Hertsmere Borough Council

Strategic Flood Risk Assessment
Level I

Hertsmere Borough Council

May 2018

Quality information

Prepared by	Checked by	Approved by
		
Luis Martin Engineer	Ipek Kaymak / Gordon Boote Senior Engineer	Fida Choudhury Project Director

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Prepared for:

Hertsmere Borough Council
Civic Offices, Elstree Way, Borehamwood WD6 1WA

Prepared by:

Luis Martin
Engineer

AECOM Limited
AECOM House
63-77 Victoria Street
St Albans
Hertfordshire
AL1 3ER
UK

T: +44(0)1727 535000
aecom.com

Contents

1 Introduction and Background 1
1.1 Terms of Reference 1
1.2 Project Background 1
1.3 Approach to Flood Risk Management 1
1.4 Partner Organisations 2
1.5 Level 1 SFRA Approach 4
2 Legislative and Planning Policy Context 5
2.1 Introduction 5
2.2 Flood and Water Management Act 5
2.3 Flood Risk Regulations 6
2.4 Thames Catchment Flood Management Plan 7
2.5 National Planning Policy Framework 8
2.6 Local Planning Policy 8
2.7 Water Cycle Strategy 10
2.8 National Receptor Dataset 10
2.9 Summary 10
3 Assessing Flood Risk 12
3.1 Introduction 12
3.2 Study Area 12
3.3 Summary of Flood Sources 13
3.4 Flooding from Rivers 13
3.5 Flooding from Surface Water 18
3.6 Flooding from Groundwater 21
3.7 Flooding from Sewers 22
3.8 Reservoirs, Canals and Other Artificial Sources 23
4 Avoiding Flood Risk – Applying the Sequential Test 24
4.1 Sequential Approach 24
4.2 Applying the Sequential Test – Plan-Making 24
4.3 Applying the Sequential Test – Individual Applications 28
4.4 Exception Test 29
5 Managing and Mitigating Flood Risk 30
5.1 Overview 30
5.2 Development Layout and Sequential Approach 30
5.3 Riverside Development (Main Rivers and Ordinary Watercourses) 30
5.4 Floodplain Compensation Storage 31
5.5 Finished Floor Levels 32
5.6 Flood Resistance 'Water Exclusion Strategy' 32
5.7 Flood Resilience 'Water Entry Strategy' 34
5.8 Structures 35
5.9 Safe Access and Egress 35
5.10 Safe Refuge 36
5.11 Car Parks 36
5.12 Flood Routing 36
5.13 Flood Warning and Evacuation Plans 37
6 Guidance for the Application of Sustainable Drainage Systems (SuDS) 38
6.1 What are SuDS? 38
6.2 Management Train 40
6.3 SuDS Costs 40
6.4 Infiltration SuDS Specific to Hertsmere 43
6.5 What is the role of the HCC? 44

7 Guidance for preparing site-specific FRAs 47
7.1 What is a Flood Risk Assessment? 47
7.2 When is a Flood Risk Assessment required? 47
7.3 How detailed should a FRA be? 47
7.4 What needs to be addressed in a Flood Risk Assessment? 49
7.5 Flood Risk Assessment Checklist 49
7.6 Pre-application Advice 49
8 Flood Risk Management Policy Considerations 51
8.1 Overview 51
8.2 Policy Considerations 51
8.3 Development Management Considerations 53
8.4 Summary of Policy Recommendations 56
9 Next Steps 59
Appendix A Maps 60
Appendix B Flood Risk Assessment (FRA) Checklist 61

Figures

Figure 1-1 Taking flood risk into account in the preparation of a Local Plan (PPG, P6) 3
Figure 2-1 Summary of Legislative and Planning Context 11
Figure 4-1 Application of Sequential Test for Plan-Making 25
Figure 5-1 Example of Floodplain Compensation Storage (Environment Agency 2009) 31
Figure 5-2 Flood Resistant/Resilient Design Strategies, Improving Flood Performance, MHCLG 2007 33
Figure 5-3 Examples of flood barriers, air bricks and on-return valves 34
Figure 5-4 Example of flood gates 34
Figure 8-1 Development Management Considerations for Flood Zone 3b 54

