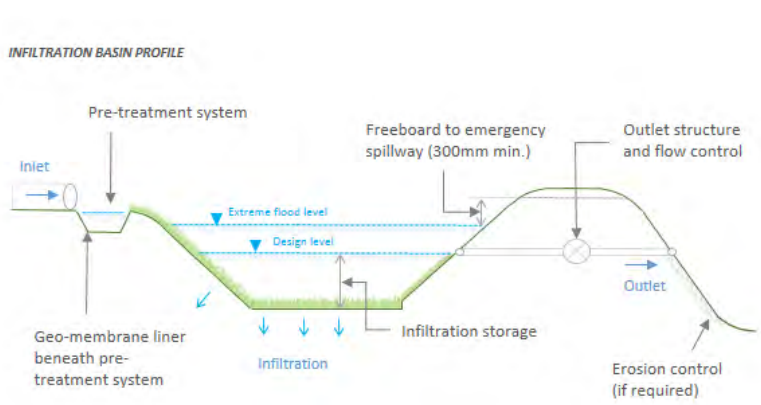
- Use of locally native, or otherwise appropriate, plant species, able to tolerate periodic cover by water, for basin base or slopes
- Maximise amenity and green infrastructure benefits

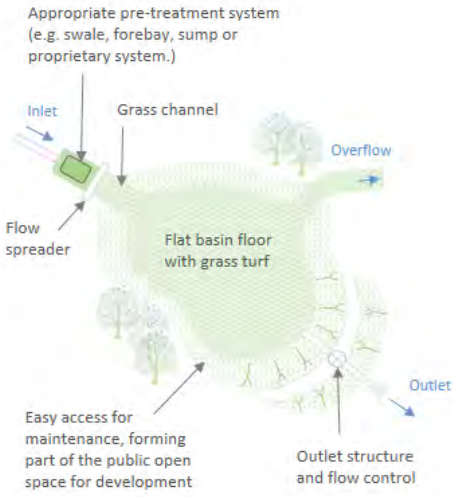
Maintenance Requirements

- Inlets and outlets to be positioned to be visible for ease of access and maintenance. Regular inspections are required to prevent blockages
- Basins to have rounded shoulders to assist cutting activities. Grass seed specification shall be confirmed by Developer including frequency of growth/cutting regime and suitability for location)
- Occasional silt removal is also recommended. Hollow tine and scarifying of ground will increase infiltration.

INFILTRATION BASIN

Modified from CIRIA C697 Figures 15.1 to 15.2





Example of Good Practice

Victoria Park Health Centre, Leicester

The Victoria Park Health Centre (VPHC) development is a two-storey health centre, of 0.7 ha.

Due to underlying permeable soils the SuDS scheme for this development focuses on infiltration, comprising of a green roof and an infiltration basin.

The green roof services the majority of the roof area, with the remaining conventional roof runoff combining with car park runoff to discharge to a marsh area where it naturally infiltrates.

Most of the site runoff is conveyed to the infiltration basin, where it is filtered through the substrate and infiltrates to the groundwater. This system is designed to accommodate the 1 in 100 year event, with no overflow/exceedance route and no flow control features as it is a relatively small site that is designed to 'soak' into the ground.

Example of an infiltration basin

Image source: Arup

Detention Basin

Detention basins are surface structures, typically vegetated depressions that provide flow control through temporary storage and attenuation with controlled release of stored runoff. They should be designed as landscape features that act as visual enhancement and habitat creation. When dry, they can be used for social space, and habitat creation.

Hydraulic Design Requirements

- Storage volume should meet site-specific requirements for storage of design storms and/or discharge requirements
- Design of on- & off-line systems must comply with current guidelines.
- Seasonal high groundwater table must be below the sub-base and the geotextile membrane liner
- Conveyance routes for runoff should be identified, with a slope of 1 in 300 minimum. to encourage flow under gravity
- Maximum depth of water in basin should not exceed 3m
- The basin bed should be fairly flat, with a gentle slope towards the outlet (recommended 1:100)

General Design Requirements

- Recommended length/width ratio for online detention basins is between 5:1 and 2:1 to further encourage settlement and filtration of runoff
- Basins with an impermeable geotextile membrane may be used in areas of low permeability and areas at high risk of groundwater contamination
- Emergency overflow points should be included in the system to accommodate events in excess of the design event, where required
- Pre-treatment to reduce accumulation of silt is preferred
- Side slopes to be a maximum of 21 degrees, with adequate access points to allow for maintenance, e.g. mowers
- Embankment design to allow for water to be impounded; fill material must be inert
- Adequate access must be provided to allow for inspection & maintenance

Landscape/Biodiversity Design Requirements

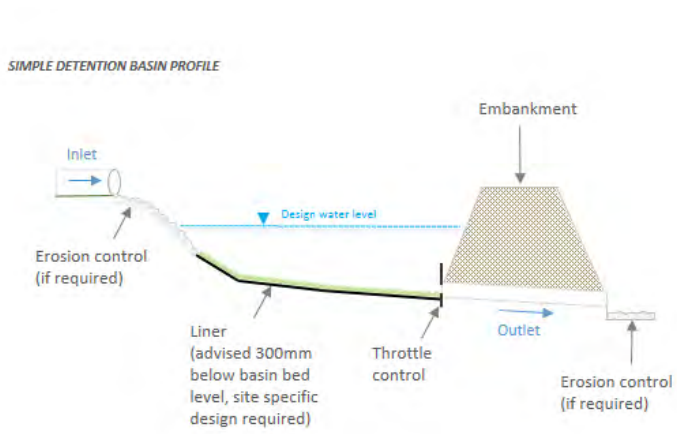
- Use of locally native, or otherwise appropriate, plant species, able to tolerate periodic cover by water, for basin base or on slopes to enhance biodiversity
- Maximise amenity and green infrastructure benefits

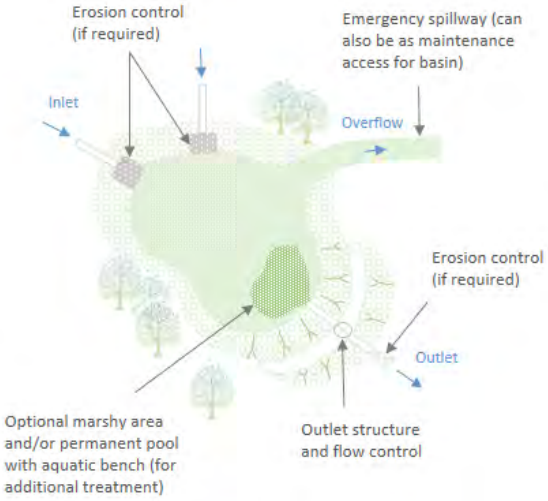
Maintenance Requirements

- Inlets and outlets to be positioned to be visible for ease of access and maintenance. Regular inspections are required to prevent blockages
- Basins to have rounded shoulders to assist cutting activities. Grass seed specification shall be confirmed by Developer including frequency of growth/cutting regime and suitability for location)
- Occasional silt removal is also recommended. Hollow tine and scarifying of ground will increase infiltration.

DETENTION BASIN

Modified from CIRIA C697 Figures 16.1 to 16.2





Example of Good Practice

Dunfermline Eastern Expansion, Scotland

This is a 550ha development site which will be developed over 20 years to include a mixture of industrial, commercial, residential and recreational areas.

A SuDS system has been used to mitigate the increase in runoff and potential pollutants, however the use of infiltration systems is limited due to underlying clay soils. A system of offset kerbs, filter drains and swales, servicing the public highway, discharge into extended detention basins and wetlands, which also serve housing areas.

Runoff is treated through a series of ponds and wetlands, using detention basins to achieve maximum attenuation of storm flows.

Example of a detention basin

Image source: Arup

Rain Garden/Stormwater Planter

Rain gardens and Stormwater planters are shallow, localised, landscaped areas which typically rely on engineered soils, enhanced vegetation and underdrains. These features are designed to manage and treat runoff from frequent storm events, providing attenuation and treatment of runoff.

Hydraulic Design Requirements

- Sufficient area to store the Water Quality Treatment Volume, or where retrofitted sufficient area to provide betterment to existing
- Seasonal high groundwater table must be greater than 1m below the sub-base in unlined systems; and must be below the geotextile membrane liner for lined systems
- Depth of standing water must not exceed 150mm during a storm event
- Systems should be designed to half empty within 24 hours of storm event, and completely dewater within 48 hours

General Design Requirements

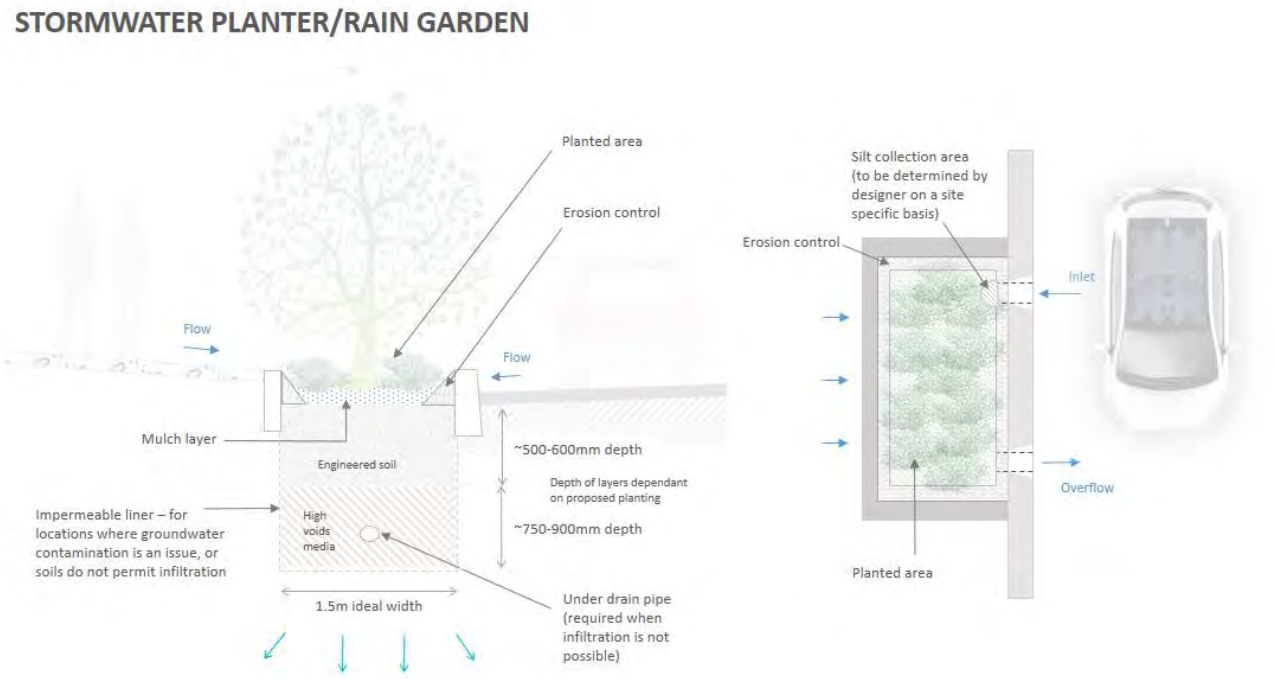
- Depth of sub-soil should be a minimum of 1m, where trees are to be incorporated, minimum sub-soil depth of 1.2m – 1.5m
- Emergency overflow points should be included in the system to accommodate events in excess of the design event, where required
- Site-specific selection of plant species is required
- Erosion control measures should be installed at inflow and outflow points, where required
- Where there is a high risk of contamination, sealed systems (use of an impermeable geotextile membrane) may be used in these areas for treatment and attenuation purposes prior to discharge to another system
- Adequate access must be provided to allow for inspection & maintenance

Landscape/Biodiversity Design Requirements

- Selection of plant species to provide an attractive landscape and enhance biodiversity. The plants selected should be appropriate to the specific location of the SuDS features; ornamental varieties rather than locally native species may be more suited to urban/formal settings.
- Selection of plant species and features that contribute to ‘local sense of place;

Maintenance Requirements

- Regular inspections, including litter removal, inlet/o utlet cleaning, vegetation management and removal of sediment



Example of Good Practice

Ribblesdale Road, Nottingham

Retrofit of 21 linear rain gardens constructed within the grass verge of a residential area consisting of 67 properties, designed to capture runoff from highway and other areas totalling 7,100m^2.

This scheme is designed to manage surface water runoff from a 1 in 30 storm event.

Example of a stormwater planter/ rain garden

Image source: www.susdrain.org

Pond

Ponds provide attenuation of stormwater runoff and treatment. These features are designed to treat pollutants in runoff, while providing an enhanced ecological environment and amenity value.

Ponds, a permanent pool of water in an existing or constructed depression, are preferably separated into a series of smaller systems to provide both water quality and quantity controls.

Hydraulic Design Requirements

- Permanent pool volume must provide adequate volume for effective water quality treatment, with the total system achieving the Water Quality Treatment Volume
- Design of offline temporary storage to allow for flow attenuation in storm events
- 1.2m minimum depth for open water areas, 2m maximum depth of permanent pool
- Conveyance routes for runoff should be identified, with a slope of 1 in 300 minimum. to encourage flow under gravity
- If the purpose of the pond is to reduce flood risk, it should not be located in the floodplain.

General Design Requirements

- Underlying soils should be sufficiently impermeable or an impermeable geotextile membrane may be used to maintain water levels in the pond
- An impermeable geotextile membrane should be used in areas at high risk of groundwater contamination
- Pre-treatment is required, preferably through a sedimentation forebay to limit silt accumulation
- Length to width ration of minimum 3:1
- Side slopes at maximum of 21 degrees
- Seasonal high groundwater table must be greater than 1m below the sub-base of the pond, or the outfall must be designed to be operational at the annual maximum water table level
- Aquatic safety shore should be provided at the edge of the pond, typically with maximum depth of 0.45m
- Public safety, particularly to children, must be considered in pond and wetland design

Landscape/Biodiversity Design Requirements

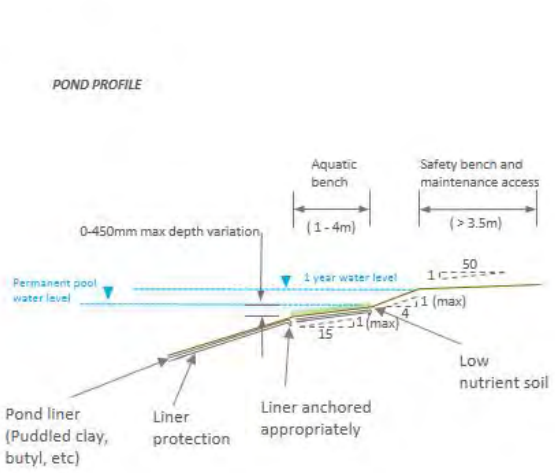
- Selection of plant species should be appropriate to the specific location and conditions of the pond; locally native species should be planted in more naturalistic settings, ornamental planting may be more appropriate in formal/urban settings, but care must be taken to ensure invasive species are not introduced to the SuDS feature (see section 7.0 for more information)
- Design to contribute to ‘local sense of place’

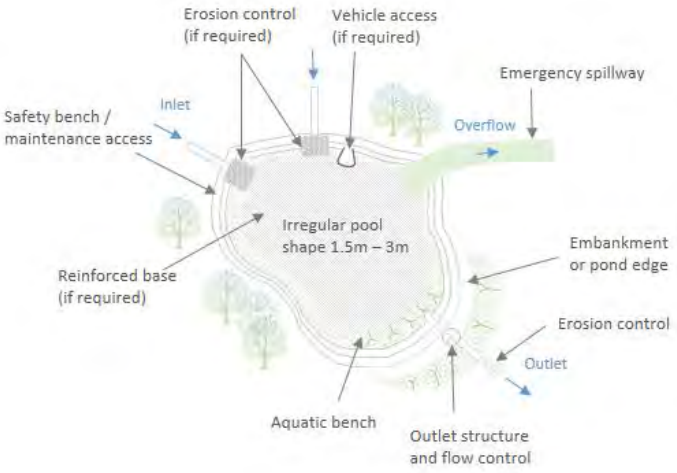
Maintenance Requirements

- Regular inspections, including litter removal, inlet/outlet cleaning, vegetation management and removal of sediment
- Adequate access must be provided to allow for inspection & maintenance

POND

Modified from CIRIA C697 Figures 17.1 to 17.2





Example of Good Practice

Blythe Valley Park, Solihull

Blythe Valley Park is a business park, covering 257 acres, which contains multiple SuDS systems of swales, ponds and wetlands.

The site lies on clay with little infiltration, therefore an attenuation system has been implemented that comprises of swales that feed through wet attenuation ponds, into constructed wetlands and 'polishing ponds', eventually discharging into either the Hawkeshaw Brook (west) or the Illshaw Brook (north).

This system is designed to attenuate the 1 in 100 year event, using balancing ponds to operate with base flows of pre-development greenfield runoff rates.

Example of a pond

Image source: Arup

Storage System: Geocellular or Tank

Geocellular storage systems are modular plastic systems with a high void ratio, typically placed below ground which allow for storage of storm water to infiltrate or discharge to another system. Tank storage systems are concrete or plastic systems, typically placed below ground which allow for attenuation of storm water to discharge to another system

These systems can be designed to meet site-specific requirements, operating as an attenuation system and/or a storage tank for rainwater reuse.

