WARRINGTON
Borough Council

Sustainable Drainage Systems (SuDS) Design and Technical Guidance

Warrington Borough Council

December 2017 – Final 01

Economic Regeneration, Growth and Environment Directorate
Warrington Borough Council
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Buttermarket Street
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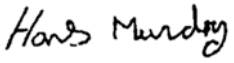
Revision Schedule

Document Title:	**Sustainable Drainage Systems (SuDS) Design and Technical Guidance**

Revision	**Name**	**Signature**	**Position**	**Date**	**Stage**
Final01: Dec-2017	Jonathan Dawson-Parry		Asset & Flood Risk Engineer	15/09/2017	Originator
	Steve Berry		Flood Risk Management Regional Officer	15/09/2017	Originator
	Jim Turton		Asset & Engineering Manager	08/01/2017	Checked & Reviewed
	Councillor Hans Mundry		Executive board member for Highways, Transportation and Public Realm	12/03/2018	Approved

Notes:	

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1 Introduction

1.1 Vision for Warrington

Water is a defining feature of the Warrington landscape, from the River Mersey flowing close to the town centre to the man-made canals and smaller watercourses that drain towards it.

The management of water resources in Warrington is therefore a necessary part of everyday life.

As Warrington's urban areas expand and grow, four main challenges face the management of surface water drainage:

- The reduction of the green spaces;
- The increased pressure on existing infrastructure;
- The increased risk of flooding and erosion;
- The effective management of impermeable soils on brownfield land and wider impacts on catchment surface water drainage.

Development planning, ensuring effective use of SuDS to manage and reduce surface water runoff, is considered an essential aspect of all new development proposals. It is intended that the Checklist and processes outlined in this Guidance are used by Developers and stakeholders as the basis of the SuDS approval process.

1.2 How to use this Guide

The information provided in this document aims to be a comprehensive and accessible guide to SuDS and their applicability to the Warrington area.

Section Summary Boxes

At the start of each section there is a summary box which highlights the key topics which will be discussed in more detail, for example:

WHAT THIS SECTION WILL COVER:

- Section divisions
- Section summary boxes
- Way markers

Way Markers

Throughout this guidance numerous 'Way Markers' can be found. These are snippets of information which provide definitions, or links to relevant supporting documents and legislation which describe in detail some features noted in this guidance.

WAY MARKER 1.1

SuDS Guidance Warrington Borough Council

National Standard

National Standards are highlighted in blue boxes. Information has been obtained from Defra's 'Non-statutory technical standards for sustainable drainage systems' - March 2015

Local Standard

Specific Local SuDS Standards are highlighted in green boxes.

1.2.1 Who Should Use It

This guidance is primarily aimed at Developers, to identify the information that they need to provide to enable the assessment of SuDS proposals by Warrington Borough Council (WBC) as the Lead Local Flood Authority (LLFA) and other Statutory Consultees. This guidance is intended to provide a standardised approach to the selection of appropriate SuDS and identify the information that the Developer is required to provide to enable the Local Authority and Statutory Consultees to effectively review planning applications. It is intended that this guidance is used by:

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

1.2.2 What will the Guide Provide?

In order to support sector capacity building and decision making, this guidance document will:

1. Provide a clear and consistent approach to implementing SuDS within the administrative area of Warrington Borough Council.
2. Enable developers to complete efficient site assessment, SuDS selection and detailed design.
3. Provide an organised structure for developer applications to Warrington Borough Council.
4. Enable planning/engineering officers to identify the key design specification requirements and legislation issues.
5. Allow efficient assessment of submitted SuDS proposals through the planning process.
6. Facilitate successful operation and maintenance.

1.3 The SuDS Submission Application Process

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

The SuDS Checklist includes for:

- Pre Application;
- Minor Developments;
- Major Developments:
    a. Outline Application.
    b. Full Application.

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

Changes to the National Planning Policy Framework (NPPF) came into effect on 6th April 2015 which made SuDS a material consideration when determining planning applications for major development.

Applicants and Developers should be aware that since the National Planning Policy Framework (NPPF) came into effect on 6th April 2015 for all "Major Developments" (10 or more dwellings, buildings of more than 1,000m^2 or development sites over 1 hectare), there is a legal requirement to incorporate SuDS drainage proposals into their planning applications. For other developments the use of SuDS is encouraged as part of drainage proposals.

1.3.1 Submission Validation and Assessment

Planning applications may be made either as one of the following:

- Minor Application;
- Outline Application (with one or more matters reserved for later determination), or;
- Full Application.

The level of information which would need to be submitted for each type of application or stage within the planning process will vary depending on the size of the development, flood risk, constraints and proposed sustainable drainage system.

The Developer shall be wholly responsible for the design and construction of SuDS systems.

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

Following receipt of the **SuDS Checklist** the Local Planning Authority will review the information provided on the **SuDS Checklist** and **Supporting Documents**. The Council will therefore assess SuDS applications to ensure proposed minimum standards of operation are appropriate and through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance of SuDS over the lifetime of the development.

The Local Planning Authority will consult with the Lead Local Flood Authority to confirm the accuracy / detail / level information provided to ensure the SuDs scheme is appropriate with respect to a Major Development. The application will not be validated if a SuDs scheme is not submitted with a full application unless justification is provided to demonstrate why SuDs scheme is not appropriate.

Sustainable Drainage Systems may not be practicable for some forms of development (for example mineral extraction). The decision as to whether a sustainable system would be inappropriate in relation to a particular development proposal is a matter of judgement for the Local Planning Authority. In making this judgement the Local Planning Authority will seek advice from the relevant flood risk management bodies, principally the Lead Local Flood Authority, including on what sort if of sustainable drainage system they would consider to be reasonably practicable. The judgement of what is reasonably practicable will be by reference to the SuDS technical standards published by the Department

WAY MARKER 1.2
Defra SuDS Non Statutory Technical Standards

Non-statutory technical standards for the design, maintenance and operation of Sustainable Drainage Systems.

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

for Environment Food and Rural Affairs (Defra) and take into account design and construction costs.

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

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

1.4 The SuDS Management Train

Individual SuDS, located both in public and private areas, should accounted for in the context of a Management Train that reinforces and, where possible, follows the natural pattern of drainage. The Management Train incorporates a hierarchy of techniques:

1. **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution;
2. **Source control** – control of runoff at, or very near, its source;
3. **Site control** – management of water from several sub-catchments;
4. **Regional control** – management of runoff from several sites.

For small developments, consideration must be given to prevention and source controls, as site or regional controls such as detention ponds may not be practical. The reduction of runoff and the treatment of runoff at source should provide the required treatment levels as required by Sections 4 and 5 of this guidance document.

The requirements for drainage should be considered when determining the overall layout of the development as the natural features of the site, such as topography, will often dictate some aspects of the drainage system design and should be incorporated as green infrastructure.

The Developer will liaise with the stakeholders identified in Section 3 of this guidance document.

This guide does not cover a specific process for the consent of pumping stations. When undertaking the design using the guidance provided, the Developer should take cognisance of the following issues:

- Pumped surface water systems are not considered to be sustainable;
- Pumping stations which are accessories belonging to a sewer shall be shown on the drainage plan.

The Developer shall undertake the design and preparation of drawings in accordance with the principles outlined in Sections 4 and 5 of this guidance document.

2 Background

What this section will cover:

- Legislation and policy context
- Warrington geology, ecology, flood risk
- Why SuDS in Warrington?

2.1 Background to SuDS

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

The **National Planning Policy Framework (NPPF)** defines that the decision as to whether SuDS should be considered will depend on the proposed development and its location.

WAY MARKER 2.1

SuDS (Sustainable **D**rainage **S**ystems**)** -

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

CIRIA SuDS Manual (C753)
http://www.susdrain.org/resources/SuDS_Manual.html

SuDS can be considered appropriate for:

- Areas currently at risk of flooding;
- New developments, and;
- Developments greater than 1 hectare or 10 residential units or more (major development) (or equivalent mixed use or commercial development).

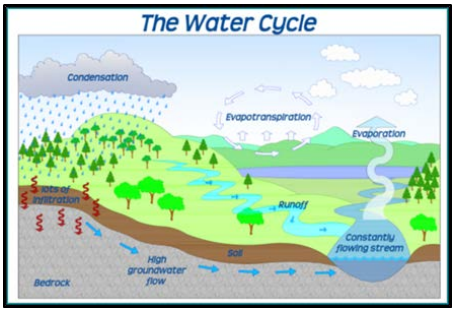
This will only be considered appropriate if priority has been given to the use of sustainable drainage within design and the details of proposed discharge have been provided.

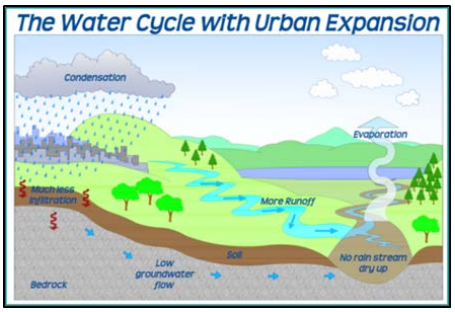
The **Planning Practice Guidance** relating to SuDS was revised March 2015 and highlights the considerations which should be made about the types of SuDS, operation and maintenance in relation to the **Defra Non-Statutory Technical Standards for SuDS**.

2.1.1 Purpose of SuDS

Figure 2.1: Purpose of SuDS

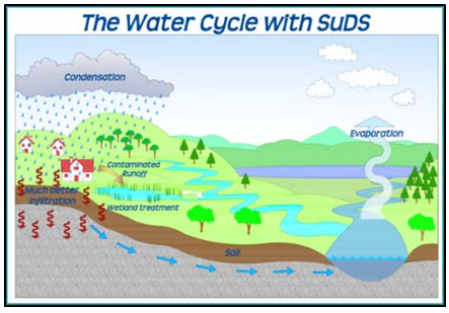
Impervious areas such as roads, footpaths, roofs and car parks are traditionally connected to sewer systems that transport runoff away from urban areas quicker than natural, vegetated conveyances.





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

SuDS aim to manage rainfall and surface runoff by allowing rainfall to be intercepted or absorbed into the ground through vegetation and specially designed landscape features, then conveying any additional flows to the nearest surface water body i.e. groundwater, stream, river, drain, where it is released at the same rate and, where feasible, volume as would occur if the site was undeveloped.



2.1.2 SuDS Philosophy

The SuDS philosophy is to replicate the drainage conditions which existed at a site prior to development. The variety of components means that SuDS are applicable for sites of any size, condition, topography or environmental condition.

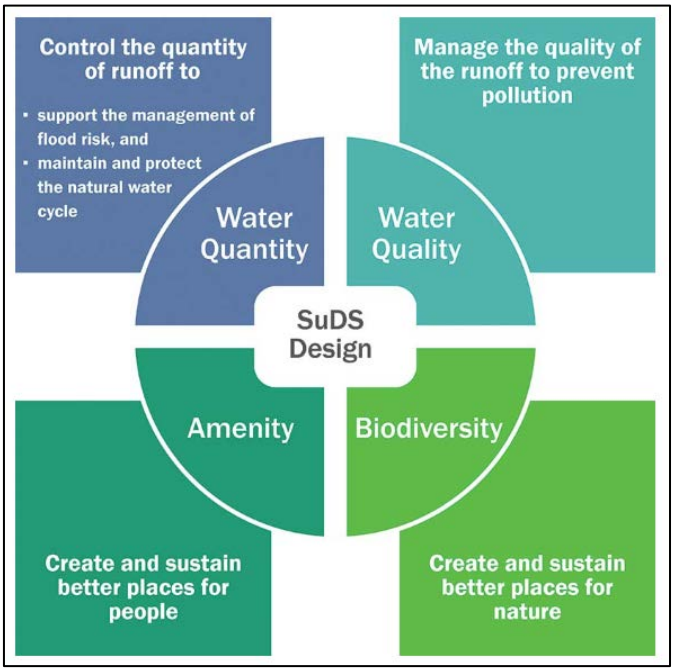
WAY MARKER 2.2

1. **WATER QUANTITY**
   Controlling the quantity of runoff to:
   - **Support the management of flood risk, and**
   - **Maintain and protect the natural water cycle**
2. **WATER QUALITY**
   Manage the quality of runoff to prevent pollution
3. **AMENITY**
   Create and sustain better places for people
4. **BIODIVERSITY**
   Create and sustain better places for nature

It is important to note that these elements of SuDS philosophy are interrelated and that any SuDS proposal does not simply seek to address runoff but considers other benefits which can be derived.

The types of benefits that can be achieved by SuDS fit into four categories. These are referred to in the **CIRIA SuDS Manual C753** as the Four Pillars of SuDS Design

Figure 2.1: The Four Pillars of SuDS Design



The SuDS Manual C753, CIRIA (2015)

2.1.3 Key Benefits of SuDS

There are a number of proven benefits which can be derived from employing SuDS components, both for new and the existing built environment. These include benefits relating directly to water management, such as temporary storage during a storm event to reduce flooding, and improve runoff water quality and removing sediments - the accumulation of which can lower water body depth, reduce capacity and thus contribute to flooding.

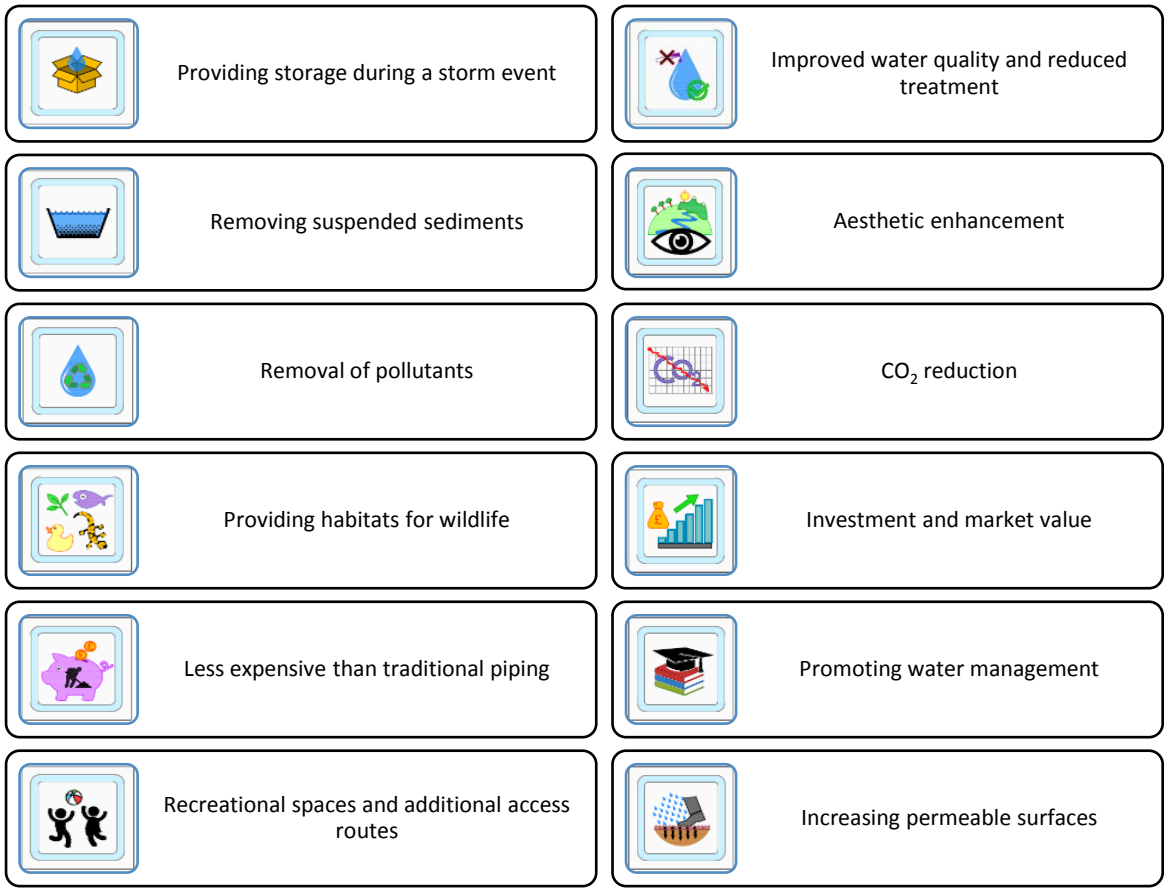
SuDS can also have indirect social benefits for the area and community. The design of SuDS components can be designed to create green areas to be used for recreation and enhance the

aesthetic qualities of the locality. In turn, these measures can improve the appeal of the area, and may also encourage investment in the area leading to economic benefits like increased prices in the property market.

These benefits will be referenced throughout the guide, particularly in Section 4, where it can be seen which of the particular benefits can be derived from each SuDS component.

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

Figure 2.2: **SuDS Icons**



2.2 National Policy Context

2.2.1 Flood and Water Management Act 2010

The **Flood and Water Management Act (FWMA) 2010** aims to provide for better, more comprehensive management of flood risk for people, homes and businesses, safeguarding community groups from unaffordable rises in surface water drainage charges, and protect water supplies to the consumer.

Serious flooding can happen at any time and climate projections suggest that extreme weather will happen more frequently in the future. The act aims to reduce the flood risk associated with extreme weather by implementing the recommendations of the

WAY MARKER 2.3

Flood and Water Management Act 2010
http://www.legislation.gov.uk/ukpga/2010/29/contents

Pitt Review 2008
http://webarchive.nationalarchives.gov.uk/20100807034701/http:/archive.cabinetoffice.gov.uk/pittreview/_/media/assets/www.cabinetoffice.gov.uk/flooding_review/pitt_review_full%20pdf.pdf

Pitt Review (2008).

2.2.2 National Flood and Coastal Risk Management Strategy for England 2011

The **National Flood and Coastal Risk Management Strategy for England 2011** sets out a framework for implementing the **FWMA 2010**, aiming to assist local authorities and communities with their responsibilities through taking a risk based approach to flood and coastal risk management and ensure a full range of options is managed in a co-ordinated manner.

Flood risk management authorities are required to consider a combination of flood storage, source control and SuDS to help manage surface water more effectively and avoiding damage to property, people, or assets.

WAY MARKER 2.4

National Flood and Coastal Risk Management Strategy for England 2011
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf

"Understanding the risks, empowering communities, building resilience"

2.2.3 National Planning Policy Framework 2012 and Planning Practice Guidance: Flood Risk and Coastal Change 2015

The **National Planning Policy Framework (NPPF) 2012** framework provides the planning policy and guidance for England which informs local plans and decisions. There is a focus on the role of sustainable development which should underpin planning and decision making, particularly with regards to reducing the causes and impacts of flooding.

It states that SuDS provide numerous opportunities in addition to reducing the causes and impacts of flooding. It advises on the need to plan for maintenance of SuDS to ensure effective drainage for properties and notes that local authorities and Developers should work together to implement SuDS.

The **Planning Practice Guidance** relating to SuDS was revised 23rd March 2015 and highlights the considerations which should be made about the types of SuDS, operation and maintenance in relation to the **Defra Non-Statutory Technical Standards for SuDS**.

WAY MARKER 2.5

National Planning Policy Framework (NPPF) 2012
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

Planning Practice Guidance: Flood Risk and Coastal Change (relating to Section 10 of NPPF): Why are Sustainable Drainage Systems important?
http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/reducing-the-causes-and-impacts-of-flooding/why-are-sustainable-drainage-systems-important/

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

2.3 Local Policy Context

2.3.1 Mersey Estuary Catchment Flood Management Plan (CFMP) 2009

The **Mersey Estuary Catchment Flood Management Plan** examines 10 sub areas in the Mersey catchment. It notes that Warrington (Area 5) is an area of moderate to high flood risk where further action can be taken to reduce flood risk.

The Manchester Ship Canal conveys 70% of the flows which by-pass Warrington from the River Mersey, reducing the flood risk to 9,800 properties in the area. The vision for the area includes: "to review existing urban drainage issues and develop an integrated urban drainage strategy, taking into account the effects of climate change and development" through the provision of SuDS.

WAY MARKER 2.6

Mersey Estuary Catchment Flood Management Plan (CFMP) 2009
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293769/Mersey_Estuary_Catchment_Flood_Management_Plan.pdf

2.4 Warrington Borough Council Policy Context

2.4.1 Preliminary Flood Risk Assessment 2017

Warrington Borough Council as an LLFA has a duty to prepare a Preliminary Flood Risk Assessment (PFRA) in accordance with Part 2 of the FRR 2009 which sets out the requirements. The PFRA is a high level screening exercise to identify areas in which the risk of local flooding is significant and warrants further examination through the production of maps and management plans. The first PFRA was completed in 2011 and updated in 2017. The latest review of the PFRA identified that Warrington had no flooding issues that were nationally significant.

WAY MARKER 2.7

Preliminary Flood Risk Assessment 2017
https://www.warrington.gov.uk/downloads/download/717/preliminary_flood_risk_assessment

2.4.2 Adopted Local Plan Core Strategy 2014

The strategy sets out a series of polices for addressing the vision for 2027 and objectives to achieve this vision. The spatial policy reflects the need for sustainable development in the **National Planning Policy Framework 2012**.

Policy QE 4 (Quality Environment - Flood Risk) states that development should "use Sustainable Drainage Systems that incorporate natural drainage, rather than using traditional piped systems in new developments unless it can be demonstrated that such techniques are impractical or would present an unacceptable pollution risk".

WAY MARKER 2.8

Warrington Borough Council Local Plan Core Strategy (2014)
https://www.warrington.gov.uk/info/200564/planning_policy/1903/local_plan

Vision for 2027: "Warrington is one of the best places to live and work in the UK, where everyone enjoys an outstanding quality of life".

Warrington Borough Council is in the process of reviewing the Local Plan to replace the adopted Core Strategy (2014). As part of this process, but not exclusively, the vision and objectives and Policy QE 4 will be assessed to ensure they meet the needs of the Borough and conform to National Planning Policy.

2.4.3 Strategic Flood Risk Assessment (SFRA) Volume II Technical Report 2011

Volume II provides detailed flood risk information collected and produced as part of the Level 1 and Level 2 assessment. It focuses on the main sources of risk in the Borough including fluvial and tidal flooding along the River Mersey, its five key tributaries (Sankey, Padgate, Spittle, Penketh and Whittle Brooks), surface water flooding, sewer flooding and residual risks associated with Bridgewater Canal, St. Helens Canal and Manchester Ship Canal.

It makes recommendations of a surface water management plan and water cycle strategy to aid decision making process on allocating sustainable development sites. It is recommended that within critical drainage areas a reduction of 50% in surface water discharge rates from new development on brownfield sites and a reduction to greenfield rates on all other development sites is achieved.

WAY MARKER 2.9

Warrington Borough Council Strategic Flood Risk Assessment 2011
https://www.warrington.gov.uk/info/200564/planning_policy/1905/evidence_base/8

"Application of SUDS should be explored at an early stage of new development projects and design requirements documented within any FRA produced."

2.4.4 Mid Mersey Water Cycle Study 2011

The study makes specific recommendations in relation to both planning and sustainable drainage and provides an Environment Agency checklist to encourage SuDS to be considered at the earliest opportunity. It also examines where infiltration SuDS would be applicable in Warrington.

WAY MARKER 2.10

Mid Mersey Water Cycle Study 2011
https://www.warrington.gov.uk/info/200564/planning_policy/1905/evidence_base/8

2.4.5 Surface Water Management Plan (SWMP) - Environment & Regeneration Surface Water Flooding Evidence Base 2012

The SWMP builds upon the information of surface water risk identified in the SFRA and sets a framework for addressing the risk in the present and future. This builds upon **Planning Policy Statement 25 (PPS25) - Development and Flood Risk Practice Guide**. This has been superseded by the **National Planning and Policy Framework (NPPF) - Planning Practice Guide**.

The preliminary flood risk assessment identifies surface water flooding in Warrington to have two main characteristics:

WAY MARKER 2.11

Surface Water Management Plan 2012
https://www.warrington.gov.uk/info/200564/planning_policy/1905/evidence_base/8

Planning Practice Guide 2016
http://planningguidance.communities.gov.uk/

- Large-scale, shallow ponding affected by widespread flooding, with the potential to affect hundreds of properties during and after very high intensity rainfall events and;
- Small-scale localised flooding issues, likely to affect few properties, but potentially occurring with much greater frequency.

2.4.6 Warrington Local Flood Risk Management Strategy (LFRMS) 2017

This document sets out the flood risk issues, the main responsibilities and measures required for flood risk management and details how these issues will be monitored and managed. It draws on Schedule 3 of the **FWMA 2010** as well as QE 4 of the Core Strategy.

Objectives 3 and 5 are most relevant to SuDS. Objective 3 aims to manage flood risk and the impact of flooding through a range of activities and by effective management. Objective 5 is to undertake flood risk management in a sustainable manner.

WAY MARKER 2.12

Warrington Local Flood Risk Management Strategy 2017
https://www.warrington.gov.uk/download/downloads/id/7429/local_flood_risk_strategy.pdf

"SuDS play a crucial role in managing the surface water from developments on site and hence reducing the flood risk"

2.4.7 Warrington Development Documents

The **Design and Construction Supplementary Planning Document (2010)** was prepared to ensure that development within the Borough is delivered in a sustainable manner in line with sustainable development principles.

Warrington Means Business: City Centre Masterplan (2017) is the Council's Economic Growth and Regeneration Programme, developed in line with the Borough's Health and Well-being Strategy. Warrington Means Business identifies 5 Growth Areas across the Borough; Warrington City Centre, Warrington South, Warrington West, Warrington North and Warrington East.

WAY MARKER 2.13

Design and Construction Supplementary Planning Document 2010
https://www.warrington.gov.uk/info/200564/planning_policy/2089/supplementary_planning_documents

Warrington Means Business: City Centre Masterplan 2017)http://warringtonandco.com/info-centre/downloads-and-publications/

2.5 Geology and Soil Type

2.5.1 What is the Geology of Warrington?

The bedrock geology of Warrington predominantly comprises red sandstone and coal measures from the Triassic and Carboniferous periods respectively. Lymm Dam and Stockton Heath Rifle Range Quarry are examples of Regionally Important Geological sites (RIGs).

Superficial geology of the area originated from the Quaternary Ice Age and includes clays and silts, gravel and sand as well as peat bogs, which formed at the end of the Ice Age.

There are three main soils which are formed from these superficial deposits - sand and gravel, clay and silt, peat and glacial deposits. These soil types support a variety of land use types, noted in Way Marker 2.14.

WAY MARKER 2.14

Landscape Character Assessment 2007
https://www.warrington.gov.uk/downloads/file/5301/tps077_landscape_character_assessment

Sand and Gravel:
Pastoral land use

Clay and Silt:
Cereal crop production

Peat and Glacial Deposits:
Fertile agricultural soil suited for arable and root crop

2.5.2 Why should Geology and Soil Type be considered when designing SuDS?

The geology of a region influences the types of SuDS that are appropriate to the soil characteristics and links to groundwater aquifers. Permeable soils assist with infiltration but soils with low permeability do not preclude the use of SuDS. The number of SuDS components have a variety of benefits aside from encouraging infiltration such as providing storage for flood waters and providing habitats.

Maps of the superficial deposits in the Warrington area can be found in Appendix D.1. Soil types in the Warrington area are shown in Appendix E.

2.6 Biodiversity and Habitat Corridors

2.6.1 What is the Biodiversity of Warrington?

Warrington's landscape types provide valuable habitats for species including those designated as UK Species of Conservation Concern.

There are 55 Local Wildlife Sites and 2 Wildlife Corridors (Mersey Valley and Sankey Valley) within the Warrington Borough. Within these areas are located 26 priority species and 7 priority habitats. There are also other landscape designations and programmes such as the Mersey Forest Initiative, which is a collection of woodlands and green spaces which provide social, economic and environmental benefits to the local people. It is recognised as part of the Green Infrastructure for the area. Warrington's older woodlands, for example at Burtonwood and Dingle Wood, have existed since 1600 and are classed as Ancient Semi-Natural Woodland, supporting a wide range of flora and fauna. These areas provide green corridors for biodiversity.

WAY MARKER 2.15

Liverpool City Region and Warrington Green Infrastructure Framework - Action Plan
http://ecosystemsknowledge.net/sites/default/files/wp-content/uploads/2014/2/LCR_GI_action_plan.pdf

Landscape Character Assessment 2007
https://www.warrington.gov.uk/downloads/file/5301/tps077_landscape_character_assessment

Warrington Borough Council Local Plan Core Strategy (2014)
https://www.warrington.gov.uk/info/200564/planning_policy/1903/local_plan

EC Green Infrastructure
http://ec.europa.eu/environment/nature/ecosystems/index_en.htm

2.6.2 Why should Biodiversity be considered when Designing SuDS?

The landscape and biodiversity of Warrington should therefore be taken into consideration for any planning application and SuDS components proposed should seek to enhance the biodiversity of the region which in turn will enhance the developments. For example, wetlands can provide habitats for a number of creatures and enhance the aesthetic quality of an area. Furthermore, areas previously used for industrial activities can also be transformed and benefit biodiversity as demonstrated by the population of Great Crested Newts now residing at Rixton Clay Pits.

Biodiversity designations in the Warrington area can be found in Appendix D.2.

2.7 Topography

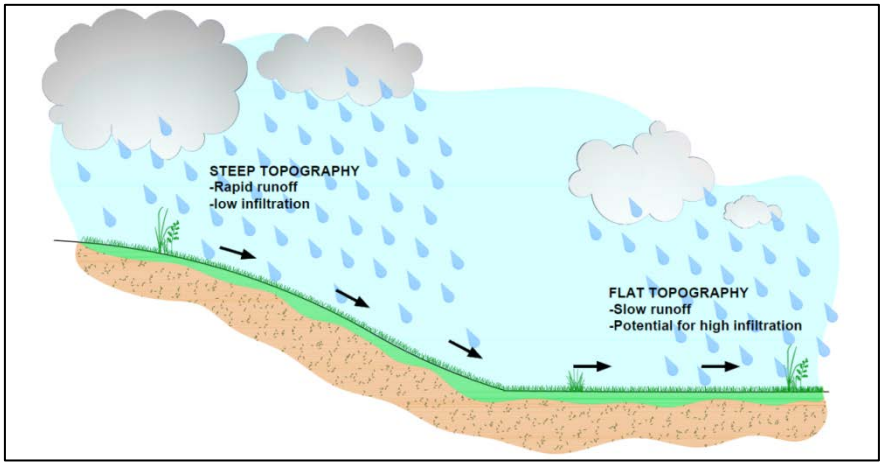
2.7.1 What is the Topography of Warrington?

Warrington is relatively flat with the majority of the land below 20m AOD, ideal to utilise SuDS. The topography of the area is a product of the geology and hydrology. The highest area is the sandstone escarpment within which are incised stream valleys and hills such a Hill Cliffe and Grappenhall Heys which formed during the Quaternary Ice Age.

WAY MARKER 2.16

Landscape Character Assessment 2007
https://www.warrington.gov.uk/downloads/file/5301/tps077_landscape_character_assessment

Figure 2.3: Topography Summary



2.8 Why should Topography be considered when Designing SuDS?

The topography of an area can dramatically influence drainage patterns. Areas of steep topography can decrease the time rainfall takes to reach urban areas and thus increases the risk of flooding. Similarly, flat land can encourage the storage of water which can prolong flooding due to the increased time which the water will take to drain away. SuDS techniques such as swales or filter trenches can assist in reducing these affects by providing areas to slow flood water.

A topography map of the Warrington area can be found in Appendix D.3.

2.9 Water Resources and Flood Risk

2.9.1 What are the Water Features of Warrington?

The annual rainfall in the Warrington region is approximately 600mm, which is reasonably distributed throughout the year with an average of 40mm in May and 70mm in October. The main watercourses are the River Mersey (second highest tidal range in the UK) and the Manchester Ship Canal into which flow a number of tributaries and smaller watercourses including three other canals - The Bridgewater Canal, Woolston New Cut Canal and the Sankey Canal (aka St Helens Canal).

The Bridgewater Canal is owned and operated by The Bridgewater Canal Company Limited, part of The Peel Group, in conjunction with the Bridgewater Canal Trust. The Bridgewater Canal Company is the statutory body responsible for navigation and maintenance of the Bridgewater Canal. It is managed as part of Peel Land and Property Group.

The Manchester Ship Canal Company is owned and operated by Peel Ports Group, which has two shareholders - The Peel Group and Deutsche Asset Management. The Manchester Ship Canal Company is the statutory body responsible for navigation and maintenance of the Manchester Ship Canal governed by Acts of Parliament.

WAY MARKER 2.17

Mersey Estuary Catchment Flood Management Plan (CFMP) 2009
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293769/Mersey_Estuary_Catchment_Flood_Management_Plan.pdf

Water features and Flood Risk Maps presented in the following pages:

- River catchments
- Fluvial and Coastal Flood Risk Areas with Critical Drainage Areas highlighted
- Groundwater Flood Risk Areas with Critical Drainage Areas highlighted

Long term Flood Risk Assessment for locations in England
https://flood-warning-information.service.gov.uk/long-term-flood-risk/#x=357683&y=355134&scale=2

The Woolston New Cut Canal is owned by the Manchester Ship Canal Company.

The section of the Sankey Canal which is contained with the administrative area of Warrington Borough Council is owned by owned by Warrington Borough Council.

United Utilities provides water and sewerage services to Warrington. Significant lengths of Warrington's waterways are graded by the Environment Agency as having poor chemical and biological quality.

The Mersey Estuary Catchment Flood Management Plan (CFMP) notes that flooding in Warrington from fluvial sources has occurred since the 18th Century. Whilst this still presents a risk, additional sources of groundwater and surface water should not be ignored.

2.9.2 Why consider Water Resources and Flooding when Designing SuDS?

Employing SuDS for future developments provides the opportunity to assist with addressing the water quality issues which Warrington faces. Components such as filter drains can remove suspended sediments and other pollutants, thus facilitating the release of water of a higher quality, which is particularly important for drainage to water bodies where effort should be made to improve water body quality status.

Water resource & Flood Risk maps (River catchments, River and Coastal Flood Risk, Groundwater Flood Risk) can be found in Appendix D.

2.10 Why use SuDS in Warrington?

80% of current development in Warrington occurs in urban areas and this urbanisation can cause significant problems for surface water drainage.

Warrington's Local Plan Core Strategy, Policy QE 4 Flood Risk will require all development proposals to use Sustainable Drainage Systems. The implementation of SuDS in Warrington could have the following benefit stated in Table 2.1.

Table 2.1: Summary of SuDS Benefits

 water storage	**Management of increased water quantity** • Increased precipitation as climate change occurs is likely to lead to wetter winters. **Management of more frequent extreme rainfall events** • SuDS can help reduce the surface water discharge rates by 50% in critical design areas (**Warrington Borough Council Strategic FRA**). **Management of brownfield sites** • SuDS can provide betterment to drainage at brownfield sites.
 pollutant treatment	**Assistance with the protection of all water bodies** • The Water Framework Directive (WFD) (Directive 2000/60/EC). **Protection of the water environment from diffuse pollution** • North West River Basin Management Plan 2015. **Potential to deliver long term benefits for pollution** • Environment Agency 2013: North West River Basin District: Challenges and Choices.
 Biodiversity  Visual amenity	**Increase green spaces and vegetated areas** • SuDS provide an array of amenity, recreational and biodiversity benefits and can help to reduce the urban heat island effect. **Components of Green Infrastructure** • Related to a number of policies in **WBC's Local Plan Core Strategy:** o Policy CS 6 Overall Spatial Strategy; o Policy QE 3 Green Infrastructure; o Policy QE 5 Biodiversity and Geodiversity; o Policy QE 6 Environment and Amenity Protection.
 Play	**Increase recreational areas** • Council planning policies encourage the provision of opportunities for access, outdoor sport, and recreation. **Development of social cohesion to enhance community life quality** • Wetlands can be wildlife parks with stepping stones and islands.
 Educational	**Understanding functionality of SuDS** • Education of the public about the environmental importance of SuDS. **Informing younger generations** • Education of surface water management and application for the future.
 Investment	**Perceived improvement of an area** • Visual attractiveness of a development can increase house values. **Connects areas** • SuDS can link public open spaces with green infrastructure and provide habitat corridors.

3 The Approval Process

What this section will cover:

- Responsibilities - who does what?
- Introduction to the planning application process
- Requirements for planning application

3.1 General Principles and Guidance

This section of the guide sets out specific technical considerations relating to this process.

This guide does not cover a specific process for the consent of pumping stations.

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

The individual SuD systems, both in public and private areas, should be used in a Management Train that reinforces and, where possible, follows the natural pattern of drainage. The Management Train incorporates a hierarchy of techniques:

Prevention – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution;

Source control – control of runoff at, or very near, its source;

Site control – management of water from several sub-catchments;

Regional control – management of runoff from several sites.

For small developments, particular attention must be given to prevention and source controls, as site or regional controls such as detention ponds may not be practical. The reduction of runoff and the treatment of runoff at source will provide the required treatment levels.