Hydraulic Design Requirements

- Storage volume should meet site-specific requirements for infiltration and/or discharge requirements
- Design of on- & off-line systems must comply with current guidelines.
- Seasonal high groundwater table must be greater than 1m below the sub-base for total and partial infiltration systems; and must be below the geotextile membrane liner for no infiltration systems

General Design Requirements

- Adequate outflow piping must be provided, with appropriate use of geotextiles to prevent clogging
- Overflow points should be included in the system to accommodate events in excess of the design event, where required
- Appropriate selection of geotextiles to prevent clogging and meet treatment requirements
- Systems should be structurally design to accommodate proposed loading e.g. vehicular loading (vertical and lateral loading to be confirmed and approved by the adopting party)
- Complete creep tests and provide data and results to the adopting party before installing any geocellular systems.
- Upstream pre-treatment to be provided to limit the accumulation of silt, e.g. silt traps
- Systems must not be allowed to infiltrate in areas where there is a high risk of contamination, sealed systems (use of an impermeable geotextile membrane) may be used in these areas for treatment and attenuation purposes prior to discharge to another system
- Adequate access must be provided to allow for inspection & maintenance

Landscape/Biodiversity Design Requirements

- Take opportunities to incorporate tree planting pits in appropriate locations that contribute to local amenity.
- Selection of tree species should be appropriate to the specific location

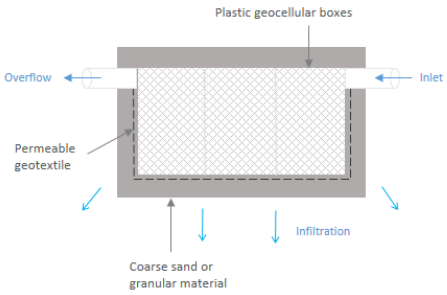
Maintenance Requirements

- Regular inspection of all system parts (silt traps, manholes, pipework and pre-treatment devices), removal of silt and debris as required

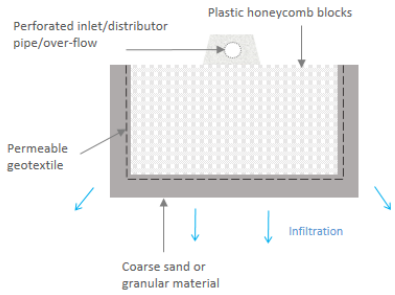
GEOCELLUAR STORAGE

Modified from CIRIA C697 Figures 13.1 to 13.3

MODULAR BOX SYSTEM IN SOAKAWAY MODE



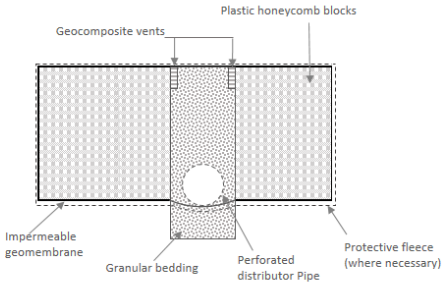
HONEYCOMB SYSTEM IN SOAKAWAY MODE

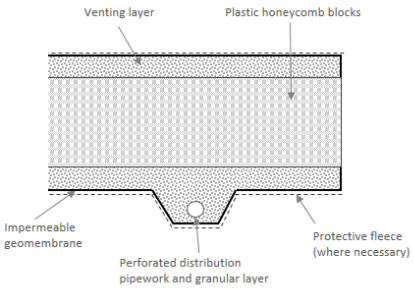


GEOCELLUAR STORAGE (Non-soakaway)

Modified from CIRIA C697 Figure 13.4

HONEYCOMB SYSTEMS IN STORAGE/ATTENUATION MODE





Example of Good Practice

St. Mary's Way, Sunderland

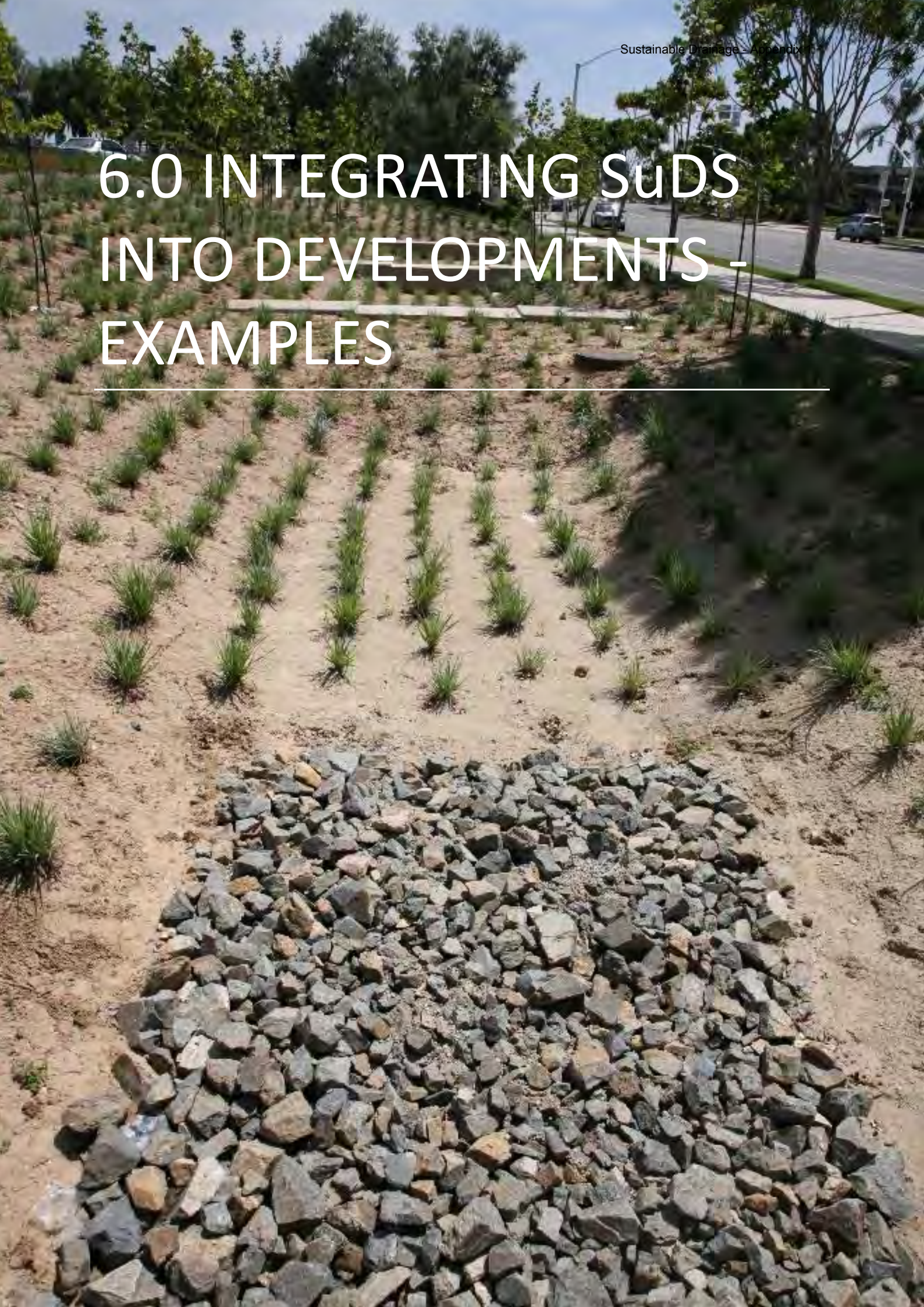
Through the realignment and merging of St. Mary's Way and Livingstone Road, a new, tree-lined boulevard (green street) has been envisaged.

This scheme incorporates a SuDS system for management of water, comprising of 31 tree pits (large trees) with underlying geo-cellular storage in the form of soil cells.

Example of geocellular storage

Image source: Arup

6.0 INTEGRATING SuDS INTO DEVELOPMENTS - EXAMPLES



Integrating SuDS into Developments - Examples

This section provides examples of the multiple SuDS that can be implemented across different types of development. These examples show that SuDS are applicable on all developments, and it is the selection of the appropriate SuDS features that is critical to their successful implementation.

Density of Development

The proposed density of a development has a direct impact on the applicability of various types of SuDS features, which adds further weight to the importance of early consideration and integrated design with respect to SuDS.

High density developments[51] are often exposed to significant pressures on available area, which is often already constrained by other requirements (public open space, recreational activities). In these developments, selection and siting of SuDS features is key to successful implementation.

Low density developments may present site-specific constraints. However, these developments present a unique opportunity to incorporate multiple SuDS features, thereby enhancing treatment and providing additional amenity & biodiversity.

Variation in Permeability of Underlying Soils

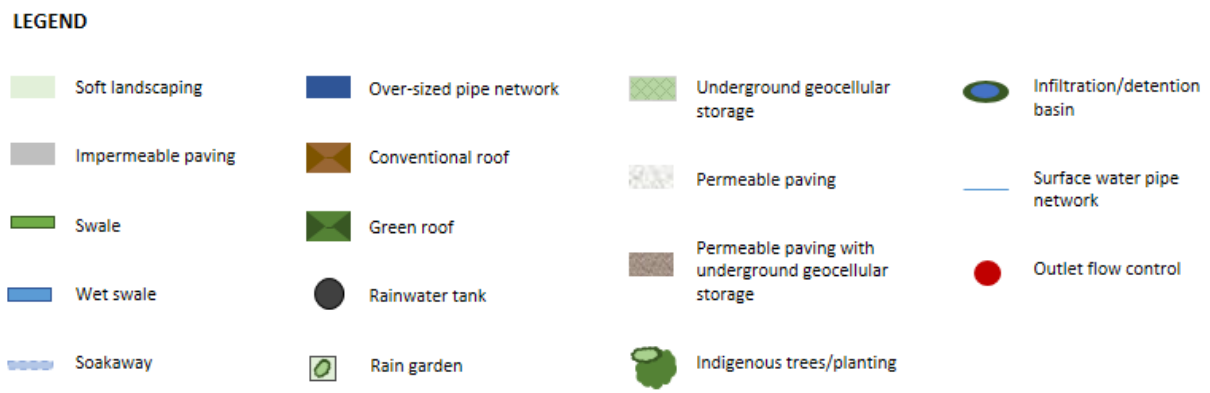
Underlying soil conditions and geology are important factors to be considered in the selection of appropriate SuDS features for any development, and flexibility in design can accommodate variations in ground conditions. Site-specific testing is recommended on all sites, at the appropriate stage of design, to determine the exact existing conditions. Every effort to select the most appropriate SuDS for the site should be made and therefore it is strongly recommended that site specific testing be carried out for all full planning applications.

While traditional SuDS features focus heavily on infiltration, there are many opportunities for SuDS in areas of poor infiltration. The range of benefits provided by SuDS can be achieved in some part on all developments, for example it is still possible to achieve attenuation, amenity value, enhanced biodiversity and increased storage in poor infiltrating soils.

[51] Further guidance and information is provided in the document 'Use of SuDS in High Density Developments', HR Wallingford Report SR 640.

Table showing suitable SuDS features under varying infiltration rates with recommended locations

	Infiltration Rate of Soils		Recommended Locations		
	Low	High	Private Space	Public Space	Highway Space
Soakaway		√	√	√	√
Green/brown roofs	√	√	√		
Filter drain	√	√	√	√	√
Swale	√	√	√	√	√
Wet swale	√	√	√	√	√
Permeable paving	√	√	√	√	
Permeable paving with underground geo-cellular storage	√	√	√	√	
Infiltration basin		√		√	
Detention basin	√			√	
Rain gardens	√	√	√	√	
Pond	√	√		√	
Underground geocellular storage	√	√	√	√	√
Underground storage tank	√	√	√	√	√
Rainwater harvesting tanks	√	√	√		
Controlled flow outlet	√			√	√
Over-sized pipe network	√				√



Example 1 - Development overlying soils with high infiltration rates

Example 2 - Development overlying soils with low infiltration rates

Permeable paving with underground storage
Collecting and storing residential road runoff

Green roof
Capturing, storing and treating roof runoff

Geocellular storage
Capturing and storing highway runoff with controlled flow outlet

Wet swale
Collecting, storing and treating road runoff

Geocellular storage
Individual property level storage

Rainwater harvesting tanks
Collecting roof water

Rain gardens
Collecting, storing and treating highway runoff

Wet Swale
Individual property level swale

Permeable paving with underground storage
Collecting and storing residential road runoff

Wet swale
Collecting and conveying road and roof runoff

Rain gardens
Collecting, storing and treating highway runoff

Detention basin
Treatment of runoff from surrounding area (highway, roof, drives etc.) with outlet to public sewer system

Permeable paving area with underground cellular storage
Collecting and storing runoff from driveways and roofs

Controlled flow Outlet
Discharge to surface water sewer at a controlled rate

Over-sized pipe network
Additional storage capacity in grey infrastructure network

There's no excuse…

If planned for early, there are limited cases where SuDS are not practicable nor viable. Common misconceptions are addressed below.

Clayey soils prevent me from utilising SuDS

Ground conditions do not prevent the use of SuDS, only the choice of the system.

Although infiltration SuDS (soakaways etc.) are not suitable in clayey soils, the likes of swales, ponds and wetlands can still be implemented, with water stored at a high level.

I'm in a floodplain or Flood Zone 2/3, I can't use SuDS

As drainage systems are required to function effectively in the 1 in 100yr plus climate change event; it is not appropriate to place SuDS features which are integral to balancing flow or contribute to system storage within a designated Flood Zone 3.

SuDS which provide surplus storage to the functional system (in addition to the required 1 in 100yr plus climate change storage), sole purpose is for improvements in water quality or is being used for additional amenity value only are appropriate to locate within a designated flood zone.

I can't fit SuDS within my development

SuDS should be considered in all developments at an early stage. This allows for allocation of appropriate land take to accommodate adequate SuDS features that are technically appropriate for the environment in which they are to be placed.

High density developments are prime candidates for permeable paving, green roofs, rainwater storage and harvesting and swales. The importance of multi-functional spaces becomes more prevalent in high density developments as allocated park space (if considered early) can integrate SuDS elements.

Green/living roofs and walls may also be utilised as a source control feature, only in association with harvested rainwater or, with special planting, grey water sources.

Groundwater contamination is an issue for my site

As already noted, ground conditions do not prevent the use of SuDS, only the choice of the system.

For example, if the site is at risk of groundwater or soil contamination the system should be lined with an impermeable geotextile liner. This impermeable geotextile liner may be removed, following receipt of evidence that demonstrates that the contaminants are not mobilised with surface water (leachability testing/hydrology modelling).

Can SuDS be located in private areas?

Yes. Some methods are appropriate (e.g. permeable driveways), but responsibility for management of the systems must be identified. Normally responsibility for SuDS serving more than one property, should rest with a management company rather than individual house owners.

SuDS techniques that are more strategic (e.g. swales serving more than one or two properties) should not be located in private gardens.

Shallow groundwater levels prevent me from utilising SuDS

SuDS should be selected and designed to be on the surface, or shallow in depth, to accommodate shallow groundwater.

Use of impermeable geotextile liners (such as a water proof membrane or compacted native clay) can be used to minimise infiltration from the surrounding groundwater.

In these instances, infiltration may be unsuitable. However, SuDS for attenuation or treatment purposes may still be integrated into the development.

My site is too flat to incorporate SuDS

Whilst it is challenging to manage surface water runoff on flat sites, the best option is to keep surface water runoff on the surface as much as possible and to manage runoff close to its source. Water can be conveyed on the surface using roadside kerbs and shallow rills and swales, and a designer should explore all alternative means of conveyance before pumping.

My site is too steep to incorporate SuDS

Steep slopes increase runoff velocity creating a challenge for SuDS. However, check dams and storage features can be used to slow runoff rates and accommodate infiltration and/or attenuation. Ponds and wetland features can also be staggered in a terraced arrangement on slopes.

How do I prevent conflicts with existing on-site infrastructure?

The design process encourages an early understanding of existing conditions, including existing drainage assets which should be considered in SuDS design to find the most cost-effective solution. Other infrastructure, such as utilities, will need to be considered in SuDS design and construction. Selection of SuDS should reflect existing constraints, for example ponds and wetlands should be avoided in major utilities corridors, as access will require disturbance and rebuilding of the SuDS system.

Early consideration of the existing conditions and constraints should allow for the design of SuDS systems to accommodate existing infrastructure.

How can I integrate SuDS with existing ecological areas?

Selection of appropriate SuDS features with suitable vegetation species can contribute to biodiversity and enhance ecology. SuDS should be designed to protect or enhance areas of interest, including designated areas for nature conservation, areas with protected species and locally important habitats, ensuring that the long-term maintenance does not harm or limit habitats.

SuDS in Minor Developments

Although legislation states that SuDS will be expected (from April 6th 2015) in all major developments, the NPPF priorities SuDS for all development in areas at risk of flooding.

Consequently developers are prompted to implement SuDS on minor developments, adopting a similar design process and utilizing similar design principles and practices as those described in this guide.

Retrofitting SuDS

New development forms only a small part of the current urban areas. If retrofit SuDS can be incorporated into existing developed areas then the opportunities for delivering sustainable solutions that offer multiple benefits will be much greater.

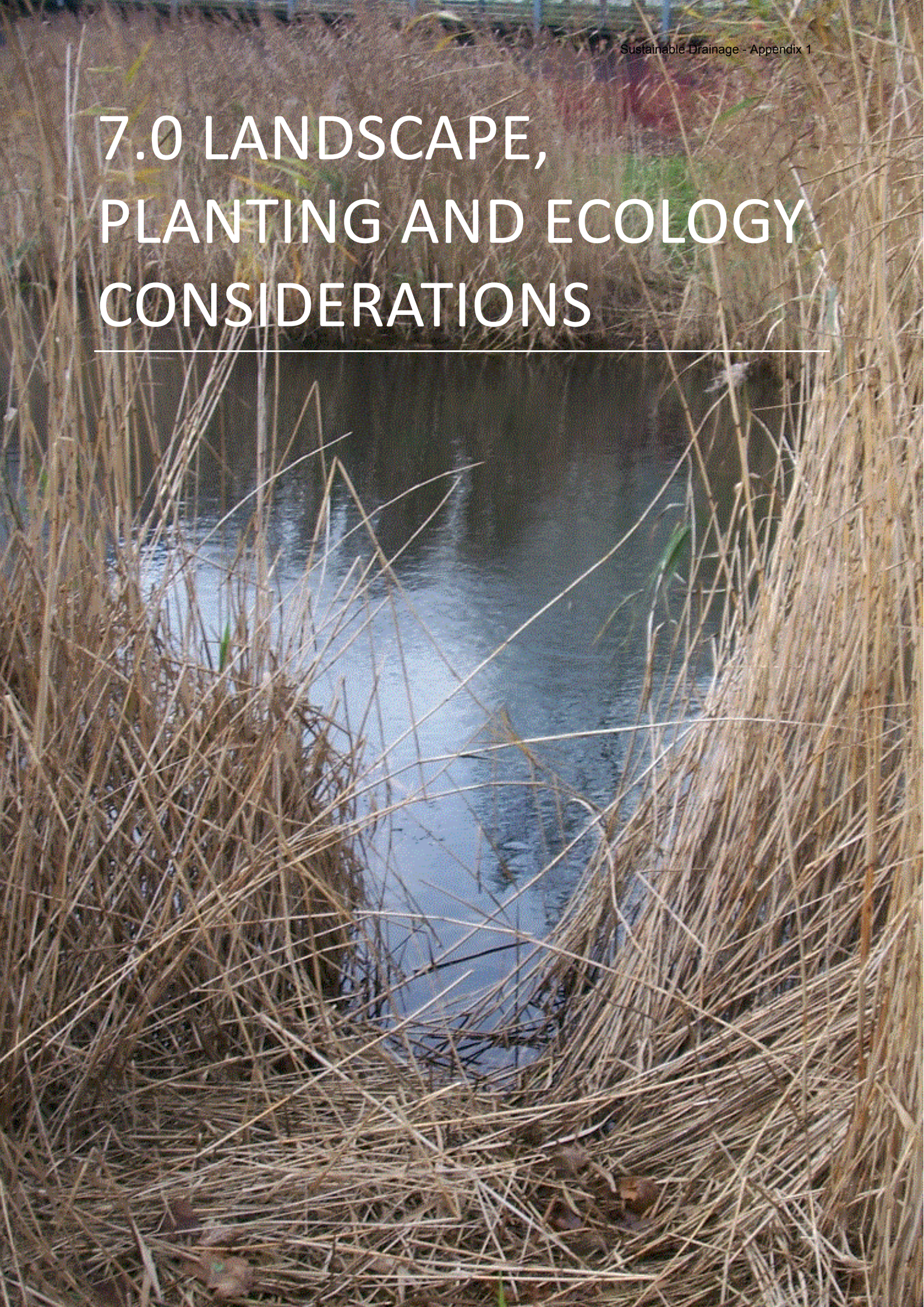
The term retrofit is employed when SuDS-type approaches are intended to replace and/or augment an existing drainage system in a developed catchment.

Retrofitting of SuDS is actively encouraged as part of redevelopment proposals of brownfield sites and promoted as a means of mitigating flood risk in existing developments and improving the amenity and biodiversity value of an area

A selection of useful guidance and best practice examples are below:

- http://www.ice.org.uk/getmedia/f5d871a3-907f-4041-ac50-25056fc8ca78/The-Challenges-and-Opportunities-with-Retrofitting-SuDS.aspx
- http://www.retrofit-suds.group.shef.ac.uk/

7.0 LANDSCAPE, PLANTING AND ECOLOGY CONSIDERATIONS



Landscape, Planting and Ecology Considerations

SuDS features have the potential to combine flood attenuation and filtration with increased biodiversity, landscape, economic, societal and health benefits. SUDs should be designed to fit the local context.

Initially it is important to understand what is desired from an engineering perspective and then to both review and understand where ecology considerations occur as either constraints to the construction of SuDS features and/or where they can benefit local biodiversity e.g. SuDS can be used to great effect to enhance the local variety of natural and semi-natural habitats present, ready for colonisation by native species. This review should be done prior to designing the SuDS feature itself and should be integrated and developed alongside both the landscaping and engineering side of the design process to ensure early identification of any issues, which then can be addressed and to ensure biodiversity opportunities can be maximised. The process should also be linked to other schemes with biodiversity opportunities within Birmingham including, but not exclusive to:

- Birmingham and Black Country Nature Improvement Area[52]
- Birmingham and the Black Country Biodiversity Action Plan[53]
- Green Infrastructure Partnership
- Nature Conservation Strategy[54]

SuDS systems vary in size from large scale filtration processes with a series of large to moderate sized ponds with interconnecting ditches to simple swales and both dry and wet systems are in existence. The majority of the biodiversity benefits come within the wet systems and are particularly valuable when they sit within an existing complex of habitats, and serve to add another valued habitat to this matrix. This should not discourage developers from designing biodiversity in SuDS schemes in small scale or more urban/formal/high-density developments, as local benefits can be achieved from all schemes if designed well.