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

The requirements for drainage should be taken into account when determining the overall layout of the development, as the natural features of the site will often dictate some aspects of the drainage system design and should be incorporated as green infrastructure.

The Developer should take cognisance of Environment Agency Main River designations paying particular attention in their master planning to the requirement for no obstructions typically within 8 meters of the edge of the watercourse.

Flood Defence Consent and Land Drainage Consent information is required as part of the submission, including distance of construction from watercourses etc. Easements for work adjacent to watercourses and culverts, drains, private sewers should be indicated and assumed to be 8m. It is the Developers responsibility to obtain all required discharge permits and evidence of this should be provided.

The Developer's design team shall liaise with the stakeholders identified and any other potential stakeholders who may be involved in the development process.

When undertaking the design using the guidance provided in Sections 6 and 7, the Developer should take cognisance of the following issues:

- Pumped surface water systems are not considered to be sustainable;
- Pumping stations which are accessories belonging to a sewer shall be shown on the drainage plan.

The Developer shall undertake the design and preparation of drawings in accordance with the principles outlined in Section 7.

Formal Application for approval of SuDS and supporting information should be made using the standard application form available from Warrington Borough Council and contained in Appendix A.

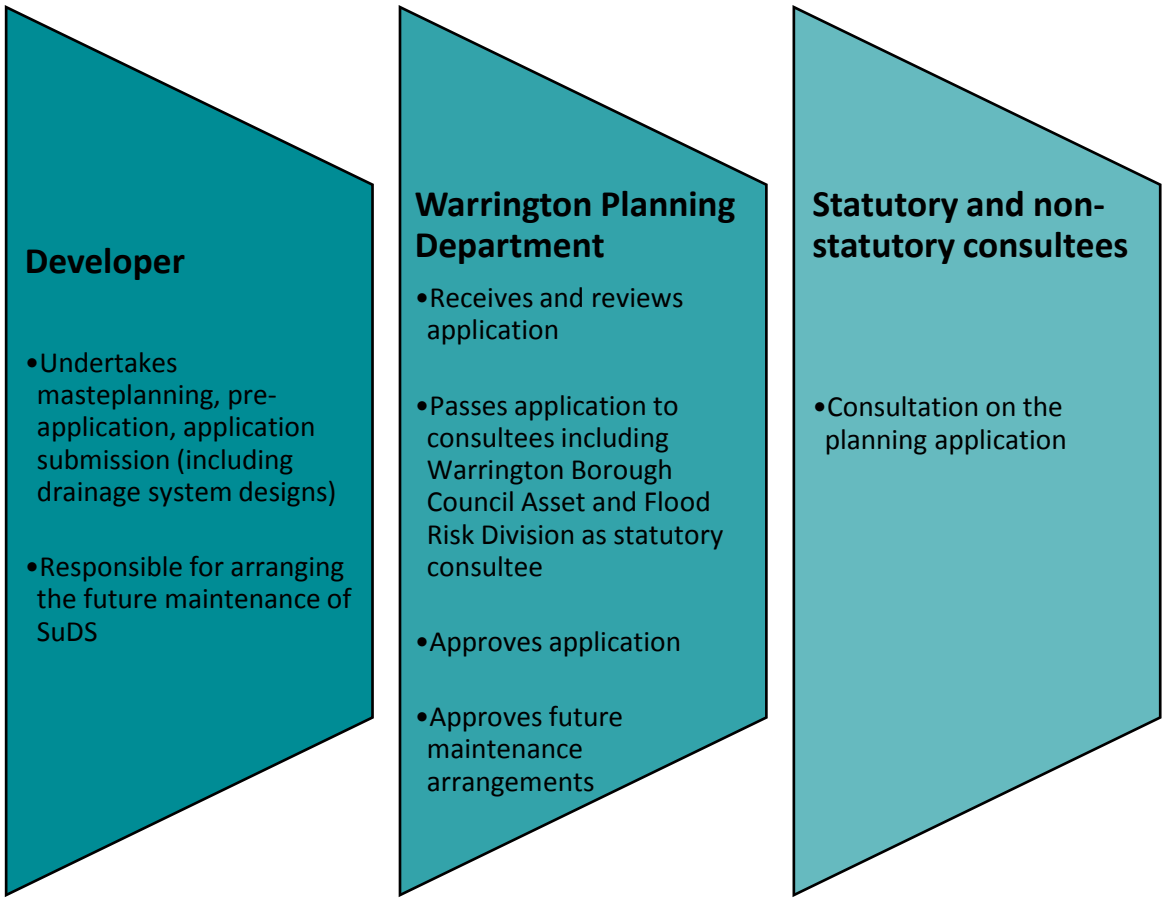
Upon completion, the following items should be supplied to Warrington Borough Council.

- **Two sets of as-built record drawings** in electronic format and compatible with AutoCAD Release 14 in *.DWG or *.DXF format (refer to Section 6.1.4 for further information);
- Where appropriate, closed circuit television (CCTV) survey of underground systems by a qualified contractor in accordance with Clause E7.6 of **Sewers for Adoption 7th Edition** in CD or DVD format with a hard copy of the written report. CCTV at completion is at the discretion of the Developer. The Developer is responsible for checking that the CCTV survey shows no defects or debris within the infrastructure.
- Health & Safety File prepared in accordance with the **Construction (Design & Management) Regulations 2015**.

3.2 Responsibility Designation

The following figure notes the responsibilities of the three key groups involved in SuDS from inception to adoption:

Figure 3.1: Responsibilities



With early consideration, SuDS are possible on any site. Warrington Borough Council strongly recommends pre-application discussions in relation to SuDS proposals so that the opportunities

to boost the multiple benefits of SuDS are maximised, costs minimised and planning applications can be determined effectively and efficiently. The inclusion of conceptual SuDS at the very start of the process of planning the development site layout has the greatest effect on their viability and cost-effectiveness. It will also affect their integration with the development and the ability of the SuDS to deliver multiple benefits.

Evidence has shown that both capital and maintenance costs for SuDS should not be greater than those for traditional piped surface water drainage systems, and in some cases can be lower. More information can be found in the **'Final Surface Water Drainage Report'** published by Defra in 2013.

WAY MARKER 3.1

Final Surface Water Drainage Report – DEFRA 2013
http://randd.defra.gov.uk/Document.aspx?Document=11852_FinalIssueSWDReport_November2013.pdf

Challenges to the viability of SuDS at development sites may include land take/space limitations, land contamination legacy, soil infiltration properties and groundwater conditions. Key to the viability of SuDS, however, is early consideration. Warrington Borough Council will not accept, for example, that SuDS are unviable simply because they do not fit in with a proposed site layout which has been designed prior to the consideration of SuDS.

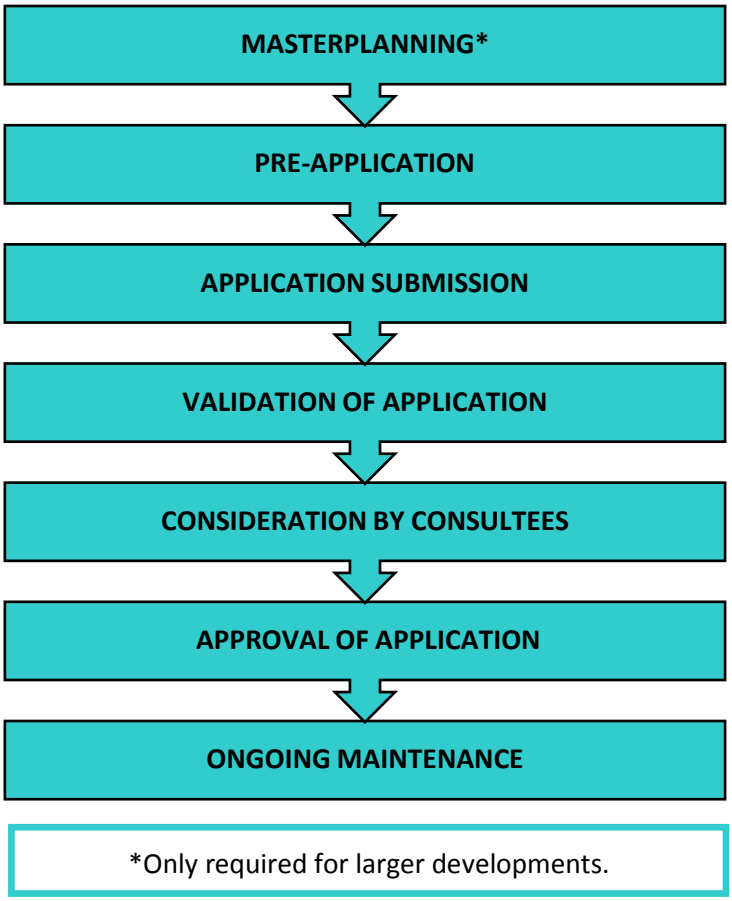
Local Standard A – Phased Development and Drainage Strategies

For phased developments, the LLFA will expect planning applications to be accompanied by a Drainage Strategy which takes a strategic approach to drainage provision across the entire site and incorporates adequate provision for SuDS within each phase**.**

3.3 Planning Application Process

Figure 3.2 illustrates the stages involved in the submission of a planning application.

Figure 3.2: Planning Application Process



The subsequent sections in this chapter describe in detail the considerations and actions which should be undertaken at each stage of the SuDS planning application.

For those cases where the Developer is uncertain whether the application should be submitted as a Lawful Development Certificate (LDC), Outline Application or a Full Planning Application, consultation should be undertaken with Warrington Borough Council Planning Department. Currently, for planning applications, only Major Applications (which have a 13 week consideration period) require SuDS proposals. Further advice is available from Warrington Borough Council Website.

WAY MARKER 3.2

Warrington Borough Council: Planning and Building Control
https://www.warrington.gov.uk/info/200557/planning_and_building_control

Changes to the National Planning Policy Framework (NPPF) came into effect on 6th April 2015 which made SuDS a material consideration when determining planning applications for major development.

WAY MARKER 3.3
Definition of "Major Development":

"Major Development" (as set out in Article 2(1) of the **Town and Country Planning (Development Management Procedure) (England) Order 2010**) means development involving any one or more of the following:

a. The winning and working of minerals or the use of land for mineral-working deposits;

b. Waste development;

c. The provision of dwelling houses where:

   I. the number of dwelling houses to be provided is 10 or more; or

   II. the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the development falls within sub-paragraph (c)(i);

d. The provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or

e. Development carried out on a site having an area of 1 hectare or more.

Changes to the National Planning Policy Framework (NPPF) came into effect on 6th April 2015 which made Lead Local Flood Authorities (LLFA) statutory consultees in planning applications for **"Major Development"** in relation to SuDS and Drainage.

The Development Management Procedure Order was also amended, designating Councils as the Lead Local Flood Authority, and therefore each Council is now a statutory consultee within the planning process on the management of surface water.

Warrington Borough Council is designated as Lead Local Flood Authority, a statutory consultee to the planning process on the management of surface water.

Applications will be assessed by Warrington Borough Council to ensure proposed minimum standards of operation are appropriate and through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

It should be noted that Warrington Borough Council have no duty to adopt SuDS and provision for the disposal of runoff remains the responsibility of the Developer.

Applications for outline planning permission seek to establish whether the scale and nature of a proposed development would be acceptable to the Local Planning Authority, before a fully

detailed proposal is put forward. This type of planning application allows fewer details about the proposal to be submitted.

If the outline permission is subject to conditions, for example, requiring submission for approval details of a specified aspect of the development which was not fully described in the application (e.g. drainage system layout with the excludes SuDs) these must be dealt with before the development can begin. The details of which may be agreed as 'reserved matters' applications at a later stage.

Outline permission is not a permission to start work on site. The permission notice will state which matters have been reserved for later approval. When all of the reserved matters have been approved, work may begin on the site.

Reserved matters applications should be submitted within 3 years of outline permission being granted.

Outline planning permission lasts for two years from the date reserved matters were approved, or three years from the date of the outline planning permission, whichever is the later. If works have yet to commence by either of these dates then a resubmission of development details to the Local Planning Authority is required.

3.3.1 Master Planning

Master planning is only necessary for larger developments and those where a full planning application is required.

At this stage the Developer or landowner should consult with the Warrington planning authority to understand the requirements of the development. The Developer should plan the SuDS layout with regard to the flows, topography and geology of the area in order to mitigate flood risk, taking account of established industry standards - **CIRIA SuDS manual C753 and BS8582:2013 Surface Water Management**. This stage also allows an initial costing of the process.

WAY MARKER 3.4

Checklist for Master Planning:

- Requirements are identified in the **SuDS Submission Application and Approval Checklist** provided in Appendix **A** of this guidance.
- Review of key evidence flood risk base documents
- Review of geology, hydrology, green infrastructure, flood risk
- Initial costing

This viewpoint is also supported by the sewerage undertaker, United Utilities.

3.3.2 Pre-Application

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

WAY MARKER 3.5

Checklist for pre-application:

- Consult with statutory and non-statutory consultees
- Seek advice from **Warrington Borough Council via the Pre-Application Advice Service:** https://www.warrington.gov.uk/info/200557/planning_and_building_control/2026/pre-application_advice

3.3.3 Application Submission

Full applications and outline (where layout is applied for) planning applications at application/validation stage will require applicants to include a draft Section 104 Adoption Agreement (Water Industry Act, 1991) or head of terms to deal with future maintenance and management of SuDS. A Section 106 Connection to a Sewer (Water Industry Act, 1991) will then be required on approval of a planning application.

Any calculations of peak flow rates and discharge volumes should also be submitted electronically.

When the application is submitted, Warrington Borough Council Planning Department will check to ensure that all the details have been provided for review. The application will then be passed to the statutory consultees for review.

WAY MARKER 3.5

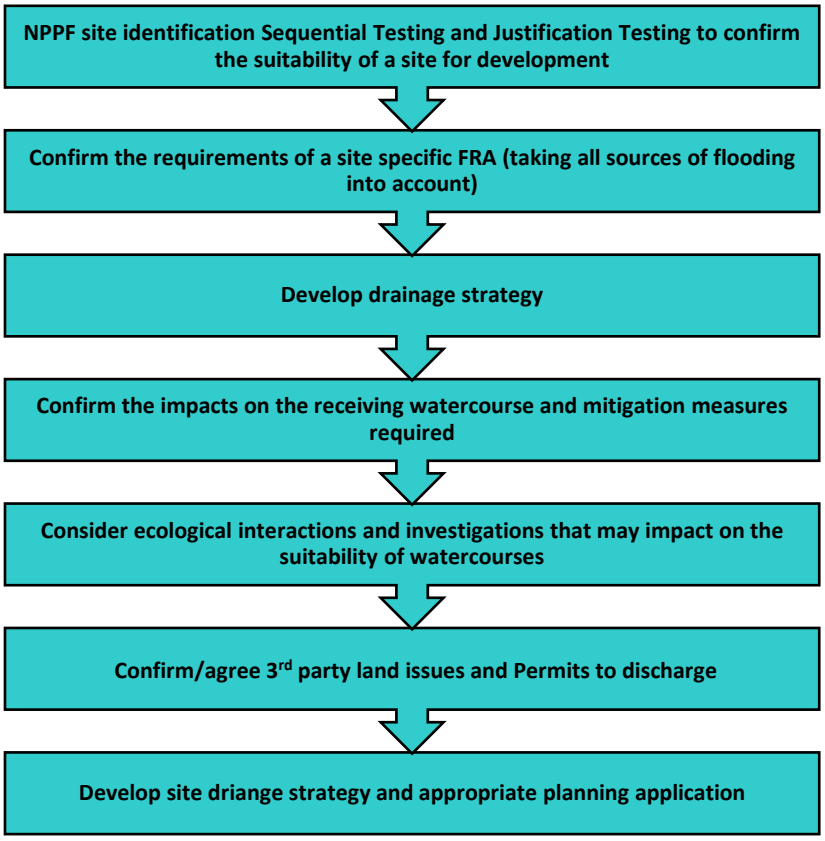
Checklist for SuDS section of Planning Application

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

3.4 Development and Flood Risk

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

Figure 3.3: Development and Flood Risk Assessment



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

The **NPPF** sets of the aims of the Sequential Test, to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The **Warrington Borough Council Strategic Flood Risk Assessment (SFRA)** will provide the basis for applying this test although the most recent Environment Agency flood maps should also be reviewed. A sequential approach should be used in areas known to be at risk from any form of flooding.

A site-specific **Flood Risk Assessment (FRA)** will be required and this will need to demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere. Where possible the overall flood risk should be reduced.

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

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

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

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

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

On brownfield sites the existing drainage systems should be modelled to demonstrate actual pre-development surface water runoff and hydraulic performance of the drainage system. This will include the number and frequency of gullies, and existing attenuation whether natural or artificial.

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

3.5 Consultation

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

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

The timescale for the consultation period is 21 days.

Table 3.1: Consultees

	Consultee	Comment
Statutory	Environment Agency	Consult if the SuDS will discharge to a main river
	Highways Authority	Consult if the SuDS will impact on adopted public highways or discharge surface water to Highways drainage systems
	Sewerage Undertaker (United Utilities)	Consult if SuDS will connect to the sewerage network
	LLFA (Warrington Borough Council)	Consult for all applications
	Cheshire Brine Subsidence Compensation Board	Consult for planning permission and building control approval within areas identified as Consultation Areas. LPA have a statutory duty to consult before determining any planning application in respect of any building proposed to be erected within a Consultation Area
Non-Statutory	Wildlife Trust/RSPB/Fisheries Trust	-
	Local community	-
	National Coal Authority	-
	Bridgewater Canal Company Limited*	The Bridgewater Canal is owned and operated by The Bridgewater Canal Company Limited, part of The Peel Group, in conjunction with the Bridgewater Canal Trust. The Bridgewater Canal Company is the statutory body responsible for navigation and maintenance of the Bridgewater Canal. It is managed as part of Peel Land and Property Group.
	Manchester Ship Canal Company*	The Manchester Ship Canal Company is owned and operated by Peel Ports Group, which has two shareholders - The Peel Group and Deutsche Asset Management. The Manchester Ship Canal Company is the statutory body responsible for navigation and maintenance of the Manchester Ship Canal governed by Acts of Parliament. The Woolston New Cut Canal is owned by the Manchester Ship Canal Company.
	Warrington Borough Council	Consult if SuDS will affect the Sankey Canal

*While non-statutory for the purpose of the planning consultation these have a have a statutory role and must be consulted where SuDS will discharge near/to a canal, whether directly or indirectly. Where a discharge ultimately leads to a canal, Warrington Borough Council will ensure that the applicant not only has the Third Party Landowner's permission but also ensure that the applicant (and if necessary the third party landowner) has permission from the relative canal company.

3.6 Approval

The approval of SuDS within an application will be determined by Warrington Borough Council Planning Department, who will base their decision on the recommendations made by Warrington Borough Council's Asset and Flood Risk Division and the other consultees. This may take the form of planning conditions.

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

The statutory time limits are usually 13 weeks for applications for major development and 8 weeks for all other types of development (unless an application is subject to an Environmental Impact Assessment, in which case a 16 week limit applies).

Where a planning application takes longer than the statutory period to decide, an extended period needs to be agreed with the LPA and the applicant. Where this has not been agreed, the government's policy is that the decision should be made within 26 weeks at most in order to comply with the 'planning guarantee'. The planning guarantee is the government's policy that no application should spend more than a year with decision-makers, including any appeal. In practice this means that planning applications should be decided in no more than 26 weeks, allowing a similar period for any appeal. The planning guarantee does not replace the statutory time limits for determining planning applications.

Currently, only large scale applications require SuDS but any future changes in legislation may change this requirement.

3.7 Adoption Process

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

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

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

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

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

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

Further details of SuDS Maintenance can be found in Section 8 of this guide.

3.8 Other Consents

In addition to planning approval, Developers may also need to obtain further consents to discharge. The LLFA will require evidence of compliance from the responsible authority, as outlined in the Table 3.2.

Table 3.2: Other Consents

Consent	Responsible Authority	Summary
Land Drainage Consent (Ordinary Watercourse) (Land Drainage Act, 1991, Section 23)	LLFA where outside an Internal Drainage Board (IDB) area. IDBs for IDB areas.	This is for works on ordinary watercourses that could affect flows, such as new culverts, weirs, protruding outfalls and bridges with supports in the channel. See LLFA website for further information.
Flood Defence Consent (Water Resources Act, 1991, Section 109)	Environment Agency	This is for works in, over, under or adjacent to (within 8m) main rivers. More information is available via the GOV.UK website 'Permission to do work on or near a river, flood or see defences (England) https://www.gov.uk/permission-work-on-river-flood-sea-defence
Environmental Permits for Waste or Emissions	Environment Agency / Local Authority	An environmental permit may be required for a business which manages or produces waste or emissions that pollute the air, water or land. These cover a range of activities including waste management, pollution prevention and control (PPC) permits, discharge consents, groundwater authorisations, abstraction licensing and radioactive substances regulation (RSR). More information is available via the GOV.UK website 'Check if you need an Environmental Permit' https://www.gov.uk/guidance/check-if-you-need-an-environmental-permit/overview
Protected Species and Habitats	Natural England	The disturbance of certain protected species and their habitats require a licence from Natural England. Other habitats and species are protected by legislation and policy. In all cases avoidance and mitigation of harm is required. Habitat and species survey and assessment is required to support most planning applications, see GOV.UK website Protected species and sites: how to review planning proposals https://www.gov.uk/guidance/protected-species-how-to-review-planning-applications
Listed Building Consent	Local Planning Authority	Consent from the Local Planning Authority (or in some circumstances the Secretary of State) for the demolition of a listed building or the carrying out of any works for the alteration or extension of a listed building in any manner that would affect its character as a building of special architectural or historic interest. More information is available from Historic England. https://historicengland.org.uk/advice/hpg/hpr-definitions/l/536329/
Scheduled Monument Consent	Secretary of State for Culture, Media and Sport.	Application for Scheduled Monument Consent (SMC) must be made to the Secretary of State for Culture, Media and Sport before any work can be carried out which might affect a monument either above or below ground level. More information is available from Historic England. https://historicengland.org.uk/advice/planning/consents/smc/
Adoption of a sewer (Water Industry Act 1991, Section 104)	Water and Sewerage Companies (United Utilities)	Links to the appropriate Water and Sewerage Company websites for the applicable forms, processes and guidance is provided within the LLFA appendices. Systems which drain either private areas such as roofs and driveways or highway drainage can be adopted through a
Connection to a sewer (Water Industry Act 1991, Section 106)		

Consent	Responsible Authority	Summary
Building over or close to a sewer (within 3m) (Building Regulations, 2015, Document H)		Section 104 Agreement. A specific condition of a Section 104 agreement is that the new sewer development meets a Mandatory Build Standard (MBS), which sets out the required standards in the design and construction of new sewers and lateral drains.
Connection to an existing highway drain or adoption of highways drainage (Highways Act, 1980, Section 38/Section 50)	Highway Authority	It is illegal to discharge drainage directly on to the highway or to connect without consent, private drainage into a highway drainage system.
Highways Technical Approval Category D	Highway Authority	This relates to the design of large drainage structures (900mm or above in diameter) under the public highway
Third party landowner permissions	Third party landowner	Disposal of development runoff via an existing culverted land drain or watercourse is not in general a favoured design solution. Any decisions on using this method of disposal should be informed by an assessment of the condition of the culvert. Where a developer proposes to discharge surface water via third party land into a connecting sewer or watercourse or where surface water discharges to a third party owned pipe, sewer or drain, a legal agreement will need to be in place. This agreement must ensure that responsibilities for any maintenance duties are clarified. Where there is an existing legal right of discharge via a pipe, ditch or overland flow through that site a new legal agreement will not be necessary. Evidence of discussions with landowners will be required. At full application stage the LLFA will require evidence of compliance with the need for obtaining additional consents, particularly where an inability to obtain these would affect the feasibility of the proposed drainage system. At outline stage, they may request evidence of compliance, where not obtaining such consents would render a proposed scheme unworkable.
Stopping Up or Diverting Public Rights of Way	Local Planning Authority	If planning permission has been granted and your proposed development will require a footpath, bridleway or restricted byway to be stopped up or diverted to allow the development to take place, you should apply to the relevant local authority through the planning process to do so.

4 SuDS Components and Design Considerations

What this section will cover:

- National standards for SuDS
- The SuDS Management Train and runoff destination
- Different SuDS components and site challenges

4.1 National Standards

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

WAY MARKER 4.1

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

Ideally SuDS should be designed with the minimum amount of underground or traditional piped linkage as possible. The Designer should always aim to use conveyance channels, swales or infiltration trenches to connect SuDS features wherever possible.

SuDS should therefore be designed with these standards in mind:

- Design;
- Construction;
- Maintenance, and;
- Operation.

WAY MARKER 4.2

A checklist for SuDS assessment is contained within Appendix A of this guide. It outlines the requirements for SuDS as part of a planning application to Warrington Borough Council with reference to the national standards and advice provided in this guidance document

The following criteria should also be considered:

- **Function** - as well as treating and attenuating runoff, SuDS should be designed with multiple benefits in mind such as public friendly spaces, enhance and create new niche habitats, encouraging wildlife to flourish, in turn creating a better places to live.

- **Maintenance** - all SuDS features should be easily maintained with suitable access provisions included.

- **Aesthetics** - designs should be appealing to the eye, use of native planting can enhance even the simplest of SuDS features.

4.2 SuDS Management Train

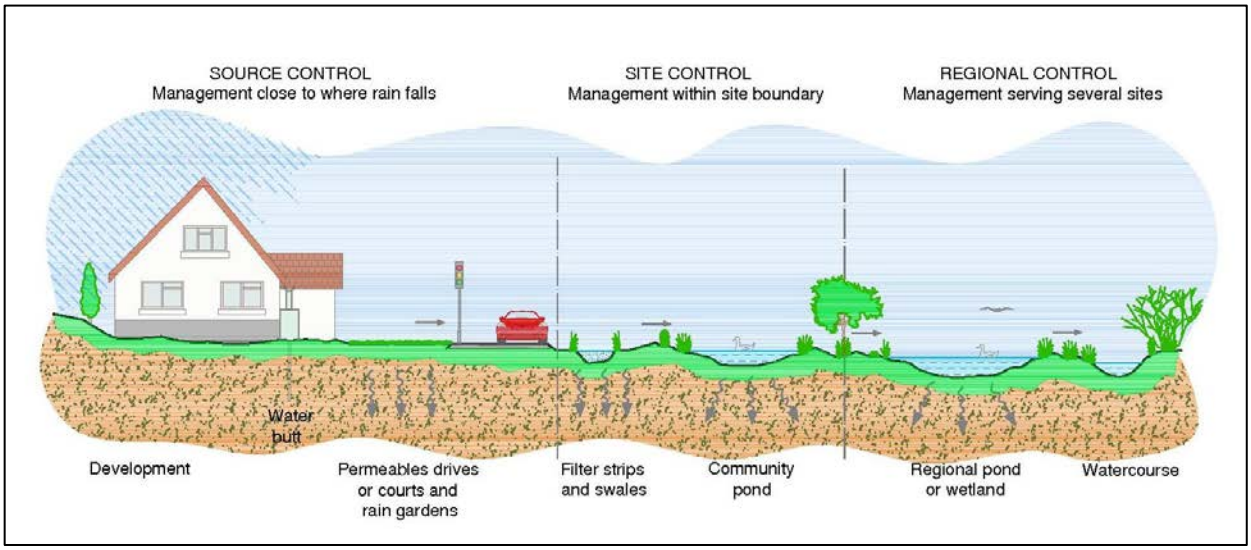
The 'Management Train' concept aims to highlight how a series of techniques may be employed in order to reduce the effect which the additional urban runoff from a development may have on the surrounding environment and watercourse as well as ensuring that pollutants and sediment are removed before water enters the watercourse.

This is considered in terms of:

- **Prevention** (reducing the introduction of impermeable surfaces),
- **Source Control** (restricting and reducing runoff to receptors within the catchment),
- **Site Control** (managing surface water at the location of development),
- **Regional Controls** (maintaining and establishing blue networks and storage).

There are many SuDS features that can be incorporated into any drainage scheme. Features should be selected based on how they fit in the SuDS Management Train, how they would fit in the local context and the suitability of the site (function, maintenance, adoptability and land available).

Figure 4.1: Control Measures



4.3 The SuDS Design Philosophy

SuDS are designed to control surface water runoff close to where it falls, mimic natural drainage as closely as possible and provide similar drainage conditions post development to the pre-development site.

SuDS can provide betterment to drainage from brownfield sites and can also aim to reduce diffuse pollution in urban runoff and maximise environmental and social benefits.

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

Urban runoff increases the volume of storm water runoff compared to greenfield runoff, especially for frequent rainfall events. Rainfall on developed land does not tend to infiltrate into the soil as much as greenfield, leading to higher runoff volumes. To minimise the impact of this additional runoff, the use of infiltration systems is encouraged where appropriate. Infiltration shall be provided using the following types of SuDS:

1. Swales (dry and conveyance);
2. Filter strip;
3. Infiltration trenches;
4. Bio-retention.

Where infiltration does not provide sufficient reduction of runoff, the use of long-term storage to address this additional runoff volume shall be provided.

Long term attenuation storage shall be provided in the following types of SuDS:

1. Detention ponds;
2. Detention basins;
3. Underground storage.

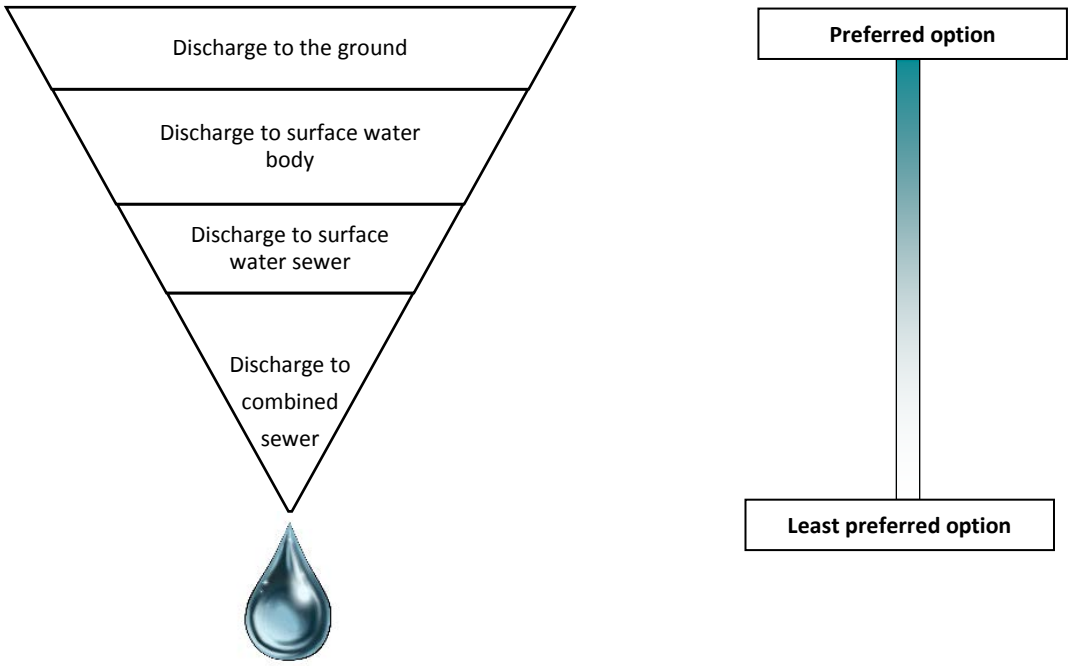
The options are listed above in order of preference. Subject to site constraints and the results of a risk assessment, ponds can provide the most effective water treatment. Underground storage does not provide water quality benefit and can only be used in conjunction with other SuDS.

4.4 Runoff Destination

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

As shown in Figure 4.2, other options of discharging to a surface water body, to a surface water sewer, or a combined sewer (in that order of preference) should be explored where infiltration is not fully possible. Surface water should **NEVER** be discharged to the foul sewer. Connections from developments are not permitted onto highway drainage unless they comprise solely water from highway gullies.

Figure 4.2: Discharge Hierarchy



4.5 Calculations for Surface Water Runoff

Once the preferred method of discharge has been decided, the following details are required for the SuDS section of the planning application:

- Peak runoff flow calculations and results to demonstrate pre- and post-development runoff rates in relation to greenfield runoff rates. For redevelopment sites, actual existing brownfield rates will be taken into consideration;
- Discharge volume calculations and results;
- Simulation modelling of runoff;
- Flood risk (from surface water, coastal, river and groundwater sources).

Details of how to undertake these calculations are provided in Section 7.

Levels in the receiving watercourse need to be taken into consideration to assess, if any, potential increase which may contribute to increase in flooding downstream.

4.6 Hazard Levels and Stages of Treatment

Table 4.1: Hazard designation of surface water runoff

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

Table 4.2: Treatment levels required for proposed discharge to the ground

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

NB. Surface runoff from roof drainage must be isolated from other sources where it is discharged to G1 and G2.

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

Table 4.3: Treatment levels required for proposed discharge to a waterbody

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

NB. Where discharge to a sensitive surface water body (defined as any catchment smaller than 50km^2; any catchment with less than 20% urbanisation; any catchment with an environmental designation or national or international recognition, or any catchment where good ecological status is at risk), one extra treatment stage must be added.

4.7 The SuDS Design Process

4.7.1 Design Team for SuDS

The design team should incorporate a range of people and organisations in order to ensure a holistic approach to the design process. By identifying the likely considerations which need to be made for the SuDS application early on, this will avoid potential delays and exceedance of time and budget allocated.

The design team should include a Drainage Engineer with experience of design SuDS. Other potential design team members may include:

- Urban Designer;
- Landscape Architect;
- Town Planner;
- Ecologist;

- Highways Engineer;
- Land Developer;
- Architect.

4.7.2 SuDS Design Process Flowcharts

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

1. **Set strategic surface water management objectives;**
2. **Conceptual design** – including initial design and layout;
3. **Outline design** – including sizing and optimisation;
4. **Detailed design** – including testing and finalisation of the scheme.

Figures 4.3 – 4.6 describes best practice for the SuDS design process based on the **CIRIA SuDS Manual C753**.

Figure 4.3: Design Stage 1- Set Strategic Surface Water Management Objectives Discharge Hierarchy

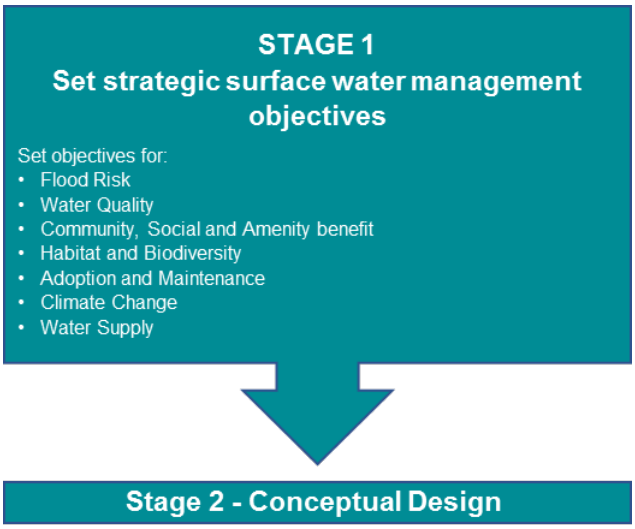


Figure 4.4: Design Stage 2- Conceptual Design

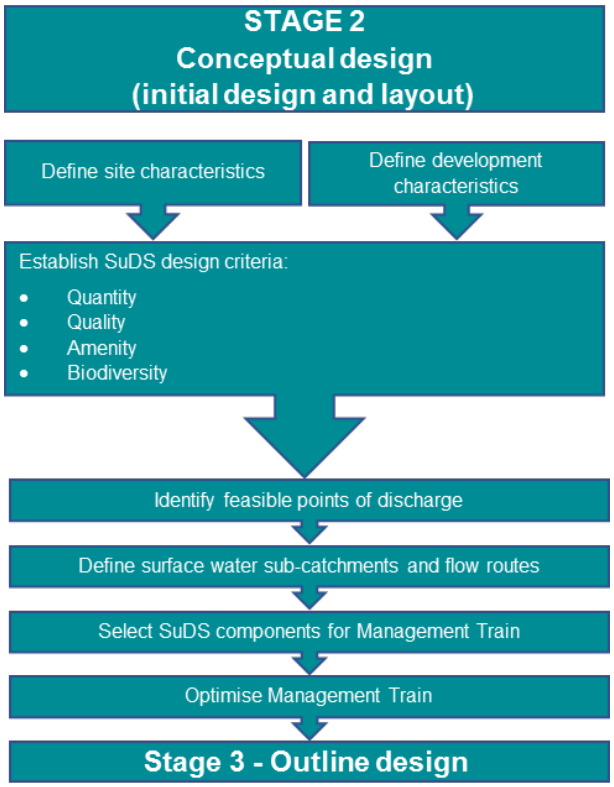


Figure 4.5: Design Stage 3 – Outline Design

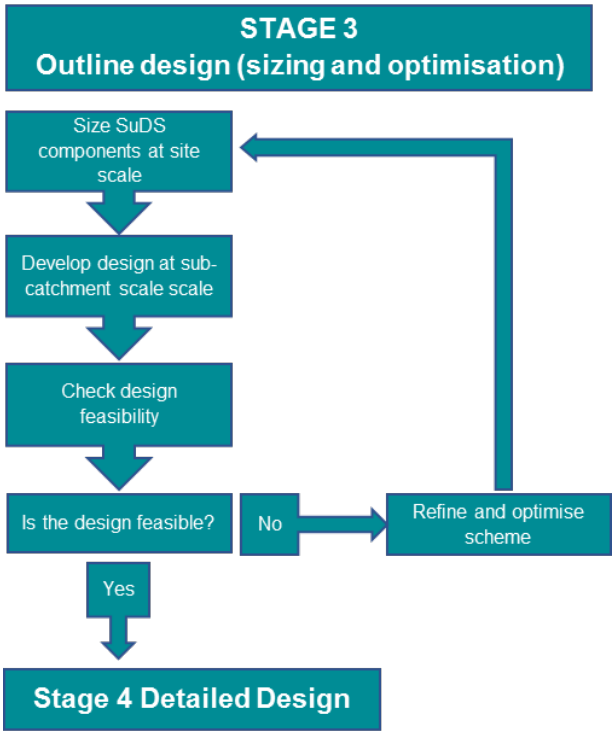
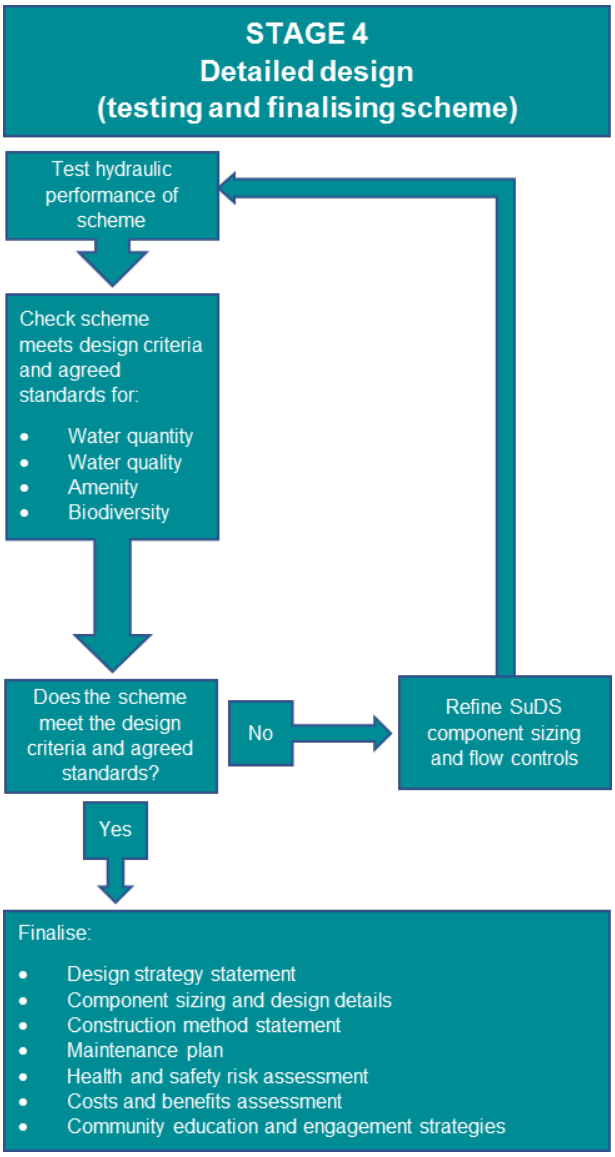


Figure 4.6: Design Stage 4 – Detailed Design



4.8 Design Considerations

There is a variety of SuDS components which may be used independently or as a combination to fit into a SuDS Management Train.

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

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

5 SuDS Suitability for Warrington Borough Council Area

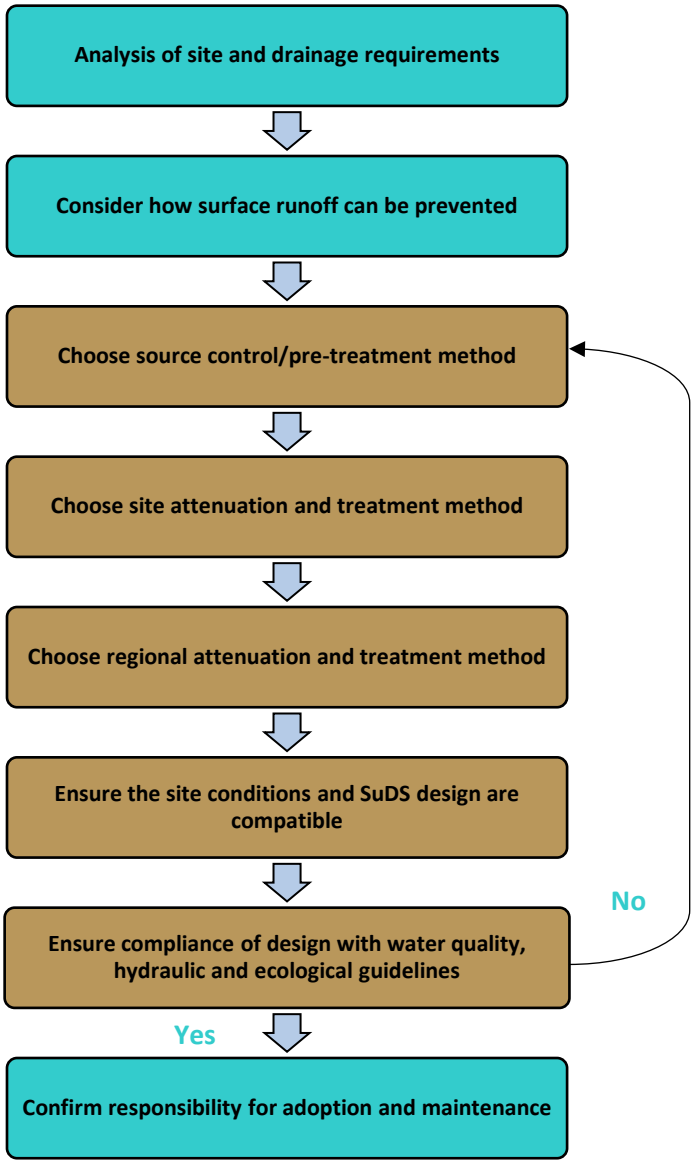
What this section will cover:

- Choosing SuDS components
- The SuDS Selection Matrix
- Considerations for discharge in the Warrington area

5.1 Choosing SuDS Components

One of the key elements of designing a site with SuDS is the decision about which components to use. As described in the previous chapter, there are a variety of SuDS components but not all will be suitable for all sites. It is therefore vital to have a comprehensive understanding about the nature of the site, particularly if there is contaminated ground and to ensure that a constant review is undertaken from project inception to SuDS operation. Figure 5.1 below describes best practice for this decision making process based on the **CIRIA SuDS Manual C753**:

Figure 5.1: How to Select SuDS Components



5.2 SuDS Suitability Matrix

To assist in the selection of appropriate SuDS, Appendix C includes a **SuDS Suitability Selection Matrix,** derived from **CIRIA SuDS manual C753**, which identifies the various benefits and constraints of common SuDS techniques.

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

1. Land use suitability,
2. Water quantity suitability,
3. Water quality suitability,
4. Environmental benefits,
5. Cost suitability.

5.3 Discharge Considerations

The types of SuDS should be chosen to suit the local conditions. Other considerations and actions that should be undertaken include:

- Calculations of pre- and post-development runoff rates to ensure a neutral or better impact as appropriate;
- Consideration of the method of attenuation;
- Identification of whether the site lies within the coastal/tidal, fluvial or surface water (pluvial) flood outlines, or affected by groundwater;
- Consideration of the effects of climate change upon surface water volumes and flow pathways;
- Consultation with the relevant bodies depending on the location to which surface water is to be discharged:
    - To the ground - consultation (where relevant) with the Environment Agency, National Coal Authority, British Geological Survey;
    - To surface water bodies - consultation (where relevant) with the Environment Agency, Manchester Ship Canal Company (for discharge near/to the Manchester Ship Canal, Bridgewater Canal, New Cut Canal) or Warrington Borough Council (for discharge near/to the St. Helen's Canal);
    - To a surface water sewer or combined sewer - consultation (where relevant) typically with United Utilities, or the Highways Authority (for highway drainage only).

5.4 Local SuDS Zones

Warrington has four predominant soil types which are described in the subsequent sections with regards to which SuDS components are most suitable. The key areas are:

- Clay and Silt Soils;
- Sand and Gravel Soil;
- Peat and Glacial Deposits;
- Other soil types.

Disposal of surface water via infiltration to ground should be considered first when developing a SuDS design. Maps of the predominant soil types in the Warrington area can be found in Appendix E.

Preliminary information on whether a site may be suitable for infiltration can be obtained from the **British Geological Survey (BGS) Infiltration SuDS Map** (chargeable data).

Where infiltration drainage techniques are indicated to be potentially viable, soil testing is necessary to quantify soakage rates. Guidance on undertaking these tests is available in **Part H of the Building Regulations** which is freely available from the **Planning Portal**.

Note that where soakaways are proposed to serve areas above 2 hectares the testing methodology should follow **BRE Digest 365** or the latest appropriate guidance should this methodology be revised.

For large sites it is recommended that infiltration testing be undertaken in close proximity to where soakaways or infiltration devices would be or are likely to be placed.

BRE Digest 365 includes design guidance which states that soakaways should be designed for the 10% Annual Exceedance Probability event. Where a soakaway is designed to accommodate only the 10% Annual Exceedance Probability event, a developer must either:

- Undertake an exceedance flow route exercise to ensure that flows in excess of those produced by the 10% Annual Exceedance Probability event do not affect people or property, or;
- Redesign the soakaway to cater for the 1% Annual Exceedance Probability event with an allowance for climate change (20% allowance on rainfall intensity for non-residential developments and 30% allowance on rainfall intensity for residential developments).

At sites where infiltration is not viable, the discharge hierarchy summarised in Section 4 Figure 4.2 should be followed and an alternative SuDS technique used.

WAY MARKER 5.1

British Geological Survey (BGS) Infiltration SuDS Map
http://www.bgs.ac.uk/products/hydrogeology/infiltrationSuDS.html

Part H of the Building Regulation – Drainage and Waste Disposal
https://www.gov.uk/government/publications/drainage-and-waste-disposal-approved-document-h

BRE Digest 365
https://www.brebookshop.com/details.jsp?id=327592

5.4.1 Clay and Silt Soils

Soil Description

SuDS aim to mimic natural drainage patterns as they would occur with a range of ground conditions. Clay and silt dominated soils have a limited infiltration potential and SuDS in these soils will tend to collect, clean and store rainfall before conveying it into the nearest watercourse, drain, or sewer. Even on clay soils, some infiltration will occur and will bring associated benefits for reducing runoff volume and groundwater recharge. Other water losses will occur through the implementation of green infrastructure by transpiration and evaporation. However, appropriate SuDS design which assumes a realistic level of infiltration will be needed to create a SuDS Management Train that works with the existing ground conditions.

Possible Constraints

Clay and silt soils also present other constraints that will need to be given appropriate consideration including:

- Landslide hazards on steeply sloping sites;
- Perched or shallow groundwater table that could present buoyancy problems or a pathway for pollutants to reach groundwater sources;
- Risk of swelling clays and underground piping.

It is most likely that volume reduction will be difficult to achieve and peak flow rate reduction will be the main water management solution.

Possible Opportunities

The low permeability of these soils makes above ground surface water management easier to implement, operate and maintain.

SuDS in these areas are more likely to be in proximity to existing wetland habitats and will be naturally exploited by existing flora and fauna. When implemented through good design practice this can enhance developments making better places to live and work.

As clay and silt soils are aquicludes, it is less likely that groundwater protection zones will be affected by surface water SuDS.

Due Diligence

It is recommended that developers complete the following due diligence to fully investigate the opportunities and constraints for SuDS in these areas:

- Surface water flooding;
- Receptor sensitivity checks;
- Groundwater protection status;
- Ground investigations;
- Pre and post development runoff rate and volume checks;
- Ensure SuDS land take is accounted for in the development plans.

Most suitable SuDS

- Swales;
- Detention Basins;
- Ponds.

5.4.2 Sand and Gravel Soils

Soil Description

SUDS aim to mimic natural drainage patterns as they would occur with a range of ground conditions. Sand and gravel dominated soils have a larger, more open texture that are generally more permeable soils. These soils tend to produce less runoff as water infiltrates more rapidly into the ground. The ability of the soil to drain provides a more stable soil mass and reduces hydrostatic pressures that could lead to land slip. However, these soils are also more susceptible to erosion and are more likely to be affected by fluctuating groundwater levels. These characteristics also mean that there can be a direct pathway for pollutants to enter underlying aquifers and adequate pre-treatment needs to be achieved prior to disposing of surface water to ground.

Possible Opportunities

The higher permeability of these soils is more likely to be suitable for soakaway techniques. It should be possible in most cases to match predevelopment runoff rates and volumes to provide a neutral development impact.

A full range of SuDS techniques (subject to other geotechnical conditions such as contamination and groundwater) can be applied in these types of soils.

Possible Constraints

Sand and gravel dominated soils tend to be more erodible. SuDS techniques that are designed to retain water, such as ponds, may need to be lined to prevent water dissipating into the ground and drying up.

Buoyancy of certain SuDS, including pond liners, needs to be considered in fluctuating groundwater conditions.

Direct disposal of surface water to ground may not be acceptable for all developments as highly permeable soils can provide a direct pollution pathway to aquifers within groundwater protection zones.

Water balance needs to be considered in the Management Train, as water sensitive SuDS such as ponds at the end of a SuDS train need to receive sufficient water to thrive and function as designed.

Due Diligence

It is recommended that developers complete the following due diligence to fully investigate the opportunities and constraints for SuDS in these areas:

- Surface water flooding;
- Receptor sensitivity check;
- Groundwater protection status;
- Ground investigations (including the assessment of seasonal groundwater levels);
- Pre and post development runoff rate and volume checks;
- Ensure SuDS land take is accounted for in the development plans.

Most Suitable SuDS

- Infiltration trench;
- Dry Swale;
- Pond (with liner).

5.4.3 Peat and Glacial Deposits

Soil Description

SuDS aim to mimic natural drainage patterns as they would occur with a range of ground conditions. These areas are a combination of organic deposits that form peat, which can hold water, thereby creating wetter conditions and mixed unsorted glacial deposits which can be free draining. Individually these form very different landscape and hydrological characteristics, but when combined make particularly good soils for farming practices. Areas of significant peat deposits tend to be found around ponds, mires and bogs and the geotechnical characteristics are not normally conducive to standard development.

Possible Opportunities

The low permeability pockets within these soils makes above ground surface water management easier to implement, operate and maintain.

The higher permeability pockets within these soils may be suitable for soakaway techniques. It may be possible to match predevelopment runoff rates and volumes to provide a neutral development impact.

SuDS in these areas are more likely to be in proximity to existing wetland habitats and will be naturally exploited by existing flora and fauna. When implemented through good design practice this can enhance developments making better places to live and work.

Possible Constraints

These soils tend to be very variable and need to consider all the constraints of other soils types.

These soils can be compressible, susceptible to erosion, underground piping and landslide hazards on steeply sloping sites.

Perched, shallow, and seasonally variable groundwater table could present buoyancy problems or a pathway for pollutants to reach groundwater sources.

SuDS aim to work with the natural environment. It is not desirable to remove peatland landscapes as these tend to provide ecological conditions and habitat for a distinctive fauna and flora.

Due Diligence

It is recommended that Developers complete the following due diligence to fully investigate the opportunities and constraints for SuDS in these areas:

- Surface water flooding;
- Receptor sensitivity checks including environmental designation;
- Groundwater protection status;
- Ground investigations (including the assessment of seasonal groundwater levels);
- Pre and post development runoff rate and volume checks;
- Ensure SuDS land take is accounted for in the development plans.

Most Suitable SuDS

- Swale (wet and dry);
- Filter drain (with liner);
- Pond (with liner and rubble ballast layer.)

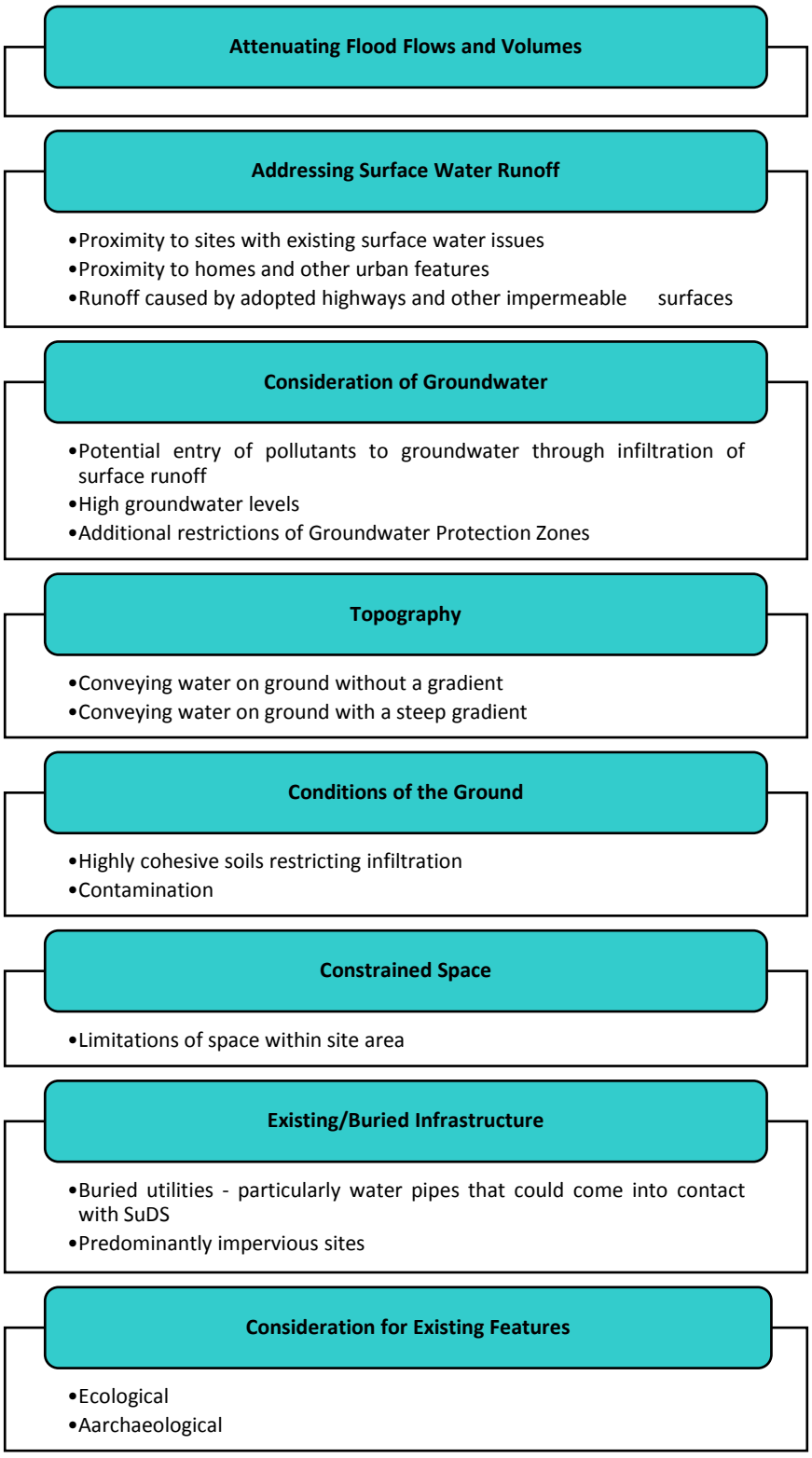
5.4.4 Other Soils

Soil Description

The other soils category in the Warrington area generally refers to superficial deposits of glacial till comprising of boulder clay with irregular bands or lenses of sand and gravel, river alluvium, or marine/estuarine clay sand and silt. The top layers of the till are likely to be weathered, siltier and somewhat softer than the underlying soils. Extremely variable nature of the soils requires sites to be considered on a site by site basis taking cognisance of the possible opportunities and considerations noted for all the other soil types.

5.5 Site Challenges

Figure 5.2: Summary of Site Challenges



5.5.1 Brownfield Sites

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

If the site drains to a combined sewer (a sewer receiving both foul and surface water flows) that is unlikely to be converted to a separate system, the surface water should be treated with a

single stage of treatment to remove grit and coarse solids. Foul sewage should be drained separately within the site.

An important criterion for all sites is the quantity of runoff. Sites discharging directly to a watercourse may potentially increase the risk of fluvial flooding. Sites discharging to combined sewers may potentially activate the operation of Combined Sewer Overflows (CSOs), resulting in increased pollution of the receiving watercourse, or increase the risk of flooding from the sewer network and/or asset failure. In the majority of circumstances United Utilities, or other interested consultees, will request a set limited rate of discharge to the receiving system or detain flows on-site until a pre-determined level with the receiving system has been achieved.

5.5.2 Contaminated Land

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

WAY MARKER 5.2

Remedial treatment for contaminated land, Volumes I - XII (SP164)

http://www.ciria.org/ItemDetail?iProductCode=SP164&Category=BOOK&WebsiteKey=3f18c87a-d62b-4eca-8ef4-9b09309c1c91

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

5.5.3 Groundwater Conditions

As well as the permeability of the soil, the position of the water table beneath a development site has a bearing on the design of a SuDS scheme. For most schemes the groundwater table should be at least 1 m below the base of the SuDS component. This is necessary to ensure that there is space for a local rise in groundwater that may result from storm water infiltration.

WAY MARKER 5.3

British Geological Society
http://www.bgs.ac.uk/research/groundwater/datainfo/levels/levels_data.html

Seasonal variation in groundwater levels should also be considered. Information on groundwater levels suitable for an outline application can be obtained from the British Geological Society.

Site specific ground investigations are required for a full or reserved matters application. As well as informing the infiltration capacity of the ground, these should identify the likely groundwater table level.

In areas where groundwater levels are high, SuDS should be designed to be on the surface or shallow in depth to prevent them becoming inundated with groundwater. Liners can be used to control infiltration and the movement of groundwater where necessary.

5.5.4 Natural and Historic Site Drainage Patterns

SuDS are most cost effective when designed to work with the natural and historic drainage patterns of a site; consequently SuDS design should begin with an assessment of these. The analysis should look at site topography, geology and soils and identify the presence of any existing or historical drainage features e.g. culverts, sewer networks, mill leats, and water

meadows. Flow routes can then be mapped out. This process may lead to the designation of small, discreet drainage areas that have their own drainage characteristics (sub-catchments).

This assessment should also be informed by ecology survey information as existing wetlands may support important habitats or species. There are a range of tools freely available to do this:

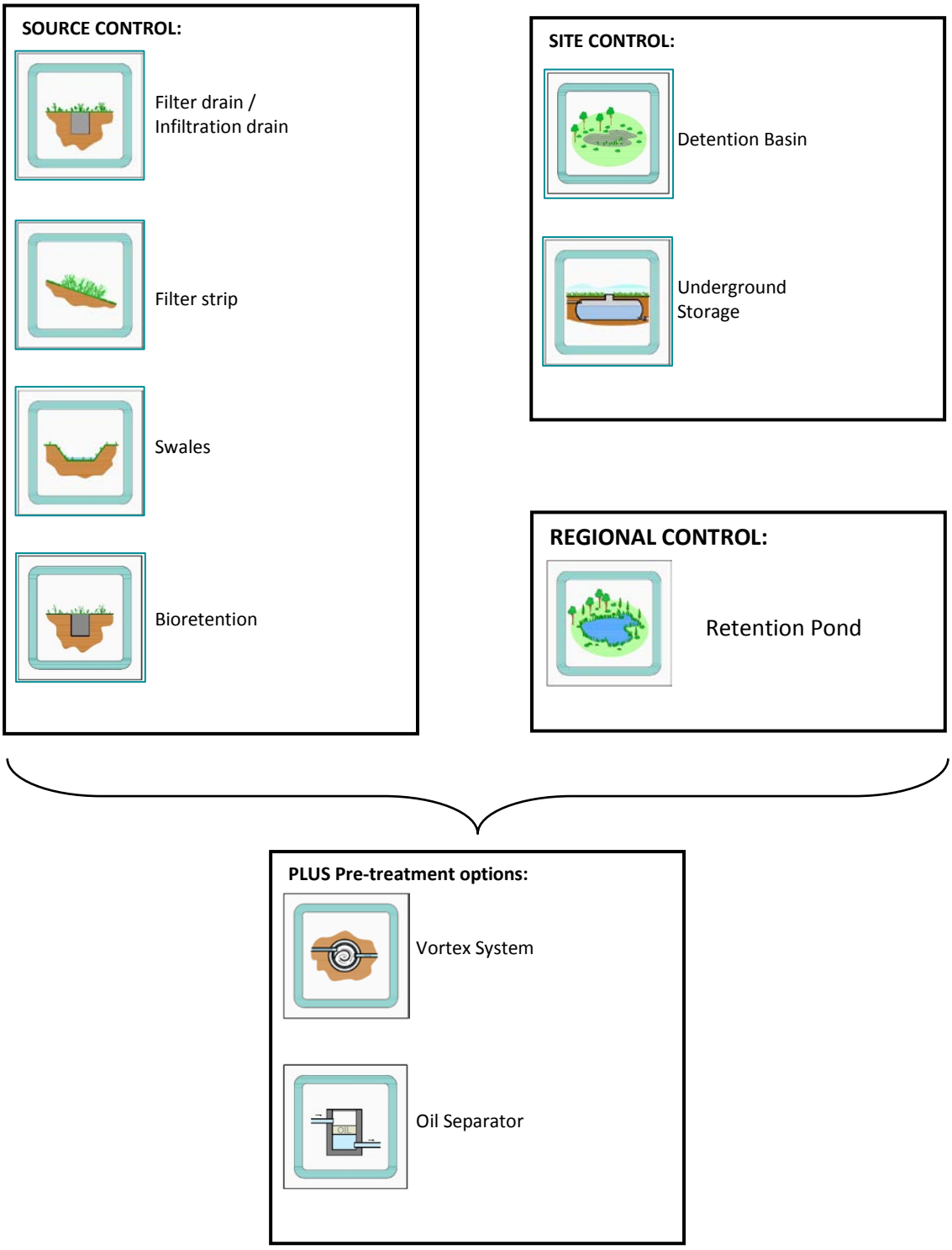
- LiDAR Data available free of charge;
- Information on geology and soils, freely available from the British Geological Society;
- Historical Maps.

5.6 Types of permitted SuDS

There are a variety of SuDS components which are considered suitable within the Warrington Borough Council area. They may be used independently or as a combination (SuDS Management Train).

Figure 5.3, and the subsequent sections of this document, summarises these SuDS components which have been categorised according to how they fit within the SuDS Management Train (source, site and regional controls).

Figure 5.3: Types of permitted SuDS



6 General Design Requirements

What this section will cover:

- General design requirements for submission

6.1 Design Submissions

6.1.1 Acceptance

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

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

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

- Maintenance Companies;
- United Utilities;
- Warrington Borough Council, and;
- Owners/occupiers.

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

The complete surface water drainage system for a development (sewers and SuDS) could be partly private, partly adopted by United Utilities and partly owned and maintained by a third party but not Warrington Borough Council.

6.1.2 Design Philosophy

SuDS are designed to control surface water runoff close to where it falls, mimic natural drainage as closely as possible and provide similar drainage conditions post development to the pre-development site. SuDS also aim to reduce diffuse pollution in urban runoff and maximise environmental and social benefits.

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

Urban runoff increases the volume of storm water runoff compared to greenfield runoff, especially for frequent rainfall events. To minimise the impact of this additional runoff, the use of infiltration systems is encouraged where appropriate. Infiltration shall be provided using the following types of SuDS:

A. Swales (dry and conveyance);
B. Filter strip;
C. Infiltration trenches;
D. Bio-retention.

Where infiltration does not provide sufficient reduction of runoff, the use of long-term storage to address this additional runoff volume shall be provided.

Long term attenuation storage shall be provided in the following types of SuD systems:

A. Detention ponds;
B. Detention basins;
C. Underground storage.

The options are listed above in order of preference. Subject to site constraints and the results of a risk assessment, ponds can provide the most effective water treatment. Underground storage does not provide treatment and can only be used in conjunction with other SuD systems.

Local Standard B - Pollution Prevention and Control

Warrington Borough Council will expect the SuDS to demonstrate how pollutants are prevented or controlled as part of the SuDS scheme. This should include consideration of the sensitivity of receiving waterbodies and particular attention should be given to the first 5mm of rainfall ('first flush' that mobilises the most pollutants).

Local Standard C - Conformity with the SuDS Management Train Principles

Warrington Borough Council will expect the SuDS design to demonstrate how the principles of the SuDS Management Train have been taken into account.

6.1.3 General Design Requirements

The Developer is responsible for the design of SuDS. The design shall be supported by a risk assessment to ensure risks to both the local community and operators of the drainage system are minimised. The Developer and/or their designer shall certify that their design complies with this design guide and the **Construction, Design and Management (CDM) Regulations 2015** and accept liability for compliance through their professional indemnity insurance. **These responsibilities/liabilities shall not be discharged to Warrington Borough Council or their representatives through the planning consent process.**

A risk assessment should be undertaken by the organisation approving the drainage (drainage approving body) when assessing the design of the SuDS scheme. The asset owner, or occupier, is ultimately responsible for conducting a suitable and sufficient assessment of the SuDS for the use, inspection and maintenance of the system.

SuDS designs shall be carried out in accordance with this guide and the best practice principles in current UK drainage guidance – **The SuDS Manual C753 (CIRIA).**

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

The Developer should pay particular attention in Warrington Borough Council's Master Planning to the requirement for no obstructions within 8 meters of the edge of the watercourse.

Design submission requirements to Warrington Borough Council (calculations, drawings and construction details) for private SuD systems and pipe drainage, are presented in Appendix A - Checklist for SuDS assessment and form part of the audit for the design of the proposed system.

The complete surface water drainage system for a development (sewers and SuD systems) could be partly private, partly adopted by United Utilities and partly owned and maintained by a third party.

6.1.4 Drawings, Calculations and Manhole Records

Drawings and calculations of the complete drainage system should be supplied with the application for SuDS assessment.

All drawings and calculations submitted should be in metric units.

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

Location and layout plans, sections and details should show the proposed SuDS and drainage system in full including private SuDS. Plan scales should be those in common use, i.e. 1:20, 1:50 and 1:100 as appropriate. The plans submitted shall include all the information required in Appendix A – SuDS Design Checklist.

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

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

6.2 Surface Water Drainage Design

Sewer Design Details

For details on the layout of pipework for surface water sewers, design of manholes, depths of sewers and minimum sewer diameters, reference should be made to text below.

Hydraulic Design

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

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

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

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

An additional increase in the paved surface area of 10% shall be assumed for all areas to allow for future urban expansion (extensions and additional paved areas) unless this would produce a figure greater than 100% of the site. Refer to Section 6.3 for further information.

Design event rainfall should be based on the use of the most recent version of the **Flood Estimation Handbook** specific to the location of the development. An allowance for climate change of an additional 20% (by factoring the rainfall intensity hyetograph values) should be applied unless otherwise specified.

WAY MARKER 6.1
Climate Change & Peak Rainfall Intensity Allowance

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

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

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

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

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

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

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

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

6.3 Urban Creep

Urban creep is the gradual loss of permeable surfaces within urban areas which results in increased surface water runoff. Typical examples of urban creep include the creation of patios, the paving over of front gardens to generate space for parking or small scale house extensions. To ensure that SuDS schemes can cope with future demand, an allowance for urban creep must be made in the design calculations.

Warrington Borough Council will expect the SuDS design to include an allowance for an increase in impermeable area to accommodate urban creep as set out in Table 6.1.

Table 6.1: Urban Creep Allowance

Residential Development Density (dwellings/ha)	Change Allowance (% of impermeable area)
<=25	10*
30	8
35	6
45	4
>=50	2
Flats and Apartments	0

*Default value suggested by CIRIA.

6.4 Attenuation Storage

The limiting discharge rates from the site should normally be assessed using the **Flood Estimation for Small Catchments (Institute of Hydrology, 1994).** For areas smaller than 50 ha it should be applied for 50 ha and linearly interpolated to the development area. Values should be determined for the 1 in 1 year, 1 in 30 year and 1 in 100 years as a minimum. An example calculation and tool for assessing greenfield runoff rates in the Warrington Borough Council area is provided in Appendix B.

WAY MARKER 6.2

Flood Estimation for Small Catchments
http://nora.nerc.ac.uk/7367/1/IH_124.pdf

CIRIA Drainage of development sites - a guide (X108)
http://www.ciria.org/Resources/Free_publications/drainage_of_development_sites.aspx

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

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

WAY MARKER 6.3
Calculation for greenfield runoff peak flows
(Institute of Hydrology Report 124)

$$QBAR_{rural} = 0.00108*AREA^{0.89}*SAAR^{1.17}*SOIL^{2.17}$$

$QBAR_{rural}$ = Mean annual runoff for rural (greenfield areas).

AREA = area of the site in hectares.
To be used as a decimal for the calculation (i.e. 0.5 for 50 hectares)
If the site is smaller than 50 hectares, the calculations should be undertaken using 50 hectares and then amended (by dividing by the actual site area) at the end of the calculation.

SAAR = Standard Average Annual Rainfall.
The SAAR for Warrington should be kept to the set value of 810.

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

Soil Description	Soil value for calculation	Soil Wrap Classification
Peat (waterlogged)	0.50	5
Clay	0.50	
Clayey loam	0.45	4
Loam	0.40	3
Sandy Loam	0.30	2
Sand	0.15	1

6.5 Sewers

Sewers and connecting pipework should be designed to the requirements of the Undertaker and **Sewers for Adoption 7th Edition.**

6.5.1 Flood Risk

The Water and Sewerage Companies (i.e. United Utilities) will be able to advise of flood risk from the sewerage network, either from existing public sewers crossing the development or where the connection of new development drainage may affect flood risk (e.g. low lying connections). Where a surface water connection to a public sewer may be required they will be able to provide advice as to whether there are likely to be capacity constraints on the sewerage network which may need to be considered as part of SuDS design to ensure additional flows do not adversely impact on flood risk from the sewerage network.

6.5.2 Assets

It is illegal to build over or close to a public sewer without first gaining approval. Where practical, any components of SuDS should be located at least 3m from a public sewer. Where it is not practical to relocate the SuDS feature, or divert the public sewer, a formal 'Building Over Agreement' will be required. This ensures that the Water and Sewerage Company can access the pipe in the event of any problems.

6.6 Peak Flow Rate and Volume

Peak flow rate and volume does not apply to any surface runoff that is discharged:

- By infiltration, or;
- To a coastal or estuarial water body, or;
- To an alternative water body where Warrington Borough Council considers it appropriate to do so.

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

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.

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.

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.

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.

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.

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.

6.6.1 Low Rainfall

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

6.6.2 High Rainfall

Either of the two approaches below must be used to manage the surface runoff discharge, unless Peak flow rate and volume does not apply:

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

The peak flow rates for the:

A. 1 in 1 year rainfall event, and;
B. 1 in 100 year + Climate Change rainfall event.

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

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

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

Approach 2: Restricting the peak flow rate

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

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

- The greenfield runoff rate from the site for the 1 in 1 year event, or;
- 2 litres per second per hectare (l/s/ha);

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

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

6.7 Previously Developed Land (Brownfield sites)

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

A. An approach as close to Approach 1 as is reasonably practicable must be used;
B. The flow rate discharged from the site must be reduced from that of the actual modelled pre-development rate for:
    - The 1 in 1 year event, and;
    - The 1 in 100 year + Climate Change event;
    - The volume of runoff may only exceed that prior to the proposed development where the peak flow rate is restricted to 2 l/s/ha.

6.8 Exceedance

The design of the drainage system must take into account the impact of rainfall falling on any part of the site and also any estimated surface runoff flowing onto the site from adjacent areas.

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

A. On any part of the site for a 1 in 30 year rainfall event; and
B. During a 1 in 100 year + Climate Change rainfall event in any part of:
    - A building (including a basement), or;

- Utility plant susceptible to water (e.g. pumping station or electricity substation), or;
- On neighbouring sites during a 1 in 100 year + Climate Change rainfall event.

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

When considering exceedance routes, particular attention should be paid to:

A. The position of walls, bunds and other obstructions that may direct water but must not cause ponding;

B. The location and form of buildings (e.g. terraces and linked detached properties)that must not impede flows or cause ponding;

C. The finished floor levels relative to surrounding ground.

Submitted drawings and calculations must identify sources of water entering a site pre development, how flows will be routed through a site, where flows leave the site pre development and where they leave the site post development.