Planting of any type – native or ornamental species – as part of a SuDS feature – will provide opportunities for wildlife (for example as sources of pollen and nectar for insects), and will add amenity value, and other benefits.

Often the more natural a system looks the more is fits within its local landscape and the more likely it is to be successful in terms of the plant and animal species that colonise it later.

Principles to increase biodiversity value include:

1. Avoid use of nutrient rich topsoil - This can help:
    - Alleviate downstream algal blooms.
    - Assist with natural colonisation by desired plant species and reduce the potential for undesired species.
    - Allow a greater number of faunal species to persist.

[52] http://www.bbcwildlife.org.uk/NIA

[53] http://www.bbcwildlife.org.uk/sites/default/files/bbcbapfinal2010.pdf

[54] http://www.birmingham.gov.uk/cs/Satellite?c=Page&childpagename=SystemAdmin%2FCFPageLayout&cid=1223092715237&packedargs=website%3D4&pagename=BCC%2FCommon%2FWrapper%2FCFWrapper&rendermode=live

2. Allow natural colonization, or if planting must occur then incorporate use of locally native species (check local flora's for advice e.g. Trueman et al. 2013. Flora of Birmingham and the Black Country. Pisces Publications and the Birmingham City Council EcoRecord[55]) - This can help:
    - Avoid the potential for invasive* species, to be inadvertently planted.
    - Ensure success of the planting which grows, it may take a little longer but will be correct for the conditions present and used to/ tolerant of the local conditions.
3. Ensure plants are from reputable nurseries, which guarantee no invasive species are inadvertently present in planting.
4. Maximise the provision for systems to hold between 500mm to 100mm, noting that the top 100mm of water supports the most lifeforms.
    - Reduce the potential for pollutant retention and build up.
    - Increase the local biodiversity interest.
5. Separate clean and dirty water systems e.g. those collecting and attenuating clean rainwater and those collecting road or car park run off (which may contain hydrocarbons). Also incorporate pollution interceptors where required as despite certain plants having cleansing properties, certain plants cannot remove all polluting material.
6. Design systems that run from dirtier to cleaner water, to reduce pollution when these connect to natural systems.
7. Where nutrient rich soils e.g. areas of amenity grassland or planting beds that are fertilised regularly are adjacent to such systems, design in buffer strips, to absorb the nutrients before they cause run off.
8. Avoid over landscaping and making everything look tidy, uneven edges and undulating topography can allow drainage features to provide for a wider variety of plants and animals.
9. Ensure drainage control features such as weirs do not present areas of entrapment for species such as amphibians or small mammals, there are several resource options to help prevent this, but the best way is to consider the potential early on in design process.
10. Provide a variety of open, lightly shaded and shaded areas to increase the diversity of habitats available.
11. Incorporate areas of dead wood into the wet areas to provide additional valuable habitat for a host of species – particularly for dragonflies and other insect species.
12. Be prepared to amend and review designs and planting at least in year 1 and 2. This will allow:
    - Identification of any inadvertent introduction of invasive species (which can be then prescribed for control or management).
    - Ability to modify edges and to identify further management prescriptions and amend the habitats to ensure the benefits are maximised for biodiversity.
    - Understand how the system is functioning in terms of the anticipated benefits.

**Invasive species in this context relate to those listed on Schedule 9 Part 2, Section 14 of the Wildlife and Countryside Act 1981 (as amended). It is illegal to cause the listed plant species to spread in the wild. A further amendment to this legislation currently prevents the sale of some of these species. The invasive plant species are listed on page 66 as plant species to be avoided in planting schemes.*

[55] http://www.ecorecord.org.uk/

Planting Species

The following species list is considered suitable for planting in a variety of SUDs (retention ponds, infiltration basins, swales and filter strips etc.) in the Birmingham area. They have been selected for their relevance to Birmingham's natural vegetation, their biodiversity benefits and their need for little regular maintenance. Plants and seeds should ideally be locally sourced or, as a minimum, UK origin and grown.

This list is not exhaustive and the exact choice should relate to site-specific design and conditions, such as soil types, microclimate, sun / shade, orientation, exposure and existing local habitats. Designs that aim to create a range of plant communities and habitats across a scheme are favourable.

Aquatics - *Submerged and floating plants. Plant with weights or weighted down in permanently wet zone*.

- *Potamogeton pectinatus* (Fennel Pondweed)
- *Potamogeton natans* (Broad-leaved Pondweed)
- *Myriophyllum spicatum* (Spiked Water-milfoil)
- *Sparganium emersum* (Unbranched Bur-reed)
- *Ceratophyllum demersum* (Hornwort)
- *Hippuris vulgaris* (Mare's-tail)
- *Potamogeton crispus* (Curled Pondweed)

Dry zone - *Plant on upper slopes and bank-top as seed*.

- *Festuca rubra* (Red Fescue)
- *Anthoxanthum odoratum* (Sweet Vernal-grass)
- *Cynosurus cristatus* (Crested Dog's-tail)
- *Briza media* (Quaking-grass) – prefers calcareous conditions
- *Deschampsia cespitosa* (Tufted Hair-grass)
- *Prunella vulgaris* (Selfheal)
- *Rhinanthus minor* (Yellow-rattle)
- *Filipendula ulmaria* (Meadowsweet)
- *Lathyrus pratensis* (Meadow Vetchling)
- *Lotus corniculatus* (Common Bird's-foot-trefoil)
- *Centaurea nigra* (Common Knapweed)
- *Plantago lanceolata* (Ribwort Plantain)
- *Potentilla anserina* (Silverweed)
- *Rumex acetosa* (Common Sorrel)
- *Knautia pratensis* (Field Scabious)
- *Leucanthemum vulgare* (Oxeye Daisy)

Damp zone - *Inundation-tolerant, plant up to 250mm above anticipated normal water level as plugs in groups of 5-10Nr plants to create stands*

- *Caltha palustris* (Marsh-marigold)
- *Veronica beccabunga* (Brooklime)
- *Angelica sylvestris* (Wild Angelica)
- *Lythrum salicaria* (Purple-loosestrife)
- *Lotus pedunculatus* (Greater Bird's-foot-trefoil)
- *Lycopus europaeus* (Gypsywort)
- *Myosotis scorpioides* (Water Forget-me-not)
- *Nasturtium officinale* agg. (Water-cress)
- *Berula erecta* (Lesser Water-parsnip)
- *Lychnis flos-cuculi* (Ragged-Robin)
- *Mentha aquatica* (Water Mint)
- *Cardamine pratensis* (Cuckooflower)
- *Ranunculus flammula* (Lesser Spearwort)
- *Juncus articulatus* (jointed Rush)
- *Stachys palustris* (Marsh Woundwort)
- *Scrophularia auriculata* (Water Figwort)

Wet zone – *Emergent vegetation, plant in 0-250mm of water, planted as plugs to create stands in groups of 5-10Nº.*

- *Potamogeton pectinatus* (Fennel Pondweed)
- *Potamogeton natans* (Broad-leaved Pondweed)
- *Myriophyllum spicatum* (Spiked Water-milfoil)
- *Sparganium emersum* (Unbranched Bur-reed)
- *Ceratophyllum demersum* (Hornwort)
- *Hippuris vulgaris* (Mare's-tail)
- *Potamogeton crispus* (Curled Pondweed)

The following plants are deemed to be unsuitable for SuDS or are classified as invasive species (*) and should not be used.

Unsuitable or invasive species – *To be avoided in all developments*

- *Phragmites australis* (Common Reed) – NB - This is suitable for large-scale schemes or designated filtration beds
- *Typha latifolia* (Bulrush / Greater Reedmace)
- *Carex pendula* (Pendulous Sedge)
- *Persicaria amphibia* (Amphibious Bistort)
- *Apium nodiflorum* (Fool's-water-cress)
- *Sparganium erectum* (Branched Bur-reed)
- *Glyceria fluitans* (Floating Sweet-grass)
- *Glyceria maxima* (Reed Sweet-grass)
- *Phalaris arundinacea* (Reed Canary-grass)
- *Impatiens glandulifera* (Himalayan Balsam)*
- *Azola filiculoides* (Water Fern)*
- *Crassula helmsii* (New Zealand Pigmyweed / Australian Swamp Stonecrop)*
- *Myriophyllum aquaticum* (Parrot's-feather)*
- *Hydrocotyle ranunculoides* (Floating Pennywort)*
- *Ludwigia peploides* (Creeping Water Primrose)*
- *Lysichiton americanus* (American Skunk-cabbage)
- *Lagarosiphon major* (Curly Waterweed)*
- *Mimulus guttatus* (Monkeyflower)
- *Elodea canadensis* (Canadian Waterweed)*
- *Elodea nuttallii* (Nuttall's Waterweed)*

It should be noted that SuDS that incorporate planting should be included in all planting condition proposals and shown on all planting plans.

Where drainage features require easements and/or specific layout arrangements these should be illustrated on planting plans in a similar war to visibility splays.

Where there are drainage features require restrictions on planting, selection of appropriate plant species is encouraged.

To ensure successful implementation of SuDS, landscape masterplans incorporating SuDS features will be required.

8.0 OPERATION & MAINTENANCE

Operation and Maintenance

A major consideration when designing and implementing SuDS is to ensure that the solutions proposed can be maintained easily over the lifetime of the development, and that maintenance considerations and costs are planned for upfront.

PPG[56] states *'When planning a sustainable drainage system, developers need to ensure their design takes account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any personnel, vehicle or machinery access required to undertake this work.'*

Ease of maintenance will impact the adoption process and will affect the determination of planning applications.

In considering planning applications, the LPA must ensure through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

Operation and Maintenance Plan

An **operation and maintenance plan** is required to be developed and submitted with all proposed developments at all levels of application.

In making every effort to simplify and provide support to the user of this guide, Birmingham City Council has provided an 'Operation & Maintenance Pro-forma' to support the user in development of an Operation & Maintenance Plan. This document can be found in Appendix D.

Full Planning Applications

An operation and maintenance plan for a full planning applicaiton should include:

- Details of the party responsible for maintenance of each feature.
- A specification for inspection and maintenance actions, including frequency of maintenance tasks required for each proposed SuDS, setting out a minimum standard to which the SuDS system must be maintained.
- Details of additional cleansing, repair and maintenance following flooding events where SuDS features are located in a designated flood zone.
- Proposed arrangements for adoption/ownership to secure the operation of the scheme throughout its lifetime.
- Where SuDS features are attached to private property, confirmation of any associated maintenance/adoption/ ownership requirements should be provided. For example, if SuDS features are to be included in property deeds, or if householders are required to pay into a communal fund to fund ongoing maintenance.
- Details of proposed contingency plans for failure of any part of the drainage system that could present a hazard to people.

Outline Planning Applications

An outline planning application should include as much detail as possible covering the points highlighted for full applications. However, should at minimum, outline an understanding of inspection and maintenance tasks that would be required.

56 http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

It should provide information regards potential party responsibilities for SuDS maintenance, adoptuion and ownership, but these do not need to be have been confirmed at this stage.

It is also unlikely that a specification for inspection and maintenance would be available at this stage.

Pre-Application Engagement

There is no mandatory pre-application process however, if it is anticipated that maintenance issues may be a significant hindrance to a proposed SuDS solution advice can and should be sought early.

Maintenance Options, Risks and Safeguards

There are many options that will allow the successful operation and maintenance of a SuDS feature for the lifetime of the development.

With each maintenance option there may be associated risks for the onsite and surrounding land and property owners; LPA, LHA and LLFA should the chosen maintenance option become compromised.

Birmingham City Council encourage developers to determine the most appropriate maintenance option reflective of the site-specific SuDS features.

For example, if the SuDS solution consists of an attenuation tank and flow control valve connecting into the existing offsite drainage infrastructure, then the most appropriate maintenance body may be the relevant sewerage undertaker responsible for the offsite system.

In an effort to mitigate the associated risks with some maintenance options the LPA may require a number safeguards to be implemented. For example, where SuDS systems are provided within private property, the LPA may require that the SuDS system be incorporated into the property deeds.

Safety and Access

Consideration should always be given to safety in design and appropriate consideration of access during the design of SuDS.

CDM Regulations 2015 must also be considered and applied to the planning, design and construction and long term maintenance of SuDS systems.

9.0 ADOPTION PROCESS

Adoption Process

As of April 6th 2015, planning applications must ensure that there are clear arrangements in place for ongoing maintenance over the *'lifetime of the development.*[57]*'*

Birmingham City Council defines the lifetime of a development as 100 years (supported by the NPPF definition[58]*), or until the development is redeveloped or significantly re-engineered so as to alter the surface water discharge regime*

Birmingham City Council believe that the adoption of SuDS is critical to the successful implementation of these features, therefore it is critical that the most appropriate party adopt the feature.

Adoption Parties

It is the responsibility of the developer to ensure that SuDS are maintained for the lifetime of the development, and in doing so the developer may wish to seek to have these features adopted. Potential adopting parties include, but are not exclusive to:

- Private management companies and trusts;
- Severn Trent Water;[59]
- Birmingham City Council; and,
- Future land owners.

Due to the potential use of traditional SuDS features and bespoke site-specific SuDS features, it is critical that an agreement be reached between the developer and the adopting party to ensure the management of SuDS for the lifetime of the development.

Birmingham City Council recommend that the developer consider the following when selecting an appropriate adoption party:

- Siting and selection of the SuDS features
- Benefitting parties of the SuDS features
- Operation & maintenance requirements
- Available access points
- Land ownership

In the instance where the adopting party's ability to continue operation & maintenance of the SuDS feature(s) is compromised, and the operation & maintenance routine is no longer active, Birmingham City Council may revert to those parties benefitting from the feature for all ongoing & future operation and maintenance requirements.

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[57] http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/

[58] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/the-exception-test/what-is-considered-to-be-the-lifetime-of-development-in-terms-of-flood-risk-and-coastal-change/

[59] STW are not in a position to adopt all SuDS features at this time, currently STW will adopt underground tanks with flow control features only.

Potential Adoption Options with Birmingham City Council

The council acknowledge that this presents a unique challenge and wish to offer guidance on a number of potential options and scenarios that may ensure SuDS are adopted and managed effectively for the lifetime of the development.

With respect to some typical locations for SuDS, the following options may be available with Birmingham City Council undertaking the role of the adopting party. All adoption agreements will be considered on a site-specific basis and the LPA may place some safeguards to ensure the success of the SuDS feature.

Inclusion of SuDS in public open space

- Commuted sum for an appropriate number of years respective to the SuDS feature, and acceptable to BCC
- Advance payment scheme; Bond/cost equivalent
- Management agreement between the developer, the Council and the adopting party

Inclusion of SuDS in privately owned space

- BCC are not willing to adopt SuDS features located in this location and encourage the developer to seek an alternative adoption party, for example a management agreement between developer and future land owner or between developer and named maintenance company

Inclusion of SuDS in new, adoptable highway

- Commuted sum for an appropriate number of years respective to the SuDS feature, and acceptable to BCC
- Management agreement between the developer, the Council and the adopting party

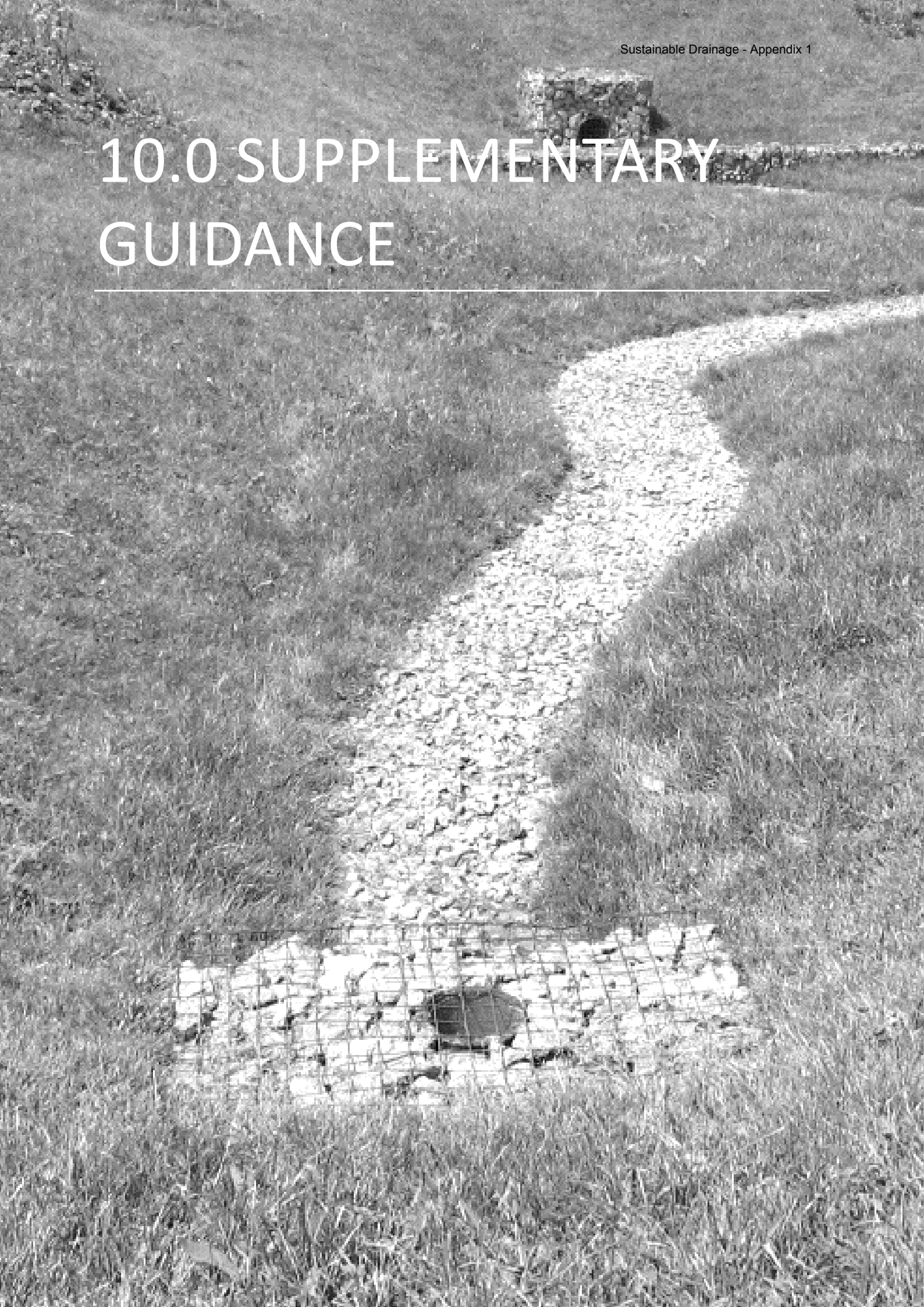
Inclusion of SuDS within new private highway

- Advance payment scheme; Bond/cost equivalent
- Management agreement between developer and named maintenance company

Inclusion of SuDS through changes to the existing highway

- Commuted sum for an appropriate number of years respective to the SuDS feature, and acceptable to BCC
- Management agreement between the developer, the Council and the adopting party

10.0 SUPPLEMENTARY GUIDANCE



Supplementary Guidance

A number of guidance documents have already been released by a large number of organisations. Existing guidance (as appropriate) should be referenced and utilised where necessary and this guide should not be used as a replacement for more in depth knowledge showcased by others.