6.9 Interaction with Highway Design Guidance

Design guidance for highway drainage is set out in the **Design Manual for Roads and Bridges**. Although highway drainage may be required only to accommodate runoff from smaller events, SuDS systems on new developments must still comply with National and Local Standards.

WAY MARKER 6.4

Design Manual for Roads and Bridges (DMRB)
http://www.standardsforhighways.co.uk/ha/standards/dmrb/

6.10 Good Urban Design

SuDS should be consistent with good urban design; likewise urban design should embrace the principles of SuDS. When considering the design of SuDS, the following points should be considered.

- No space on a development site is useless; all space can have a function. This can be particularly relevant for small scale SuDS features which can work together to create a local network of drainage features, managing water at source within sub-catchment units;
- Creating a diverse scheme increases the quality of the feature for humans and the environment. When planning a development, consideration is required about the types of SuDS features which will work within the site;
- Improve connections and cohesion across the site by creating networks of SuDS features which link up allowing movement not only of surface water but also of residents and wildlife;
- Where appropriate, SuDS should be informed by Local Planning Authority specific Conservation Design Guidance, Village Design Plans and Conservation Area Appraisals;
- Water storage facilities should be designed to reflect natural shapes and contours so as to create a natural appearance/landscape. Highly engineered finishes and landforms should be avoided.

6.11 Land Take

When planning for SuDS in high density developments both innovative design and selection of appropriate components are fundamental.

Good design should ensure that no space is wasted and by integrating vegetated/landscaped and proprietary/more engineered components, an effective SuDS scheme that minimises land take can be delivered. However good design must also ensure that sufficient space is allowed so that features such as retention and infiltration basins and swales can be sensitively designed to deliver landscape and biodiversity enhancement.

6.12 Planting

Many SuDS features are vegetated and plant selection will depend upon locally native species, climate/microclimate and ground conditions. A survey of locally native species may contribute to plant selection. Warrington Borough Council should be consulted for further details.

New planting should, where appropriate, reflect historic landscape character in the location and scale of planting.

The following factors need to be considered to ensure that systems function as designed:

1. The vegetated side slopes of SuDS features should not exceed a gradient of 1:4 in order to avoid soil slippage, the resultant non-establishment of vegetation, for Health and Safety reasons and to ensure access for maintenance.
2. Landform design should be appropriate for plant colonisation, e.g. shelves on the margins of ponds.
3. Planting areas should be designed to be lower than adjacent surfaces and dished wherever possible, to avoid excessive volumes of silt washing onto permeable surfaces. Care will be required with the design of tree pits in hard surfaces, to ensure that they do not become toxic 'salt traps' following winter de-icing operations. A variety of proprietary tree products and systems have been developed to ensure successful tree planting and establishment, as part of SuDS schemes. Research and development continues apace in this field.
4. Consideration should be made as to how quickly and how large trees and plants will grow ensuring that there is sufficient space both above and below ground for the plant to develop.
5. The potential impacts of ground compaction as a result of any pedestrian or vehicular activity should be considered as this may reduce the effectiveness with which rainwater can reach the roots and/or result in stunted growth.
6. Plants appropriate to site conditions (soil type, slope and orientation, light availability) should be selected that are suitable for the expected flow velocities and weather conditions.
7. Planting should be undertaken at the appropriate time of year and allow planting to establish before drainage that would otherwise damage immature plants, is allowed to enter the system.
8. The maintenance requirements of SuDS planting need to be considered. For example, unless the feature includes deep water some plant species such as common reed and reedmace that spread rapidly should be avoided. SuDS maintenance should be included in site landscape management planning.

There are a variety of planting techniques available for use in SuDS features. Where drainage systems are to be planted, the following are options should be considered.

- Use of aquatic plants placed in small groups or more densely if erosion is a concern on water body margins;

- Grass seeding (including wildflower meadow mixes), is particularly applicable for attenuation basins and swales and around ponds;
- Where a dense ground cover is required quickly, planted or seeded coir mats or rolls can be used. This avoids soil erosion and prevents soil and mulch washing into the drainage system.

In general fertiliser use should be avoided as this affects water quality.

6.13 Designing for Maintenance and Safety

WAY MARKER 6.5

The Construction (Design and Management) Regulations 2015
http://www.legislation.gov.uk/uksi/2015/51/contents/made

Design should minimise maintenance requirements and Health and Safety should be appropriately managed as part of the design process. **The Construction Design and Management (CDM) Regulations** require all designers to identify, eliminate or control foreseeable risks that could arise at any time during the lifetime of a scheme because of its design. Therefore, the design process must include consideration of how the SuDS scheme in its entirety is to be maintained.

SuDS components should have shallow side slopes and ponds should have shallow shelving at their edges. Guidance on the selection of appropriate side slopes for different SuDS components is contained within the **CIRIA C753 SuDS Manual**. Good use of vegetation should be made to prevent access to open water features where required.

Pipe connectors should be shallow and short, allowing simple jetting to keep them clear. Inlets, outlets and control structures should be at or near the surface to allow day to day care by landscape contractors or site managers. Inspection points which are easy to access should be incorporated.

Chapter 36 of the **CIRIA C753 SuDS Manual** provides guidance on managing the safety risk associated with SuDS. Risks should be identified and managed through the use of an appropriate risk assessment.

A template Health and Safety Risk Assessment is provided in Appendix B3 of the **CIRIA C753 SuDS Manual.**

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.

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.

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.

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.

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.

Local Standard D - Maintenance Requirements

Warrington Borough Council will expect SuDS to be designed so that they are easy to maintain. Proper use of the SuDS Management Train, including surface features, is one way to achieve this. The developer must set out who will maintain the system, how the maintenance will be funded and provide a maintenance and operation manual.

Local Standard E - Minimising the Risk of Blockages

Warrington Borough Council will expect the SuDS design to minimise the risk of blockage as far as is reasonably possible e.g. by using suitable pipe sizes and making underground assets as visible and accessible as possible.

Local Standard F - Use of Pumped Systems

If it can be demonstrated that a partial or completely pumped drainage system is the only viable option, Warrington Borough Council will expect the residual risk of flooding due to the failure of the pumps to be assessed. The design flood level must be determined under the following conditions:

- If the pumps were to fail;
- If the attenuation storage was full, and;
- If a design storm occurred.

The finished floor levels of the affected properties should be raised above this level and all flooding should be safely stored onsite.

An emergency overflow must be provided for piped and storage features above the predicted water level arising from a 1 in 100 year Annual Exceedance Probability rainfall event inclusive of allowances for climate change and urban creep.

6.14 Flood Risk

6.14.1 Watercourses

Where a SuDS proposal relies on the use of components which attenuate and convey storm water (e.g. attenuation ponds, basins or swales), these should not be situated within Flood Zone 3 inclusive of an allowance for climate change. During a flood event, such features would be at risk of filling with fluvial floodwater thus rendering them ineffective for storm water management.

SuDS design in areas at risk of river or watercourse flooding should limit use of surface features which could be washed out during a flood and should focus instead on dispersing surface water as sheet flow across the site. Discharge from the SuDS scheme must be timed to minimise the impact on the receiving watercourse relative to its response time. Consultation with Warrington Borough Council or the Environment Agency may be necessary to assess this.

High level information on river (and surface water) flooding is available from the Environment Agency. This is likely to be sufficient to inform outline applications; although the presence of small watercourses that may not have been included on the Environment Agency's national scale **Flood Map for Planning** needs to be considered. These flow routes are often shown on the surface water flood mapping.

WAY MARKER 6.6

Environment Agency – Flood Map for Planning
https://flood-map-for-planning.service.gov.uk/

For a full application, flood risk from watercourses at or near a development site must be considered in detail by undertaking local quantitative assessments (utilising hydraulic modelling where necessary), using topographic and watercourse cross section survey and hydrological data. An assessment should incorporate peak river flows for a 1 in 100 year + Climate Change Annual Exceedance Probability flood event, inclusive of the impacts of climate change. Such models, built using readily available hydraulic computer modelling software, can then be used to inform development site layout, finished floor levels and flood mitigation measures that may be necessary. The Environment Agency or Warrington Borough Council may already hold flood model information for some watercourses.

In all cases, it is recommended that consideration of the joint probability of the occurrence of surface water flooding and high flood levels in receiving watercourses is considered.

6.14.2 Surface Water

The Environment Agency publishes maps showing the risk of flooding from surface water. The methodology used in generating these maps means that they tend to highlight natural drainage paths and can therefore be used to inform the layout of SuDS features on a site. Due consideration must be given to locations where surface water flows are shown to enter a development site from outside the site boundary as additional space for storage and conveyance may be required to accommodate this. Likewise, any onsite measures should not adversely impact on surface water flow routes and volumes downstream.

WAY MARKER 6.7

Environment Agency – Flood Risk Maps
https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

Reference should also be made to the **Surface Water Management Plan (SWMP)** for any more detailed surface water modelling which may be available.

For large major developments, where surface water flooding has been shown on the national scale mapping to be a potential issue, detailed surface water flood modelling using topographic survey of the site should be undertaken to inform full planning applications.

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.

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 substation) within the development.

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.

Local Standard G - Emergency Overflows

Warrington Borough Council will expect an emergency overflow to be provided for piped and storage features above the predicted water level in a 1 in 100 year Annual Exceedance Probability rainfall event, with an allowance for climate change.

Local Standard H - Freeboard Levels

Warrington Borough Council will expect all surface water storage ponds to provide a 600mm freeboard above the predicted water level arising from a 1 in 100 year Annual Exceedance Probability rainfall event inclusive of an allowance for climate change. Care must be taken to ensure that excavations do not take place below the ground water level.

Local Standard I - Watercourse Floodplains

Warrington Borough Council will expect the floodplains of ordinary watercourses to be mapped to an appropriate level of detail considering the nature of the application (i.e. detailed flood modelling should be undertaken to support full planning applications). The layout of the development will then take a sequential approach, siting the least vulnerable parts of that development in the highest flood risk areas.

Local Standard J - Retention of Natural Drainage Features

Warrington Borough Council will expect natural drainage features on a site should be maintained and enhanced. Culverting of open watercourses will not normally be permitted except where essential to allow highways and/or other infrastructure to cross. In such cases culverts should be designed in accordance with **CIRIA's Culvert design and operation guide, (C689).**

Where a culverted watercourse crosses a development site, it should be reverted back to open channel. In such a case the natural conditions deemed to have existed prior to the culverting taking place should be re-instated.

Local Standard K - Impact of Downstream Water Levels

If high water levels within a receiving watercourse into which a SuDS scheme discharges are anticipated, Warrington Borough Council will expect that they will not adversely affect the function of that SuD system. The joint probability of the occurrence of peak surface water flows with peak river levels in the receiving watercourse should be considered.

6.15 Historic Environment

The historic environment is comprised of buried archaeological remains (and the remains of upstanding earthworks), historic buildings and structures and historic landscape character. Some heritage assets have been identified as being of national importance and are statutorily

designated. Details of nationally designated heritage assets can be identified on the government's **National Heritage List for England**. A SuDS scheme may impact on significant heritage assets and therefore consent for the works must be sought at an early stage. Further information on these can be found on the **Historic England website.**

WAY MARKER 6.8

Historic England - National Heritage List for England
https://historicengland.org.uk/listing/the-list/

Historic England - Consent and Planning Permission Requirements
https://historicengland.org.uk/advice/hpg/consent/

Undesignated heritage assets are usually recorded in a county (or equivalent) Historic Environment Record (HER); this record is not exhaustive as heritage assets may come to light at any time and therefore contact should be made with Warrington Borough Council. These assets may be as significant as designated heritage assets but are considered as part of the planning process rather than as separate consented works.

Developers should identify the presence of heritage assets during the planning stage and make the presence of these clear to Warrington Borough Council, where they have the potential to inform or affect the drainage of the site. This will enable Warrington Borough Council to liaise with relevant organisations and colleagues to ensure the SuDS system is in keeping with the historic setting of the site, where appropriate. Developers should also ensure that the design of a SuDS system does not have a detrimental impact on any heritage assets. Opportunities for SuDS schemes to enhance the historic environment shall be explored.

6.16 Delivering Multiple Benefits

Well planned SuDS will deliver multiple environmental, social and economic benefits. In addition to managing flows, volumes, and diffuse pollution, some components (particularly vegetated or landscaped features) can positively impact air quality, carbon reduction, recreation, education and other elements of community health and vitality, having monetary or intangible social value. CIRIA has developed a freely available tool with associated guidance which makes it easier to assess the benefits of SuDS. The **BeST (Benefits of SuDS Tool)** can be accessed via the Susdrain website.

In designing SuDS features, the Developer should consider how these could be co-located with open space and public areas to create multi-functional spaces. By integrating SuDS features with other street features such as traffic calming measures, parking bays and verges, opportunities to improve the streetscape are presented.

Where a new development is proposed on existing undeveloped land, it may be that existing land drainage features are present e.g. field drainage ditches, minor ponds or elements of surviving historic water management e.g. mill leats, water meadows. These present opportunities to manage surface water via existing pathways and also to enhance their attributes e.g. by improving conveyance or habitat potential. Care should be taken to accommodate any existing drainage functions.

Local Standard L - Multiple Benefits

The SuDS design must demonstrate, where appropriate, how environmental site constraints have been considered and how the features design will provide multiple benefits e.g. landscape enhancement, biodiversity, recreation, amenity, leisure and the enhancement of historical features.

6.17 Wildlife and Biodiversity

Any development site has potential to support habitats and/or species of importance for biodiversity; guidance can be found in **British Standard BS42020:2013 Biodiversity. Code of Practice for Planning and Development.** Proposed SuDS schemes should be informed by appropriate ecological surveys and assessments in line with Warrington Borough Council policies and guidance. The location and design of SuDS should be informed by surrounding habitats and land-uses with an aim of contributing to green infrastructure and provision of features of value for wildlife to help species breed, feed and move through the landscape. Opportunities to create wildlife habitats that can be enjoyed by residents should be demonstrated.

WAY MARKER 6.9

BS 42020:2013 - Biodiversity Code of Practice for Planning and Development
https://shop.bsigroup.com/ProductDetail/?pid=000000000030258704

Biodiversity Opportunity maps are developed to highlight where priority habitats can be enhanced, restored or created in a particular area, county or region. They are used as a basis from which to develop policies and targets.

A variety of initiatives focused on improving and restoring ponds across the UK are in existence and the contribution of a SuDS scheme to these should be explored. It is recommended that ecological advice be taken when designing SuDS and deciding on planting schemes. Well designed and maintained SuDS can become valuable features within site greenspace.

6.18 Trees

Trees, particularly long-lived, large-canopied species, are important and often defining components of the rural landscape or urban 'streetscene', conferring a wealth of social, economic and environmental benefits. Trees and woodland can play an active part in SuDS through canopy interception of rain and root uptake of water from the soil, which attenuates surface water run-off by decreasing peak flow rate and volume.

The **British Standard BS5837:2012 Trees in relation to design, demolition and construction - Recommendations** provides guidance on deciding, in relation to planning applications, which trees are appropriate for retention, on the effect of trees on design and layout considerations and on the means of protecting trees during development. Care should be taken during the design and construction of the SuDS scheme that this guidance is adhered to and that designs maximise the opportunity to maintain existing tree cover where appropriate and enhance future cover through new planting. Trees (and their requirement for suitable rooting volume and canopy space) should be considered as an integral part of SuDS from the earliest stages of project concept and design.

WAY MARKER 6.10

BS 5837:2012 - Trees in relation to design, demolition and construction. Recommendations
https://shop.bsigroup.com/ProductDetail/?pid=000000000030213642

6.19 Public Open Space and Amenity

The requirement to provide Public Open Space on all new developments presents an opportunity for the provision of SuDS as many of the integral system features can function as green parks, wildlife corridors and gardens. Good SuDS design will ensure that systems act as

truly multifunctional spaces and will avoid poorly conceived design features such as steep sided, fenced basins.

It is highlighted however that not all SuDS will contribute to Public Open Space; for example the requirement to provide functioning or usable open space specifically for sport, recreation and leisure activities may not always be offset against the requirements to include SuDS within a development. Details on Public Open Space requirements may be set out in Site Allocations and Management of Development (SAMDev) Plan policies.

Warrington Borough Council should be contacted to determine what and how much of a SuDS scheme can contribute to the Public Open Space.

6.20 Landscape

Many developments are likely to be in an urban setting or part of proposals that create new urban environments. Good design should be informed by local character and distinctiveness as well as the historic landscape character and historic built environment, and should contribute to a sense of place. For greenfield development sites **Trees in relation to design** within and around villages and small towns, the full context of the site and its surroundings should be considered to inform design through reference to Local Landscape Character Assessments. Where relevant, landscape architects and historic environment specialists should work together to develop an appropriate design strategy for the SuDS. Reference should also be made to local design and development guides as well as any relevant Supplementary Planning Documents (SPD).

National Character Areas have been defined for 159 major landscape areas in England. They utilise a variety of environmental information to create a profile for each landscape area which sets out the landscape, wildlife, cultural and geological features in conjunction with information on the local environmental opportunities for the future.

WAY MARKER 6.11

National Character Area profiles: data for local decision making
https://www.gov.uk/government/publications/national-character-area-profiles-data-for-local-decision-making

The information provided on opportunities within the National Character Area along with an understanding of the local character should be used to guide the SuDS strategy in order to deliver landscape and biodiversity enhancement. This may extend to choice of vegetation, use of buffer strips alongside watercourses and the types of features use e.g. ponds to encourage key wildlife species. Where detailed design requires hard engineering then this should use materials appropriate to the locality. Soft landscape solutions should use grass seed and planting mixes that are ecologically appropriate, although in some urban situations a combination of native and ornamental species may be acceptable.

6.21 Water Quality and Framework Directive

River Basin Management Plans are subject to a six year review cycle; the last review took place in 2015 and the next review is scheduled for 2021.

6.21.1 Key Water Framework Directive Objectives

The Water Framework Directive, established in October 2000, is a piece of European Union legislation with the aim of preserving, restoring and improving the water environment. This was transposed into national law via **The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 (Statutory Instrument 2003 No. 3242) for England and Wales.**

WAY MARKER 6.12

The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003
http://www.legislation.gov.uk/uksi/2003/3242/regulation/7/made

The key environmental objectives of the directive from the first cycle (2009 – 2015):

- All surface water bodies to achieve good ecological and chemical status by 2015. This covers inland waters, transitional waters (estuaries) and coastal waters;
- All groundwater bodies to achieve good groundwater quantitative and chemical status by 2015;
- Heavily-modified water bodies and artificial water bodies to achieve good ecological potential and good surface water chemical status by 2015;
- No water bodies to experience deterioration in status from one class to another;
- Protected Areas to achieve the requirements made under their designation in relation to the water environment.

The second cycle (2015 – 2021) of the Water Framework Directive is now underway and a review of the Directive is expected in 2019. The aim is to continual development of the objectives from the first cycle. The current expectation from the Environment Agency is that 60% of waters will achieve 'good' status by 2021.

All of the objectives are to be met by the end of the third cycle (2021 – 2027).

6.21.2 River Basin Management Plans

The basic unit at which the Directive is implemented is the River Basin District and management plans have been developed for each district which set statutory objectives for the water bodies within them. These river basin level objectives contribute to meeting the overall objectives of the Directive.

Warrington is located within the North West River Basin District. Information on the current and future chemical and ecological status of a watercourse can be found via the **Environment Agency online maps**. This information should be used in conjunction with the SuDS Management Train to determine the most appropriate approach to water quality management.

WAY MARKER 6.13

River Basin Management Plans
https://www.gov.uk/government/collections/river-basin-management-plans-2015

Environment Agency – Catchment Data Explorer
http://environment.data.gov.uk/catchment-planning/

6.21.3 Role of SuDS in Meeting Water Framework Directive

Using SuDS to manage surface water plays an important role in preventing the pollution of water bodies from surface water runoff. The implementation of the SuDS approach for the drainage for new developments will ensure that these sites cannot contribute to the degradation in the quality of surface or ground water. Specific reference is made to the role of SuDS within the River Basin Management Plans.

The SuDS Management Train should be used to assess storm water quality requirements.

WAY MARKER 6.14
Treatment Stages for Surface Water Bodies

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

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

WAY MARKER 6.15
Treatment Stages for Groundwater

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

NB. Surface runoff from roof drainage must be isolated from other sources where it is discharged to G1 and G2.

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

6.22 Designation of SuDS Constructed on Third Party Land

The **FWMA 2010** enables LLFAs to designate features or structures, constructed on third party land, which may impact on flood risk, at their discretion. All designated structures will be recorded onto an asset database. This process may be used to designate private SuDS serving new developments. Once a SuDS feature has been designated and placed on the asset register, formal consent from the LLFA will be required for any changes.

No action on the part of the developer is required; all decisions relating to the designation of SuDS will be made by the LLFA.

6.23 Riparian Responsibilities

Anyone owning land or property next to a river, stream or ditch is classed as a riparian landowner and has associated rights and responsibilities.

Wherever possible, watercourses should be made features of development sites and integrated into the overall drainage system. This includes opening up culverted watercourses where this would not increase

WAY MARKER 6.16

Living on the Edge: A Guide to Your Rights and Responsibilities of Riverside Ownership
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/454562/LIT_7114.pdf

flood risk to others up or downstream. Access to maintain a watercourse should be provided at all times and buildings should not be placed directly on the banks of watercourses. Future owners of properties who will have riparian responsibilities should be made aware of these when purchasing properties.

Further details and explanation of all rights and responsibilities pertaining to riparian ownership can be found in the Environment Agency's publication **'Living on the Edge: A Guide to Your Rights and Responsibilities of Riverside Ownership'.**

7 Technical Design Requirements

What this section will cover:

- Technical design requirements for submission

Appendix F of this document contains diagrams for the various SuDS considered acceptable to be used within the administrative area of Warrington Borough Council. These should be referred to when reading this section.

Table 7.1: Drawing List – Appendix F

Appendix	Drawing
F.1	Filter Drain/Infiltration Trench
F.2	Filter Strip
F.3	Swales
F.4	Bioretention
F.5	Retention Pond
F.6	Detention Basin
F.7	Underground Storage
F.8	Vortex Separator

7.1 Source Control

7.1.1 Filter Trench/Infiltration Trench

<table>
<tr><td>  </td><td>Guidance Documents</td><td>Key Benefits</td></tr>
<tr><td></td><td>CIRIA C753 The SuDS Manual
Part D: Chapter 16.

Design Manual for Roads and Bridges HA 103/06</td><td> 
</td></tr>
<tr><td>  </td><td colspan="2">Gravel or rubble filled trench that creates subsurface storage for infiltration, or filtration of surface water runoff. Trenches can be used to filter, attenuate and dissipate storm water into the ground through the base and sides of the trench and/or provide a level of treatment prior to reaching a secondary SuDS feature.</td></tr>
</table>

Best Practice

- The location of the filter trenches should be carefully considered so there is no interaction with people and vehicles.
- Work best with SuDS components which provide attenuation of storm flows
- Use in combination with effective pre-treatment.
- Separate filter media from surrounding ground with a geotextile where infiltration is desirable, or a membrane where infiltration is not permitted.

- Include a geotextile layer within the upper gravel and incorporate observation wells and rodding points for maintenance.
- Use a distribution pipe in combination with point discharges.
- Consider the impacts of stone scatter.

Local Context - Opportunities

- Ideal for use with small contributing areas.
- The land-take is usually low, typically 0.5-1.5m wide.
- Can be used to reduce both runoff rate and volume.
- Good water quality treatment.
- Can be easily incorporated into site landscaping/along roads.

Local Context – Considerations

- Can be prone to blockage and work best in combination with pre-treatment such as filter strips to reduce sediment load.
- Features to help inspection and maintenance are critical.
- Can be expensive to replace the filter material if poorly designed or neglected maintenance.
- Difficult to identify pollution and maintenance issues underground.

Configuration and Dimensions

A. Filter/Infiltration Trenches should be used as source controls only.

B. Filter/Infiltration Trenches should not be designed as sediment traps.

C. Filter/Infiltration Trenches should be designed to the requirements of the **Design Manual for Roads and Bridges Volume 4, Section 2, Part 5, HA40/01 - Determination of Pipe and Bedding Combinations for Drainage Works, Drawing F2, trench Type H and the requirements of this document Appendix F - Figure 1.**

D. Filter/Infiltration Trenches should not exceed 3m in depth.

E. It is preferred that storm water inflow be sheet flow from drainage areas. Where this is not practical point flow inputs will be acceptable.

F. Where point flows are used, a pre-treatment stage be installed that will effectively remove particulate matter present in the water and prevent clogging of the trench.

G. Point flow inputs should be connected to a slotted high level distributor pipe. The pipe should be capable of conveying the design flow.

H. The stone filter material should be wrapped in geotextile to the diagram as shown on Figure F.1, with a minimum 150mm overlap at all joins. The geotextile should meet the requirements of the **Specification for Highway Works Series 500**.

I. Filter/Infiltration Trenches should be provided with a high level overflow to accommodate design exceedance.

Hydraulic and Water Quality Design

A. The trench design should be checked for design exceedance and modelled explicitly and holistically to demonstrate the impact to the downstream drainage components.

B. Infiltration trenches should be designed to half-empty in 24 hours to allow for incoming flows from subsequent storms.

C. The base of the trench should be at least 1m above the highest seasonal or permanent groundwater table.

Selection and Siting

A. A risk assessment shall include all relevant safety and environmental issues associated with siting a filter/infiltration trench.

B. The trench shall be designed for easy maintenance.

C. Infiltration trenches should be sited on stable ground, soil and groundwater conditions should be assessed to verify ground stability.

D. Design of infiltration trenches must comply with groundwater protection regulations and with EA policy on infiltration.

Safety

The risk assessment shall include risks associated with scatter of filter material.

Operation and Maintenance

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

7.1.2 Filter Strip

	Guidance Documents	Key Benefits
	CIRIA C753 The SuDS Manual Part D: Chapter 15.	
	A vegetated strip of land located between the urbanised area and the receiving water body. Filter strips are designed to intercept sheet flows and provide vegetative filtration and encourage some infiltration.	

Best Practice

- Integrated into the site and surrounding landscape.
- Consider opportunities for green corridors.
- Can be used in conjunction with SuDS components offering attenuation.

Local Context - Opportunities

- Ideal for use with small contributing areas.
- Good for pre-treatment.
- The land-take is usually moderate, minimum of 6m wide with a slope not exceeding 1 in 20.
- Moderate water quality treatment.

- Can be easily incorporated into site landscaping and alongside roads.
- Can be enhanced through the use of grass/wildflower seed mixes.
- Can link green areas.
- Low cost and maintenance.

Local Context – Considerations

- Relatively large land-take.
- Not suitable for step sites.
- Does not attenuate or significantly reduce peak flow or volume.

Configuration and Dimensions

A. Filter strips should be used as source controls only.

B. Filter strips should be designed to the requirements of **CIRIA C753 – The SuDS Manual** and the requirements of this document Appendix F - Figure 2.

C. Filter strips should be site specific designed to provide optimum pollutant removal and easy access and maintenance.

D. Filter strip should be between 2% and 5% in crossfall.

E. A 50 to 100mm drop should be provided at the transition from the hard surface to the strip.

F. The filter strip should extend the entire length of the drainage area, either road or development.

G. It is preferred that storm water inflow be sheet flow from drainage areas. Where this is not practical point flow inputs may be acceptable.

H. Where point flows are used, the dissipation of surface water should to be included in the design.

Hydraulic and Water Quality Design Criteria

A. The 1 year 30 minute storm event shall be used as design event for water quality design. Water depth at the design event shall be 50mm maximum.

B. Maximum flow velocity to promote settlement shall be 0.3m/s. Water velocity to prevent erosion during design exceedance conditions shall be kept below 1.5m/s.

C. Flow velocity shall be calculated using Manning's formula with a coefficient value for flows through grass n=0.025 and for flow above grass n=0.01.

Selection and Siting

A. A risk assessment shall include all relevant safety and environmental issues associated with siting a filter strip.

B. Filter strips should be used to treat runoff from relatively small impervious areas.

C. Filter strip shall be sited next to the impermeable area and integrated to overall design and landscaping.

D. The filter strip shall be installed in well-draining topsoils, suitable to support dense grass.

E. Ground water pollution risk shall be reduced by avoiding the drainage of polluted hard surfaces through filter strips over permeable soils.

Pre-treatment, Inlets and Outlets

A. A level spreading system is required to achieve consisted sheet flow along the length of the strip.

B. At the outlet a gentle slope is required to reduce flow velocities and erosion.

C. The outflow shall be to a surface water dissipation area or to the next SuDS in the treatment train.

Landscaping and Amenity

A. In landscaping the strip priority shall be given to unrestricted sheet flow. Trees and dense scrub shall not be planted within the footprint of the filter strip.

B. Vehicular traffic over the strip shall be prevented. Pedestrian and pet traffic through the strip shall be kept to a minimum.

C. Future re-developments and alterations to the strip shall be prevented.

D. Appropriate seed mix shall be used to ensure dense growth, operation in both wet and dry weather conditions and sediment accumulation. Strips shall be turfed or seeded at a rate of 45g/m^2 over 100 – 150mm of topsoil with the following grass mix:

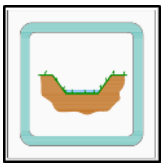
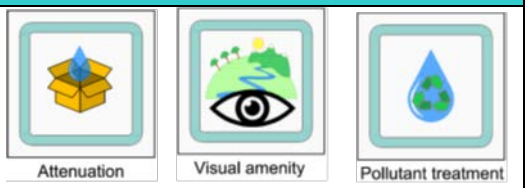
Table 4.1: Specie and Grass mix Percentage

Species	Percentage
Perennial rye grass	25%
Smooth stalked meadow grass	25%
Slender creeping red fescue	30%
Chewings fescue	10%
Browntop bent	10%

Health and Safety

A risk assessment shall include all relevant safety and environmental issues associated with siting a filter strip.

7.1.3 Swales

	Guidance Documents	Key Benefits
	CIRIA C753 The SuDS Manual Part D: Chapter 17 Design Manual for Roads and Bridges HA 103/06	
	A vegetated shallow channel or depression designed to treat, filter, store and convey runoff. Swales can be either 'dry' (where water is stored beneath the ground in a gravel layer) or 'wet' where runoff is stored above the surface in the channel so may be permanently wet. Lining can be added to enable infiltration even when there are known contaminants in the water.	

Best Practice

- Conveyance swales are suited to directing flow.
- Dry swales provide additional filter treatment.
- Wet swales encourage filtering and attenuation through wet and marsh like conditions.

Local Context - Opportunities

- Difficult to achieve minimum length in residential developments due to access crossings.
- Relatively moderate land-take.
- Check dams needed for steeper sites.
- Needs to be enhanced to attenuate or significantly reduce peak flow or volume.
- May require lining on contaminated sites.

Local Context – Considerations

- Ideal for use with linear contributing areas like roads.
- Good for pre-treatment
- Can be enhanced to provide two stages of treatment.
- The land-take is usually moderate, minimum of 4m wide.
- Good water quality treatment.
- Can be easily incorporated into site landscaping and alongside roads.
- Can be enhanced through the use of grass/wildflower seed mixes.

Configuration and Dimensions

A. Swales should be used as source controls only.

B. Swales should be designed to the requirements of **CIRIA C753 – The SuDS Manual** and the requirements of this document Appendix F - Figure 3.

C. Swales should be:
   1. Trapezoidal or parabolic in cross section.
   2. The side slopes of a swale shall be a maximum of 1 vertically to 4 horizontally.

3. The base of the swale shall be a minimum of 0.5m and a maximum of 2m wide and designed to avoid the formation of rills.
4. The depth of the swale shall be between 400mm to 600mm deep and achieve a freeboard of 150mm during design flow conditions.
5. Swales shall be no less than 30m in length.
6. The longitudinal slope of the swale shall not exceed 1 vertically to 40 horizontally without the use of checkdams and shall not exceed 1 vertically to 10 horizontally.

Hydraulic and Water Quality Design Criteria

A. Swales should be designed so that the flow arising from a 1 in 1 year 30 minute storm event does not exceed 0.3 m/s or 100mm in depth.

B. The average velocity should be calculated using Manning's equation with a roughness coefficient of 0.025 for flows up to the grass height. Grass height in the channel should be assumed to be 100-150 mm height. At depths of flow above the grass height the friction factor can be reduced to 0.01 for the analysis of design exceedance storm events.

C. Storage volumes for the 1 in 1 year design event should dissipate within 24 hours, so that subsequent storms can be accommodated in terms of storage and treatment.

D. Where practical, swales should form part of a wide blue/green network, designed for the temporary storage and conveyance of design exceedance storm events 30 to 100 year storm event. The maximum flow velocity should be below 1.0m/s. Higher velocities up to 2.0m/s may be permissible if erosion, soil stability and safety aspects can be demonstrated to the satisfaction of Warrington Borough Council.

Selection and Siting

A. Swales should be:
   1. Positioned as close to the source of receiving runoff as possible.
   2. In a location that is easily and safely accessible by maintenance machinery.
   3. On stable ground and where groundwater will not occur within 1m of the base of the swale.

B. Infiltration swales shall not be positioned adjacent to building foundations without a design certificate from a suitably qualified geotechnical engineer.

C. Infiltration swales shall not dissipate water directly to ground without a suitable groundwater risk assessment.

Pre-treatment, Inlets and Outlets

A. Sheet flow is desirable to minimise erosion and increase treatment potential. Other options to provide an approximate to sheet flow, such as flush kerbs, shall be considered on a site by site basis.

B. Point flow outlets such as road gullies and pipes shall flow into a flow spreader to minimise the risk of erosion and silting.

C. A drop of 50 to 100 mm shall be included at the edge of the hard surface to prevent the formation of a sediment lip.

D. Conveyance swale discharge pipes and underdrain pipes shall be provided with a hydraulically designed outlet structure that is resistant to erosion.

E. Swales shall include a suitably designed overflow to safely convey flows arising from design exceedance events. Overflows shall be incorporated within the development strategy for managing exceedance events and routed to planned temporary storage areas.

Landscaping and Amenity

A. Swales shall be turfed or seeded at a rate of 40 g/m^2 over 100 – 150mm of topsoil with the following grass mix:

Table 4.2: Specie and Grass mix Percentage

Species	Percentage
Perennial rye grass	25%
Smooth salked meadow grass	25%
Slender creeping red fescue	30%
Chewings fescue	10%
Browntop bent	10%

B. Where appropriate alternative specifications can be used such as wild flower species, where the Developer can demonstrate that the proposed mix will be resistant to pollution and periods of prolonged dry and wet conditions.

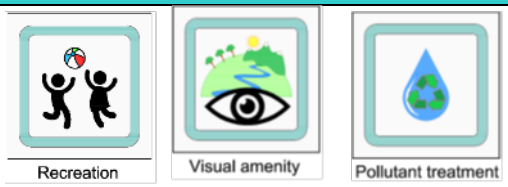
Safety

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

Operation and Maintenance

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

7.1.4 Bioretention

	Guidance Documents	Key Benefits
	CIRIA C753 The SuDS Manual Part D: Chapter 18. Design Manual for Roads and Bridges HA 103/06	
	Larger areas of shallow vegetated open water with specially selected plant species and varying water levels and treatment areas. Water flows horizontally and is gradually treated prior to discharge; flow control is required.	

Best Practice

- Generally applied to small catchments and are typically 5% -10% of the contributing area.
- Bioretention should be lined where infiltration could cause slope stability or foundation problems.
- Groundwater table must be 1m below the base of the feature.
- Suggested width of 3m and a 2:1 length to width ratio to allow random planting of vegetation.

- Standard landscape mulch should be used for the top dressing not exceeding 75mm.
- Plants must be able to withstand pollution and extended dry and wet periods.

Local Context - Opportunities

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

Local Context – Considerations

- Requires landscaping and management

Configuration and Dimensions

A. Bioretention should be used as source controls only.

B. Bioretention should be designed to **CIRIA C753 – The SuDS Manual** and the requirements of this document Appendix F - Figure 4.

C. The use of proprietary bioretention units is permitted and shall be considered on a case by case basis.

D. Performance of the bioretention units is independent of shape. Any shape can be used successfully. A minimum plan area of $20m^2$ with length to width of 2 to 1 should be considered to provide opportunities for diverse planting and easy access for maintenance.

E. The 75mm mulch layer composed of shredded wood chips shall cover the bioretention area to reduce erosion and help to maintain moisture levels for plants.

F. The filtration/bedding material shall comprise of engineered soil designed to sustain selected plants and achieve a permeability of 250 to 1,000mm per hour under design conditions. The depth of the engineered soil will vary depending on the selected planting scheme, but shall be a minimum of 1m and a maximum of 2m.

G. The engineered soil, transition sand later and coarse bedding material shall be wrapped in geotextile to the as shown on Figure F4, with a minimum 150mm overlap at all joins. The geotextile shall meet the requirements of the **Specification for Highway Works Series 500**.

Hydraulic and Water Quality Design Criteria

A. Ponding in the bioretention area should not exceed 150mm.

B. The bioretention design should be checked for design exceedance and modelled explicitly and holistically to demonstrate the impact to the downstream drainage components.

C. The bioretention should be designed to half-empty in 24 hours to allow for incoming flows from subsequent storms.

D. The base of the bioretention shall be at least 1m above the highest seasonal or permanent groundwater table.

E. The underdrain pipe design should follow standard hydraulic design methods. Bioretention areas shall be provided with high level overflows and sub-surface collection pipe to accommodate design exceedance.

F. A maintenance pipe for cleaning the underdrain should be provided and secured against vandalism. Transition layer below the soil filter media shall consist of 100mm of coarse sand with a grain size of 0.5 to 1mm.

G. The gravel around the perforated underdrain shall be 5 to 20mm size.

Selection and Siting

A. A risk assessment shall include all relevant safety and environmental issues associated with siting bioretention. This should be carried out by a qualified Engineer or Geologist where infiltration systems are proposed.

B. The bioretention shall be designed for easy maintenance.

C. Bioretention should be sited on stable ground, soil and groundwater conditions should be assessed to verify ground stability.

D. Design of bioretention must comply with groundwater protection regulations and with Environment Agency policy on infiltration.

Pre-treatment, Inlets and Outlets

A. Sheet flow is desirable to minimise erosion and increase treatment potential. Other options to provide an approximate to sheet flow, such as flush kerbs, shall be considered on a site by site basis.

B. Point flow outlets such as road gullies and pipes shall flow into a flow spreader to minimise the risk of erosion and silting.

C. A drop of 50 to 100 mm shall be included at the edge of the hard surface to prevent the formation of a sediment lip.

D. Bioretention units shall include a suitably designed overflow to safely convey flows arising from design exceedance events. Overflows shall be incorporated within the development strategy for managing exceedance events and routed to planned temporary storage areas.

Landscaping and Amenity

A. Bioretention unit design shall consider the different water availability regimes involved. Appropriate seed mix shall be applied to the wetter of the facility which will be subject to fluctuating water levels for extended periods.

B. Planting of the higher parts of the bioretention shall include species resistant to extended dry periods as well as periods of excessive rainfall and wetting.

Health and Safety

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

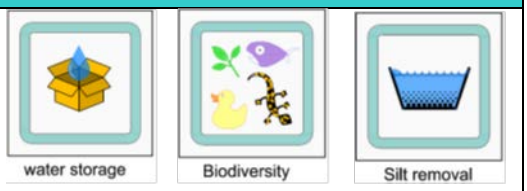
Operation and Maintenance

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

7.2 Site and Regional Controls

7.2.1 Retention Pond

<table>
<tr><td>  </td><td>Guidance Documents</td><td>Key Benefits</td></tr>
<tr><td></td><td>CIRIA 753 The SuDS Manual
Part D: Chapter 23.

ROSPA Safety at Inland Water Sites - Operational Guidelines.</td><td> 
</td></tr>
<tr><td>  </td><td colspan="2">Retention ponds are structures that provide both retention and treatment of contaminated storm water runoff. Retention ponds include a permanent pool of water into which storm water runoff is directed and outflows are controlled to reduce flow rate. A well designed pond provides a community asset and opportunities for new habitats. The pond's physical, biological, and chemical processes work to remove storm water pollutants. Sedimentation processes remove particulates, organic matter and metals, while dissolved metals and nutrients are removed through biological uptake. In general, a higher level storm water quantity control can be achieved as well providing positive amenity benefits.</td></tr>
</table>

Best Practice

- The pond should have 4 zones:
    1. Sediment forebay;
    2. Permanent pool;
    3. Temporary storage volume, and;
    4. Shallow wetland-type zone.
- Located outside the floodplain.
- Water quality treatment levels required should determine design.
- Depth should be <2m to prevent stratification.
- A liner may be required to prevent infiltration if the water is polluted or if the pond is in close proximity to an aquifer.
- Maintenance should account for invasive species.
- Health and safety should be considered to restrict proximity of the public to the pond.

Local Context - Opportunities

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

Local Context – Considerations

- Large area of land required.
- Not suited to sloping sites.
- Requires landscaping and management.

- Perceived safety risks need to be managed.

Configuration and Dimensions

A. Retention ponds should be designed to **CIRIA C753 – The SuDS Manual** and the requirements of this document Appendix F - Figure 5.

B. The aesthetic element should prevail in the design of ponds. Angular shapes and symmetry should be avoided in the design of pond layout and details. All ponds should contain several zones:
    1. The sediment forebay;
    2. The permanent pool;
    3. The temporary storage volume, and;
    4. An aquatic bench.

C. Additional elements to be included in the design of ponds include:
    1. A 3.5m wide maintenance route, suitable for vehicles.
    2. An inflow structure.
    3. A bypass sewer.
    4. An outlet with flow control and drain down chamber.
    5. An emergency overflow structure.

D. The sedimentation forebay should be separated from the permanent pool by a permeable berm and have an average width of 5 to 10 times the inlet pipe diameter and a length of 10m or four times the width, whichever is greater.

E. Inlets and outlets shall be placed at the maximum distance to maximise flow paths.

F. The flow path length to width ratio shall be 3:1 minimum to avoid short circuiting.

G. A maximum depth of 2m should be used for the permanent pool to prevent anoxic conditions and water stratification. The minimum water depth of the permanent water zone shall be 1.2m to prevent plant growth.

H. The maximum depth of attenuation storage should not exceed 2m.

I. The aquatic bench should be a minimum of 2m continuous around the pond, except at inlets and should range in depth up to 450mm below the design permanent pool level.

J. The top level of the permeable berm shall be 150mm below the permanent pool water level.

K. Energy dissipation should be provided at the inlet and outlet to the pond

L. Ponds should be designed to hold a permanent volume of water equivalent to the treatment volume, also referred to as Vt.

M. The treatment volume (Vt) should be calculated using the fixed depth method of 15mm of rainfall from impermeable (including paved and roofed) surfaces draining to the pond.

N. The volume of the sediment forebay should be approximately 10% of the pond's permanent volume (Vt).

O. The maximum volume of any retention pond should be 5,000m^3.

P. The sedimentation forebay should be designed to provide efficient deposition of sediment and should be accessible for cleaning and maintenance operations in its entire area.

Q. The floor of the sedimentation forebay should be a minimum of 300mm above the main pond bottom.

R. The design should include a safe and efficient means of draining the lowest point in the detention pond.

Hydraulic and Water Quality Design Criteria

Ponds Hydraulic Design

A. The top of the embankment should be 600mm above the maximum design water level.

B. The outlet structure should be designed to operate and discharge the design discharge flow rates up to the 100 year + Climate Change 6 hour storm event.

C. Ponds should provide a minimum permanent pool volume equal to one times the treatment volume for paved surfaces.

D. Pond liners should be finished at a height 150mm below the outlet control unit, where appropriate, to encourage infiltration and to minimise discharges to the receiving water for small events. However, they should not be lower than the invert level if used on a site with a sensitive underlying groundwater zone or if used to treat runoff from a potential pollution hotspot.

E. The by-pass sewer network should be designed for flows equal to the incoming flows.

F. The hydraulic capacity of the draw down facility for emptying the pond should consider the geotechnical stability of the pond and associated embankments.

Selection and Siting

A. The risk assessment should include all relevant safety issues associated with siting a pond.

B. A detailed analysis and impact assessment of a flood exceedance event indicating flow paths shall be undertaken and submitted to Warrington Borough Council. Where ponds are impounded behind engineered embankments, the unlikely scenario of embankment failure should be examined and potential impacts downstream of the pond assessed.

C. The siting of retention ponds should follow a multicriteria analysis to provide the widest benefits to the public.

D. The highest design water level in retention ponds should be at least 600mm below the floor level of any adjacent premises.

E. The maximum 1 year return period event pond water level should be higher than the appropriate return period event water level of the adjacent watercourse, as specified by Warrington Borough Council. Appropriate hydraulic checks on the implications of high watercourse levels should be made, where appropriate.

F. In sites containing contaminated soils or contaminated groundwater, ponds should be fully contained within an impermeable liner to prevent cross contamination of surface water.

Pre-treatment, Inlets and Outlets

A. Bypass structures shall be provided at both the inlet and outlet chambers. The risk to the embankment stability shall be kept to a minimum.

B. A man entry chamber shall be provided at the inlet of the pond.

C. The invert level of the incoming sewers to the inlet structure shall be at or above the 1 year water level in the pond.

D. A man entry chamber shall be provided for the pond outlet equipped with a flow control device. Minimum diameter of the control device shall be 100mm.

E. Bypass structures shall be provided at both the inlet and outlet chambers. The risk to the embankment stability shall be kept to a minimum.

Landscaping and Amenity

A. Ponds should be designed to protect and enhance the landscape.

B. Ponds should be planted and seeded with native species to promote variation in the physical habitat value of the pond.

C. Trees shall not be planted within the pond or embankments needed to retain water.

Safety

A. A safety risk assessment shall examine all relevant safety issues for both operatives and the public.

B. The maximum side slope between the maintenance access path and the aquatic bench shall be 1:4 to allow easy egress from the pond.

C. The aquatic bench should be planted with appropriate species to achieve a high-density barrier when they mature which effectively dissuades people from trying to get access to the open water. Dense or tall vegetation (bushes and trees) around the external perimeter of the ponds is discouraged in order to provide high levels of visibility of the whole pond area.

D. Barrier fencing must be provided at all retention ponds. All access gates must be lockable. The locks must be childproof. The minimum height of the fence shall be 1.1m and shall be constructed in such a manner that there are no step-ups to reduce the 1.1m minimum height. The form of the fence should not detract from the aesthetic value of the local environment.

E. All exposed pipe inlets or outlets, which are larger than 350mm, should normally have safety grilles. However, where grilles can be avoided by the use of appropriate design to restrict human access into the structures, this is preferred. Grille designs should be suitable to minimise the risk of blockage, have safe access for clearing during extreme events and prevent unauthorised access particularly by children and dogs. A typical outfall safety grille is illustrated in Appendix F - Figure 5 of this document.

F. Bar spacing should not exceed 150mm and should not be less than 75mm to avoid trapping small debris.

G. Consideration should be given to the potential failure of any embankment and the subsequent flood flows through, and downstream, of the site.

H. Warning signs should be erected providing information on pond function, basic data and prohibition of swimming.

I. The perimeter of the pond 1m inside and outside the water's edge (water level during dry periods) should have a gradient of less than 1:10. This shall provide a margin which is attractive to flora and fauna and is a disincentive for people to enter the pond. Other areas (above and below the pond) shall have gradients of less than 1:4.

Operation and Maintenance

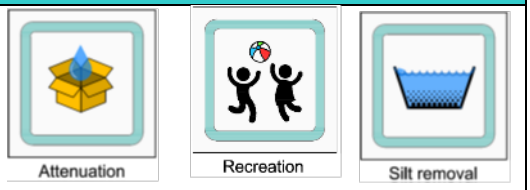
A. The pond shall be accessible to cleaning equipment by an access road 3.5m minimum width.

B. A summary of the maintenance activities is given below and shall be taken into account for pond accessibility design. Summary of maintenance activities:

- Removal of litter, debris and grass cutting;
- Removal of nuisance plant species and dead plant growth;
- Removal of submerged and emergent aquatic plants if present;
- Bank vegetation cutting and removal;
- Sediment removal from forebays and main pond body;
- Reseeding and replanting as required.

C. Pond outlet design shall provide for removal of blockages.

7.2.2 Detention Basins

	Guidance Documents	Key Benefits
	CIRIA C753 The SuDS Manual Part D: Chapter 22 Design Manual for Roads and Bridges HA 103/06	
	Dry vegetated depressions in the ground that have been designed to attenuate storm water flows, provide temporary storage and some pollution removal through settling of particulates. They can also be designed to function as recreational areas.	

Best Practice

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

Local Context - Opportunities

- Can be applied to large contributing catchments
- Works well in low permeability soils.
- Can be incorporated into larger landscaping.
- Good flow control.
- Easy to design, build and maintain.
- Can be used for sports, playgrounds or car parking if designed carefully.

Local Context – Considerations

- Low volume and pollution reduction.
- Requires landscaping and management.

Configuration and Dimensions

A. Detention basins should be designed to **CIRIA C753 – The SuDS Manual** and the requirements of this document Appendix F - Figure 6.

B. An irregular shape should be used for maximising the aesthetic aspect of the detention basins. Angular shapes should be avoided as far as practical in the design of basin elements and details.

C. As a minimum detention basins should contain the following sections:
   - The sediment forebay if expected sediment loading is significantly high;
   - The main basin;
   - A part of the main basin depressed to form a micropool.

D. Additional elements to be included in the design of basins should be:
   - An inflow structure;
   - an emergency overflow structure;
   - Bypass sewer piping, and;
   - Outlet with flow control device.

   The sedimentation forebay shall be separated from the permanent pool by a permeable berm.

E. Detention basin bases shall be designed with gentle inner slopes (1 to 100 maximum) towards the centre.

F. Embankment inner slopes shall be less than 1 to 4.

G. The maximum design water depth of the basins shall be 3m.

H. The length to width ratio for online detention basins shall be between 5:1 to 2:1.

I. The maximum volume of the detention basins shall be 5,000m^3.

Hydraulic and Water Quality Design Criteria

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

Selection and Siting

A. A risk assessment should include all relevant safety issues associated with siting a basin.

B. Siting of detention basins should follow a multicriteria analysis to provide the widest benefits to the public.

C. The 100 year + Climate Change water level in any detention basin shall be at least 600mm below the finished floor level of any adjacent properties.

D. Consideration should be given to the potential failure of any embankment and the subsequent flood flows through, and downstream, of the site.

E. The maximum 1 year return period event basin water level shall be higher than the appropriate return period event water level of the adjacent watercourse, as specified by Warrington Borough Council as part of its flood prevention duties. Appropriate hydraulic checks on the implications of high watercourse levels should be made, where appropriate.

F. At sites of high groundwater table, the basin bottom level shall be built 500mm above the annual maximum groundwater level.

G. At sites with contaminated soil detention basins shall be designed water tight. Unlined detention basins should not be used on brownfield sites unless it has been clearly demonstrated that there is no risk of groundwater pollution.

Pre-treatment, Inlets and Outlets

A. Energy dissipation and erosion protection should be provided at the basin inlets. Basin inlets to be at least 300mm higher than the base of the basin.

B. Safety grilles should be provided in all pipe inlets diameter greater than 350mm. During extreme events operatives should be able to access safely the inlet pipe for cleaning.

C. Detention basins should be designed with a slight depression in the area of the inlet structures to encourage the water quality benefits of bioretention processes.

D. A manhole and a flow control device should be provided at the outlet of the basin. Discharge from the basin should be limited to the allowable Warrington Borough Council limit. The flow conditions in the receiving stream downstream of the basin should be modelled to the satisfaction of the Warrington Borough Council.

E. An overflow structure should be provided at the outlet. A spillway shall also be provided for an emergency. The spillway should be designed as a controlled overtopping of the embankment. It should not be designed to pass through the embankment. Emergency overflows should be routed back to the receiving watercourse to protect downstream properties.

F. The top of embankment at the spillway should be 300mm above the 100 year + Climate Change allowance storm event.

G. The outlet structure should be designed to operate and discharge the design discharge flow rate up to the 1 in 100 year + Climate Change 6 hour storm event. Appropriate hydraulic checks on the implications of high watercourse levels shall be performed, where applicable.

Landscaping and Amenity

A. Consideration should be given to the suitable aesthetic design of the detention basin and its surrounds.

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

Safety

A. A safety risk assessment shall examine all relevant safety issues for both operatives and the public.

B. The maximum cross slope of the embankment shall be 1:4 to allow safe working conditions for grass cutting.

C. Dense vegetation around the external perimeter of the detention basin is discouraged to allow high levels of visibility of the area. Detention basins should not normally require to be fenced.

Operation and Maintenance

A. Access road for maintenance of 3.5m minimum width access road shall be provided.

B. A summary of the maintenance activities is provided below and shall be taken into account for basin accessibility design. Summary of maintenance activities:

- Removal of litter, debris and grass cutting.
- Removal of unwanted plant species and dead plant growth.
- Removal of aquatic plants if present.
- Bank vegetation cutting and removal.
- Sediment removal from forebays and micropools.
- Reseeding of areas with poor vegetation growth.

Ecology

Suitable native planting should be selected to maximise the ecological value of the detention basin and surrounds.

7.3 Underground Storage

	Guidance Documents	Key Benefits
	CIRIA C753 The SuDS Manual Part D: Chapter 21 Design Manual for Roads and Bridges HA 103/06	 Attenuation
	Underground structures with capacity to store water below ground. They only provide attenuation and not treatment - cleaning of the water is therefore required prior to release.	

Best Practice

- Clear evidence of where the storage structure fits into a planned SuDS Management Train to provide silt removal and pollution treatment.
- Examine possibility of enabling infiltration through geotextile layer.
- Suitable internal void ratio of the structure (>90%).

Local Context - Opportunities

- Can be designed to attenuate stormwater from any drainage area.
- Ideal where above ground space is not available.
- Stable ground is required.

Local Context – Considerations

- The underground storage must be part of a wider SuDS Management Train.
- Designs should ensure avoidance of structural failure and collapse as well as expected loading.

Configuration and Dimensions

A. The use of underground storage (which provides no surface water treatment) shall only be allowed where the use of other SuDS methods are inappropriate.

B. The design of the underground storage shall aim to minimise sedimentation. Underground storage should be designed to the requirements of **CIRIA C753 – The SuDS Manual** and Appendix F – Figure 7 of this document.

C. Larger underground storage structures shall permit man-entry to enable inspection and maintenance activities to be carried out within the storage chambers. This shall include suitable clear opening and internal step irons for safe access/egress. Smaller underground storage structures should have suitable access points to permit remote cleaning and inspection to be readily carried out. Covers should be large enough to allow man-entry with breathing apparatus. Entry points should be on level ground to permit the erection of man-entry safety tripods.

D. Design options that shall be acceptable for public areas are pre-fabricated structures, oversized pipes or cast *in-situ* concrete structures.

E. The maximum water level in any underground storage structure shall be at least 600mm below the lowest floor level of any adjacent premises.

F. Underground storage should normally be designed as off-line storage and should be sized in accordance with the hydraulic design requirements.

G. Low-flow channels should be provided.

H. The minimum gradient for storage systems should be 1:100 for off-line tanks and 1:200 for on-line tanks to minimise sedimentation. The gradient will vary dependent on the pipe diameter used; however minimum self-cleansing velocities between 0.7 and 1m/s need to be achieved to minimised sedimentation.

Selection and Siting

Underground storage should be located beneath public areas or roads.

Pre-treatment, Inlets and Outlets

A. The outlet structure should be designed to operate and discharge the design-limiting discharge rates. Appropriate hydraulic checks on the implications of high downstream water levels should be made, where appropriate, and take account of the receiving watercourse or downstream sewer capacity.

B. Flow controls shall be designed to the requirements of **Sewers for Adoption 7th Edition**. The minimum size of any orifice should be 100mm diameter to prevent restrictions.

C. The outlet structure should have an overflow provided.

Safety

A. A risk assessment should cover all aspects of safety, including access, for operatives during maintenance operations.

B. A minimum of two access points (upstream and downstream) should be provided with maximum intervals between access points of 50m.

C. Ventilation should be provided to minimise the risk of build-up of dangerous gases.

Operation and Maintenance

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

7.4 Privately-owned SuD Systems

The drainage of privately-owned areas should, be served by appropriate SuDS as part of the overall Management Train.

Most source control features will be located within the private or highway areas of a development and as such will not be adopted by Warrington Borough Council. The purpose of source control is to manage rainfall close to where it hits the ground instead of allowing it to become problem elsewhere. The main types of source control that will be used in private areas are:

- Green Roofs;
- Permeable Pavements;
- Soakaways;
- Geo-cellular Storage.

Other features such as filter strips, swales, canals, rills and treatment channels can also be used as source control in private areas. Water re-use features such as water butts or more comprehensive water harvesting systems are also useful additions to a SuDS system to provide an overall sustainable water management system.

Privately owned SuDS can be included in the treatment Management Train, but **shall not** be included in the hydraulic modelling of the holistic system due to extensions or permeable surfaces being sealed, etc.

Early consultation with Warrington Borough Council is advised to provide addition guidance to privately-owned SuD systems.

7.5 Pre- treatment options

7.5.1 Oil and Sediment Separators

Oil and sediment separators can be used as pre-treatment, or as a last resort, site treatment for the removal of sediment, litter and oil from surface water runoff. These systems can be

installed in a standard size manhole. Captured pollutants are retained within the separator, providing a single point of maintenance

Vortex System

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

Best Practice

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

Configuration and Dimensions

A. Vortex separators are cylindrical units where the water flows in a rotational manner which facilitates the removal of coarse sediment, litter and debris.

B. The use of proprietary units is permitted and shall be considered on a case by case basis.

C. An integral flow bypass without disturbing the collected solids shall be provided.

Hydraulic and Water Quality Design Criteria

The design of a vortex solids separator shall be based on the anticipated type and quantity and the settlement potential of pollutants to be removed.

Selection and Siting

A. Vortex pre-treatment units shall be considered primarily for use in small to medium size catchments.

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

Health and Safety

A risk assessment shall include all relevant safety and environmental issues associated with siting the vortex separator units.

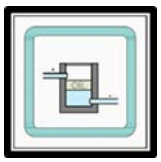
Operation and Maintenance

A. Removal of litter and debris is a regular maintenance requirement of vortex separators. Collected sediment can be removed as required based on the volume collected in the unit. As a minimum sediment should be removed on a six month basis.

B. Regular inspection of the vortex units is required usually on a bi-annual basis. The frequency of inspections shall be established following an initial 30 day inspection period. During this period the unit shall be checked for performance and sediment collection after every rainfall event.

C. Collection and disposal of the collected sediment shall be performed by a licenced waste management company.

Oil Separator

	Design Standards	Key Benefits
	Must comply with BS EN standards for separating systems. Require maintenance to prevent re-suspension of pollution. Should be situated close to the pollution source	 Pollutant treatment

Best Practice

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

Configuration and Dimensions

A. Oil separators used for the removal of oil and grease present in storm waters operate on the flotation principle. Separated oils are floating on the water surface inside the unit.

B. The use of proprietary units is permitted and shall be considered on a case by case basis.

Hydraulic and Water Quality Design Criteria

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

WAY MARKER 7.1

Separator systems for light liquids (e.g. oil and petrol). Principles of product design, performance and testing, marking and quality control - BS EN 858-1:2002
https://shop.bsigroup.com/ProductDetail/?pid=000000000030131162

Selection and Siting

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

B. Guidance on selection and use of oil separators is provided by **www.gov.uk** website, replacing **Pollution Prevention Guideline 3 (PPG 3) - Use and design of oil separators in surface water drainage systems**, published by the Environment Agency and SEPA, on 14th December 2015.

Health and Safety

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

Operation and Maintenance

A. Regular inspection of the unit in accordance with the manufacturer's maintenance requirements but no longer than every six months. The volumes of bottom sludge and the floating layer shall be estimated and cleaning of the unit should be scheduled.

B. Cleaning of the oil separator shall be performed by a licenced waste management company to ensure appropriate disposal of the collected oils, floatables and sediment.

C. Following cleaning the separator shall be filled with clean water, ready to fully operate with the first rainfall.

D. At present United Utilities will not adopt these as part of an adoptable system.

8 SuDS Maintenance

What this section will cover:

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

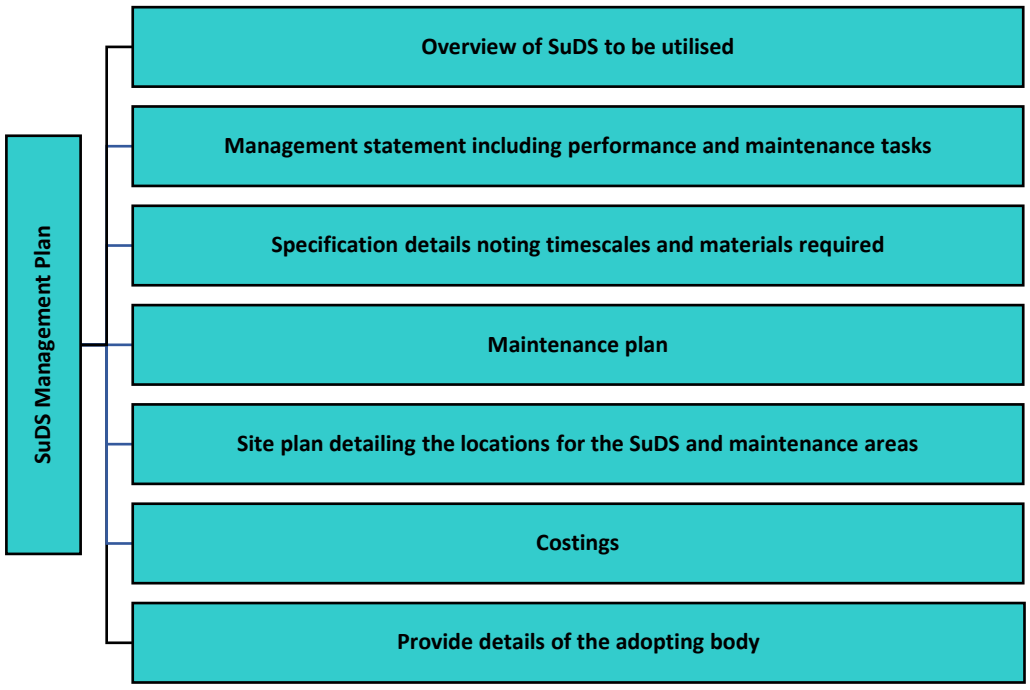
Unlike more conventional drainage systems, SuDS should be designed to be visible and function under anticipated loading conditions over the design life of the development. This will enable those who are responsible for maintenance to easily identify and remediate problems as they occur. When systems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

8.1 SuDS Management Plan

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

The approved Maintenance and Management Plan must include information on the safe operation, design assumptions, maintenance of SuDS components and how SuDS components interact. Where appropriate the Maintenance and Management Plan must make provision for a warning system and contingency arrangements. If undertaken correctly, the design of SuDS will ensure that day to day and long term maintenance is feasible, cost-efficient and easy to undertake. The majority of the SuDS components are features of the landscape and so should be managed according to existing landscape practices (**CIRIA SuDS Manual C753, Chapter 29**). Maintenance fits into the management plan as follows:

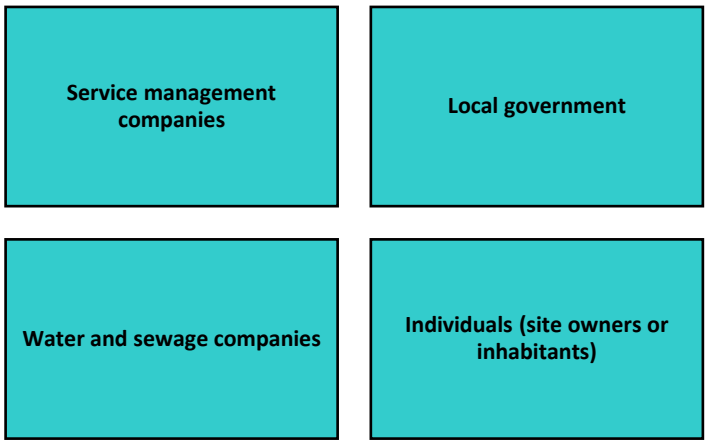
Figure 8.1: SuDS Management Plan



8.2 Who should undertake the Maintenance?

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

Figure 8.2: Potential Maintenance Ownership

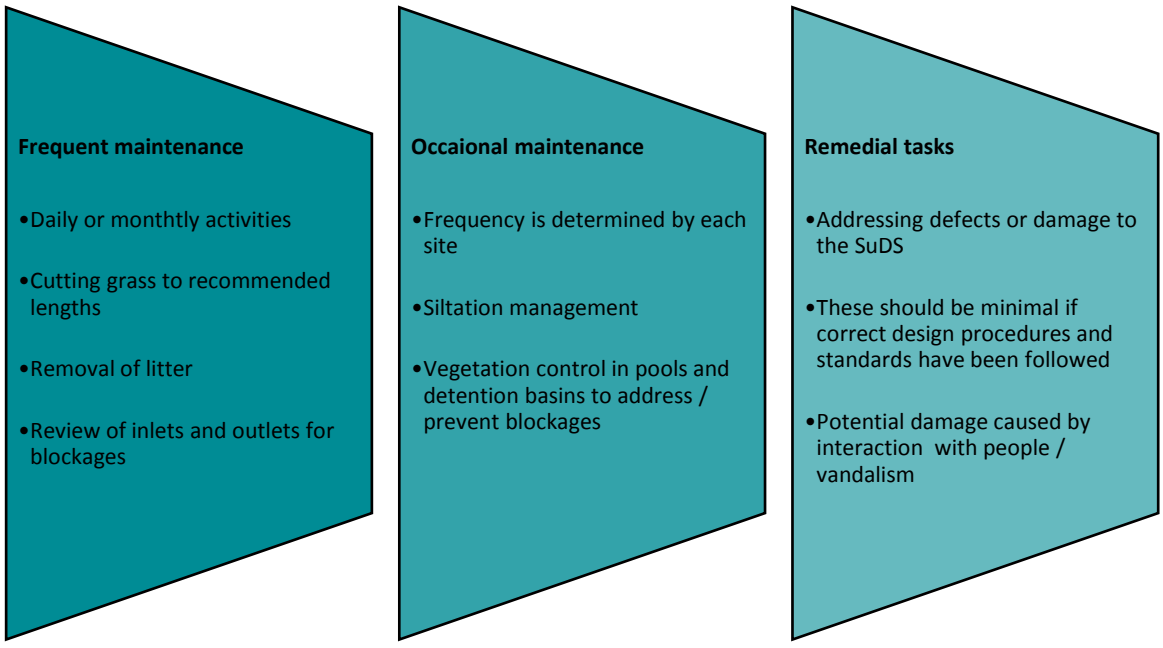


It should be noted Warrington Borough Council are currently not adopting or maintaining SuDS schemes.

8.3 What does Maintenance of SuDS Involve?

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

Figure 8.3: Maintenance Works



8.4 Maintenance of SuDS Components

Table 8.1: Maintenance of SuDS Components

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

8.5 Waste management for SuDS

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

Table 8.2: Key Areas of Maintenance Programme

Area	Action
Litter	Regular removal from the site
Silt entering waterbody	Intercept and control at source
Silt entering SuDS	Regular removal from silt traps, inlets and outlets of SuDS
Organic pollution i.e. small amounts of animal waste	Bio-remediation through the SuDS
Vegetation waste from grass prunings	Removal from SuDS area
Heavy metals and other pollutants	Captured at the source or through lining of the SuDS

8.6 Asset Inspection

Warrington Borough Council regularly inspects all council owned assets that contribute to reducing flood risk from ordinary watercourses and surface water. The Environment Agency regularly inspects assets that contribute to reducing flood risk on main rivers and sections of the coast that are subject to sea flooding, regardless of asset ownership.

WAY MARKER 8.1

EA Asset Performance Tools – Asset Inspection Guide
http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/APT_2_report.sflb.ashx

Asset inspection is divided into the following areas:

- Tier 1 - Routine Inspection;
- Tier 2 - Non-intrusive investigations carried out by an appropriate expert;
- Tier 3 - Intrusive investigations into the make-up of the asset.

Tiers 2 and 3 both require a notable investment (Tier 2 less so than Tier 3) and need to be justified in terms of efficiency gains, performance and risk. These are primarily aimed at schemes that are “hard” engineered. SuDS schemes are designed to provide a natural approach to manage drainage, therefore Tier 1 inspections are considered most appropriate.

The following sections will refer to the Tier 1 process in further detail due to the appropriate level of investigation required for the majority of SuDS schemes. Early contact with Warrington Borough Council should be made to provide guidance if Tier 2/3 investigations are required for the level of SuDS scheme to be constructed.

The asset owner, or occupier, is ultimately responsible for conducting a suitable and sufficient assessment of the SuDS for the use, inspection and maintenance of the system.

8.6.1 Frequency of Routine Inspection

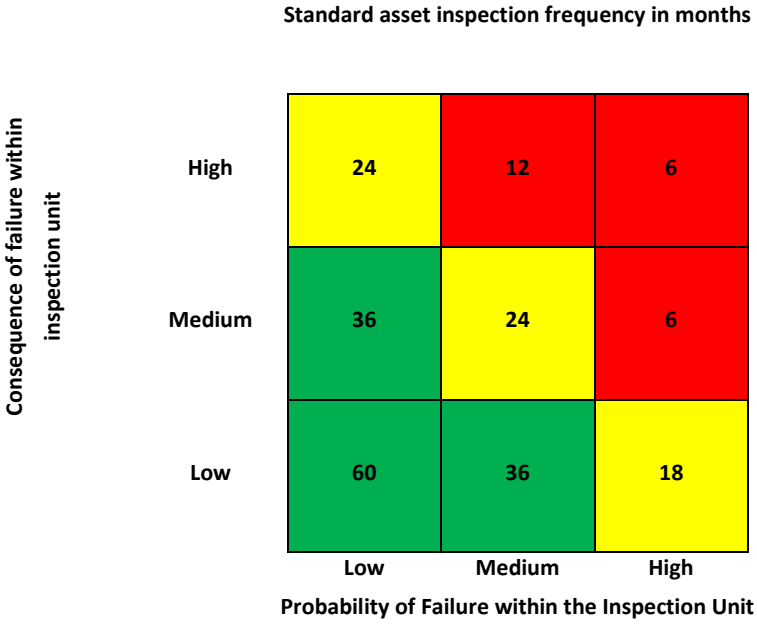
The frequently of inspections undertaken by Warrington Borough Council and the Environment Agency is risk based, taking account factors such as the nature and significance of the flood defence and particularly the consequences should the asset fail structurally, or fail to perform as expected. Inspection periods range from 6 monthly in the highest risk areas to 5 yearly in low risk areas.

The maintenance programme must take into the consideration the frequency of inspection to ascertain SuDS performance. The inspection programme will need to be regularly reviewed and updated in response to changing circumstances, such as changes in asset condition or performance expectations, in relation to flood risk and consequence. Warrington Borough Council recommends a similar approach undertaken by the Environment Agency as this is a

good, established example of a sensible risk-based approach. Other organisations will have its own guidelines for inspection frequency, suitable for the purpose. For example, Highways Authority assets generally have a significantly different cost/risk balance than that applied to traditional flood risk management assets; this will influence the frequency of inspection.

The normal inspection frequency is based on the consequences and probability of failure. This derives from a 'performance and risk assessment' activity which is an essential input into the visual inspection activities. The standard frequency of inspection is the maximum interval allowed between inspections. For particularly high consequence systems the frequency of inspection is likely to be increased even if the probability of failure is low.

Figure 8.4: Matrix of consequences and probability of failure for setting inspection frequencies



Further information is contained within the **Environment Agency's Asset Performance Tools – Asset Inspection Guide** (Way Maker 8.1)

8.6.2 Assessing condition

Scoring Mechanism

Warrington Borough Council adheres to the scoring system devised by the Environment Agency to assess asset condition which is contained in the **Environment Agency's Condition Assessment Manual (CAM)** published in 2012. The condition grading system ranges from 1 to 5, where 1 is Very Good condition, and 5 is Very Poor. Each asset is given a target condition grade, based on several factors such as the asset type, and what it is protecting.

Table 8.3: Definitions of condition grade in the Condition Assessment Manual

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce the performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset
5	Very Poor	Severe defects resulting in complete performance failure

A minimal score of 2 (Good) should be obtained upon completion of a SuDS scheme with the first routine inspection to be completed no later than 2 years after initial assessment in which a minimum score of 3 (Fair) should be achieved. The minimal target score of 3, set by Warrington Borough Council, should be achieved on all future inspections. The actual condition recorded during inspection in relation to the target condition to identify if further assessment or remedial works are required.

Inspections should be undertaken by an accredited T98 inspector. If one cannot be sought please contact Warrington Borough Council for further assistance.

Further information is contained within the **Environment Agency's Asset Performance Tools – Asset Inspection Guide** (Way Maker 8.1)

Weighting of elements

A scheme can be broken down into a number of elements. Weightings can then be used to indicate the importance of each element to the overall integrity and performance of the asset in undertaking its primary role in flood risk management.

Any weighted system involving a number of elements is complex. The Environment Agency approach is considered a good model and is a clearly directed one. The weightings used in this model range from 1 (elements that do not have a flood or risk reduction function) to 9 (critical elements whose failure would lead to the immediate or imminent failure of the whole asset or its failure to perform its intended function). But like all complex models, the Environment Agency model relies on a high degree of understanding and careful application by the inspector.

Within both the Environment Agency and Warrington Borough Council, the target condition for most assets is set at condition grade 3 and in some specific cases a target grade of 2. Caution is advised in the way scores are rounded from an inspection. A score of 3.49 is actually rounded to a score of 3, which would show the asset as meeting its target, whereas it is actually below target (that is, in less than satisfactory condition) and should flag an alert.