A non-exhaustive list of current (at time of publication) and relevant guidance is detailed below:

- CIRIA The SuDS Manual. C697.
- CIRIA Site handbook for constructing SuDS. C698.
- CIRIA Structural design of modular geocellular drainage tanks. C680.
- CIRIA Source control using constructed pervious surfaces. C582
- CIRIA Rainwater and greywater reuse in buildings: best practice guidance.C539.
- CIRIA Designing for exceedance in urban drainage – good practice. C635.
- CIRIA Building greener. Guidance on the use of green roofs, green walls and complementary features on buildings. C644.
- DEFRA WT1505, WSP Final Surface Water Drainage Report (2013)
- British Standard BS 7533-13: 2009. Pavements constructed with clay, natural stone or concrete pavers – Part 13: Guide for the design of permeable pavements constructed with concrete paving blocks and fl ags, natural stone slabs and setts and clay pavers.
- Interpave - Guide to the Design, Construction and Maintenance of Concrete BlockPermeable Pavements
- Interpave - Understanding Permeable Paving
- Environment Agency Green roof tool kit.
- Kellagher RBB and Lauchlin CS Use of SuDS in high density developments, defining hydraulic performance criteria. HR Wallingford Report SR 640.
- Kellagher RBB and Lauchlin CS Use of SuDS in high density developments, guidance manual. HR Wallingford Report SR 666.
- The Water Performance Directive 2000/60/EC.
- National Planning Policy Framework and December 2014 Written Ministerial Statement
- Planning Practice Guidance and related Technical Standards for Sustainable Drainage
- Building Regulations Part H, Drainage and Waste Disposal.
- Biodiversity Action Plans.
- Environment Agency Pollution Prevention Guideline PPG 3.
- Environment Agency Drainage Details.
- Highway Agency Drainage and Construction Details.
- BRE 365 Soakaway design guide
- www.susdrain.org

All features designed within Birmingham City Council jurisdiction should be in accordance with The SuDS Manual (CIRIA, C697).

Glossary

Term	Meaning / Definition
Aquifer	A source of groundwater compromising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Brownfield site	Any land or site that has been previously developed[60].
Catchment	An area of land that contributes flow to a particular point.
Climate change	Long-term variations in global temperature and weather patterns both natural and as a result of human activity (anthropogenic) such as greenhouse gas emissions
Combined sewer	A combined sewer system is a sewer that accepts storm water, sanitary water/sewage, and industrial waste water.
Culvert	A structure which fully contains a watercourse as it passes through an embankment or below ground.
Department for Environment, Food and Rural Affairs	Department for Environment, Food and Rural Affairs.
Development	The undertaking of building, engineering, mining or other operations in, on, over or under land or the making of any material change in the use of any buildings or other land.
Development plan	As set out in Section 38(6) of the Planning and Compulsory Purchase Act (2004), an authority's development plan consists of the relevant regional spatial strategy (or the spatial development strategy in London) and the development plan documents contained within its local development framework.
Discharge	Rate of flow of water.
Environment Agency	Government Agency responsible for flooding issues from main river, and strategic overview of flooding.
Flood event	A flooding incident usually in response to severe weather or a combination of flood generating characteristics.
Flood risk	The combination of the flood probability and the magnitude of the potential consequences of the flood event.
Flood Risk Assessment	An appraisal of the flood risks that may affect development or increase flood risk elsewhere.
Flood Zones	Flood Zones provide a general indication of flood risk, mainly used for spatial planning.
Floodplain	An area of land that would naturally flood from a watercourse, an estuary or the sea.
Flood and Water Management Act	The Flood and Water Management Act clarifies the legislative framework for managing surface water flood risk in England.
Floodwater	Excess runoff that cannot be stored or conveyed safely.
Fluvial flooding	Flooding caused by a river.
Freeboard	A vertical distance that allows for a margin of safety to account for uncertainties.
Geocellular storage systems	Modular plastic systems with a high void ratio, typically placed below ground which allow for storage of storm water to infiltrate or discharge to another system.

[60] http://planningguidance.planningportal.gov.uk/blog/policy/achieving-sustainable-development/annex-2-glossary/

Geotextiles	Permeable fabrics used in association with soil that have the ability to separate, filter, reinforce, protect, or drain.
Greenfield	Undeveloped land.
Greenfield runoff rate	The rate of runoff which would occur from a site that was undeveloped and undisturbed.
Groundwater	Water that exists beneath the ground in underground aquifers and streams.
Groundwater flooding	Flooding caused by groundwater rising and escaping due to sustained periods of higher than average rainfall (years) or a reduction in abstraction for water supply.
Highway Authority	A local authority responsible for the maintenance and drainage of highways maintainable at public expense.
Local Authority	An administrative unit of local government
Local Flood Risk Management Strategy	Strategy outlining the Local Authorities approach to local flood risk management as well as recording how this approach has been developed and agreed.
Local Planning Authority	Body responsible for planning and controlling development, through the planning system.
Main River	A watercourse designated on a statutory map of Main rivers, maintained by Department for Environment, Food and Rural Affairs (Defra).
Mitigation measure	A generic term used in this guide to refer to an element of development design which may be used to manage flood risk to the development, or to avoid an increase in flood risk elsewhere.
Model	A representation of the environment. This is often undertaken using a computer software package that performs hydraulic calculations, but can also be undertaken by constructing a physical representation of an environment.
National Planning Policy Framework	Framework setting out the Government's planning policies for England and how these are expected to be applied. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.
Overland Flow	Flooding caused by surface water runoff when rainfall intensity exceeds the infiltration capacity of the ground, or when the soil is so saturated that it cannot accept any more water.
Pitt Review	An independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Redevelopment	The construction of new development on land which is, or has been, developed (brownfield).
Runoff	Overland flow as well as rainfall that flows over an impermeable surface
Source Protection Zone	Defined areas showing the risk of contamination to selected groundwater sources used for public drinking water supply.
Strategic Flood Risk Assessment	A study to examine flood risk issues on a sub-regional scale, typically for a river catchment or local authority area during the preparation of a development plan.
Surface water flooding	Flooding caused by the combination of pluvial flooding, sewer flooding, flooding from open channels and culverted urban watercourses and overland flows from groundwater springs.
Surface Water Management Plan	A study undertaken in consultation with key local partners to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term.
Sustainable Drainage Systems	A sequence of management practices and control structures that are designed to drain surface water in a more sustainable manner.
Watercourse	Any natural or artificial channel that conveys surface water.
Water table	The level below which the ground is saturated with water.

APPENDIX A: Non-Statutory Technical Standards

No.	Sustainable Drainage Systems Non-Statutory Technical Standards for Sustainable Drainage Systems (Published by Defra March 2015)	Birmingham City Council requirements
FLOOD RISK OUTSIDE THE DEVELOPMENT		
S1	Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or a large estuary) the peak flow control standards (S2 and S3 below) and volume control technical standards (S4 and S6 below) need not apply.	This condition will not be applicable to the surface water bodies in Birmingham.
PEAK FLOW CONTROL		
S2	For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.	As stated in the National Standard, until such times as the (emerging) TP6 Policy comes into effect. Under TP6, all sites requiring a site-specific FRA and/or Sustainable Drainage Assessment, surface water discharge rates shall be limited to the equivalent site-specific greenfield runoff rate for all return periods up to the 1 in 100 year plus climate change event, unless it can be demonstrated that the cost of achieving this would make the proposed development unviable.
S3	For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.	As stated in the National Standard, until such times as the (emerging) TP6 Policy comes into effect. Under TP6, all sites requiring a site-specific FRA and/or Sustainable Drainage Assessment, surface water discharge rates shall be limited to the equivalent site-specific greenfield runoff rate for all return periods up to the 1 in 100 year plus climate change event, unless it can be demonstrated that the cost of achieving this would make the proposed development unviable.
VOLUME CONTROL		
S4	Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.	As stated in the National Standard, until such times as the (emerging) TP6 Policy comes into effect. Under TP6, all sites requiring a site-specific FRA and/or Sustainable Drainage Assessment, surface water discharge rates shall be limited to the equivalent site-specific greenfield

		runoff rate for all return periods up to the 1 in 100 year plus climate change event, unless it can be demonstrated that the cost of achieving this would make the proposed development unviable.
S5	Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.	As stated in the National Standard, until such times as the (emerging) TP6 Policy comes into effect. Under TP6, all sites requiring a site-specific FRA and/or Sustainable Drainage Assessment, surface water discharge rates shall be limited to the equivalent site-specific greenfield runoff rate for all return periods up to the 1 in 100 year plus climate change event, unless it can be demonstrated that the cost of achieving this would make the proposed development unviable.
S6	Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.	As a minimum, for the range of annual flow rate probabilities up to and including the one per cent annual exceedence probability (1 in 100 years) event, including an appropriate allowance for climate change, the developed rate of run-off into a watercourse, or other receiving water body, should show a minimum of a 20% reduction in peak flows between the existing and developed scenarios. Developers are, however, strongly encouraged to further reduce runoff rates from previously-developed sites as much as is reasonably practicable.
FLOOD RISK WITHIN THE DEVELOPMENT		
S7	The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.	As National Standard.
S8	The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity	As National Standard.

S9	The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.	As National Standard.
STRUCTURAL INTEGRITY		
S10	Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.	As National Standard.
S11	The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use	As National Standard.
DESIGNING FOR MAINTENANCE CONSIDERATIONS		
S12	Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.	As National Standard.
CONSTRUCTION		
S13	The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.	As National Standard.
S14	Damage to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed.	As National Standard.

APPENDIX B: Zoning Maps

NorthField (West)

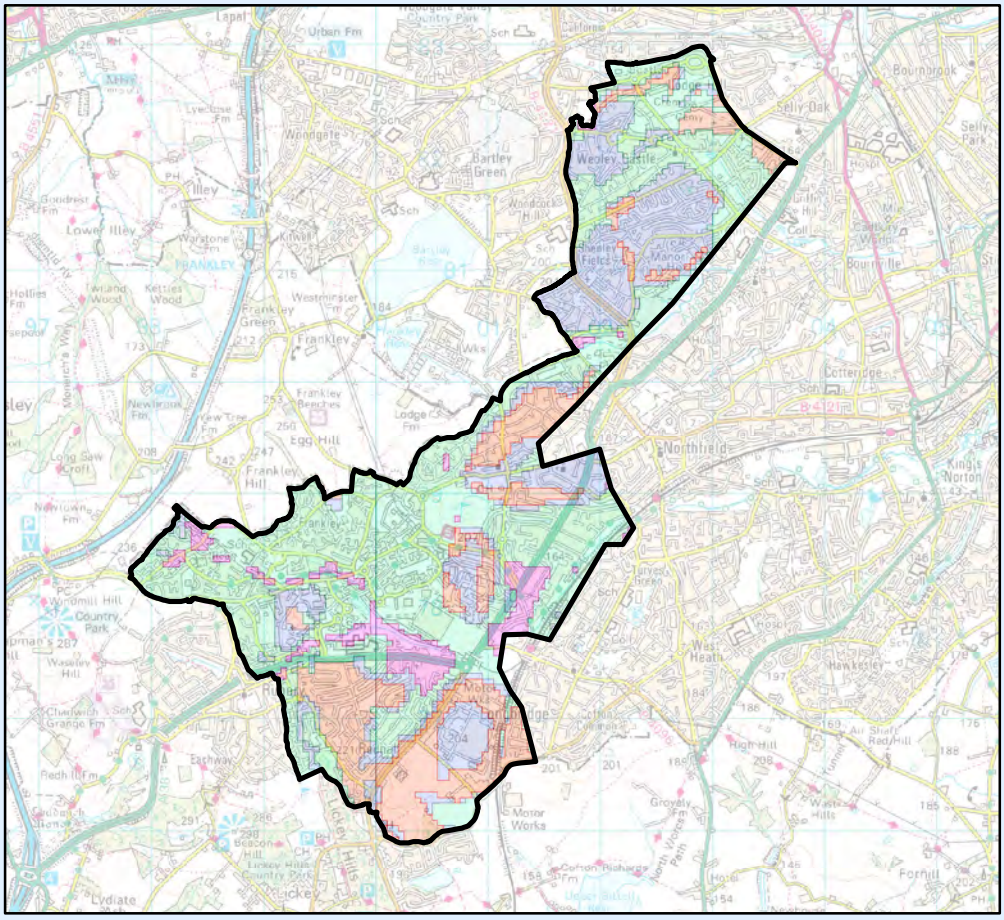
SuDS development within this area should give primary consideration to:

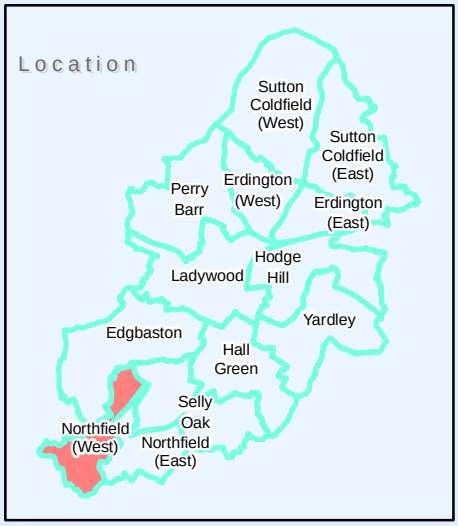
Surface Water Flood Risk

Groundwater Contamination

Groundwater Flood Risk

DRAINAGE SUMMARY

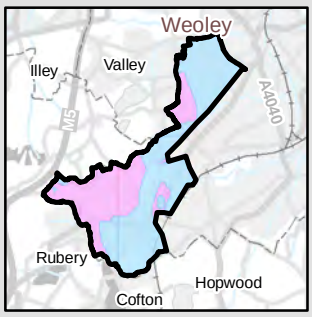




Legend

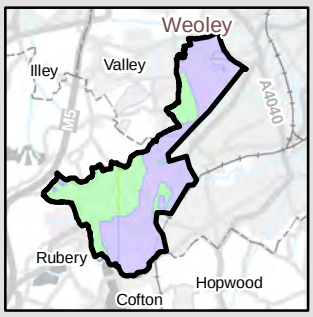
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



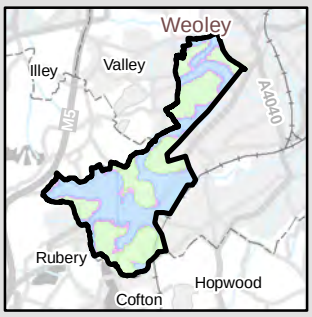
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



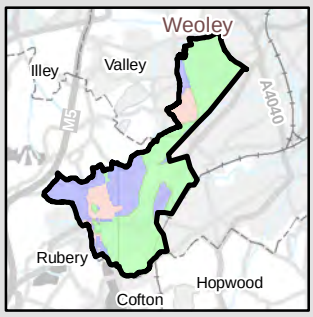
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

NorthField (East)

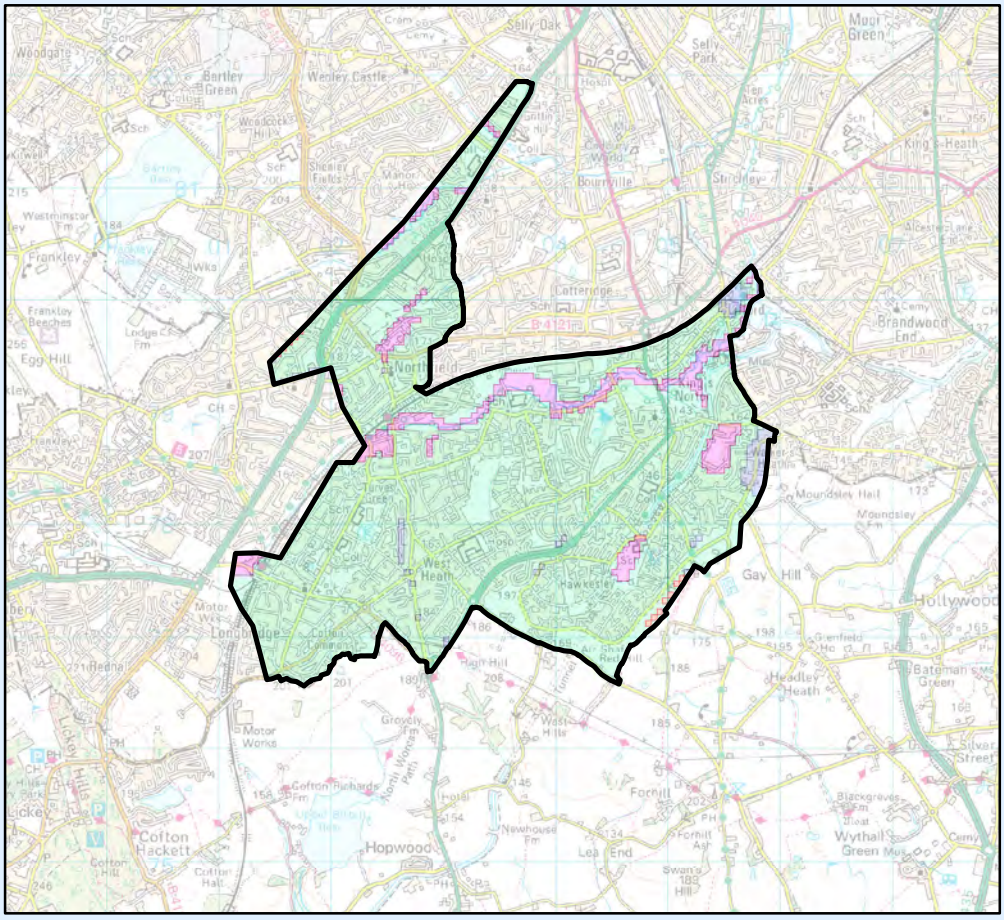
SuDS development within this area should give primary consideration to:

Surface Water Flood Risk

Groundwater Contamination

Poor Soil Permeability / Infiltration Rate

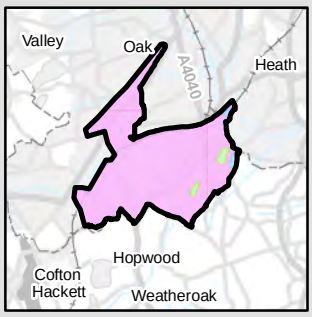
DRAINAGE SUMMARY



Legend

- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination

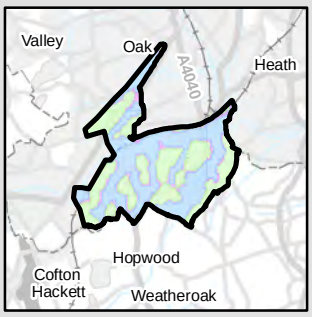


- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type

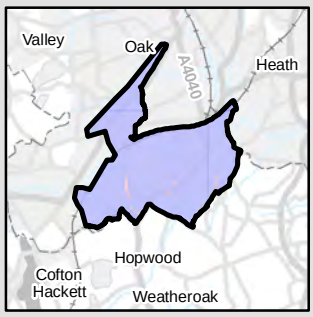
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Edgbaston

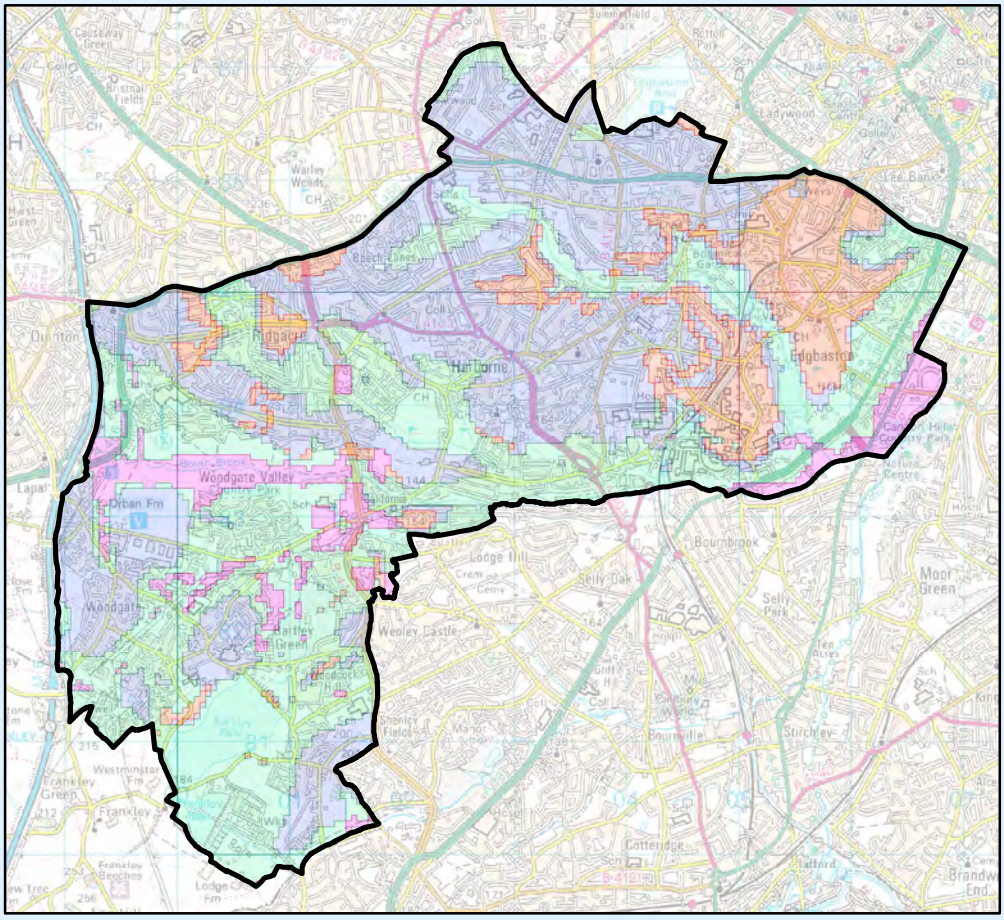
SuDS development within this area should give primary consideration to:

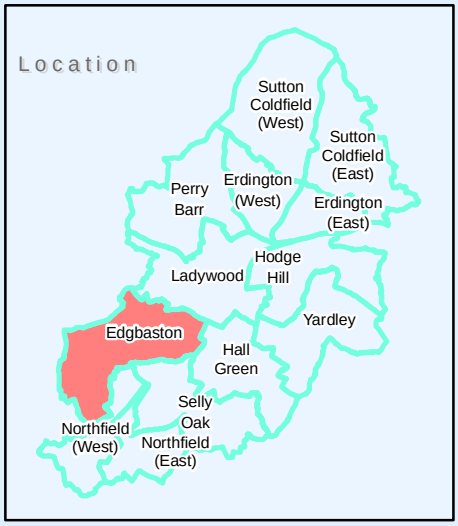
Surface Water Flood Risk

Water Quality

Depth to Water Table

DRAINAGE SUMMARY





Legend

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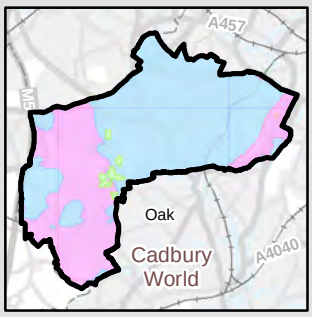
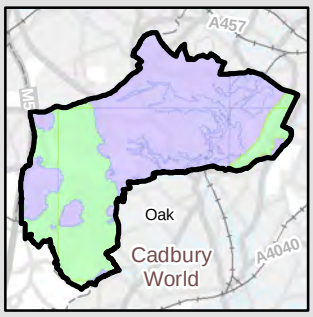
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



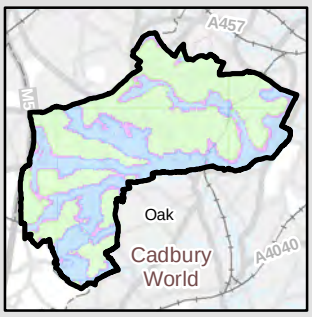
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



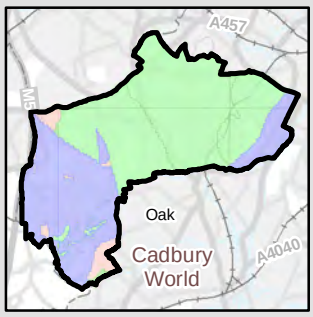
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Selly Oak

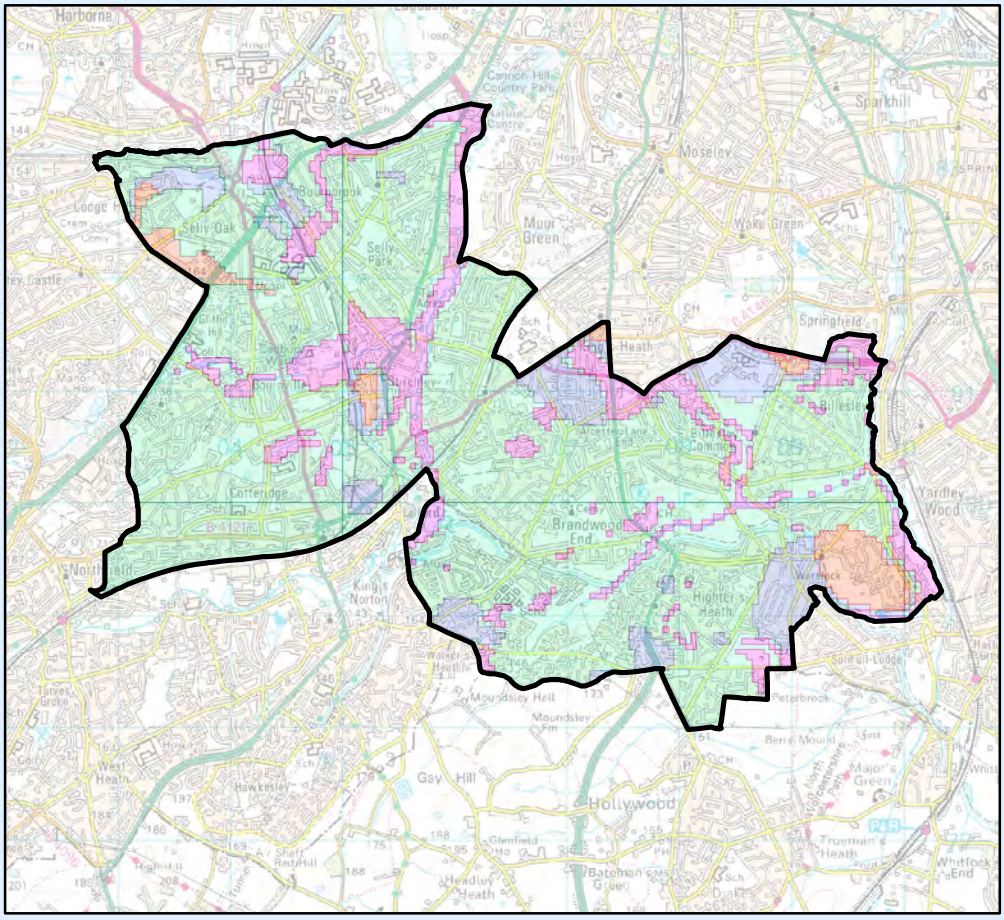
SuDS development within this area should give primary consideration to:

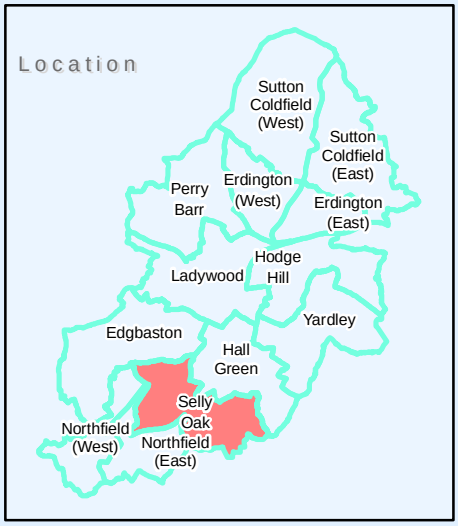
Surface Water Flood Risk

Groundwater Contamination

Poor Soil Permeability / Infiltration Rate

DRAINAGE SUMMARY

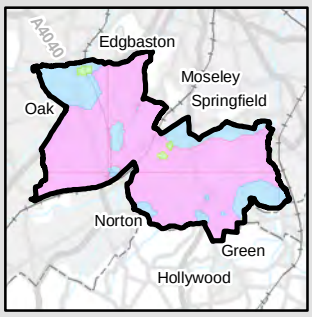




Legend

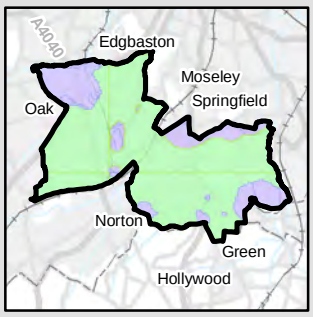
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



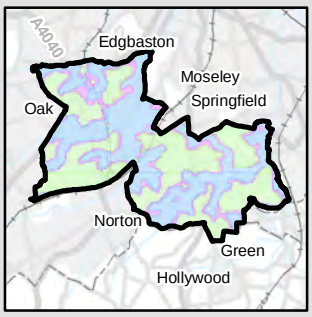
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
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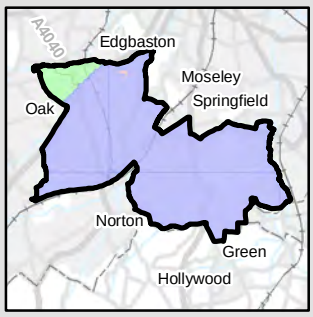
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Hall Green

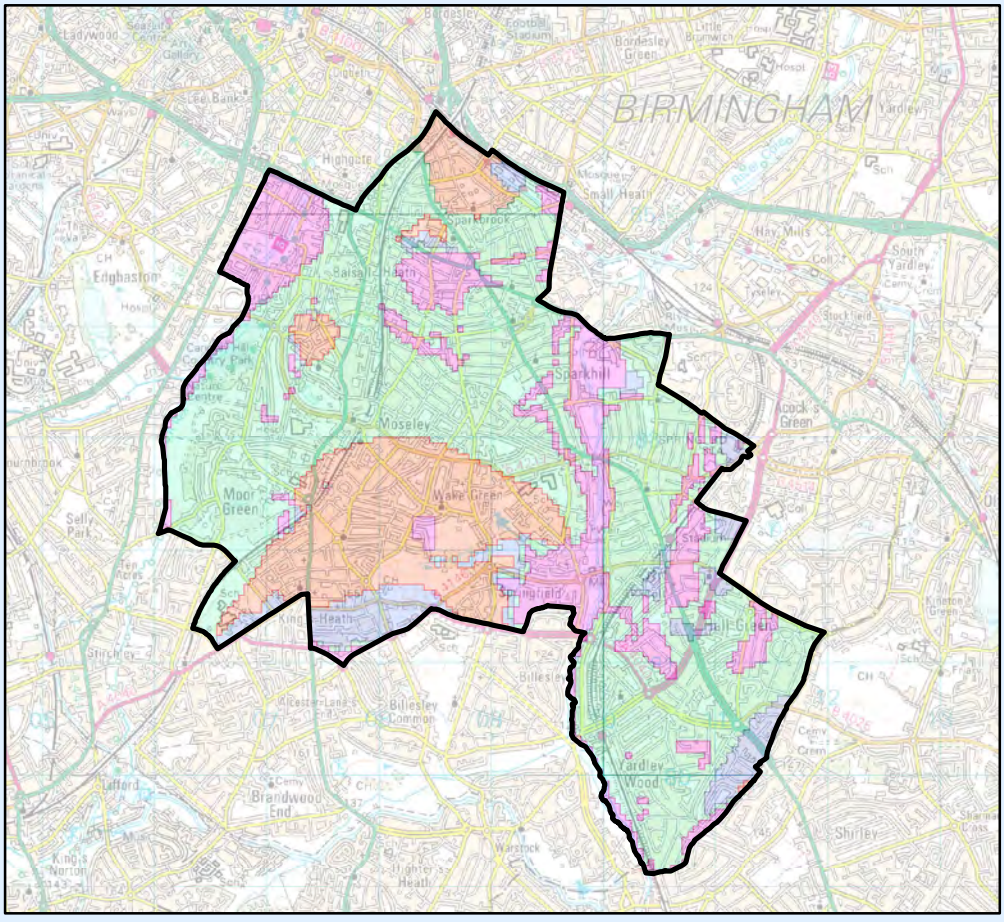
SuDS development within this area should give primary consideration to:

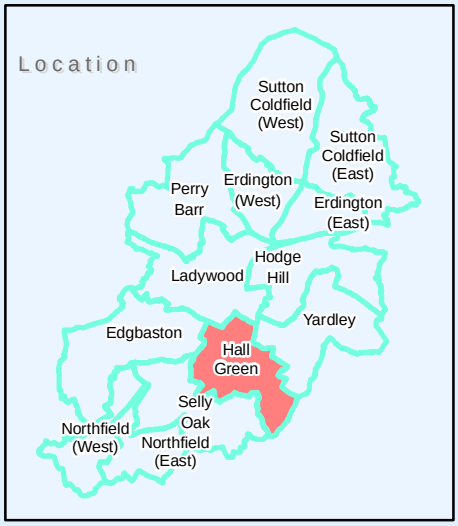
Surface Water Flood Risk

Groundwater Contamination

Poor Soil Permeability / Infiltration Rate

DRAINAGE SUMMARY

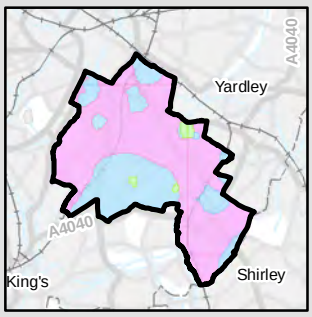




Legend

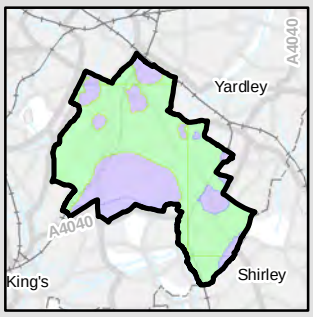
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



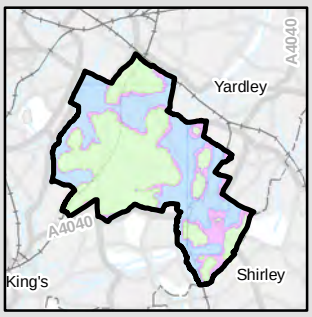
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



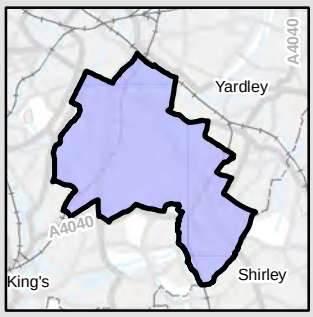
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Ladywood

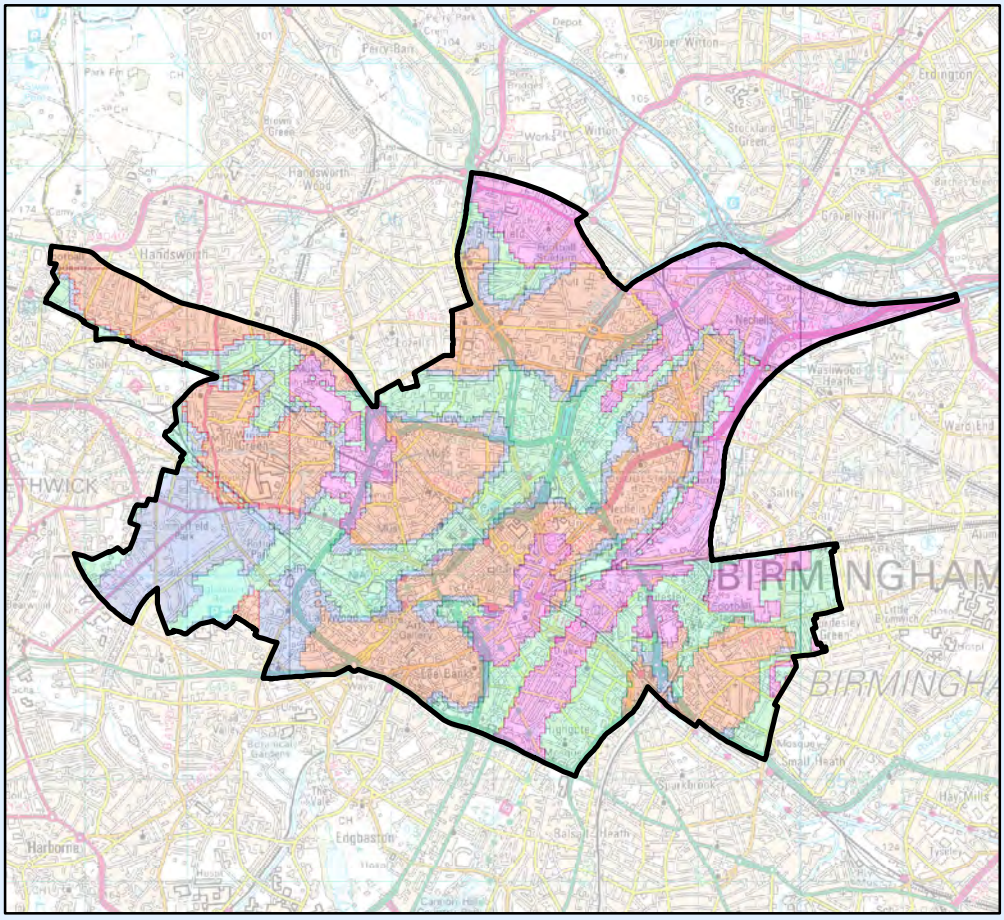
SuDS development within this area should give primary consideration to:

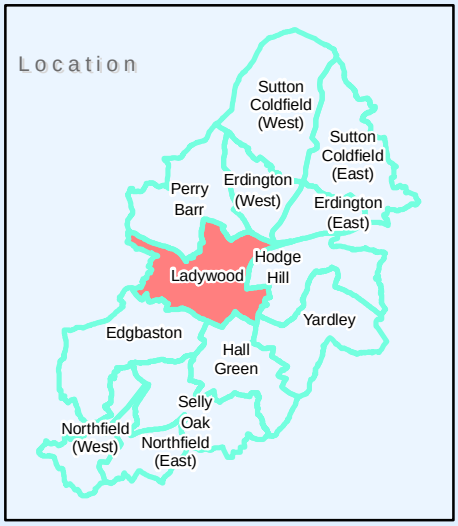
Surface Water Flood Risk

Fluvial Flood Risk

Groundwater Flood Risk

DRAINAGE SUMMARY

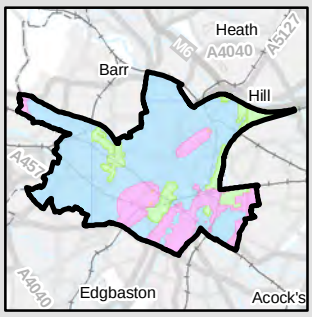




Legend

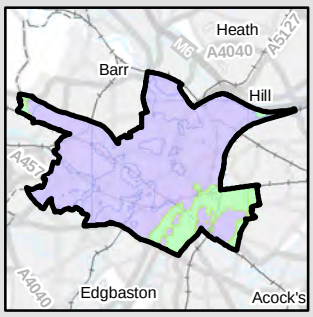
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



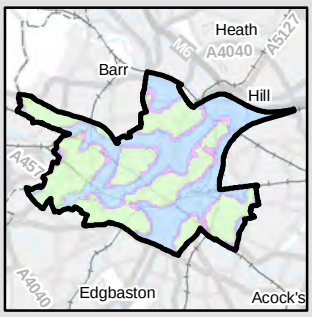
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



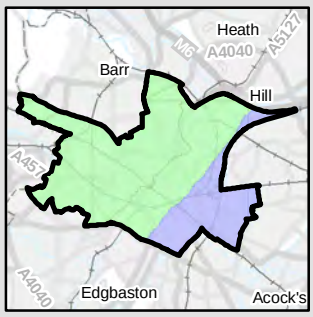
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Perry Barr