The overall grade of the asset is the sum of (weightings × condition grades) divided by the sum of the weightings.

If any individual element with a weighting of 9 (a critical element) falls below the target condition and the above calculation shows the asset is numerically meeting its target condition, this should be overridden to give an overall condition grade below the target.

Table 8.4: Example calculation of condition grade from grade and weighting of elements

Element Type	Weighting (W)	Condition Grade (CG)	W x CG
Channel side	3	3	9
Berm	5	2	10
Exposed Face	8 (9)	4	32 (36)
Crest	8	1	8
Landward face	8	2	16
Sum (W)	32 (33)		
Sum (CG x W)		75 (79)	
Overall Asset Grade	Sum of (weightings × condition grades) divided by the sum of the weightings.	75/33 = 2 (2.28 but rounded down to whole number) (79/33 = 2.39) (override to 4 due to failed element)	

Further information is contained within the **Environment Agency's Asset Performance Tools – Asset Inspection Guide** (Way Maker 8.1)

Appendices

Appendix	Title
A	Checklist for SuDS Assessment
B	Runoff Calculator Guide
C	SuDS Suitability Selection Matrix
D	Warrington Environment Maps
E	Warrington Soil Maps
F	Schematic Design Layouts
G	Useful Resources
H	Document References

A Checklist for SuDS Assessment

Application Checklist for SuDS Assessment

This checklist outlines the requirements of a SuDS application for submission to Warrington Borough Council.

WAY MARKER A.1 - Key points to remember

- SuDS aim to mimic natural drainage, encourage infiltration and attenuate both flows and pollution to minimise adverse impacts on people and the environment.
- Surface water drainage measures proposed as part of a planning application should have a neutral or better effect on the risk of flooding both on and off the site.
- SuDS design should consider prevention, source and site controls.
- Well-constructed SuDS will ensure maintenance for both the short and long term.

1 Process Summary

1.1 Pre-Application

Warrington Borough Council should be involved in any pre-application discussions relating to a development as it will preliminary identify the most efficient method of SuDS to be utilised in the formulation of the development design and layout. It is beneficial for a range of people to be involved at the pre-application stage, including the Local Planning Authority (LPA), Lead Local Flood Authority (LLFA), Highway Authority, Environment Agency (where relevant), sewerage undertakers, the developer, consultants, drainage engineers, landscape architects or urban designers and ecologists.

Where pre-application discussions are to be held with the LPA specific advice should be sought with the LPA regarding any charges that are applicable. This will enable different areas or features to be integrated as part of the overall development at the different scales and for potential adoption by different bodies to be defined. Pre-application will allow development of conceptual drainage designs with subsequent working up to outline designs. This will allow applicants to design to detail with confidence that applications will be approved.

No formal submission of information is required at this stage, however some important information is strongly recommended.

Pre-design discussion with Warrington Borough Council is advised prior to any submission and should include the following:		
1	Site assessments including the existing drainage characteristics, geology and topography	
2	Existing flood risks	
3	Identification of any watercourses running through the site	
4	Natural flow paths, discharge locations, sub-catchments	
5	Identification of any potential off-site flood risk impact	
6	Likely design criteria applicable to the site	
7	Potential SuDS integration	
8	Evidence of discussions with Water Companies, EA, and/or other interested parties	
9	Adoption options/ownerships/easements	
10	Maintenance and access arrangements	

1.2 Outline Design

Following the initial meeting designers will be able to develop concepts for drainage design, working with other disciplines involved in the development. This can then be developed in to a design outline which provides information for approval, in-principle, by the LPA.

Following pre-design discussion with LLFA it is recommended that the following be submitted prior to submitting the application in order to obtain an 'agreement in principle'		
1	Detailed Flood Risk Assessment	
2	Existing utilities plan (if applicable)	
3	Impermeable areas estimate	
4	Confirmed discharge locations and conditions	
5	Drainage sub-catchments	
6	Storage volume estimate	
7	Storage location(s) source to regional	
8	Flow control(s)	
9	Ecology and water quality implications, e.g. treatment train	
10	Areas where SuDS will form recreational features	
11	Public Health and Safety consideration	
12	Identification of adoption responsibilities	
13	Maintenance and access arrangements	

1.3 Master Planning

Master planning should be undertaken at the beginning of the design process to develop an area wide strategy especially where a number of developments could resolve SuDS issues together. This would enable the creation of larger schemes with lakes, ponds, basins etc. including access paths within the green infrastructure area.

When undertaking master planning the following should be taken into consideration:

- Large scale natural flow paths informing SuDS catchments;
- Integration of SuDS within the overall green infrastructure of the site;
- Distribution of water storage between regional and source/site controls;
- Adoption arrangements of all infrastructures;
- Solutions to investment requirements to cater for phased nature of developments;
- Maintenance and access arrangements in perpetuity for all SuDS.

1.4 Full Application

Any application should clearly identify who will be responsible for maintaining the sustainable drainage systems and funding for maintenance.

To complete the application the following needs to be submitted to the LPA		
1	Detailed Flood Risk Assessment	
2	Detailed design	
3	Specification of materials	
4	Flow calculations (.mdx files where possible)	
5	Details of inlets, outlets and flow controls	
6	Construction details	
7	Phasing of development including Construction Management Plan	
8	Cross sections including design levels	
9	SuDS Design Statement	
10	Operation and Maintenance Plan	
11	Health and Safety Risk Assessment	

1.5 Outline Planning Approval

The LLFA will be consulted on outline planning applications. An outline planning application should therefore include a conceptual Drainage Design for the LLFA to provide comments on, otherwise more information may be required at the reserved matters stage and the developer may discover problems later on that will be harder to resolve.

2 Check List

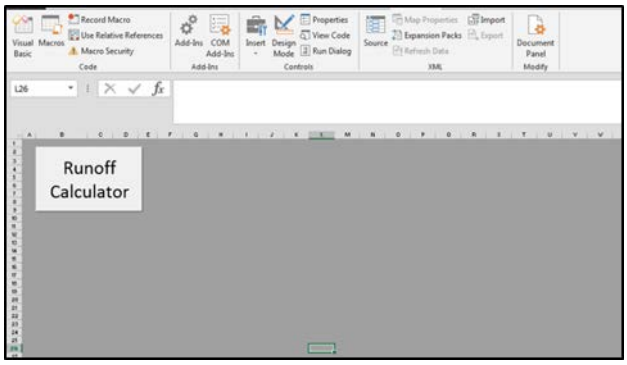
The checklist is contained with excel file "**WBC SuDS Assessment Checklist v1.0.xlsx"**.

The checklist should be used as a guide by the applicant and completed by Warrington Borough Council as part of the relevant planning application in order to demonstrate that the necessary information has been supplied to assess the suitability of the proposed sustainable drainage system, in line with the National Planning Policy Framework (NPPF). Failure to provide any of the information requested below may result in the LLFA making recommendation for refusal of the planning application on grounds of insufficient information.

B Runoff Calculator Guide

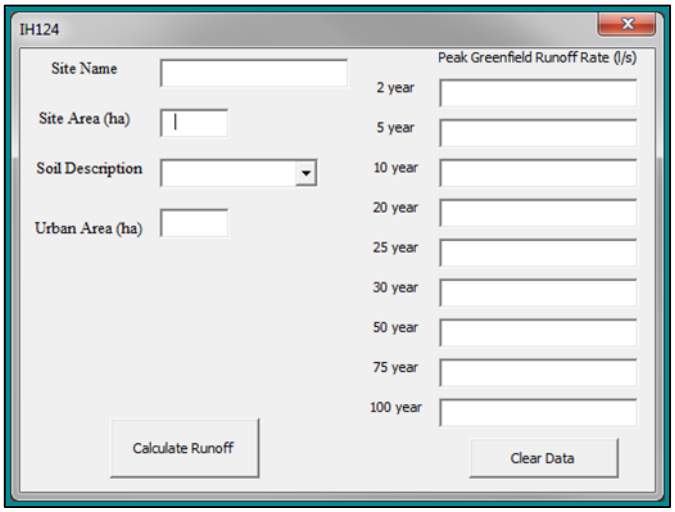
The Runoff Calculator is a programme constructed in Microsoft Excel. To use the programme open the file "**Runoff Calculator.xlsm" and ensure macros are enabled.** When open the file should look similar to Figure B.1.

Figure B.1



To use the Calculator, press the "Runoff Calculator Button" A window should be displayed similar to Figure B.2.

Figure B.2



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

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

Once these have been completed press the **"Calculate Runoff"** button to calculate the peak Greenfield Runoff Rate in litres per second for the displayed return periods.

C SuDS Suitability Selection Matrix

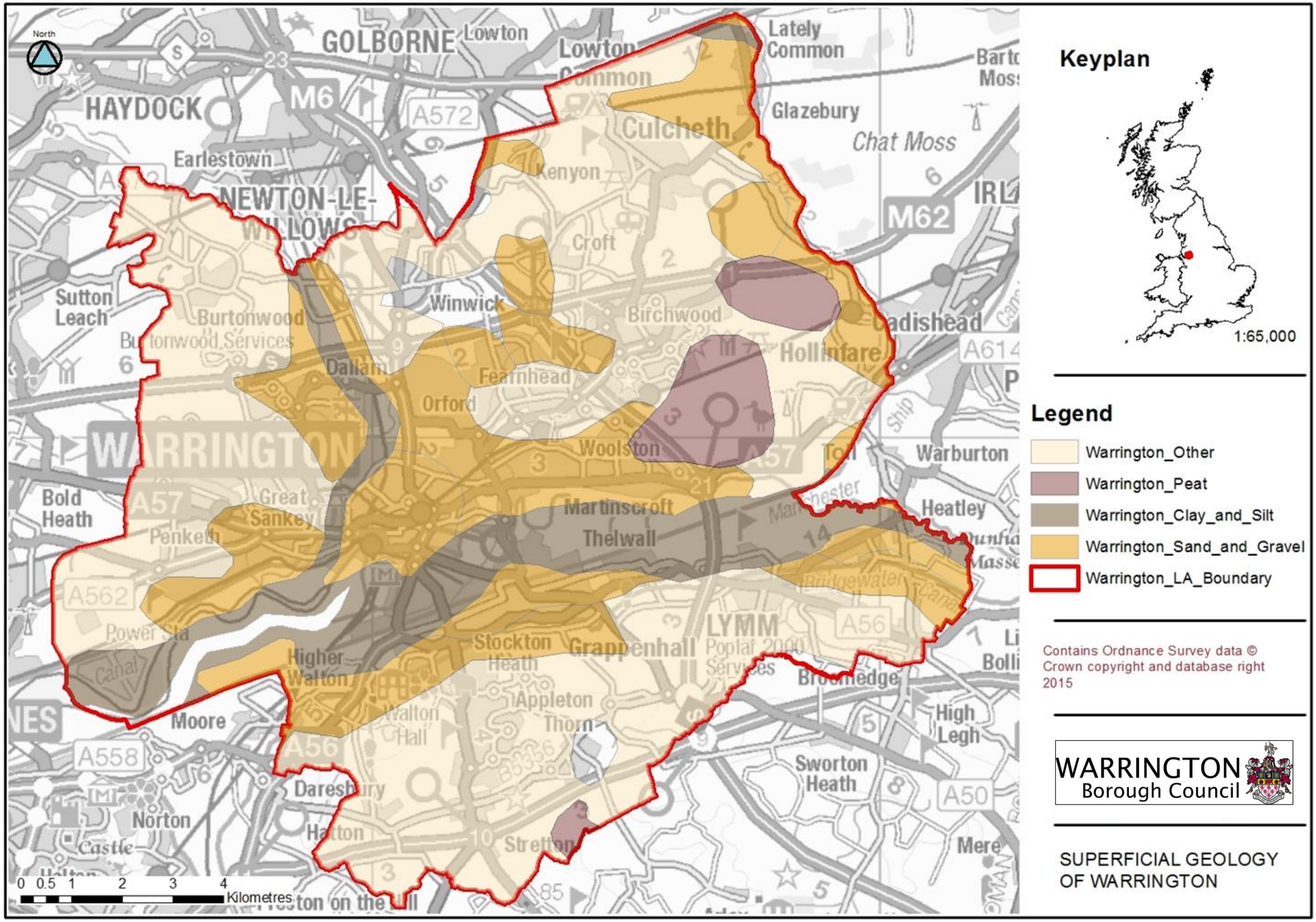
SuDS Urban Drainage Suitability Matrix

General Suitability				Landuse Suitability								Water Quality Suitability								Hydraulic control				Cost suitability		Environmental Benefits	
															Removal Treatment Potential						Suitability for flow rate control (probability)						
SuDS Group	Technique	Suitability Conditions	Management Train Suitability	Low density	Residential	Local roads	Commercial	Hotspots	Construction site	Brownfield	Contaminated land	Water Quality Suitability	Water Quality Removal Technique	Pollutants Removed	Total Suspended Solids	Heavy Metals	Nutrient (phosphorous, nitrogen)	Bacteria[4]	Fine suspended sediments and dissolved Pollutants	Runoff volume reduction	0.5 (1 / 2 yr)	0.1 - 0.3 (10 / 30 yr)	0.01 (100 yr)	Maintenance	Capital	Habitat creation potential	Community acceptance
Retention	Retention Pond	A, F	Site control, regional control	Y	Y	Y[2]	Y[2]	Y[2]	Y[2]	Y	Y[2]	Detention, infiltration[3], water harvesting	Sedimentation, filtration, adsorption, bio-degradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	M	M	H	L	H	H	H	M	M	H	H
	Subsurface storage	-	Conveyance, site control	Y	Y	Y	Y	Y	Y[2]	Y	Y	Conveyance, detention	Sedimentation[3], filtration[3]	Nutrients, sediments, metals, hydrocarbons	L	L	L	L	L	L	H	H	L	M	L	H
Wetland	Shallow wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance[3], detention, infiltration[3], water harvesting	Sedimentation, filtration, adsorption, bio-degradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	L	H	M	L	H	H	H	H[7]
	Extended detention wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance[3], detention, infiltration[3], water harvesting	Sedimentation, filtration, adsorption, bio-degradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	L	H	M	L	H	H	H	H[7]
	Pond/wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance[3], detention, infiltration[3], water harvesting	Sedimentation, filtration, adsorption, bio-degradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	L	H	M	L	H	H	H	H[7]
	Pocket wetland	B, D, H	Conveyance*, site control, regional control	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance[3], detention, infiltration[3], water harvesting	Sedimentation, filtration, adsorption, bio-degradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	L	H	M	L	H	H	H	M[7]
	Submerged gravel wetland	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance[3], detention, infiltration[3], water harvesting	Sedimentation, filtration, adsorption, bio-degradation, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	L	H	M	L	M	H	M	L
	Wetland channel	B, D, F, I	Conveyance*, site control, regional control	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance[3], detention, infiltration[3], water harvesting	Sedimentation, filtration, adsorption, volatisation, precipitation, uptake by plants, de-nitrification	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	M	H	M	H	L	H	M	L	H	H	H	H[7]
Infiltration	Infiltration trench	C, H, J	Conveyance, source control, site control	Y	Y	Y[2]	Y[2]	N	N	Y	Y[2]	Conveyance[3], detention, infiltration	Filtration, adsorption, bio-degradation, volatisation	Sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	H	H	H	L	L	L	L	M
	Infiltration basin	C, F, J	Site control, regional control	Y	Y	Y[2]	Y[2]	N	N	Y	Y[2]	Detention, infiltration	Filtration, adsorption, bio-degradation, volatisation	Sediments, hydrocarbons, metals, pesticides, cyanides, nutrients, organic matter, BOD	H	H	H	M	H	H	H	H	H	M	L	M	H[7]
	Soakaway	C, H, J	Source control	Y	Y	Y[2]	Y[2]	N	N	Y	Y[2]	Infiltration	Filtration, adsorption, bio-degradation	Sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	H	H	H	L	L	M	L	M
Filtration	Surface sand filter	C, D, F, K	Pre-treatment, site control, regional control*	N	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Detention, Infiltration[3]	Filtration, adsorption, bio-degradation, volatisation, precipitation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	L	H	M	L	M	H	M	L
	Sub-surface sand filter	C, D, H, K	Pre-treatment, site control, regional control*	N	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Detention, Infiltration[3]	Filtration, adsorption, bio-degradation, volatisation, precipitation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	L	H	M	L	M	H	L	L
	Perimeter sand filter	C, D, H	Pre-treatment, site control, regional control*	N	N	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Detention, Infiltration[3]	Filtration, adsorption, bio-degradation, volatisation, precipitation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	L	H	M	L	M	H	L	L
	Bioretention/filter strip	C, D, F, H	Pre-treatment, source control	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance[3], detention[3], infiltration[3]	Sedimentation, filtration, adsorption, bio-degradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD	H	H	H	M	H	L	H	M	L	H	M	H	H
	Filter trench	A, C, D, H	Conveyance, source control, site control*	Y	Y	Y[2]	Y[2]	Y[2]	N	Y	Y[2]	Conveyance, detention	Filtration, adsorption, bio-degradation, volatisation, precipitation	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	H	H	H	M	H	L	H	M	L	M	M	L	M
Detention	Detention basin	A, C, F, K	Site control, regional control	Y	Y	Y[2]	Y[2]	Y[2,7]	Y[2]	Y	Y[2]	Detention	Sedimentation, filtration[3], adsorption[3], bio-degradation, uptake by plants*	Nutrients, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	M	M	L	L	L	L	H	H	H	L	L	M	H[7]
Open channels	Conveyance swale	C, E, F, H, J	Conveyance, pre-treatment, site control	Y	Y	Y[2]	Y[2]	Y[2]	Y[2]	Y	Y[2]	Conveyance[3], detention[3], infiltration[3]	Sedimentation, filtration, adsorption, uptake by plants[3], biodegradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD	H	M	M	M	H	M	H	H	H	L	L	M	M[7]
	Enhanced dry swale	C, E, F, H, J	Conveyance, pre-treatment, site control	Y	Y	Y[2]	Y[2]	Y[2]	Y[2]	Y	Y[2]	Conveyance[3], detention[3], infiltration[3]	Sedimentation, filtration, adsorption, uptake by plants[3], biodegradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD	H	M	M	M	H	M	H	H	H	L	M	M	M[7]
	Enhanced wet swale	B, E, F, H, J	Conveyance, pre-treatment, site control	Y	Y	Y[2]	Y[2]	Y[2]	Y[2]	Y	Y[2]	Conveyance[3], detention[3], infiltration[3]	Sedimentation, filtration, adsorption, uptake by plants[3], biodegradation	Nutrients, sediments, hydrocarbons, metals, pesticides, organic matter, BOD	H	M	M	M	H	L	H	H	H	M	M	H	M[7]
Source control	Green roof	G, H	Prevention, pre-treatment, source control	Y	Y	N	Y[2]	Y	N	Y	Y	Detention	Filtration, adsorption, volatisation, precipitation, uptake by plants, de-nitrification, bio-degradation	Sediments, hydrocarbons, metals, pesticides, chlorides, cyanides, organic matter, BOD, nutrients	N/A	N/A	N/A	N/A	H	H	H	H	H	L	H	H	H	H
	Rain water harvesting	H	Prevention, conveyance*, source control	Y	Y	N	Y[2]	N	N	Y	Y	Conveyance[3], detention[3], infiltration, water harvesting[6]	Sedimentation[2], filtration[2], adsorption[2], bio-degradation[2], volatisation[2], precipitation[2], uptake by plants[3], de-nitrification[3]	Chlorides, sediments, hydrocarbons, metals, pesticides, cyanides, organic matter, BOD	M	L	L	L	N/A	M	M	H	L	H	H	L	M[7]
	Pervious pavements	C, D	Prevention, source control, site control*	Y	Y	N	Y[2]	Y[2]	N	Y	Y[2]	Detention, infiltration, water harvesting	Sedimentation, filtration, adsorption, bio-degradation, volatisation	Sediments, hydrocarbons, metals, pesticides, nutrients, cyanides, organic matter, BOD	H	H	H	H	H	H	H	H	L	M	M	L	M

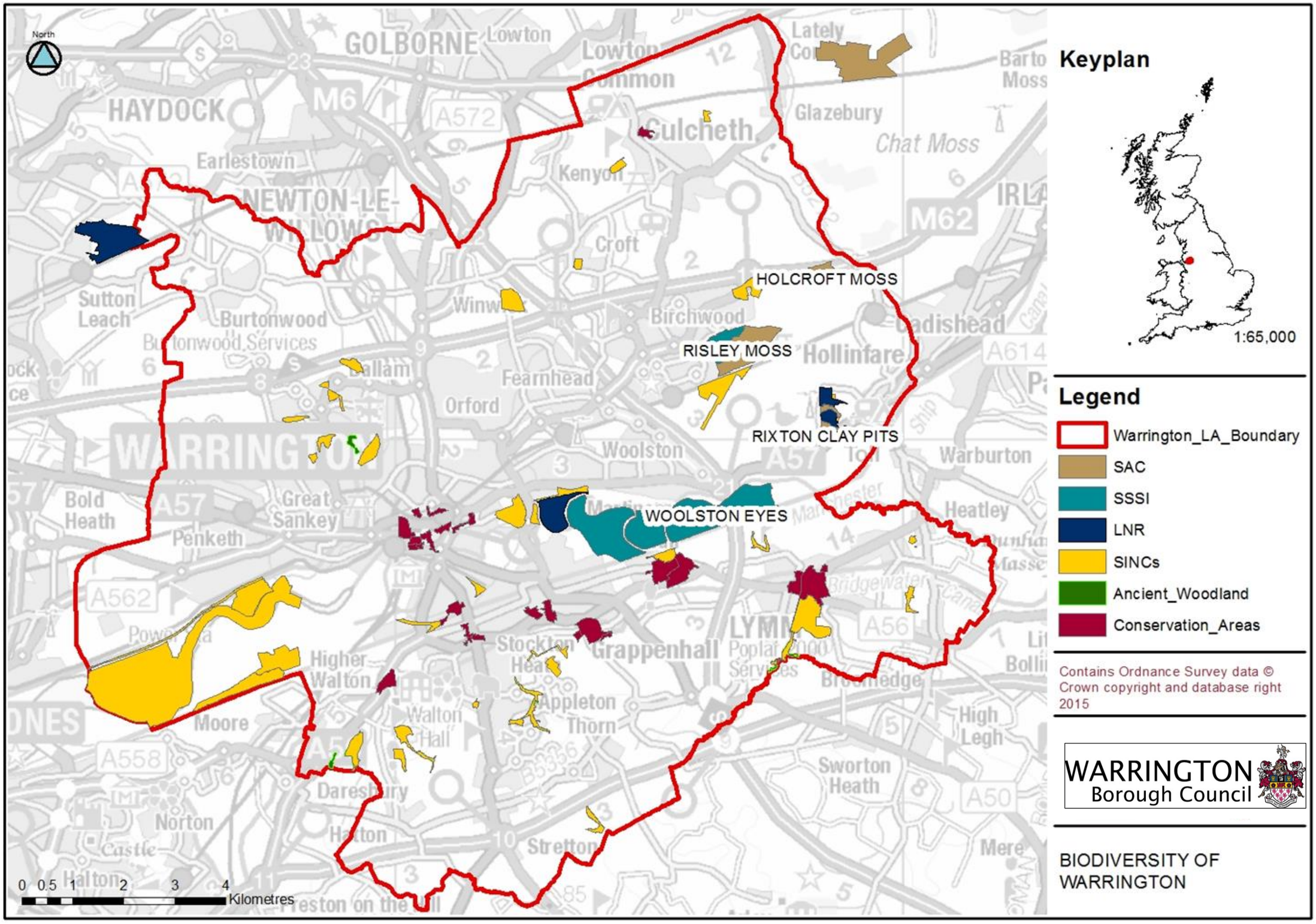
Key			
	A	Liner is required for permeable soil	Y	Yes
	B	Surface base flow maybe required	Y	Potential suitable providing that design prevents mobilisation of contamination
	C	Minimum depth to water table shouldn't be less than 1m	N	No
	D	Slope should not exceed 5%	N/A	Non-applicable
	E	Follows contours for slope greater than 5%	H	High potential
	F	Only suitable for large spaces	M	Medium potential
	G	A roof has to be support 2 KN/m^2 for extensive, 7 KN/m^2 for semi-intensive and 10 KN/m^2 for intensive configurations.	L	Low potential
	H	Not suitable if area draining to SuDS is more than 2ha	1	May require two treatment train stages, depending on type and intensity of road use and receiving water sensitivity.
	I	Only suitable where high flows are diverted around SuDS component for area of more than 2ha	2	May require three treatment train stages, depending on receiving watercourse sensitivity.
	J	Only if available head is less than 1m	3	Will require draw-down and rehabilitation following construction activities, prior to use as a permanent drainage system.
	K	Only if available head is between 1m and 2m	4	Providing designs prevent mobilisation of contamination.
	*	Some opportunities, subject to design	5	Some opportunities, subject to design
		Infiltration-dependent components; will only work with permeable soil	6	Limited data available
			7	There may be some public safety concern associated with open water which needs to be addressed at the design stage

D Warrington Environment Maps

D.1 Map of Superficial Deposits Overlain by Landscape Character Types


North
GOLBORNE
Lowton
Lowton Common
Lately Common
HAYDOCK
M6
A572
Culcheth
Glazebury
Chat Moss
Earlestown
NEWTON-LE-WILLOWS
Kenyon
M62
Croft
Winwick
Sutton Leach
Burtonwood
Burtonwood Services
Birchwood
Hollinfare
Dallam
Fearnhead
Orford
WARRINGTON
Woolston
Warburton
Bold Heath
Great Sankey
Penketh
Martinscroft
Thelwall
Heatley
A562
Power Sta
Canal
Stockton Heath
Grappenhall
LYMM
Poplar 2000 Services
Broomedge
Higher Walton
Appleton Thorn
Walton Hall
Moore
A558
A56
High Legh
Sworton Heath
A50
Daresbury
Norton
Castle
Hatton
Stretton
Mere
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_Other
Warrington_Peat
Warrington_Clay_and_Silt
Warrington_Sand_and_Gravel
Warrington_LA_Boundary
Contains Ordnance Survey data © Crown copyright and database right 2015
WARRINGTON Borough Council
SUPERFICIAL GEOLOGY OF WARRINGTON

D.2 Map of Biodiversity and Landscape Designations


North
GOLBORNE
Lowton
Lowton Common
Lately Com
Barto Moss
HAYDOCK
M6
A572
Culcheth
Glazebury
Chat Moss
Earlestown
Kenyon
NEWTON-LE-WILLOWS
Croft
M62
IRL
Sutton Leach
Burtonwood
Burtonwood Services
Winw
Birchwood
Cadishead
HOLCROFT MOSS
RISLEY MOSS
Hollinfare
A614
Ballam
Fearnhead
Orford
RIXTON CLAY PITS
WARRINGTON
Woolston
Warburton
A57
Bold Heath
Great Sankey
Penketh
WOOLSTON EYES
Heatley
A562
Powe
Higher Walton
Stockton Heath
Grappenhall
LYMM
Poplar 2000
Services
A56
Broomedge
Bolli
Moore
Walton Hall
Appleton Thorn
High Legh
A558
Sworton Heath
A50
Daresbury
Norton
Castle
Halton
Hatton
Stretton
Mere
Preston on the Hill
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_LA_Boundary
SAC
SSSI
LNR
SINCs
Ancient_Woodland
Conservation_Areas
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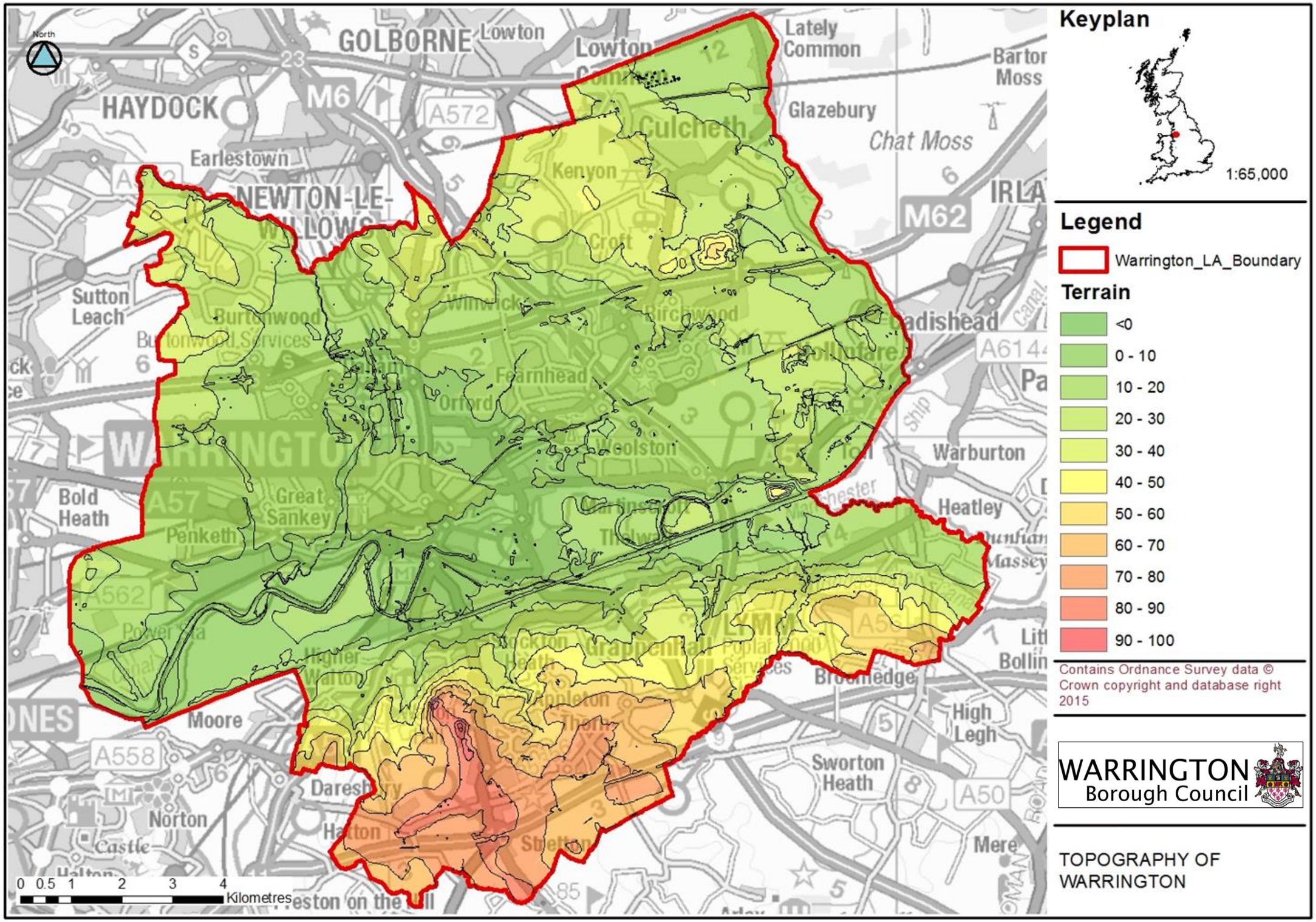
BIODIVERSITY OF WARRINGTON

D.3 Topography


North
GOLBORNE
Lowton
Lowton
Lately Common
Barton Moss
HAYDOCK
M6
A572
Glazebury
Culcheth
Chat Moss
Earlestown
Kenyon
NEWTON-LE-WILLOWS
M62
IRLAM
Sutton Leach
Burtonwood
Winwick
Birchwood
Risley
Fearnhead
Orford
Woolston
Warburton
Bold Heath
Great Sankey
Penketh
Heatley
Massey
Higher Walton
Grappenhall
Broomedge
Moore
High Legh
Sworton Heath
A558
Daresbury
Norton
Castle
Hatton
Stretton
Mere
A50
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_LA_Boundary
Terrain
<0
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
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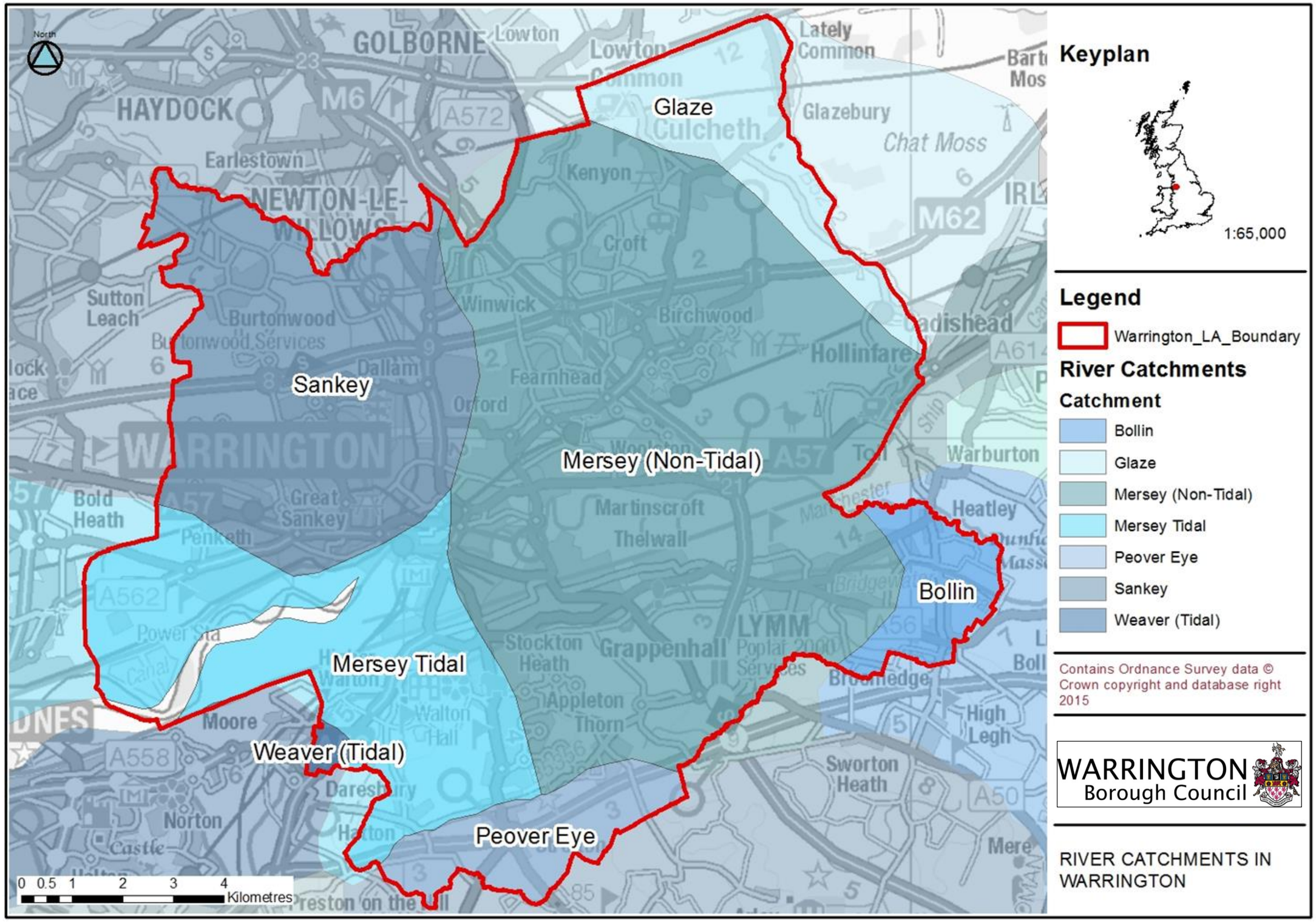
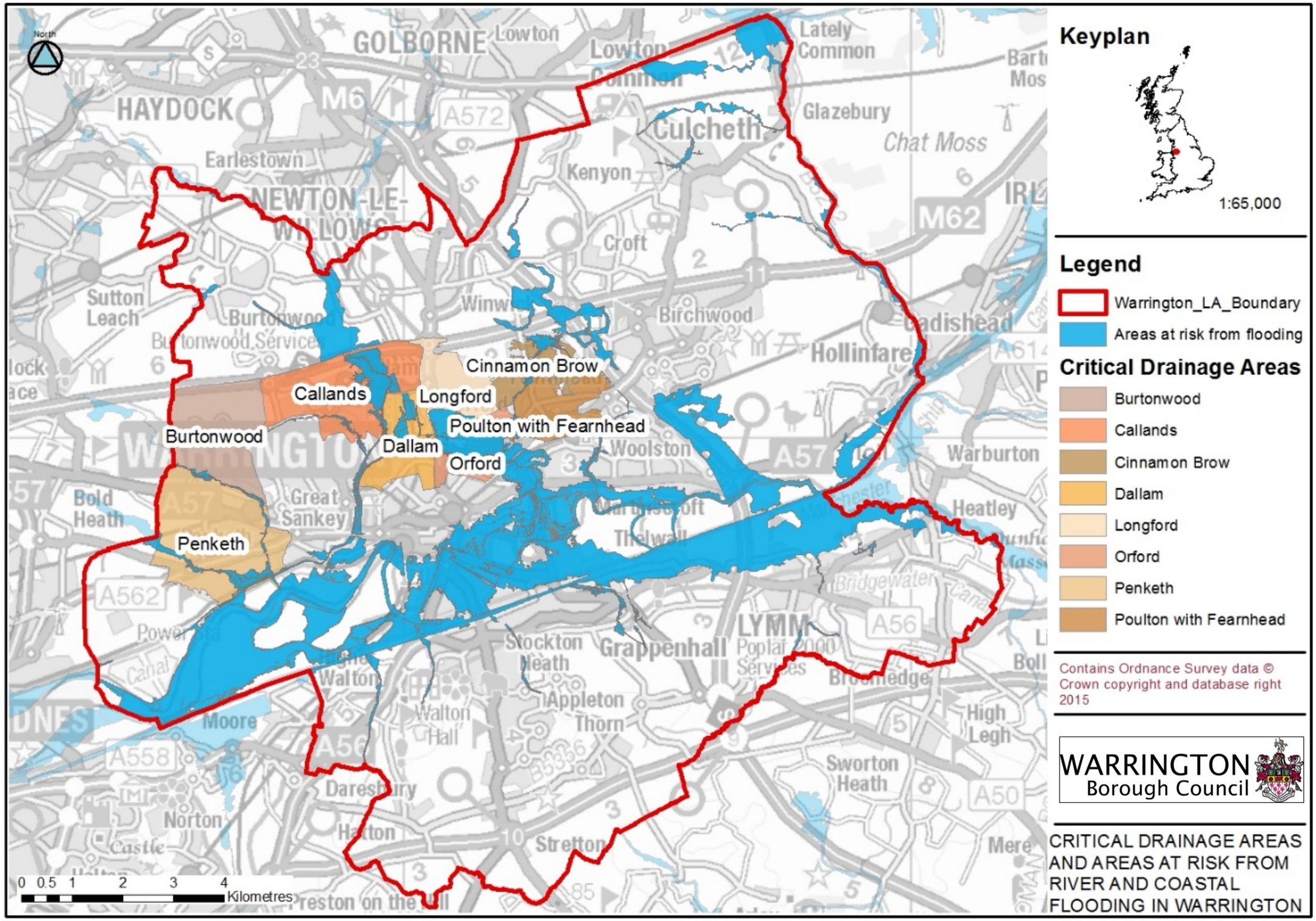
WARRINGTON Borough Council
TOPOGRAPHY OF WARRINGTON