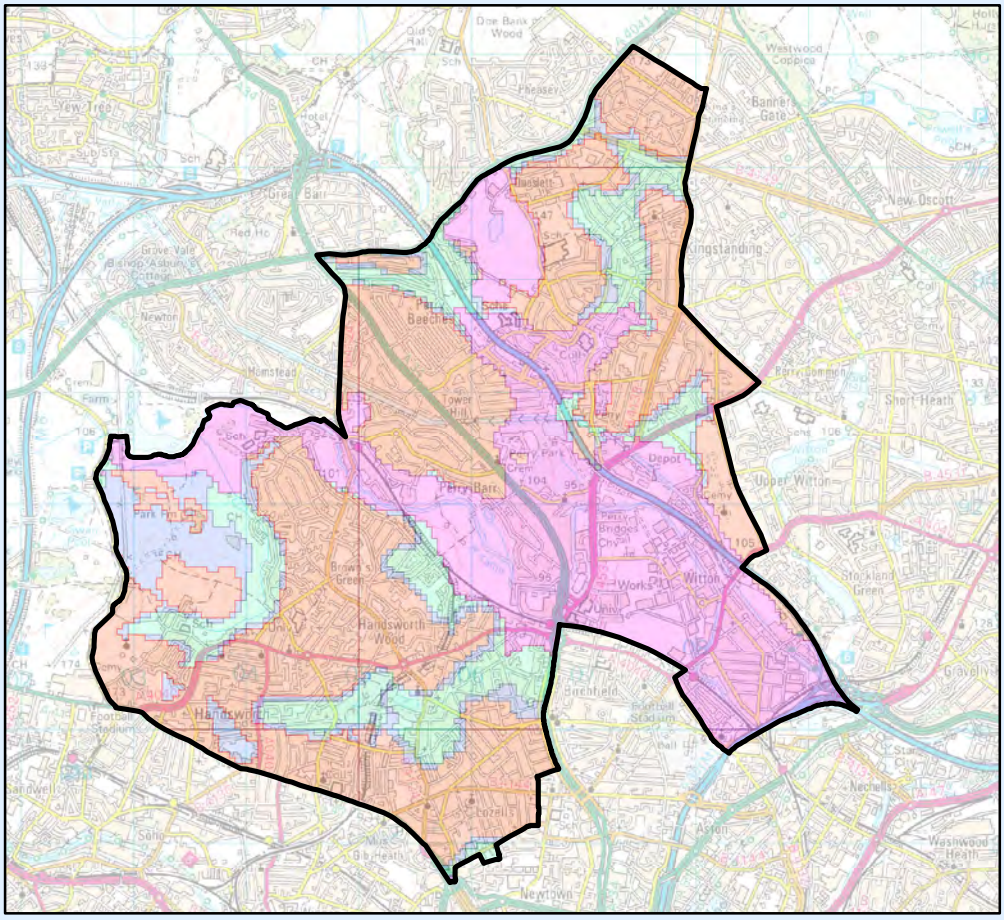
SuDS development within this area should give primary consideration to:

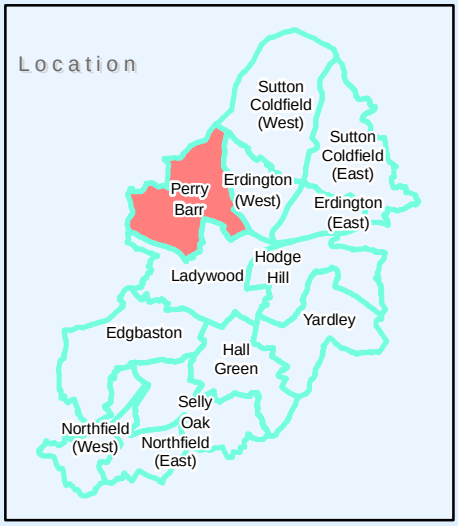
Surface Water Flood Risk

Fluvial Flood Risk

Water Quality

DRAINAGE SUMMARY

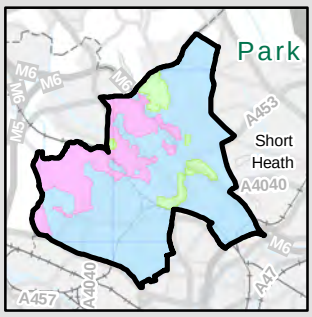




Legend

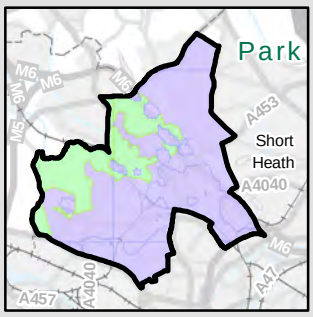
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



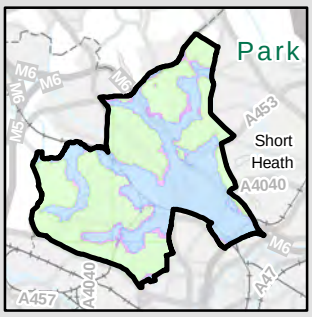
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability

- Free draining
- Highly variable permeability
- Poorly draining

Hodge Hill

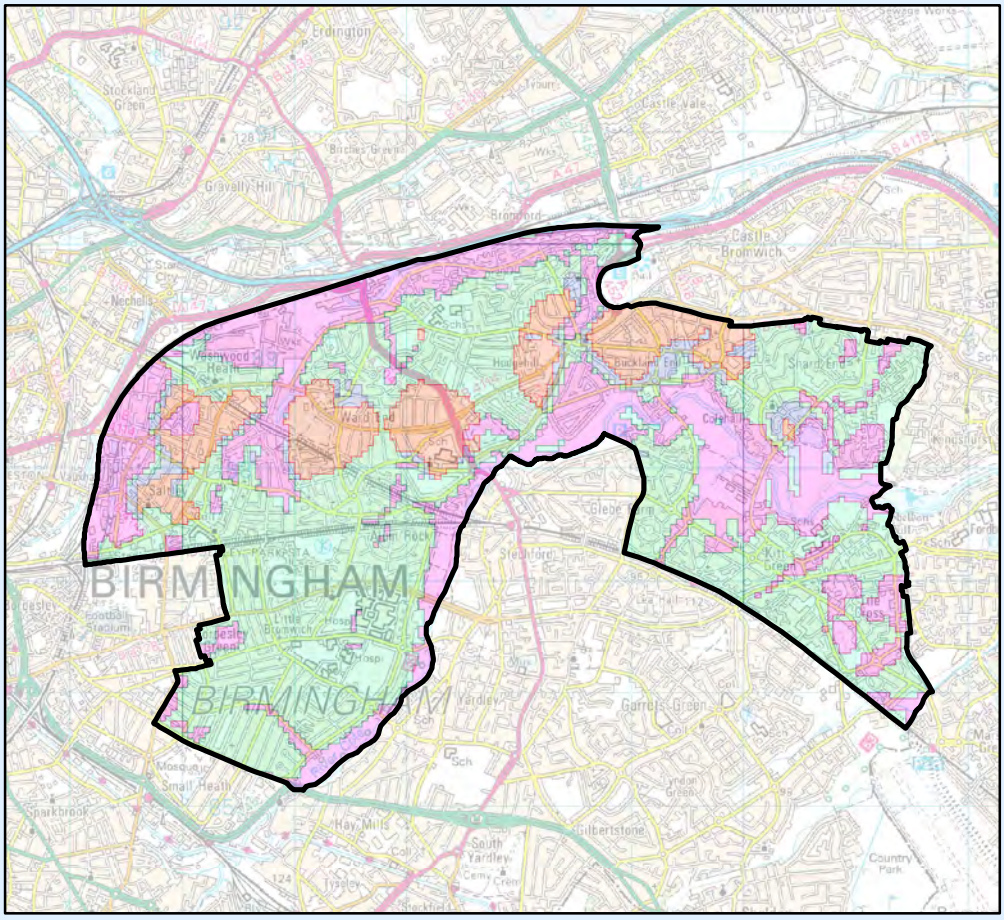
SuDS development within this area should give primary consideration to:

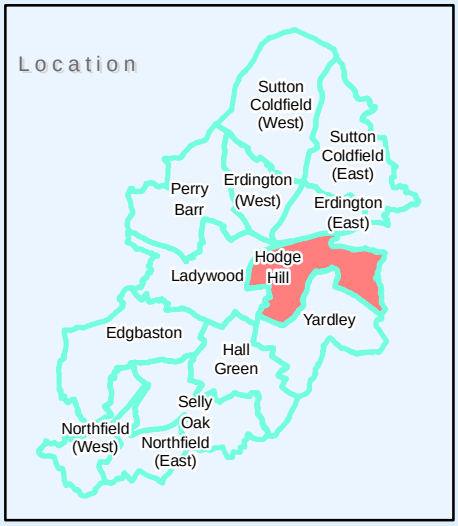
Surface Water Flood Risk

Fluvial Flood Risk

Poor Soil Permeability / Infiltration Rate

DRAINAGE SUMMARY

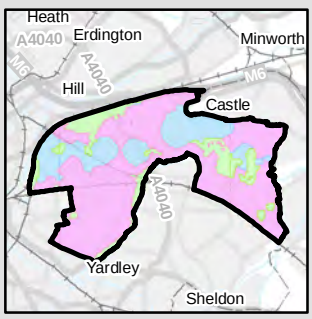




Legend

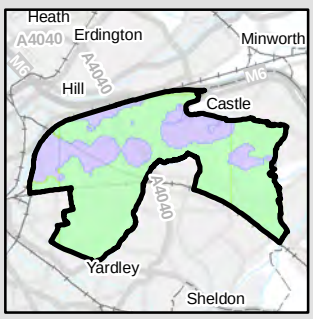
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



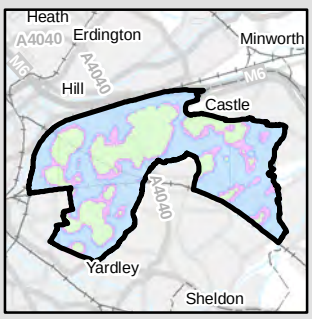
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



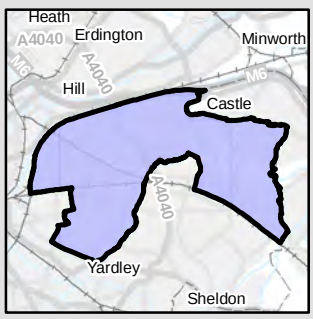
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Yardley

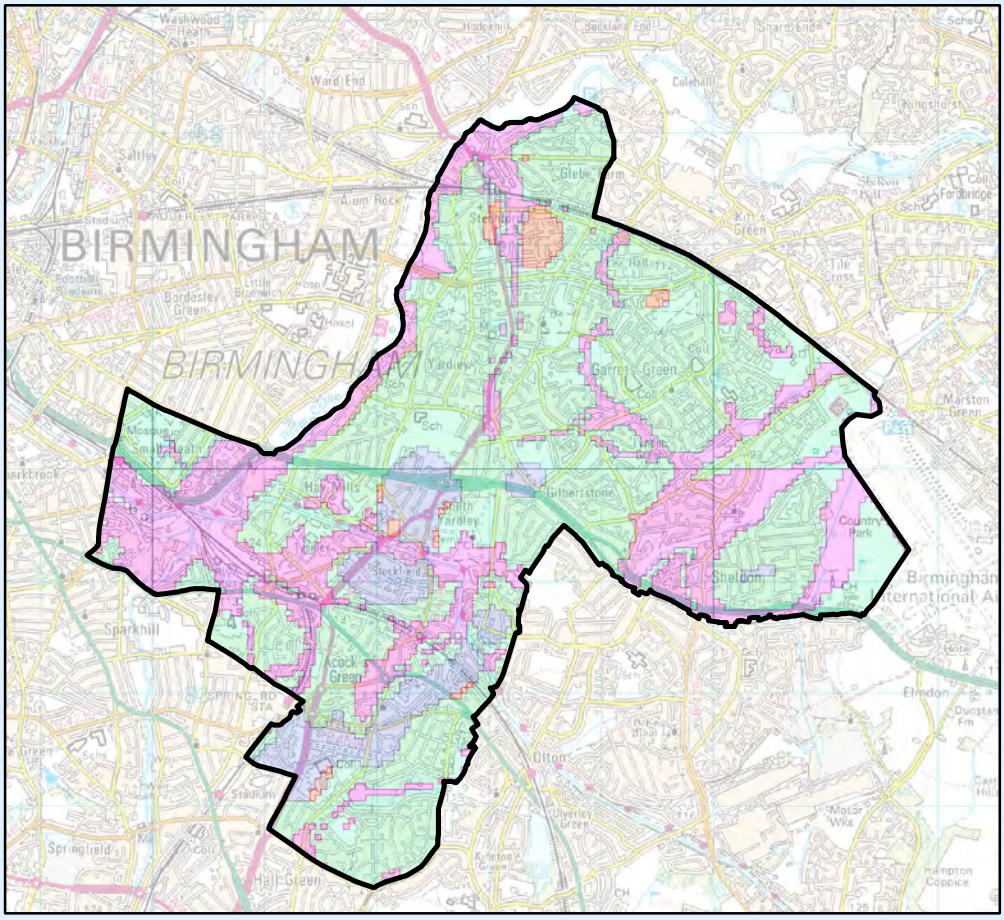
SuDS development within this area should give primary consideration to:

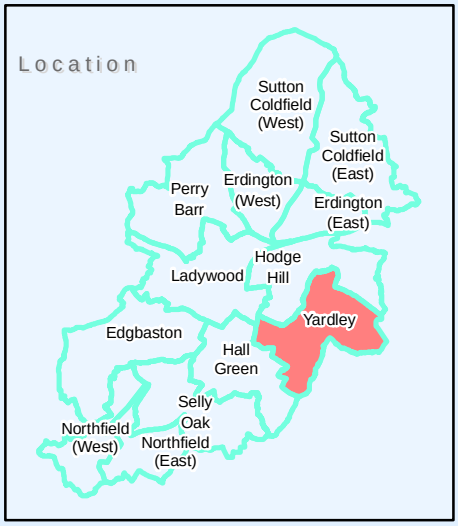
Water Quality

Groundwater Contamination

Poor Soil Permeability / Infiltration Rate

DRAINAGE SUMMARY

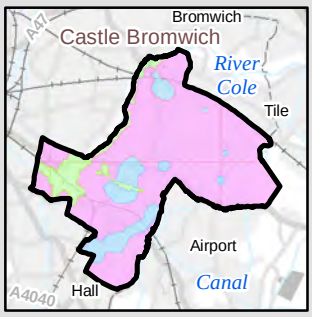




Legend

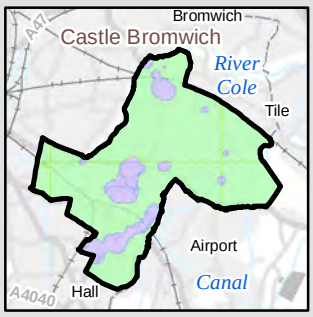
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



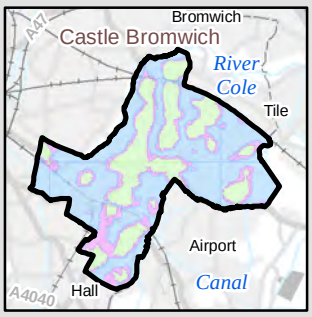
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



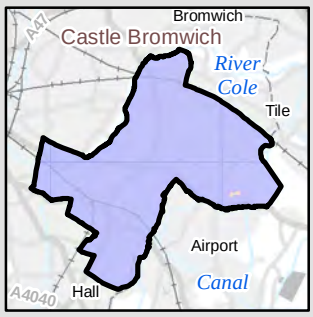
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Erdington (West)

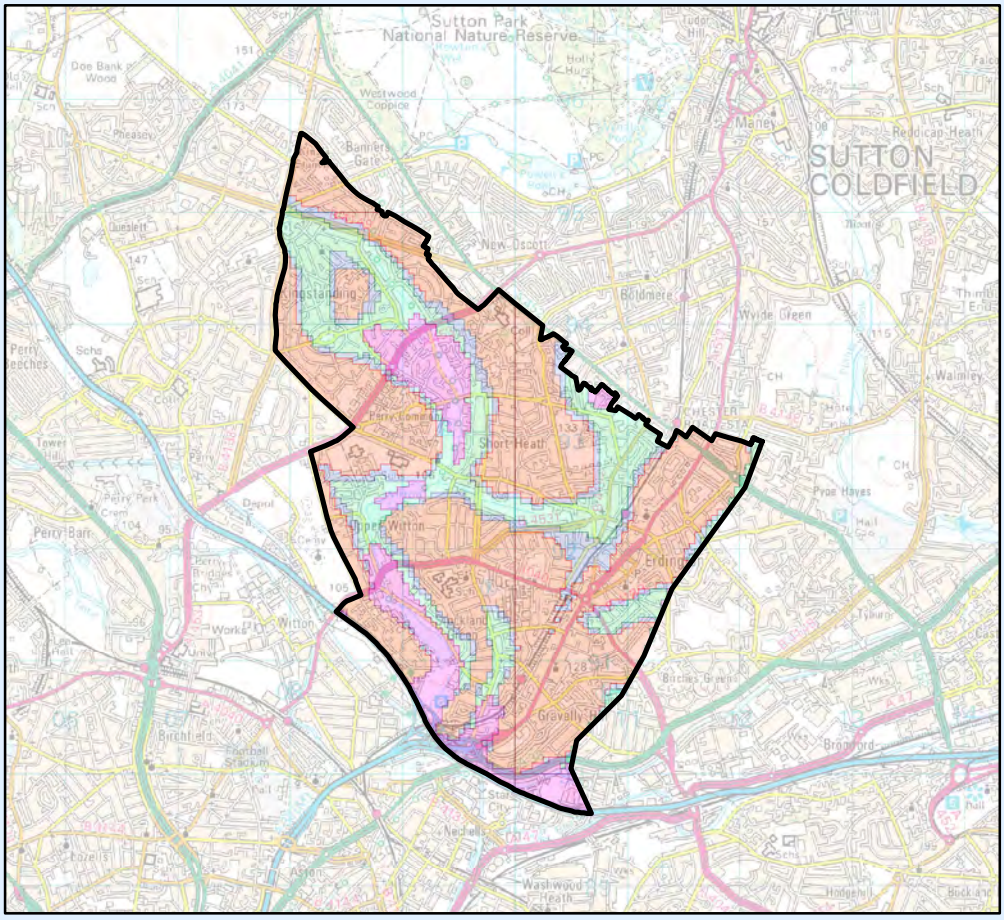
SuDS development within this area should give primary consideration to:

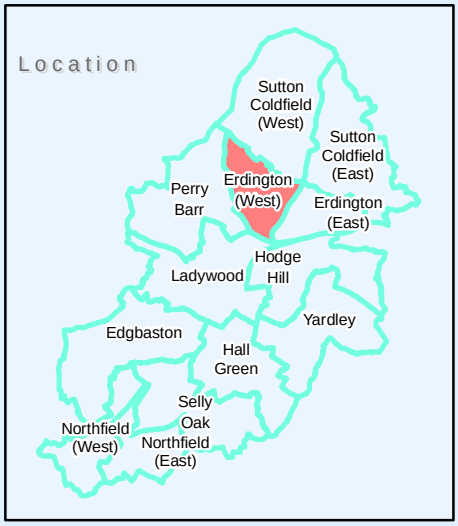
Surface Water Flood Risk

Water Quality

Limited Available Space

DRAINAGE SUMMARY





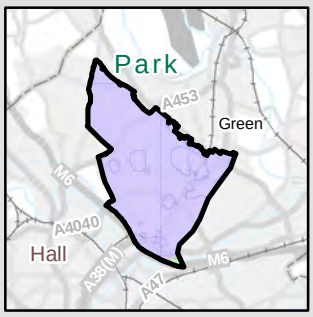
Legend

- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination

- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



- Fracture flow
- Intergranular or mixed flow

Depth to Water Table

- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability

- Free draining
- Highly variable permeability
- Poorly draining

Erdington (East)

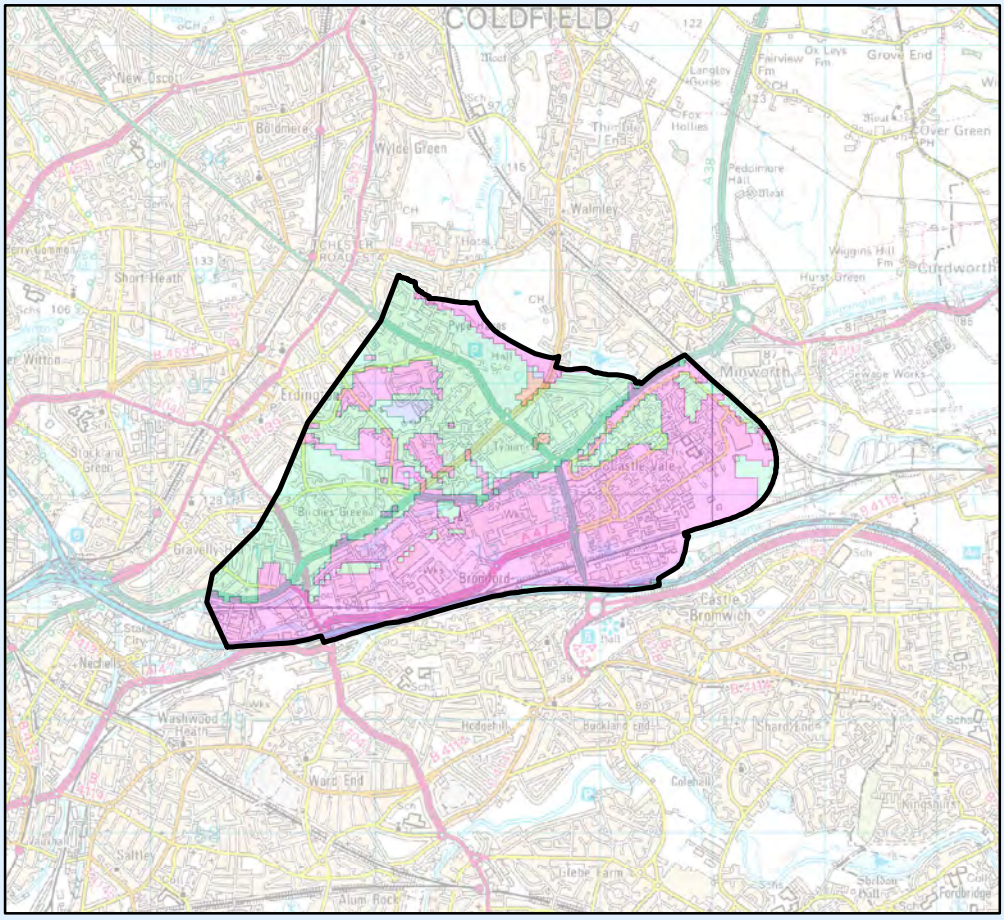
SuDS development within this area should give primary consideration to:

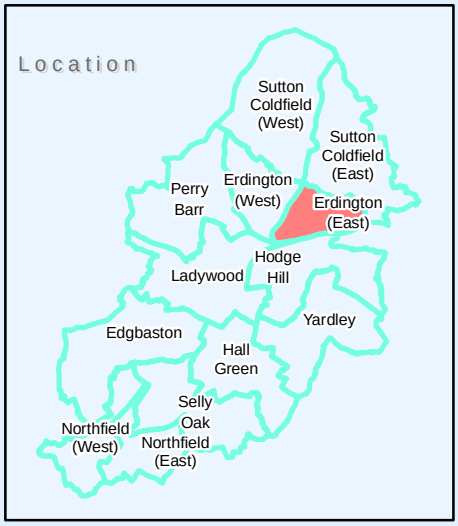
Water Quality

Groundwater Contamination

Depth to Water Table

DRAINAGE SUMMARY

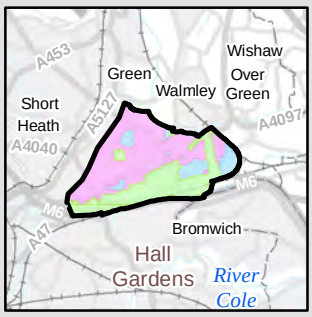




Legend

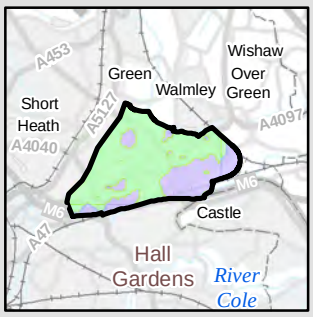
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



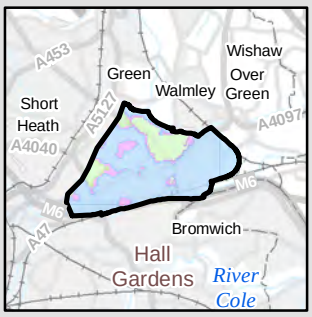
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



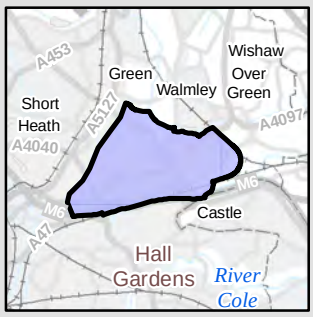
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Sutton Coldfield (West)

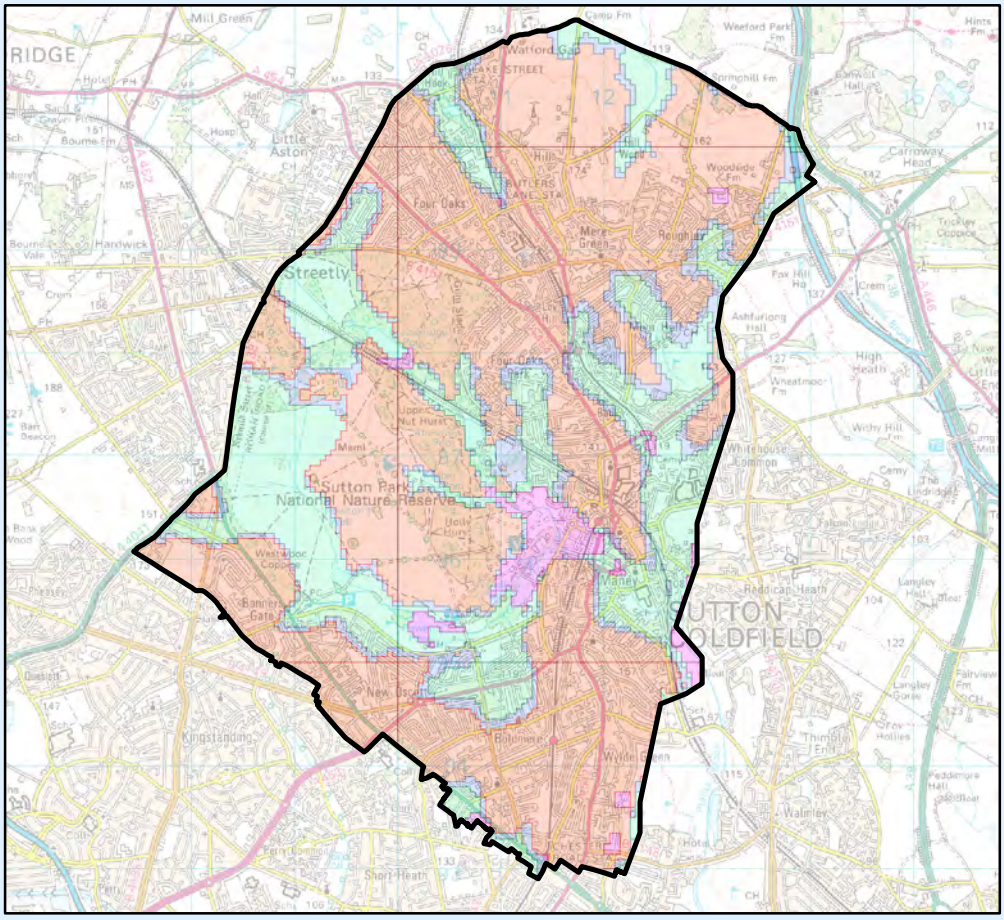
SuDS development within this area should give primary consideration to:

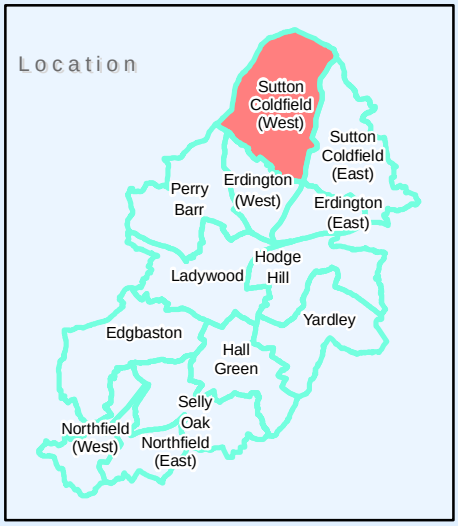
Surface Water Flood Risk

Water Quality

Groundwater Flood Risk

DRAINAGE SUMMARY

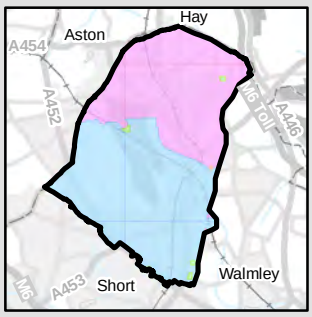




Legend

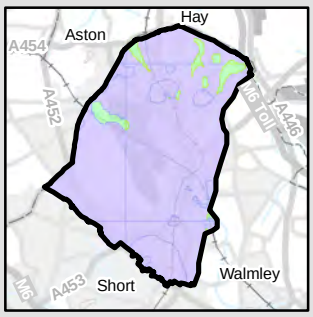
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type

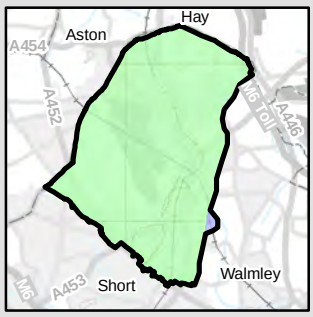


- Fracture flow
- Intergranular or mixed flow

Depth to Water Table

- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

Sutton Coldfield (East)

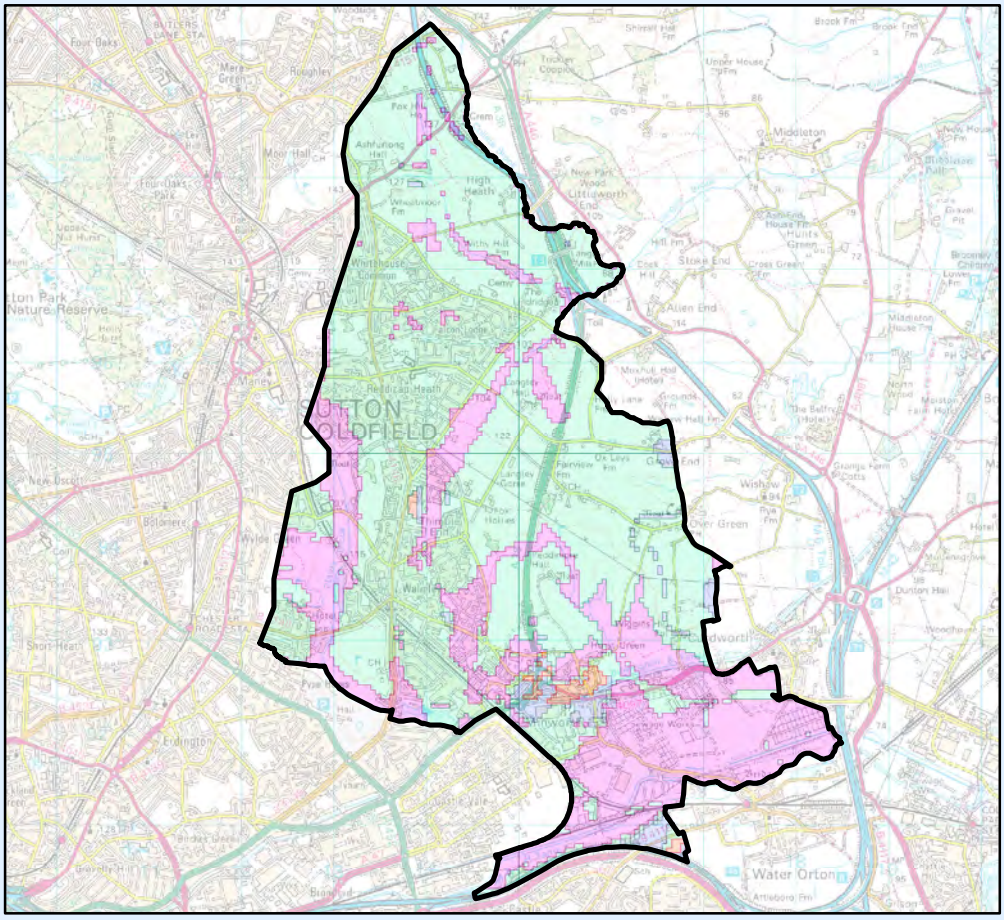
SuDS development within this area should give primary consideration to:

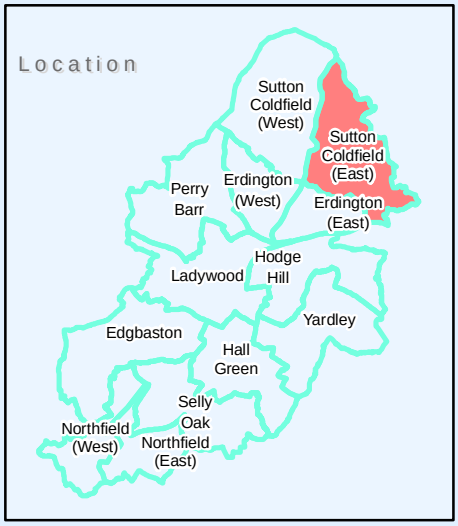
Groundwater Flood Risk

Groundwater Contamination

Poor Soil Permeability / Infiltration Rate

DRAINAGE SUMMARY

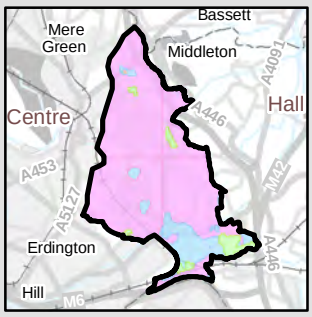




Legend

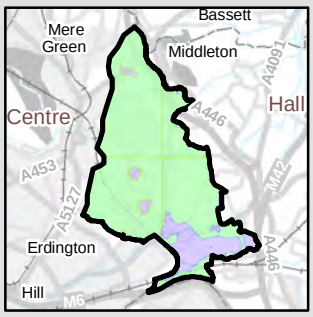
- Highly compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Probably compatible for infiltration SuDS
- Very significant constraints are indicated

Groundwater Contamination



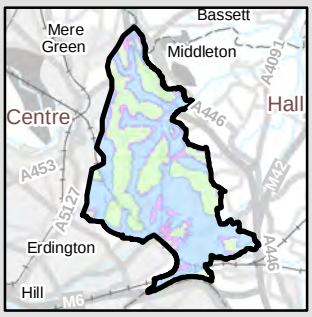
- Considerable susceptibility
- Low susceptibility
- Moderate susceptibility
- Very significant constraints are indicated

Predominant Flow Type



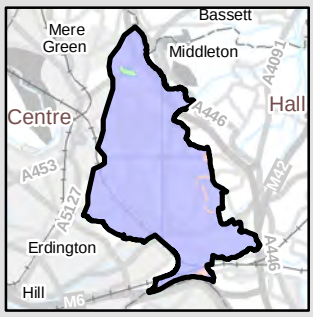
- Fracture flow
- Intergranular or mixed flow

Depth to Water Table



- 3-5 m below ground surface
- < 3 m below ground surface
- > 5 m below ground surface

Permeability



- Free draining
- Highly variable permeability
- Poorly draining

APPENDIX C: Drainage Pro-Forma

Surface Water Management

Drainage Pro-forma for new developments

This pro-forma is a tool that aims to support developers in devising an effective surface water drainage strategy that looks to mitigate flood risk through effective water quantity management, improve the quality of Birmingham's watercourses through effective water quality management, and enhance the potential for biodiversity & amenity value in Birmingham.

It is recommended that this pro-forma should be considered and completed alongside other supporting guidance, including:

- Sustainable drainage systems: non-statutory technical standards (Defra)
- Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance
- Delivering Benefits through Evidence, Rainfall Runoff Management for Developments (Defra/Environment Agency)
- National Planning Policy Framework (and supporting Technical Guidance)

There are eight sections within this pro-forma and it is recommended that all sections be completed and submitted, with supporting information, to the Local Planning Authority (LPA) for approval.

1.0 Site Location

The following section requires information on the proposed development site location.

	Development name	
1.1	Address & postcode/Grid reference	
1.2	Constituency	
1.3	Site area	
1.4	Planning application no./Ref.	

2.0 Site Summary

The following section summarises a brief overview of the comparison between the existing site and the proposed development. It is recommended that summary information noted in this section be expanded further in subsequent sections.

		Existing Site	Proposed Development	Additional Points to Note
2.1	Greenfield or Brownfield Site		N/A	A greenfield site is land that has not been previously developed within a city or rural area, it has been used for agriculture, landscape design or left to naturally evolve. A brownfield site is land that has been previously developed, with the potential of being redeveloped.
2.2	Impermeable area (ha)			Where impermeable area increases it is likely to increase surface water runoff and potentially increase flood risk on and offsite. The LLFA encourage impermeable area to be limited, reducing impermeable area where possible and using a sustainable approach to drainage to minimise runoff.
2.3	Drainage discharge method (Expanded in Section 3.0)			All development should apply the drainage hierarchy (Store rainwater for later use → Discharge to ground (infiltration) → Discharge to surface water body → Discharge to surface water sewer → Discharge to combined sewer). The LLFA encourage all developers to explore and apply this hierarchy to the development site, selecting the highest stage possible.
2.4	Peak discharge rates (Expanded in Section 4.0)			The calculated peak discharge rate (l/s) permitted to leave the development site under in 100year plus climate change storm event.
2.5	On site storage (Attenuation volume for 30yr) (Expanded in Section 5.0)			Volume of storage proposed on site in 100year plus climate change storm event.
2.6	On site storage (Attenuation volume for 100yr + climate change) (Expanded in Section 5.0)			Volume of storage proposed on site in 100year plus climate change storm event.
2.7	Level of treatment (Expanded in Section 7.0)	N/A	P / S / T	Proposed level of treatment to be achieved (Primary → Secondary → Tertiary).
2.8	SuDS features incorporated (Expanded in Section 8.0)	N/A	Y / N	SuDS provide a unique opportunity within a drainage system to enhance the key benefits of the system; flood risk management, water quality management and biodiversity & amenity value. It is expected that SuDS be considered on all developments (see Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance for more details).

3.0 Drainage Discharge Method

The LLFA expect each developer to eliminate the higher stage of the drainage hierarchy prior to moving down through the stages, the developer must provide evidence that each form of drainage discharge is possible or not. An explanation of the drainage hierarchy adopted, as below, is required.

		Is it possible?	Supporting Evidence	Examples of Supporting Evidence
3.1	Store rainwater for later use	Y / N		Preliminary plans/designs for rainwater harvesting

3.2	Discharge to ground (infiltration)	Y / N		Infiltration testing (BRE Digest 365 –Soakaway design), British Geological Society (BGS) mapping
3.3	Discharge to surface water body	Y / N		Site maps showing watercourse(s) in close proximity
3.4	Discharge to surface water sewer	Y / N		Severn Trent Water (STW) mapping & consultation documents
3.5	Discharge to combined sewer	Y / N		Severn Trent Water (STW) mapping & consultation documents

4.0 Peak Discharge Rates (Flow Control)

The peak discharge rate is the maximum flow rate (l/s) that is permitted to leave the site in any given storm event. Additional guidance is available, including the Birmingham (Emerging) TP6 Policy and Birmingham specific requirements based on the Non-Statutory Technical Standards. The following sections allow for explanation of the calculations of permissible peak discharge rates.