D.4 River Catchments


Glaze
Mersey (Non-Tidal)
Sankey
Mersey Tidal
Weaver (Tidal)
Peover Eye
Bollin
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_LA_Boundary
River Catchments
Catchment
Bollin
Glaze
Mersey (Non-Tidal)
Mersey Tidal
Peover Eye
Sankey
Weaver (Tidal)
Contains Ordnance Survey data © Crown copyright and database right 2015
WARRINGTON Borough Council
RIVER CATCHMENTS IN WARRINGTON

D.5 Tidal Extents/Coastal Flooding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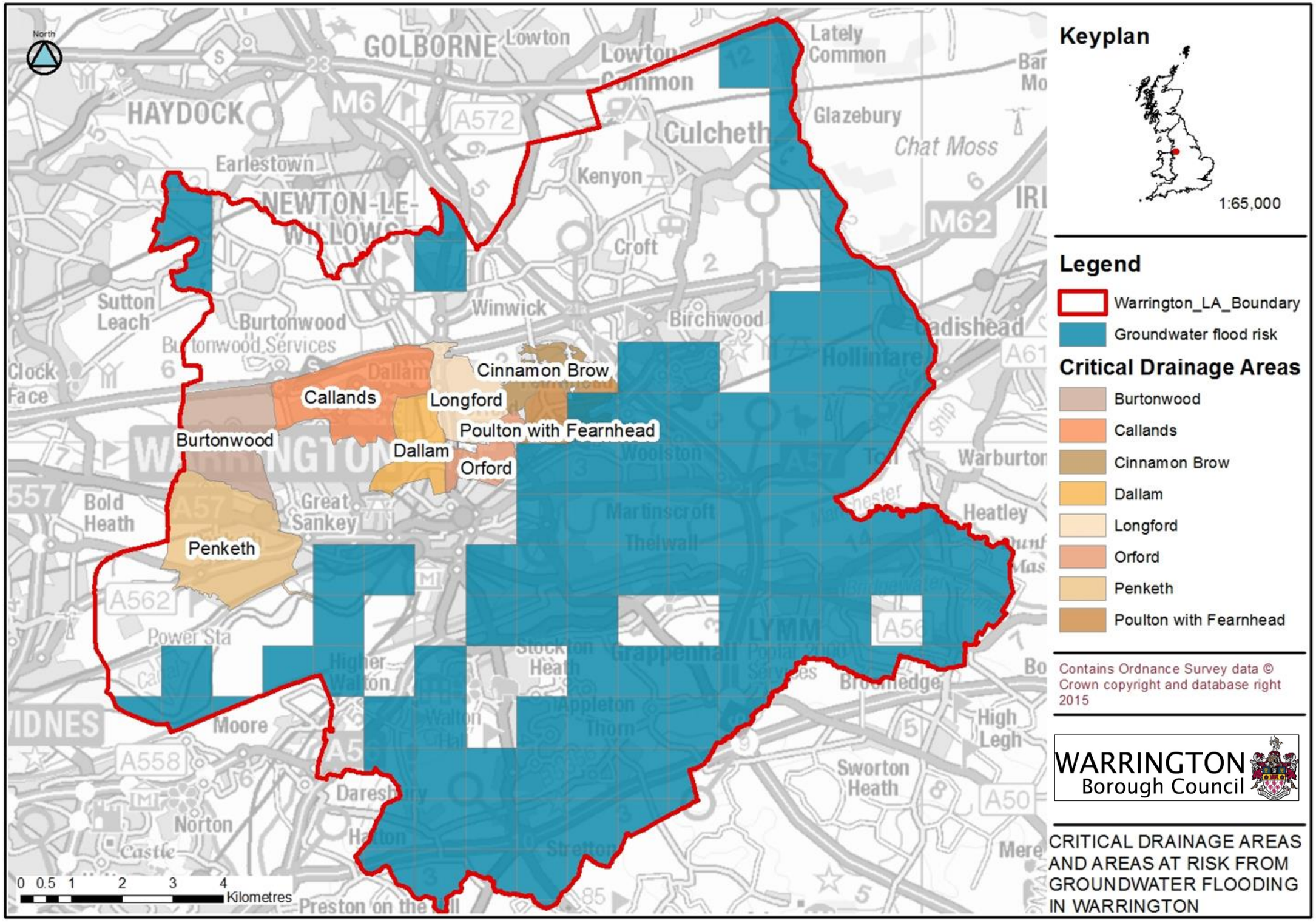
Lowton
Lowton Common
Lately Common
HAYDOCK
M6
A572
Culcheth
Glazebury
Chat Moss
Earlestown
Kenyon
NEWTON-LE-WILLOWS
Croft
M62
Sutton Leach
Burtonwood
Birchwood
Hollinfare
Cinnamon Brow
Callands
Longford
Poulton with Fearnhead
Burtonwood
Dallam
Orford
Woolston
A57
Warburton
Bold Heath
Great Sankey
Penketh
Thelwall
Heatley
A562
Stockton Heath
Grappenhall
LYMM
A56
Walton
Appleton Thorn
Moore
Walton Hall
Broomedge
High Legh
A558
Sworton Heath
A50
Daresbury
Norton
Hatton
Stretton
Mere
Castle
Preston on the Hill
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_LA_Boundary
Areas at risk from flooding
Critical Drainage Areas
Burtonwood
Callands
Cinnamon Brow
Dallam
Longford
Orford
Penketh
Poulton with Fearnhead
Contains Ordnance Survey data © Crown copyright and database right 2015
WARRINGTON Borough Council
CRITICAL DRAINAGE AREAS AND AREAS AT RISK FROM RIVER AND COASTAL FLOODING IN WARRINGTON

D.6 Groundwater/Aquifers/Critical Drainage Areas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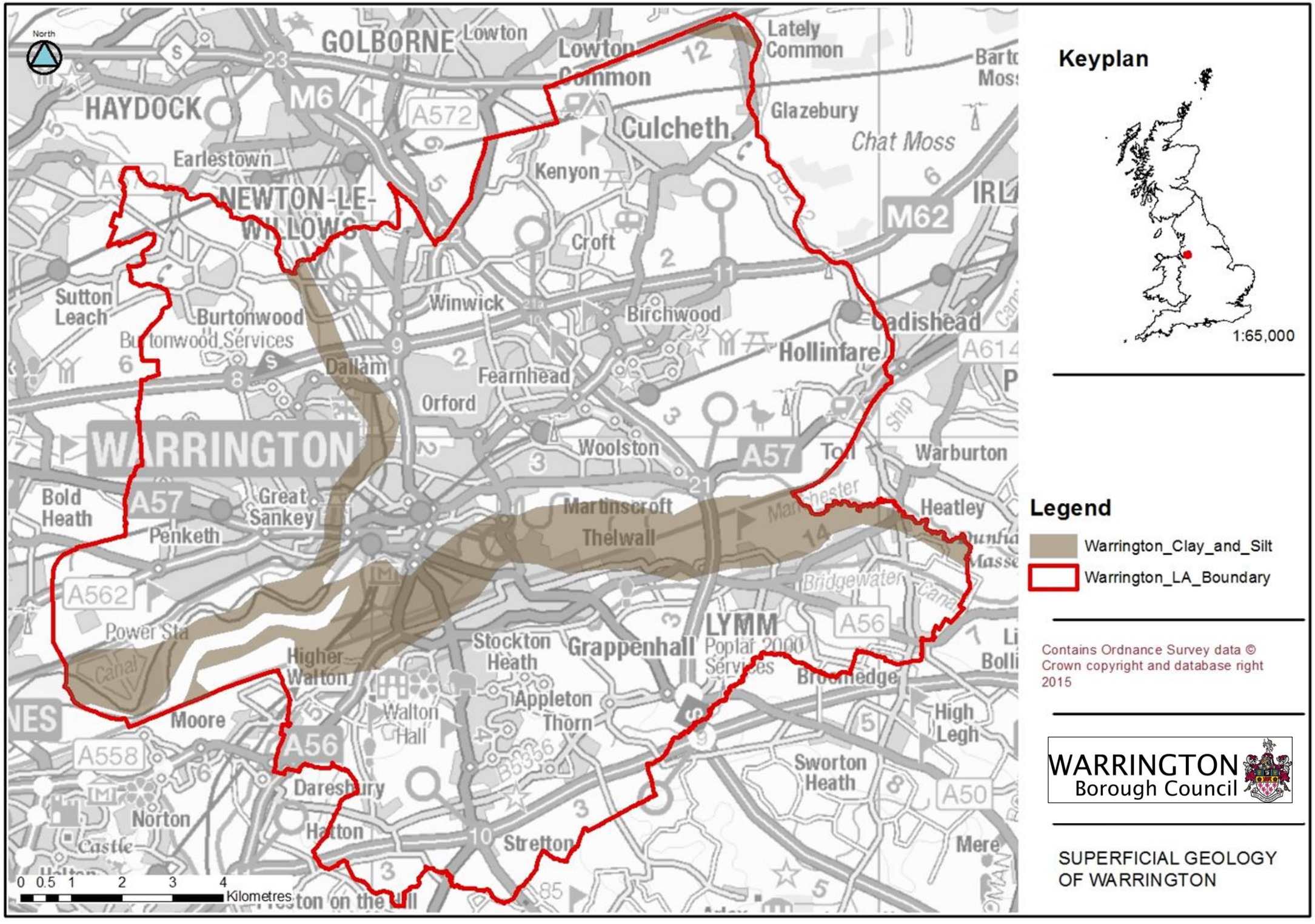
Lowton
Lowton Common
Lately Common
HAYDOCK
M6
A572
Culcheth
Glazebury
Chat Moss
Earlestown
Kenyon
NEWTON-LE-WILLOWS
M62
Croft
Sutton Leach
Burtonwood
Winwick
Birchwood
Burtonwood Services
Hollinfare
Clock Face
Cinnamon Brow
Callands
Longford
Poulton with Fearnhead
Burtonwood
Dallam
Orford
Penketh
Bold Heath
Great Sankey
Warburton
Heatley
Martinscroft
Thelwall
Power Sta
Higher Walton
Stockton Heath
Grappenhall
Broomedge
Appleton Thorn
Moore
High Legh
Sworton Heath
Norton
Castle
Daresbury
Halton
Stretton
Mere
Preston on the Hill
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_LA_Boundary
Groundwater flood risk
Critical Drainage Areas
Burtonwood
Callands
Cinnamon Brow
Dallam
Longford
Orford
Penketh
Poulton with Fearnhead
Contains Ordnance Survey data © Crown copyright and database right 2015
WARRINGTON Borough Council
CRITICAL DRAINAGE AREAS AND AREAS AT RISK FROM GROUNDWATER FLOODING IN WARRINGTON

E Warrington Soil Maps

E.1 Clay and Silt Soil


North
GOLBORNE
Lowton
Lowton Common
Lately Common
HAYDOCK
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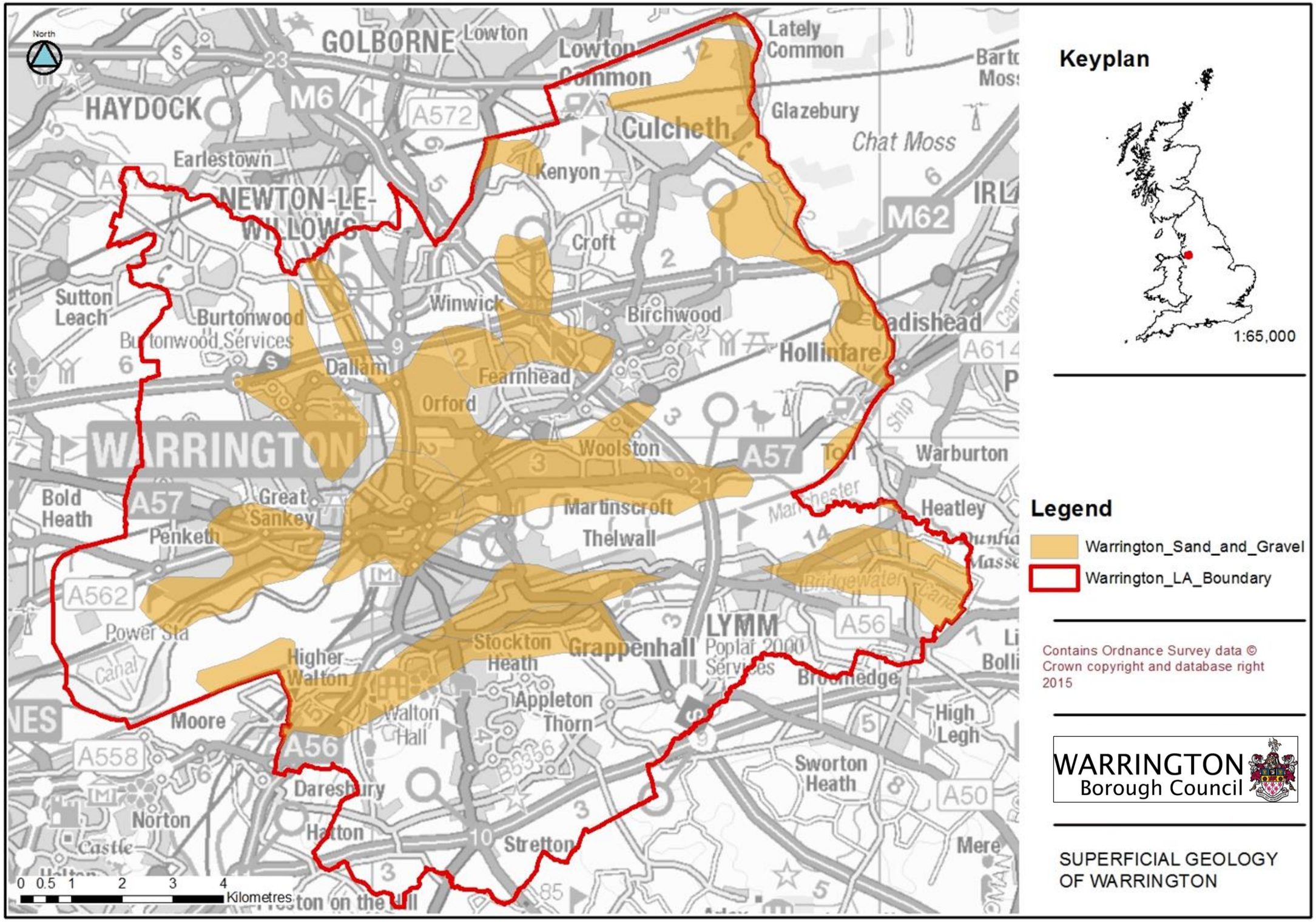
A572
Culcheth
Glazebury
Chat Moss
Earlestown
Kenyon
NEWTON-LE-WILLOWS
M62
Croft
Sutton Leach
Burtonwood
Burtonwood Services
Winwick
Birchwood
Hollinfare
Dallam
Fearnhead
Orford
WARRINGTON
Woolston
A57
Warburton
Bold Heath
Great Sankey
Penketh
Martinscroft
Thelwall
Heatley
A562
Power Sta
Canal
Higher Walton
Stockton Heath
Grappenhall
LYMM
Poplar 2000 Services
A56
Bridgewater Canal
Broomedge
Appleton Thorn
Walton Hall
High Legh
Moore
A558
Sworton Heath
A50
Daresbury
Norton Castle
Hatton
Stretton
Mere
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_Clay_and_Silt
Warrington_LA_Boundary
Contains Ordnance Survey data © Crown copyright and database right 2015
WARRINGTON Borough Council
SUPERFICIAL GEOLOGY OF WARRINGTON

E.2 Sand and Gravel Soil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GOLBORNE
Lowton
Lowton Common
Lately Common
HAYDOCK
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A572
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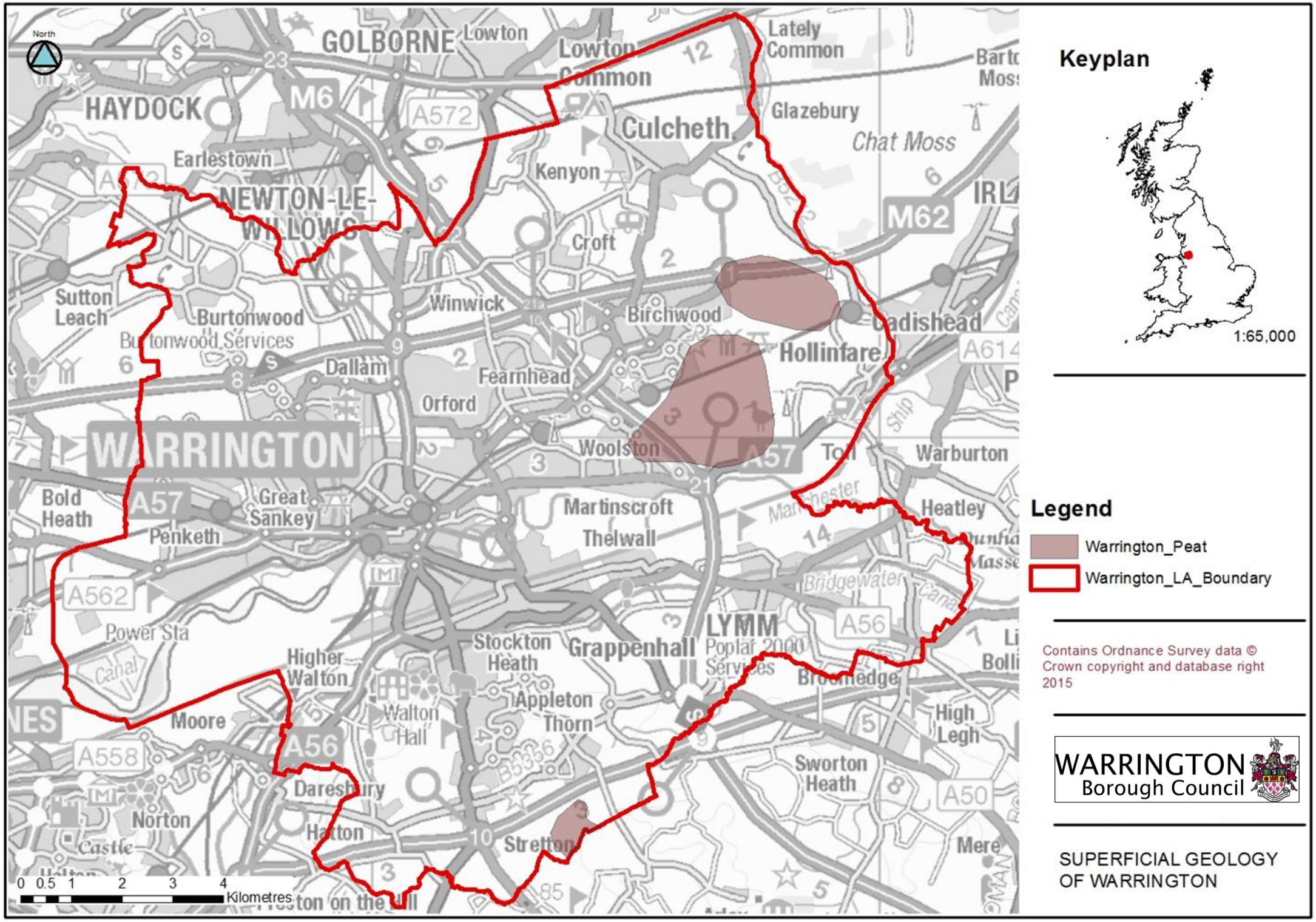
Glazebury
Chat Moss
Earlestown
Kenyon
NEWTON-LE-WILLOWS
M62
Croft
Sutton Leach
Burtonwood
Burtonwood Services
Winwick
Birchwood
Hollinfare
Dallam
Fearnhead
Orford
WARRINGTON
Woolston
A57
Warburton
Bold Heath
Great Sankey
Penketh
Martinscroft
Thelwall
Heatley
A562
Power Sta
Canal
Higher Walton
Stockton Heath
Grappenhall
LYMM
Poplar 2000 Services
A56
Broomedge
Appleton Thorn
Walton Hall
Moore
A558
Daresbury
Sworton Heath
High Legh
A50
Norton Castle
Hatton
Stretton
Mere
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_Sand_and_Gravel
Warrington_LA_Boundary
Contains Ordnance Survey data © Crown copyright and database right 2015
WARRINGTON Borough Council
SUPERFICIAL GEOLOGY OF WARRINGTON

E.3 Peat and Glacial Soil



Keyplan

Legend

Warrington_Peat

Warrington_LA_Boundary

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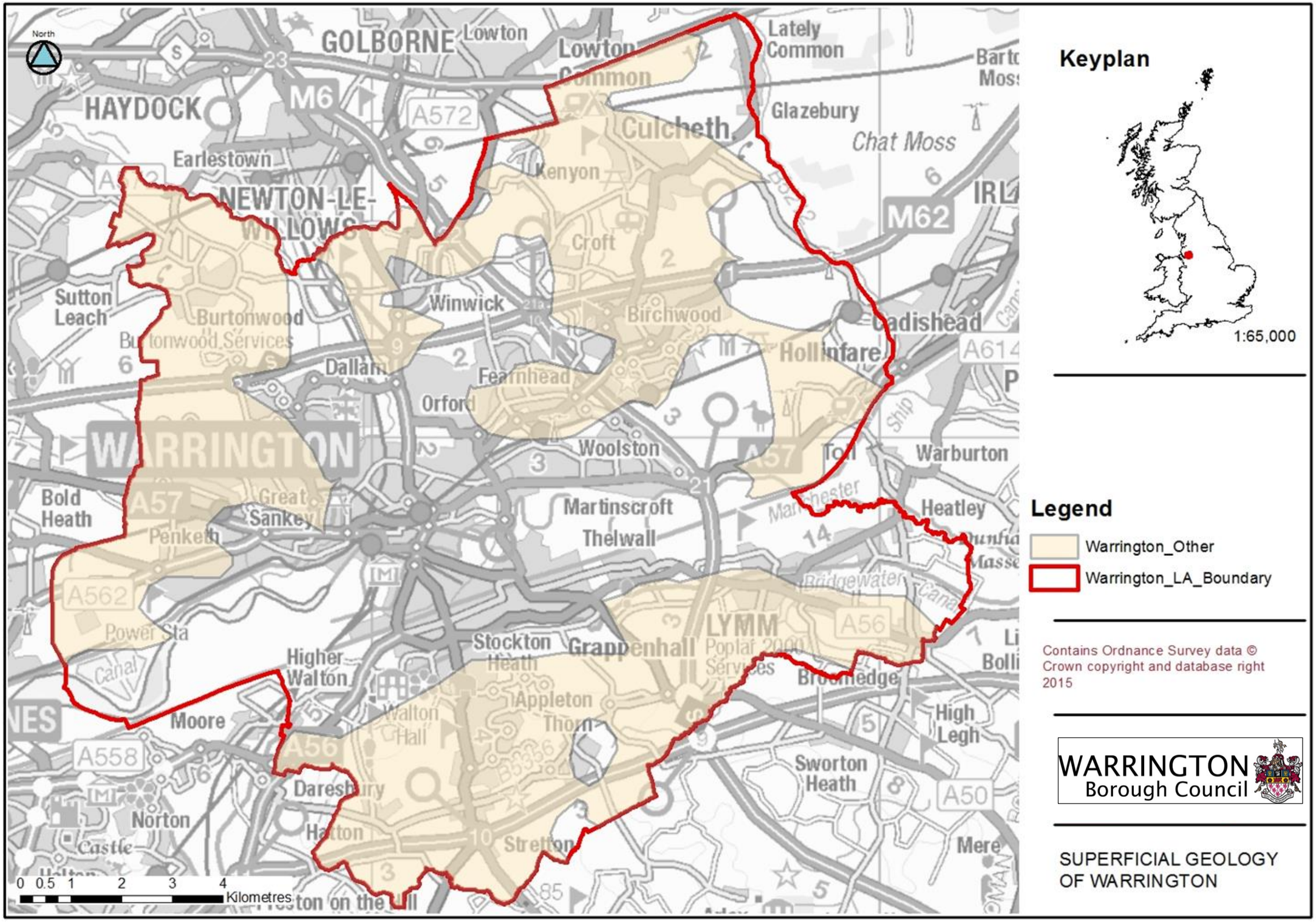
WARRINGTON Borough Council

SUPERFICIAL GEOLOGY OF WARRINGTON

E.4 Other Soils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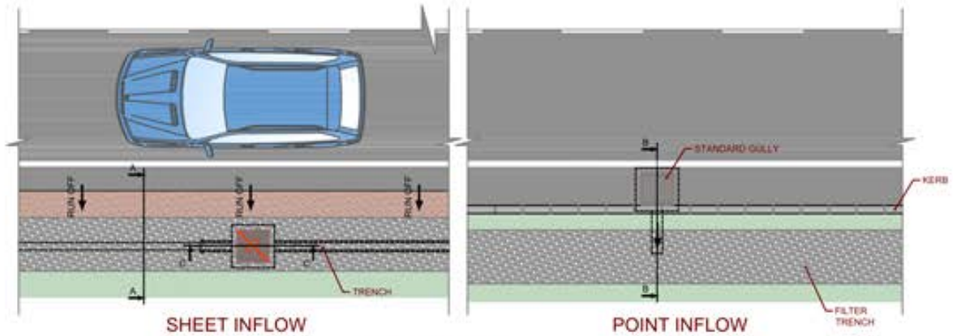
GOLBORNE
Lowton
Lowton Common
Lately Common
HAYDOCK
M6
A572
Culcheth
Glazebury
Chat Moss
Earlestown
NEWTON-LE-WILLOWS
Kenyon
M62
Croft
Winwick
Birchwood
Sutton Leach
Burtonwood
Burtonwood Services
Cadishead
Hollinfare
Dallam
Fearnhead
Orford
WARRINGTON
Woolston
Warburton
Bold Heath
Great Sankey
Penketh
Martinscroft
Thelwall
Heatley
A562
Power Sta
Canal
Stockton Heath
Grappenhall
LYMM Poplar 2000 Services
Bridgewater Canal
Broomedge
Higher Walton
Appleton Thorn
Walton Hall
Moore
High Legh
A558
Sworton Heath
A50
Daresbury
Norton Castle
Hatton
Stretton
Mere
Preston on the Hill
0 0.5 1 2 3 4
Kilometres
Keyplan
1:65,000
Legend
Warrington_Other
Warrington_LA_Boundary
Contains Ordnance Survey data © Crown copyright and database right 2015
WARRINGTON Borough Council
SUPERFICIAL GEOLOGY OF WARRINGTON