		Existing Site (l/s)	Proposed Development (l/s)	Additional Points to Note
4.1	Greenfield rate (QBAR)			Calculation of greenfield runoff rate may be provided through the use of use of appropriate industry standard drainage design software, use of EA guidance (Rainfall Runoff Management for Developments) or use of the greenfield runoff calculator (http://www.uksuds.com/greenfieldrunoff_js.htm)
4.2	1 in 1 year event			Calculation of discharge rates for each storm event for the existing site and the proposed development should be provided (calculations may be provided). It should be noted that for all development (greenfield & brownfield) surface water discharge rates shall be limited to the equivalent site-specific greenfield runoff rate for all return periods up to the 1 in 100 year plus climate change event, unless it can be demonstrated that the cost of achieving this would make the proposed development unviable.
4.3	1 in 30 year event			
4.4	1 in 100 year event			
4.5	1 in 100 year plus climate change event			

5.0 On-Site Storage (Volume Control)

In addition to the peak discharge rate, there are limits on the permitted volume of water leaving a site in any given storm event. Impermeable area restricts the amount of runoff that is able to infiltrate into the ground, thereby this excess runoff volume will need to be controlled, generally in the form of storage, to mitigate the flood risk on and offsite. The following section allows for explanation of (if required) the level of storage onsite to achieve the permissible peak discharge rates.

		Existing Site (m^3)	Proposed Development (m^3)	Additional Points to Note
5.1	1 in 1 year event			Calculation of attenuation storage for each storm event for the existing site and proposed development. may be provided through use of appropriate industry standard drainage design software use of the EA Guidance (Rainfall Runoff Management for Developments) or use of a stormwater storage calculator (e.g.http://www.uksuds.com/surfacewaterstorage_js.htm) It should be noted that for all development (greenfield & brownfield) runoff volume shall be limited to the equivalent site-specific greenfield runoff rate for all return periods up to the 1 in 100 year plus climate change event, unless it can be demonstrated that the cost of achieving this would make the proposed development unviable.
5.2	1 in 30 year event			
5.3	1 in 100 year event			
5.4	1 in 100 year plus climate change event			

6.0 Flood Risk & Exceedence Events within the Development

Development has the potential to increase flood risk on and offsite. A drainage system must be designed to mitigate this risk, accounting for all events up to and including the 1 in 100 year event. Furthermore, consideration must be given to flows generated by those events above and beyond the 1 in 100 year events (exceedence flows). Nationally and locally there is a requirement to protect development from flooding. The following section requires details of the proposed flood risk mitigation measures for the development under consideration.

		Have flood risk measures been incorporated within the proposed development?	Mitigation Measures	Example of Mitigation Measures
6.1	Flooding should not occur on any part of the site in a 1 in 30 year event	Y/N		Capacity in proposed drainage network (calculations), use of freeboard in design of finished floor levels (FFLs), grading of proposed development (high points and low points), and identification of flow paths and placement of buildings.
6.2	Flooding should not occur during a 1 in 100 year rainfall event in any part of a building	Y/N		
6.3	Exceedence flows for events greater than 1 in 100 year plus climate change (30%)	Y/N		Mapping of potential flow paths relative to proposed buildings and hazards

7.0 Water Quality

Development has the potential to increase pollutants in surface water runoff from a site. Sustainable drainage approaches have the potential to mitigate this impact on surrounding watercourses and infrastructure. Where possible, potential pollutants should be identified during the design process and appropriate levels of treatment incorporated into the drainage system. The following section allows for explanation of high level assessment of potential pollutants and determination of a suitable level of treatment as identified for the proposed development.

		Existing Site	Proposed Development	Additional Points to Note
7.1	Potential pollutants			Identification of potential pollutants and contaminants. For example, car parks and highways will result in potential pollution by petrochemicals, litter removal requirements etc.
7.2	Level of treatment			Identification of the level of treatment required (Primary → Secondary → Tertiary, see Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance for more details).

8.0 Proposed Sustainable Drainage (SuDS) Features

SuDS provide a unique opportunity within a drainage system to enhance the key benefits of the system; flood risk management, water quality management and biodiversity & amenity value. While it is acknowledged that it is not always possible for each of the key benefits to be achieved with one SuDS feature or within one drainage system, it is expected that a minimum of one key benefit be achieved in each system. The following section requires input of the summary details of SuDS features that are planned to be incorporated within the proposed development. An example has been provided.

	Type of SuDS feature	Key Benefits Achieved			Supporting information
		Flood Risk Management	Water Quality Management	Biodiversity & Amenity Value	
Example	*Permeable Paving with geo-cellular storage*	(Y)/N	(Y)/N	Y/(N)	*Attenuates flow, allowing infiltration and treatment. Drawings showing typical cross-section of feature and supporting calculations submitted to LPA.*
Feature 1		Y/N	Y/N	Y/N	
Feature 2		Y/N	Y/N	Y/N	
Feature 3		Y/N	Y/N	Y/N	

APPENDIX D: Operation & Maintenance Pro-Forma

Surface Water Management

Operation & Maintenance Pro-forma for new developments

Planning Practice Guidance states that '*When planning a sustainable drainage system, developers need to ensure their design takes account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any personnel, vehicle or machinery access required to undertake this work.*'

This pro-forma is a tool that aims to support developers in devising an effective operation & maintenance strategy for all surface water features proposed within a development, aiming to mitigate the risk of failure within features by establishing robust operation and maintenance protocols for all proposed features.

It is recommended that this pro-forma should be considered and completed alongside other supporting guidance, including:

- Sustainable drainage systems: non-statutory technical standards (Defra)
- Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance
- CIRIA The SuDS Manual. C697

There are three sections within this pro-forma and it is recommended that all sections be completed and submitted, with supporting information, to the Local Planning Authority (LPA) for approval. In addition to completing the sections below, it is recommended to provide plans & drawings showing proposed drainage layout, including proposed SuDS features.

1.0 Site Location

The following section requires information on the proposed development site location.

	Development name	
1.1	Address & postcode/Grid reference	
1.2	Constituency	
1.3	Site area	
1.4	Planning application no./Ref.	

2.0 Site Summary

The following section summarises a brief overview of the comparison between the existing site and the proposed development. It is recommended that summary information noted in this section be expanded further in subsequent sections.

		Existing Site	Proposed Development	Additional Points to Note
2.1	Permeable area (ha)			Where impermeable area increases it is likely to increase surface water runoff and potentially increase flood risk on and offsite. The LLFA encourage impermeable area to be limited, reducing impermeable area where possible and using a sustainable approach to drainage to minimise runoff.
2.2	Impermeable area (ha)			
2.3	Drainage discharge point			All development should apply the drainage hierarchy (Store rainwater for later use → Discharge to ground (infiltration) → Discharge to surface water body → Discharge to surface water sewer → Discharge to combined sewer). The LLFA encourage all developers to explore and apply this hierarchy to the development site, selecting the highest stage possible.
2.4	Peak discharge rate			The calculated peak discharge rate (l/s) permitted to leave the development site under in 100year plus climate change (30%)storm event.
2.5	On site below ground storage volume (m^3)			Volume of attenuation storage proposed in below ground features on site (up to and including the 100year plus climate change (30%) storm event)
2.6	On site above ground storage volume (m^3)			Volume of attenuation storage proposed in above ground features on site (up to and including the 100year plus climate change (30%) storm event)
2.8	SuDS features incorporated	Y / N	Y / N	SuDS provide a unique opportunity within a drainage system to enhance the key benefits of the system; flood risk management, water quality management and biodiversity & amenity value. It is expected that SuDS be considered on all developments (see Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance for more details).

3.0 Proposed Sustainable Drainage (SuDS) Feature

SuDS provide a unique opportunity within a drainage system to enhance the key benefits of the system; flood risk management, water quality management and biodiversity & amenity value. While it is acknowledged that it is not always possible for each of the key benefits to be achieved with one SuDS feature or within one drainage system, it is expected that a minimum of one key benefit be achieved in each system.

Furthermore, the LPA and Lead Local Flood Authority (LLFA) expect each developer to consider the ongoing maintenance of each SuDS feature over the lifetime of the development. Each SuDS feature should be considered individually and appropriate requirements. The following section requires input of the summary details of each SuDS feature that is planned to be incorporated within the proposed development.

SuDS Feature 1

		Information of proposed SuDS Feature	Additional Points to Note
3.1	Type of SuDS Feature	N/A	SuDS features take many forms, e.g. soakaway, green roof, filter drain, swale, permeable paving, infiltration/detention basin, rain garden, pond, storage structures. (see Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance for more details).
3.2	Dimensions of SuDS Feature		Proposed dimensions of SuDS feature. Consideration should always be given to safety in design and appropriate consideration of access during the design of SuDS. CDM Regulations 2015 must also be considered and applied to the planning, design and construction and long term maintenance of SuDS systems. For example, maximum side slope in basins to allow for safe access for O&M purposes. Drainage layout plans & details should be submitted to illustrate the dimensions detailed within this section.
	- Surface Area (m)		
	- Length (m)		
	- Width (m)		
	- Depth (m)		
	- Side Slope (m)		
	- Bed Slope (m)		
3.3	Party responsible for maintenance		Identify the party responsible for the maintenance of the proposed SuDS feature for the lifetime of the development. For example, if there is an agreement between the developer and the water company the details of the water company should be provided.
	- Name		
	- Address		
	- Contact Information		
3.4	Maintenance Specifications		A maintenance specification should be provided for each SuDS feature. This specification should include the frequency and detail of all required inspections and maintenance tasks for each SuDS feature, thereby setting out a minimum standard to which the feature must be maintained.
	- Weekly		
	- Monthly		
	- Quarterly		
	- Six monthly		
	- Annually		
3.5	Remediation inspections & tasks following significant storm events:		Following a significant storm event, additional maintenance inspections and tasks may be required to ensure that SuDS features continue to operate effectively.
3.6	Contingency plan details		Details of proposed contingency plans for failure of any part of the drainage system that could present a hazard to people. For example, failure of a feature may result in significant overland flows, plans showing proposed grading to ensure that water will flow away from people and property, ponding in low risk areas.

SuDS Feature 2

		Information of proposed SuDS Feature	Additional Points to Note
3.1	Type of SuDS Feature	N/A	SuDS features take many forms, e.g. soakaway, green roof, filter drain, swale, permeable paving, infiltration/detention basin, rain garden, pond, storage structures. (see Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance for more details).
3.2	Dimensions of SuDS Feature		Proposed dimensions of SuDS feature. Consideration should always be given to safety in design and appropriate consideration of access during the design of SuDS. CDM Regulations 2015 must also be considered and applied to the planning, design and construction and long term maintenance of SuDS systems. For example, maximum side slope in basins to allow for safe access for O&M purposes. Drainage layout plans & details should be submitted to illustrate the dimensions detailed within this section.
	- Surface Area (m)		
	- Length (m)		
	- Width (m)		
	- Depth (m)		
	- Side Slope (m)		
	- Bed Slope (m)		
3.3	Party responsible for maintenance		Identify the party responsible for the maintenance of the proposed SuDS feature for the lifetime of the development. For example, if there is an agreement between the developer and the water company the details of the water company should be provided.
	- Name		
	- Address		
	- Contact Information		
3.4	Maintenance Specifications		A maintenance specification should be provided for each SuDS feature. This specification should include the frequency and detail of all required inspections and maintenance tasks for each SuDS feature, thereby setting out a minimum standard to which the feature must be maintained.
	- Weekly		
	- Monthly		
	- Quarterly		
	- Six monthly		
	- Annually		
3.5	Remediation inspections & tasks following significant storm events:		Following a significant storm event, additional maintenance inspections and tasks may be required to ensure that SuDS features continue to operate effectively.
3.6	Contingency plan details		Details of proposed contingency plans for failure of any part of the drainage system that could present a hazard to people. For example, failure of a feature may result in significant overland flows, plans showing proposed grading to ensure that water will flow away from people and property, ponding in low risk areas.

SuDS Feature 3

		Information of proposed SuDS Feature	Additional Points to Note
3.1	Type of SuDS Feature	N/A	SuDS features take many forms, e.g. soakaway, green roof, filter drain, swale, permeable paving, infiltration/detention basin, rain garden, pond, storage structures. (see Birmingham City Council, Sustainable Guidance: Design, Adoption & Maintenance for more details).
3.2	Dimensions of SuDS Feature		Proposed dimensions of SuDS feature. Consideration should always be given to safety in design and appropriate consideration of access during the design of SuDS. CDM Regulations 2015 must also be considered and applied to the planning, design and construction and long term maintenance of SuDS systems. For example, maximum side slope in basins to allow for safe access for O&M purposes. Drainage layout plans & details should be submitted to illustrate the dimensions detailed within this section.
	- Surface Area (m)		
	- Length (m)		
	- Width (m)		
	- Depth (m)		
	- Side Slope (m)		
	- Bed Slope (m)		
3.3	Party responsible for maintenance		Identify the party responsible for the maintenance of the proposed SuDS feature for the lifetime of the development. For example, if there is an agreement between the developer and the water company the details of the water company should be provided.
	- Name		
	- Address		
	- Contact Information		
3.4	Maintenance Specifications		A maintenance specification should be provided for each SuDS feature. This specification should include the frequency and detail of all required inspections and maintenance tasks for each SuDS feature, thereby setting out a minimum standard to which the feature must be maintained.
	- Weekly		
	- Monthly		
	- Quarterly		
	- Six monthly		
	- Annually		
3.5	Remediation inspections & tasks following significant storm events:		Following a significant storm event, additional maintenance inspections and tasks may be required to ensure that SuDS features continue to operate effectively.
3.6	Contingency plan details		Details of proposed contingency plans for failure of any part of the drainage system that could present a hazard to people. For example, failure of a feature may result in significant overland flows, plans showing proposed grading to ensure that water will flow away from people and property, ponding in low risk areas.

APPENDIX E: Typical Maintenance Schedules

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Soakaway

Regular Maintenance	
Monthly	• Mow grasses (where required) and remove resultant clippings (during growing season only) • Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required
Six Monthly	• Not applicable
Annually	• Remove sediment and debris from pre-treatment devices and floor of chamber • Clean gutters and filters on downpipes (where applicable) • Trim any roots causing blockages • Inspect and document the presence of wildlife
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Birmingham City Council

Green/Brown Roof

Regular Maintenance	
Monthly	• During establishment, replace dead plants as required (for 12 months following installation) • Mow grasses (where required) and remove resultant clippings
Six Monthly	• Remove fallen leaves and debris from deciduous plant foliage • Remove nuisance and invasive vegetation, including weeds • Remove debris & litter to prevent clogging of inlet drains and interference with plant growth • Noxious weed treatment (3 times a year)
Annually	• Replace dead plants as required (typically in the Autumn) • Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes, and roof structure for proper operation, integrity of waterproofing and structural stability, take action where required • Inspect soil substrate for evidence of erosion channels and identify any sediment sources, take action where required • Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system, take action where required • Inspect underside of roof for evidence of leakage, take action where required • Inspect and document the presence of wildlife
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Birmingham City Council

Filter Drain

Regular Maintenance	
Monthly	• Litter and debris removal • Mow grasses (where required to promote lateral runoff inflow) and remove resultant clippings (during growing season only) • Remove nuisance and invasive vegetation (for 12 months following installation) • Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required
Six Monthly	• Not applicable
Annually	• Not applicable
Annually	• Remove nuisance and invasive vegetation • Inspect and document the presence of wildlife
As Required	• Repair erosion or other damage by re-turfing, reseeding or replacing filter material • Re-level uneven surfaces and reinstate design levels (typically every 60 month period) • Remove and replace top 300 – 500mm of gravel, clean and replace where required (typically every 60 month period) • Remove and dispose of oils or petrol residues using safe standard practices
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Swale

Regular Maintenance	
Monthly	• Litter and debris removal • Mow grasses (where required) and remove resultant clippings (during growing season only) • Remove nuisance and invasive vegetation (for 12 months following installation) • Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required
Six Monthly	• Remove nuisance and invasive vegetation
Annually	• Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where required • Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, where required • Inspect and document the presence of wildlife
As Required	• Repair erosion or other damage by re-turfing or reseeding • Re-level uneven surfaces and reinstate design levels (typically every 60 month period) • Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface where required (typically every 60 month period) • Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip, where required • Remove and dispose of oils or petrol residues using safe standard practices
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Permeable Paving

Regular Maintenance	
Monthly	• Refer to manufacturer specifications • For sealed systems, inspection of outfalls should be undertaken
Six Monthly	• Brushing and vacuuming to manufacturer requirements. Re-grit where necessary after brushing.
Annually	• Not applicable
As Required	• Inspect/check all inlets, outlets, inspection chambers, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required (for 3 months following installation) • Removal of weeds where required • Stabilizing and mowing of contributing areas where required
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Birmingham City Council

Infiltration Basin

Regular Maintenance	
Monthly	• Litter and debris removal • Mow grasses (where required) and remove resultant clippings (during growing season only) • Remove nuisance and invasive vegetation (for 12 months following installation) • Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required
Six Monthly	• Remove nuisance and invasive vegetation
Annually	• Remove all dead growth prior to the start of growing season • Inspect and document the presence of wildlife • Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, where required
As Required	• Prune and trim trees and remove cuttings. • Repair erosion or other damage by re-turfing or reseeding • Re-level uneven surfaces and reinstate design levels; scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface (typically once every 60 month period) • Remove sediment from pre-treatment system (e.g. forebays) when 50% full • Remove and dispose of oils or petrol residues using safe standard practices
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Detention Basin

Regular Maintenance	
Monthly	• Litter and debris removal • Mow grasses (where required) and remove resultant clippings • Remove nuisance and invasive vegetation (for 12 months following installation) • Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required
Six Monthly	• Remove nuisance and invasive vegetation
Annually	• Remove all dead growth prior to the start of growing season • Remove sediment from inlets, outlet and forebay • Manage wetland plants, where required • Inspect and document the presence of wildlife • Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, where required
As Required	• Prune and trim trees and remove cuttings. • Remove sediment from forebay, when 50% full and from micropools if volume reduced by more than 25% • Repair erosion or other damage by re-turfing or reseeding • Re-level uneven surfaces and reinstate design levels (typically once every 60 month period) • Remove and dispose of oils or petrol residues using safe standard practices
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Rain Garden/Stormwater Planter

Regular Maintenance	
Monthly	• Litter and debris removal • Mulching (where required) • Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required
Six Monthly	• Remove nuisance and invasive vegetation
Annually	• Pruning and trimming of trees • Inspect and document the presence of wildlife • Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where required
As Required	• Repair erosion or other damage by re-mulching or re-seeding • Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required • Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface (typically every 60 month period) • Remove build-up of sediment, reinstate design levels (typically every 60 month period) • Remove and dispose of oils or petrol residues using safe standard practices
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Birmingham City Council

Pond

Regular Maintenance	
Monthly	• Litter and debris removal • Mow grasses (if required) and remove resultant clippings • Inspect vegetation to pond edge and remove nuisance and invasive vegetation (for 36 months following installation) • Inspect water body for signs of algae & eutrophication (May to October) • Inspect/check all inlets, outlets and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required
Six Monthly	• Inspect vegetation to pond edge and remove nuisance and invasive vegetation (following initial 36 month period) • Inspect silt accumulation rates and establish appropriate removal frequencies
Annually	• Hand cut submerged and emergent aquatic plants (at minimum of 0.1 m above pond base. Include max 25% of pond surface) • Remove up to 25% of bank vegetation from water's edge to a minimum of 1 m above water level • Tidy all dead growth before start of growing season • Remove sediment from forebay (Year 1 to 5) • Inspect and document the presence of wildlife
As Required	• Remove sediment from forebay (following initial 60 month period) • Remove sediment from the main body of big ponds when pool volume is reduced by 20% • Aerate pond when signs of eutrophication are detected
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Geocellular Storage System

Regular Maintenance	
Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action. (for 3 months following installation) • Debris removal from catchment surface (where may cause risks to performance) • Inspect systems as specified by the manufacturer • Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.
Six Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action. (following initial 3 month period)
Annually	• Remove sediment from pre-treatment structures (e.g. upstream silt-traps or Vortex flow control upstream) and geocellular system where required (High pressure water jetting) • Inspect and document the presence of wildlife
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Attenuation Tank

Regular Maintenance	
Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action (for 3 months following installation)
Six Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action (following initial 3 month period)
Annually	• Remove sediment from pre-treatment structures
As Required	• De-silt as required
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order

Sustainable Drainage Systems (SuDS):
Typical Maintenance Schedule

Flow Control Structures

Regular Maintenance	
Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action (for 3 months following installation)
Six Monthly	• Inspect and identify any areas that are not operating correctly. If required, take remedial action • Remove sediment from pre-treatment structures
Annually	• Not applicable
Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events	
Following all significant storm events	• Inspect and carry out essential recovery works to return the feature to full working order