F Schematic Design Layouts

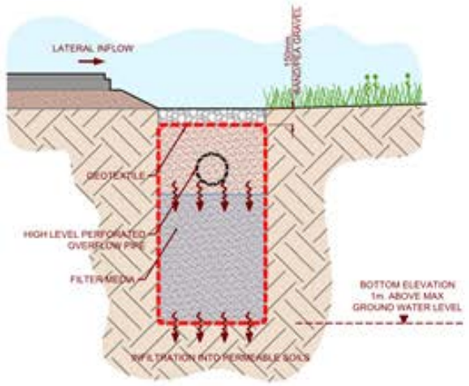
F.1 Filter Drain/Infiltration Trench



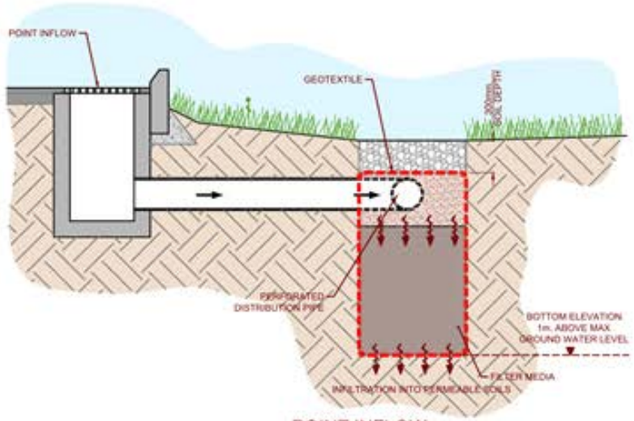
SHEET INFLOW

POINT INFLOW

TRENCH PLAN
SCALE 1:50

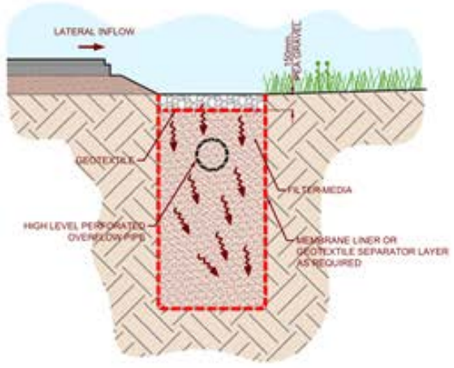


SHEET INFLOW
SECTION A-A
INFILTRATION TRENCH SCHEMATICS
SCALE 1:25

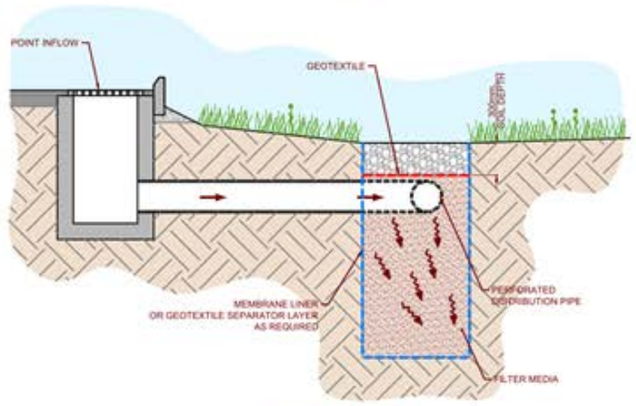


POINT INFLOW
SECTION B-B
INFILTRATION TRENCH SCHEMATICS
SCALE 1:25

POINT INFLOW
SECTION C-C
INFILTRATION TRENCH MANHOLE SCHEMATICS
SCALE 1:25

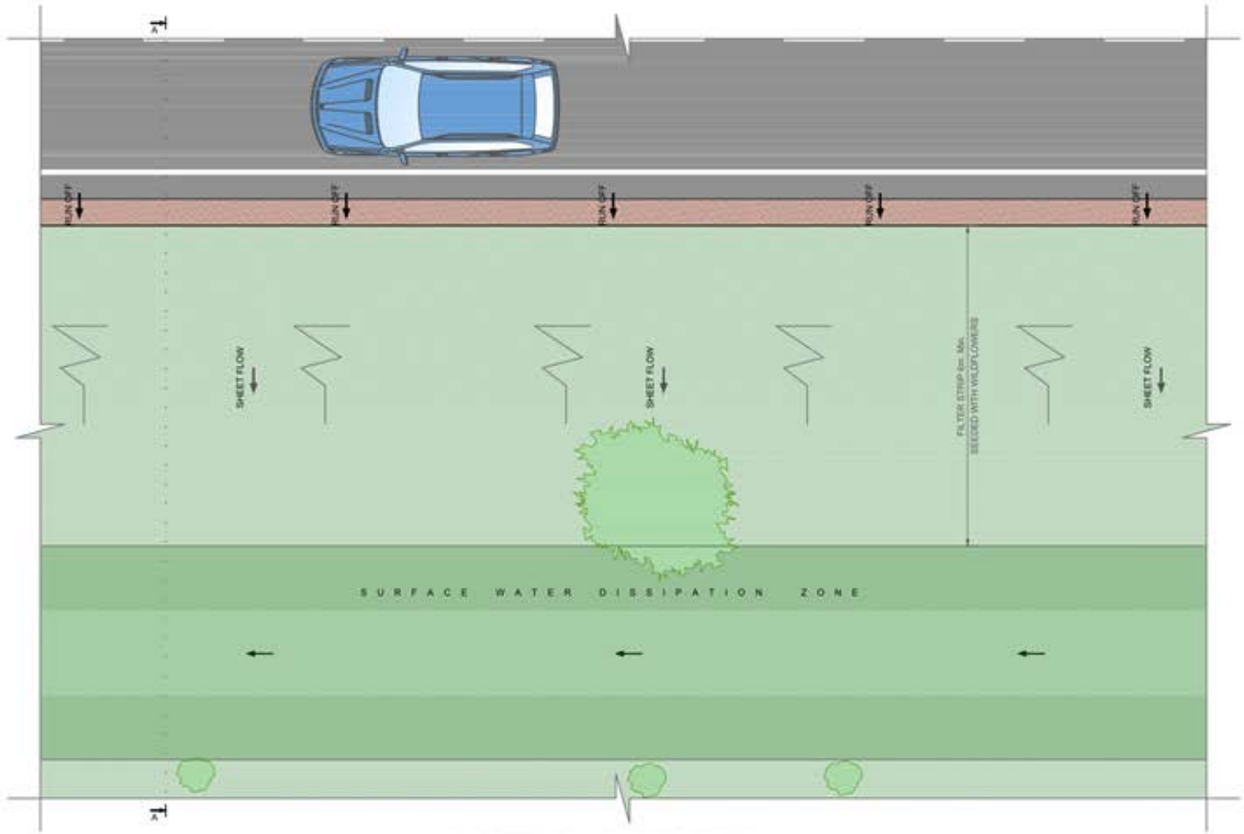


SHEET INFLOW
SECTION A-A
FILTER TRENCH SCHEMATICS
SCALE 1:25



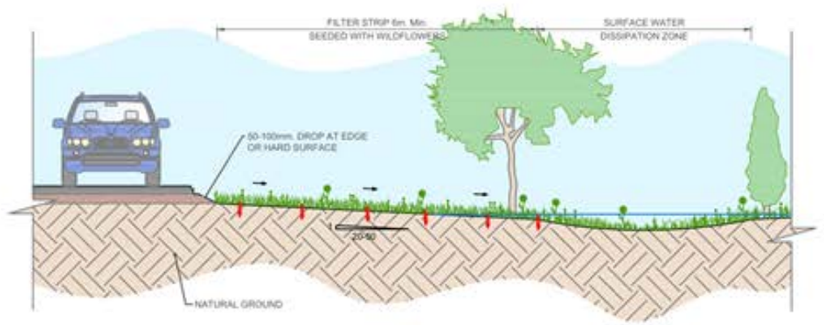
POINT INFLOW
SECTION B-B
FILTER TRENCH SCHEMATICS
SCALE 1:25

F.2 Filter Strip



BIORETENTION / FILTER STRIP PLAN

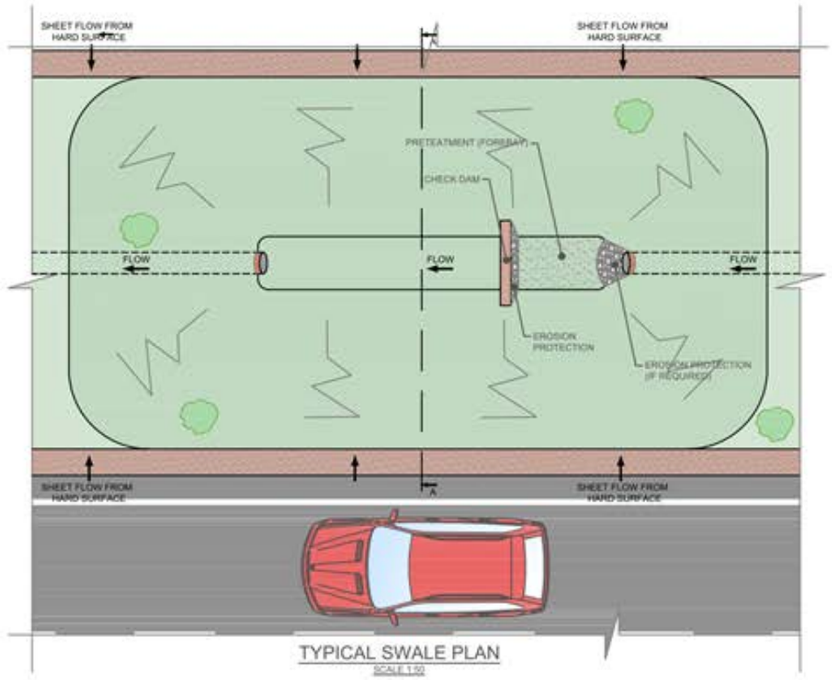
SCALE 1:50



SECTION A-A

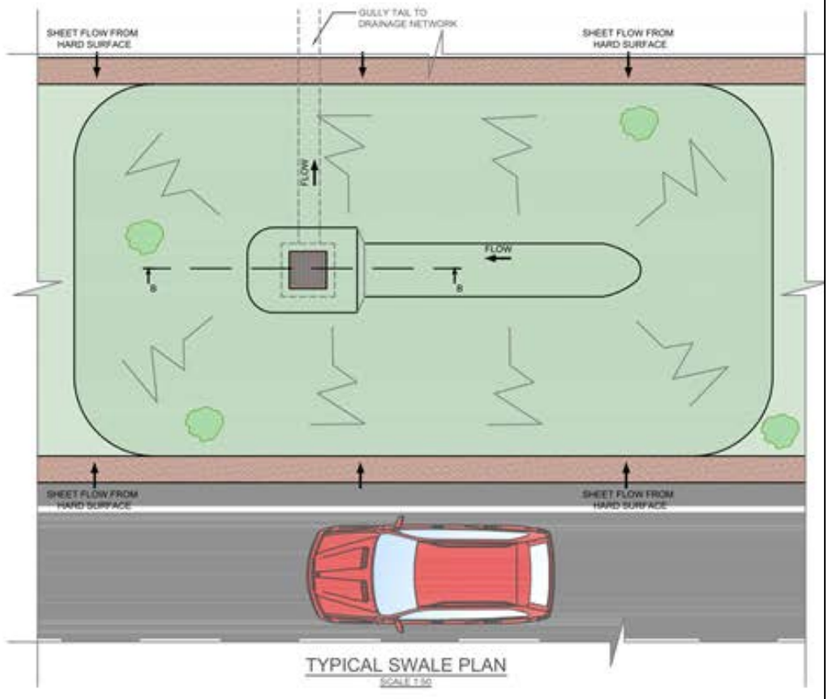
SCALE 1:50

F.3 Swales



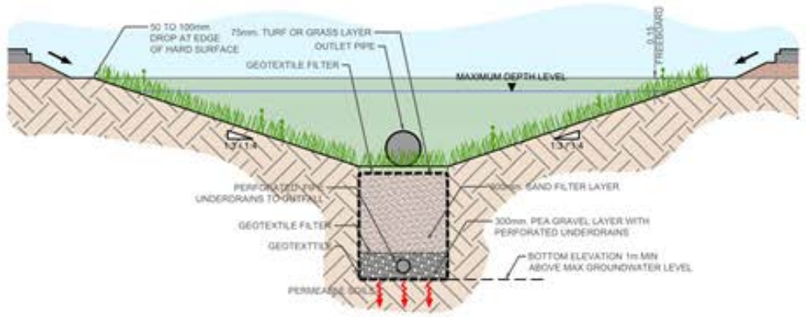
TYPICAL SWALE PLAN

SCALE 1:50



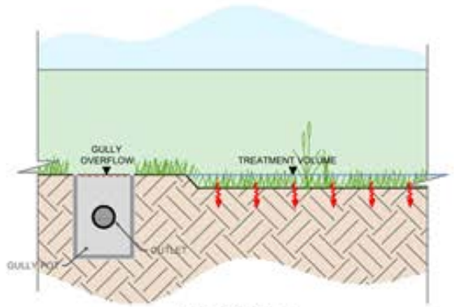
TYPICAL SWALE PLAN

SCALE 1:50



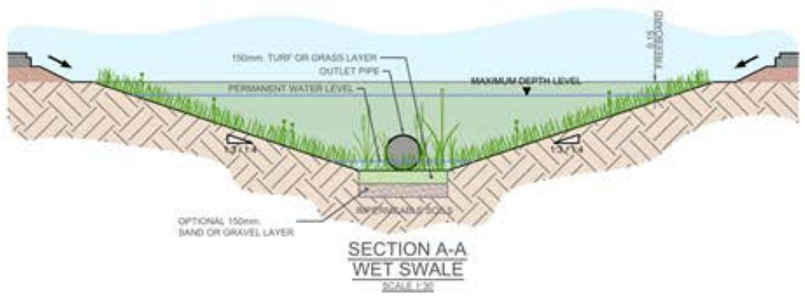
SECTION A-A
DRY SWALE

SCALE 1:30



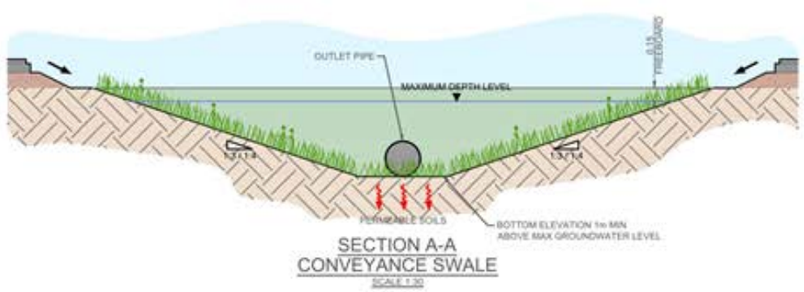
SECTION A-A
GULLY OVERFLOW

SCALE 1:30



SECTION A-A
WET SWALE

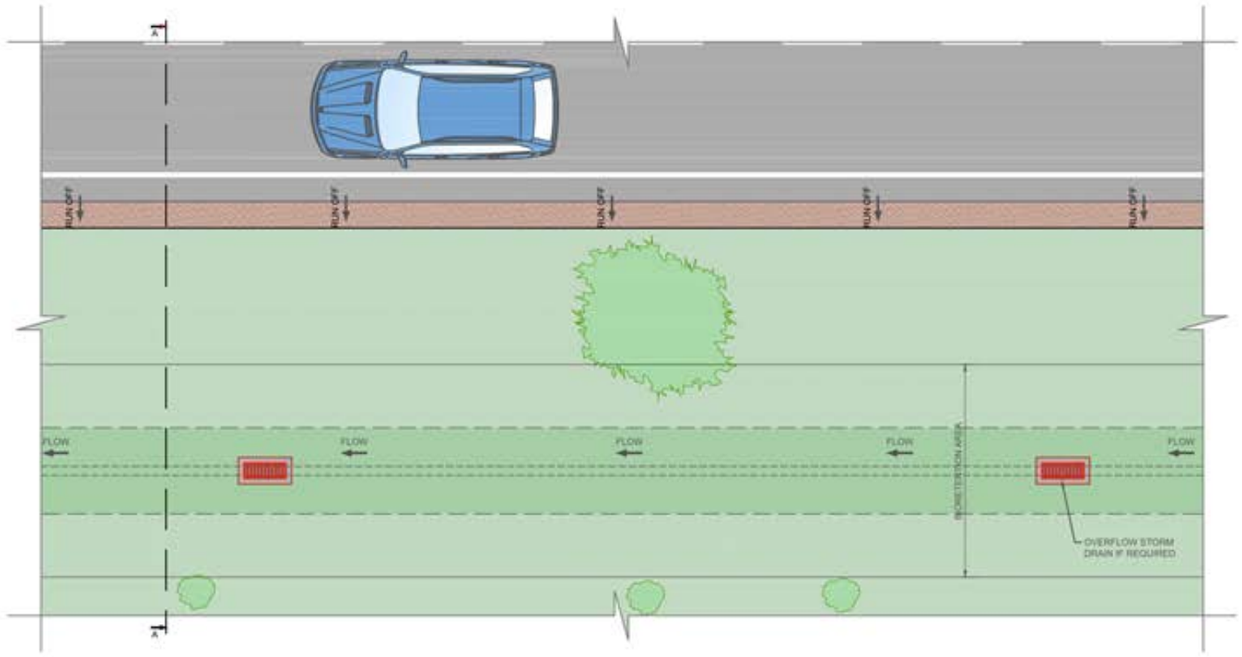
SCALE 1:30



SECTION A-A
CONVEYANCE SWALE

SCALE 1:30

F.4 Bioretention

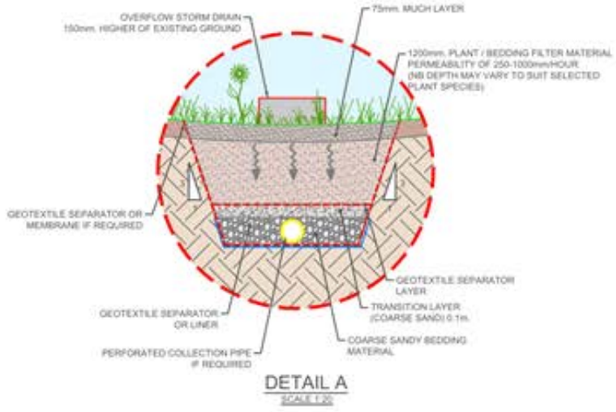


BIORETENTION / FILTER STRIP PLAN

SCALE 1:50

SECTION A-A

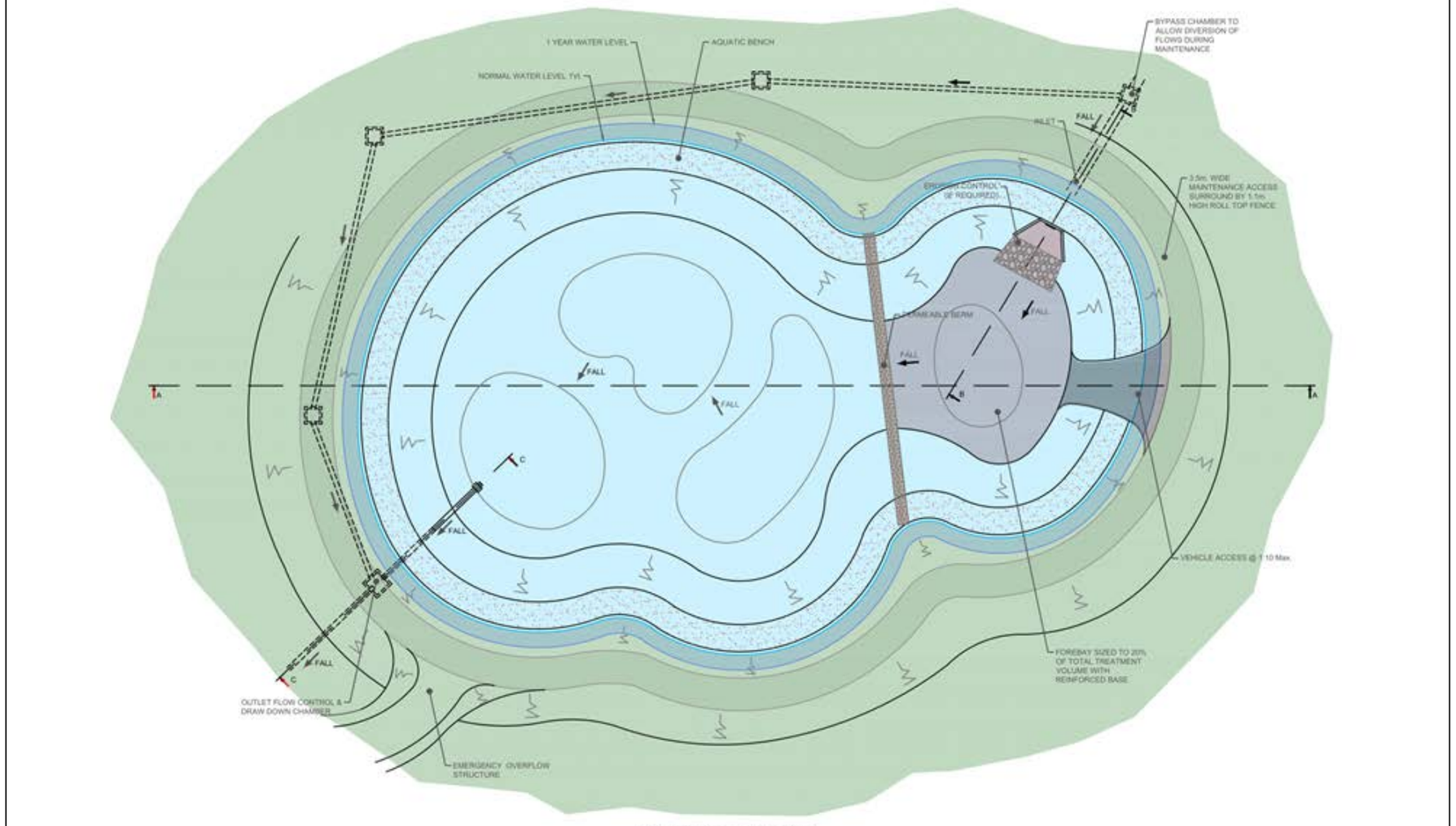
SCALE 1:50



DETAIL A

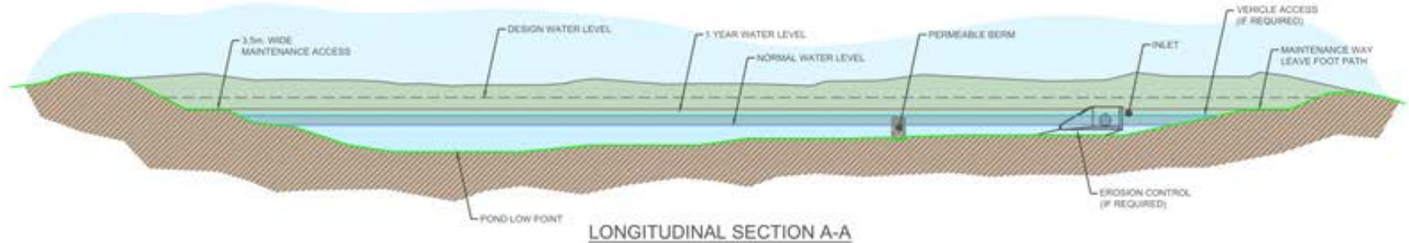
SCALE 1:20

F.5 Retention Pond



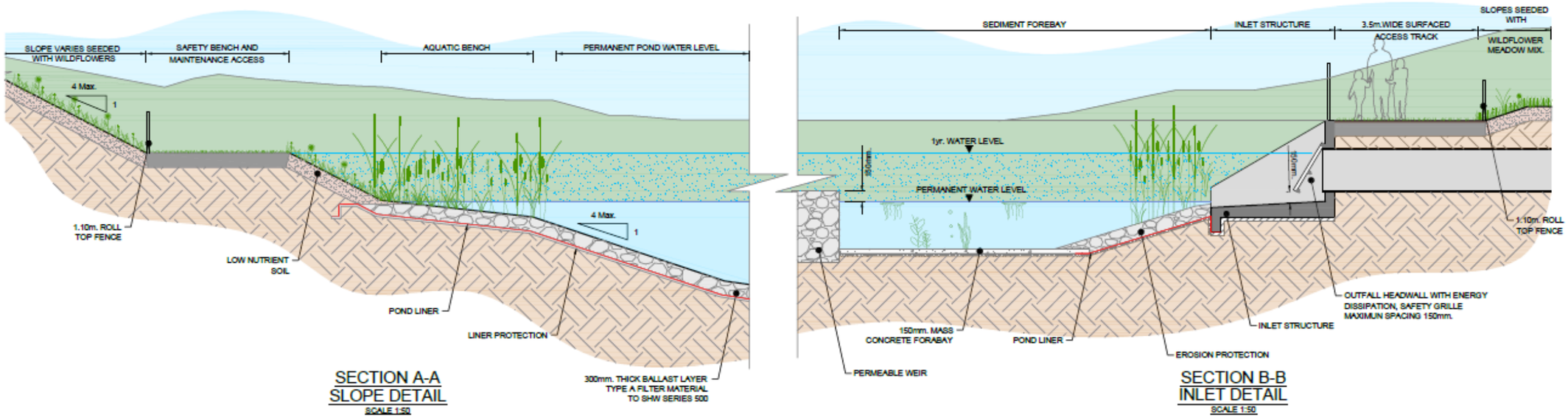
RETENTION POND PLAN

SCALE 1:200



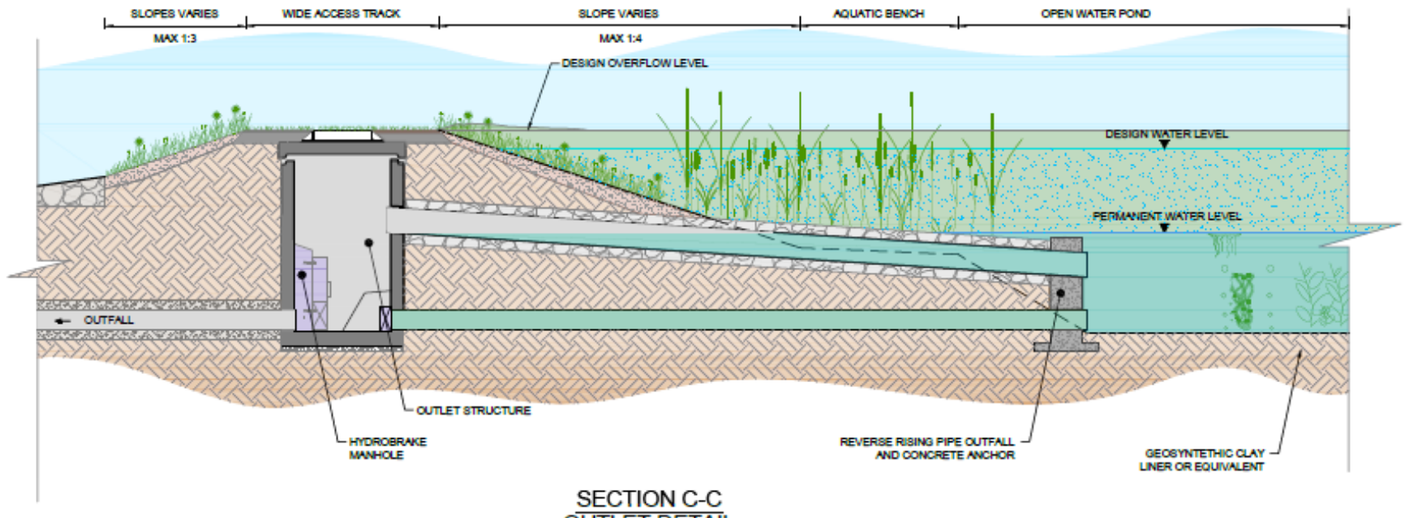
LONGITUDINAL SECTION A-A

SCALE 1:200



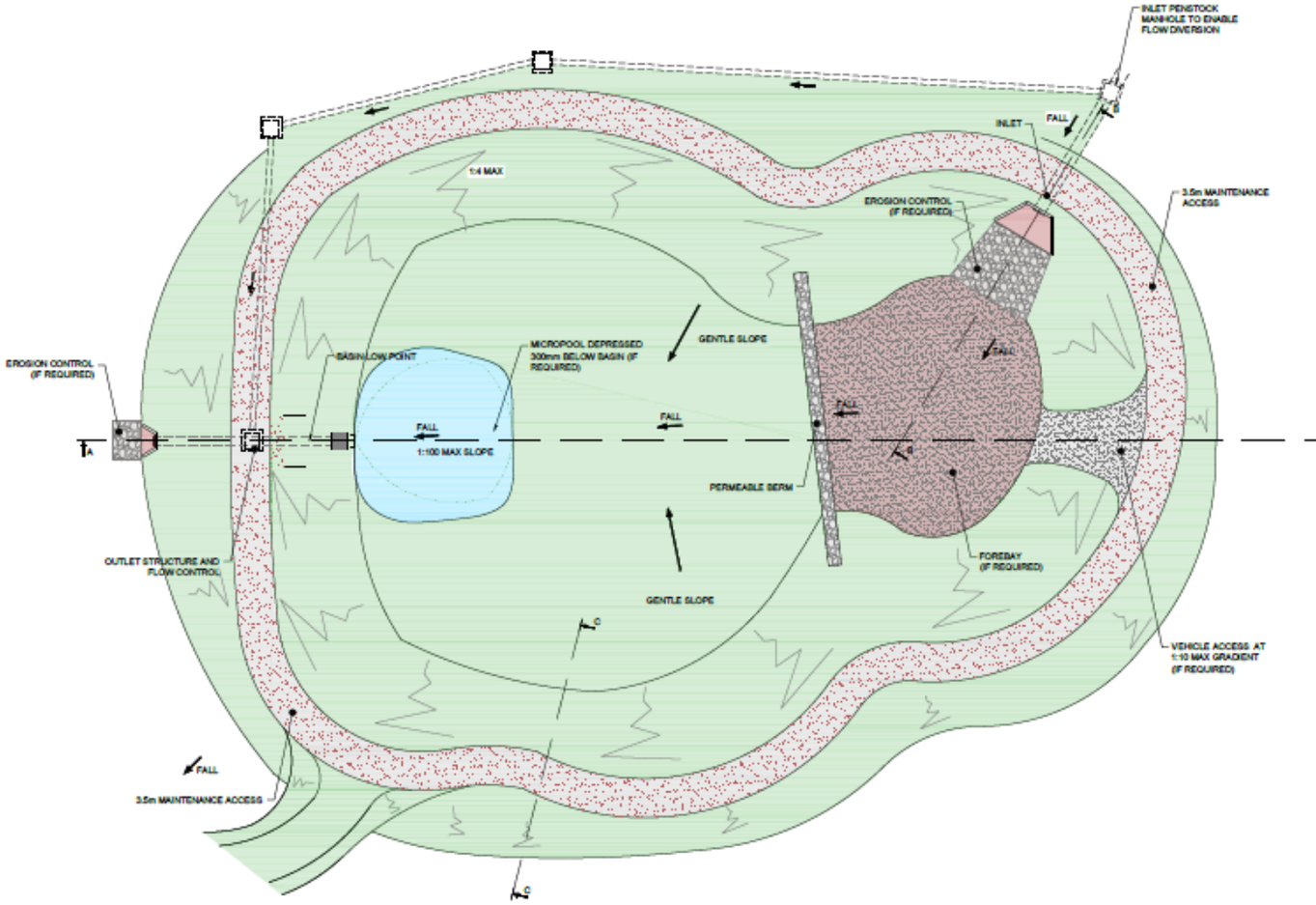
SECTION A-A
SLOPE DETAIL
SCALE 1:50

SECTION B-B
INLET DETAIL
SCALE 1:50

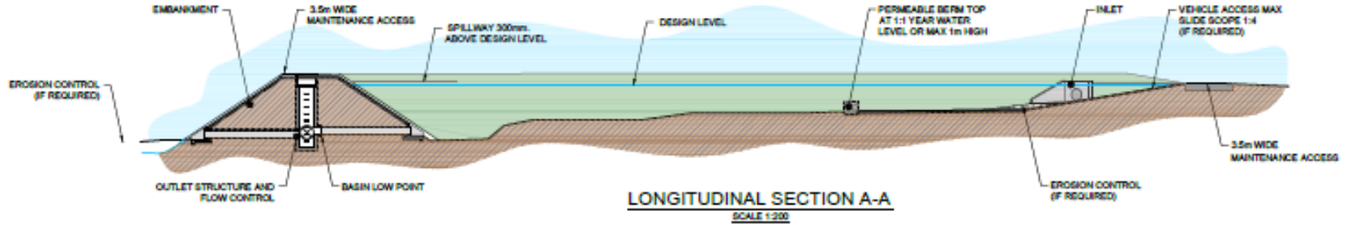


SECTION C-C
OUTLET DETAIL
SCALE 1:50

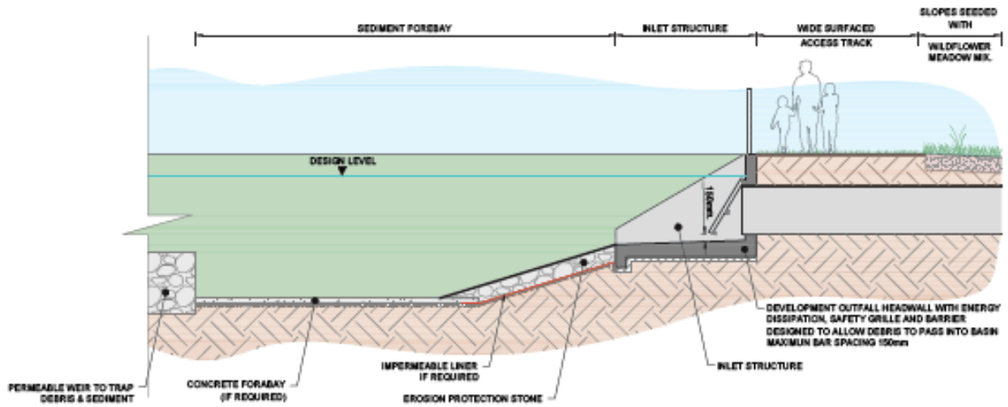
F.6 Detention Basin



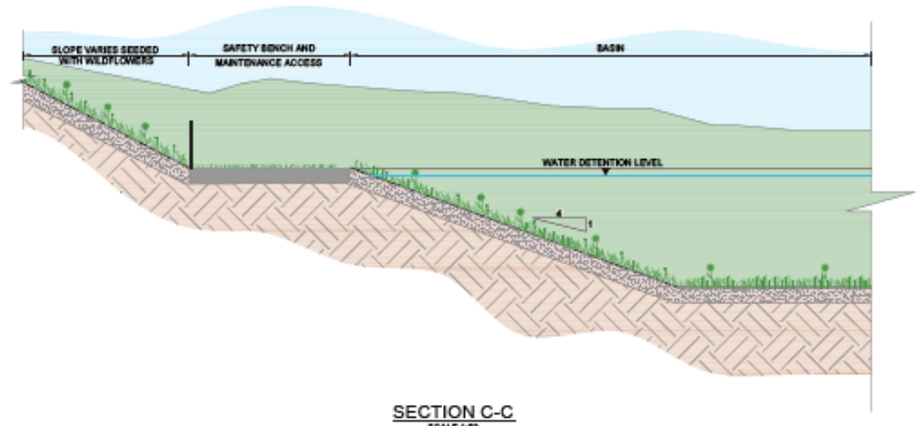
DETENTION BASIN PLAN
SCALE 1:200



LONGITUDINAL SECTION A-A
SCALE 1:200

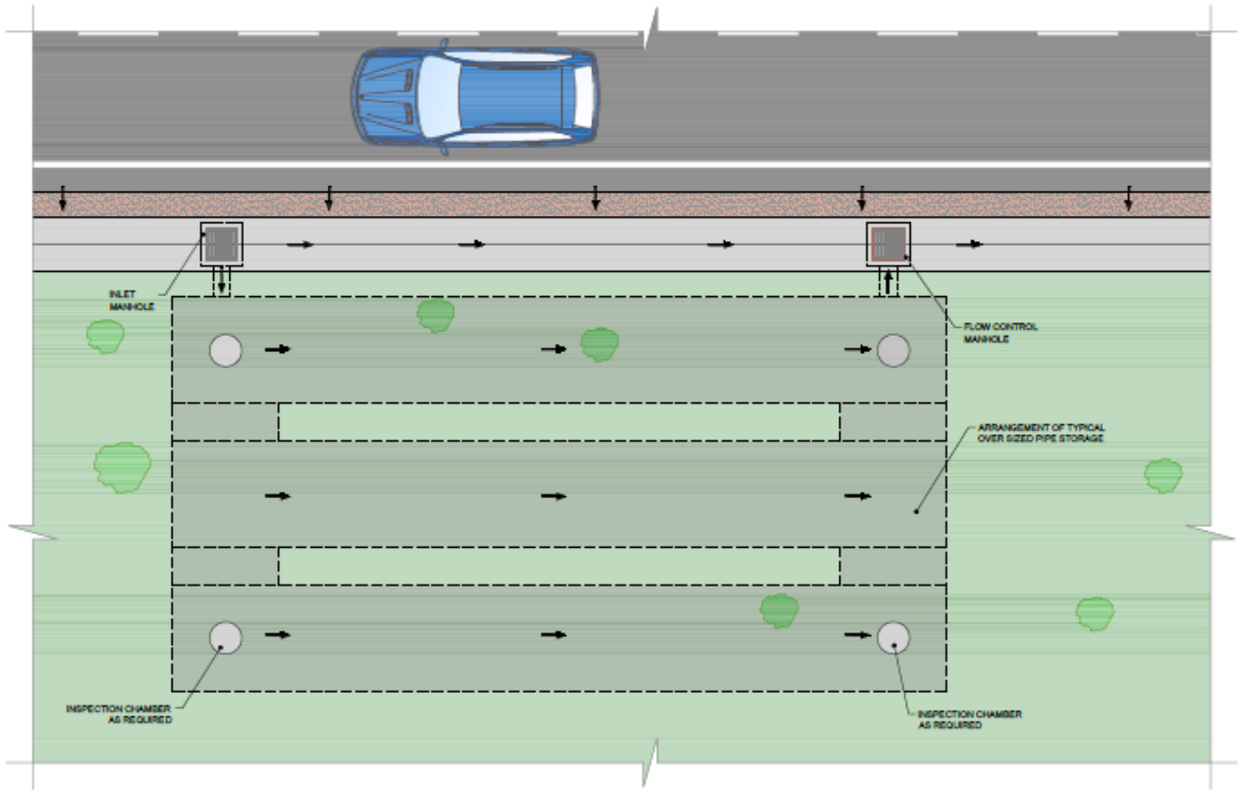


SECTION B-B
INLET DETAIL
SCALE 1:50



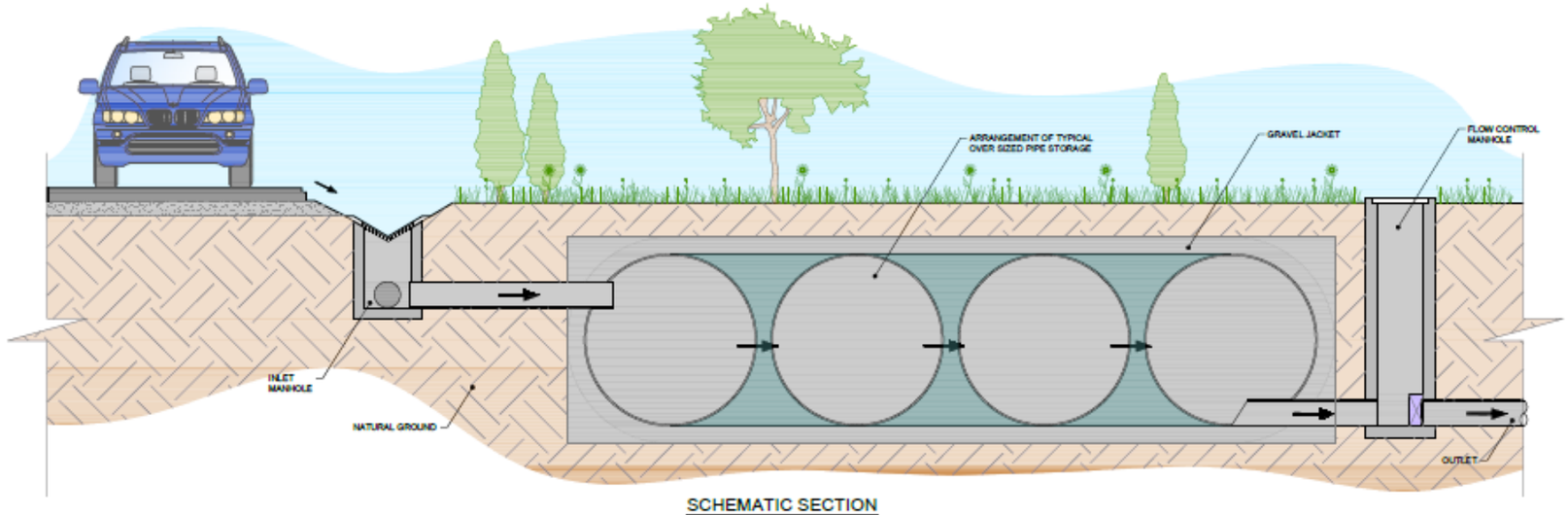
SECTION C-C
SCALE 1:50

F.7 Underground Storage



TYPICAL UNDERGROUND STORAGE PLAN

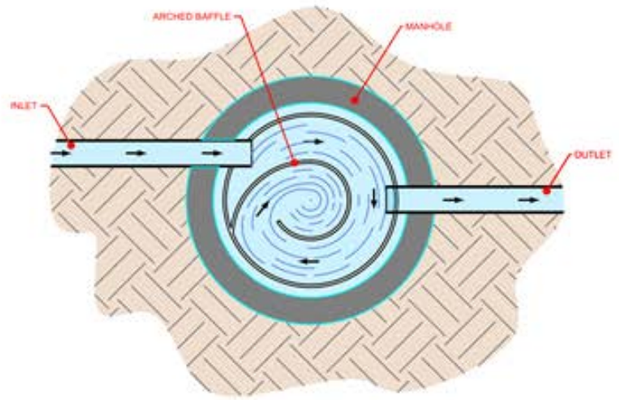
SCALE 1:50



SCHEMATIC SECTION

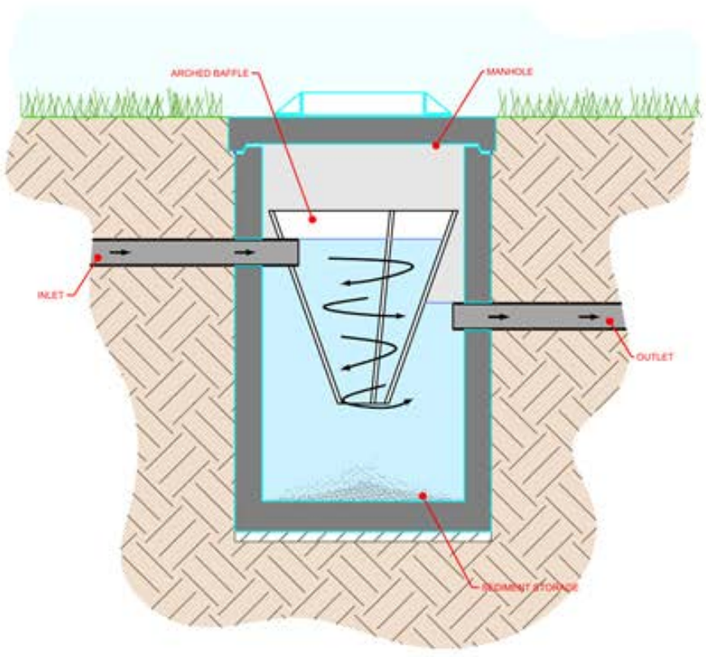
SCALE 1:20

F.8 Vortex Separator



VORTEX SEPARATOR PLAN

SCALE 1:20



SECTION A-A
VORTEX SEPARATOR

SCALE 1:20

G Useful Resources

Master Planning and Concept Design	
CIRIA (2010) Guidance on water cycle management for new developments (WaND) (C690)	http://www.ciria.org/ItemDetail?iProductCode=C690&Category=BOOK
CIRIA (2010) Planning for SuDS: Making it Happen (C687)	http://www.ciria.org/Resources/Free_publications/Planning_for_SuDS_ma.aspx
CIRIA (2013) Creating water sensitive places: scoping the potential for Water Sensitive Design in the UK (C724)	http://www.ciria.org/Resources/Free_publications/Creating_water_sens1.aspx
CIRIA (2013) Water sensitive urban design in the UK: Ideas for built environment practitioners.	http://www.ciria.org/Resources/Free_publications/Water_Sensitive_Urba.aspx

Outline Design	
BSI Standards Publication (2013) Code of Practice for Surface Water Management for Development Sites (Section 5)	http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030253266
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