Tables

Table 1-1 Approach to Flood Risk Management set out by the NPPF 2
Table 1-2 Strategic Flood Risk Maps 4
Table 2-1 Summary of CFMP Policies for HBC 7
Table 3-1 Potential flood sources and pathways 13
Table 3-2 Fluvial Flood Zones (extracted from the NPPF, 2014) 15
Table 3-3 Receptors at risk of flooding from rivers 16
Table 3-4 Revised climate change allowances for the Thames River basin 16
Table 3-5 Peak river flow allowances for flood risk assessments 16
Table 3-6 Comparison between 1:100yr and 1:1000yr model results 17
Table 3-7 Hertsmere Borough Council Flood Records 19
Table 3-8 Receptors at risk from surface water flooding 21
Table 3-9 Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline) 21
Table 3-10 Receptors at areas susceptible to groundwater flooding 22
Table 3-11 Reservoirs in HBC 23
Table 4-1 Flood Risk Classifications for Sequential Test 24
Table 4-2 Flood Risk Vulnerability Classification (PPG, 2014) 26
Table 4-3 Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG, 2014) 27
Table 5-1 Hazard to People Rating (HR=d x (v +0.5) + DF) (Table 13.1 FD2320/TR2) 35
Table 6-1 Typical SuDS Components (Y; primary process. * some opportunities, subject to design) 39
Table 6-2 Indicative costs for SuDS options (Defra, Environment Agency 2015) 41
Table 6-3 Indicative annual maintenance costs for key SuDS options 42
Table 7-1 Levels of Site-Specific Flood Risk Assessment 48

1 Introduction and Background

1.1 Terms of Reference

Hertsmere Borough Council (HBC) has commissioned AECOM to review and update the Level 1 Strategic Flood Risk Assessment (SFRA) for its administrative area. This Report comprises the updated Level 1 SFRA Report.

1.2 Project Background

The National Planning Policy Framework[1] (NPPF) and associated Planning Practice Guidance (PPG)[2] for Flood Risk and Coastal Change emphasise the active role Local Planning Authorities (LPA) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. The NPPF outlines that Local Plans should be supported by an SFRA and LPA should use the findings to inform strategic land use planning. The original SFRA for HBC was prepared by Halcrow Group Limited in May 2008 and formed part of the evidence base for the Core Strategy and Site Allocations and Development Management (SADM) Policies Plan.

A number of additional strategic flood risk datasets have been made available for the Hertsmere study area since the initial SFRA (2008), and the Environment Agency has published new guidance on the approach for considering climate change for river flooding. In addition, there have been a number of further changes in legislation and guidance relating to planning and flood risk. The introduction of the Localism Act in 2011 was intended to create a planning system oriented around consideration of local planning issues. Planning Policy Statements (PPS), covering all aspects of national planning policy have since been replaced by the NPPF. The accompanying technical guidance document relating to flood risk, originally derived from the PPS documents has also been recently replaced by the Planning Practice Guidance (PPG). Furthermore, the wider planning system has been subject to considerable change since 2008 with the withdrawal of the previous regional planning framework and the revocation of Regional Spatial Strategies in 2010.

The Flood and Water Management Act (FWMA) attained royal assent in 2010, with the intention of enabling the provision of more effective flood management following the flooding of July 2007. As such, HBC is designated as a Risk Management Authority (RMA) and its primary duty is to cooperate with Lead Local Flood Authority (LLFA) and other RMAs to manage flooding from local sources across the Borough, specifically surface water, groundwater and ordinary watercourses. HBC power as an RMA includes designation of flood risk structures and features. As well as powers of designation, HBC is the RMA holding the powers to manage flood risk from ordinary watercourses under S14A of the Land Drainage Act 1991. The Environment Agency retains responsibility for leading and coordinating the management of flood risk associated with main rivers.

The purpose of the Level 1 SFRA Update is to collate and analyse the most up to date readily available flood risk information for all sources of flooding, to provide an overview of flood risk issues across the Borough. This will be used by HBC to inform the preparation and examination of HBC's emerging Local Plan – Planning for Growth, including the application of the Sequential Test to future site allocations. It is also intended that the revised Level 1 SFRA deliverables will assist prudent decision-making on flood risk issues by Development Management Officers on a day-to-day basis.

1.3 Approach to Flood Risk Management

The NPPF sets stringent tests to protect people and property from flooding, which all LPAs are expected to follow. Where these tests are not met, national policy is clear that new development should not be allowed. The main steps to be followed can be summarised as Assess, Avoid and Manage and Mitigate flood risk. These steps are set out below (Table 1-1), and are designed to ensure that if there are better sites in terms of flood risk, or a proposed development cannot be made safe, it should not be permitted.

A flow chart to provide guidance on the use of the SFRA when taking flood risk into account during the planning process and preparation of the Local Plan is outlined in Figure 1-1.

[1] Department for Communities and Local Government. 2012. National Planning Policy Framework. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2

[2] Department for Communities and Local Government. 2014. Planning Practice Guidance: Flood Risk and Coastal Change. Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

Table 1-1 Approach to Flood Risk Management set out by the NPPF

Assess Flood Risk	LPAs should undertake a SFRA to fully understand the flood risk in the area to inform Local Plan preparation. For sites in areas at risk of flooding, or with an area of 1 hectare or greater, developers must undertake a site-specific Flood Risk Assessment (FRA) to accompany planning applications (or prior approval for certain types of permitted development).
Avoid Flood Risk	HBC should apply the sequential approach to site selection so that development is, as far as reasonably possible, located where the risk of flooding from all sources is lowest, taking account of climate change and the vulnerability of future users to flood risk. In plan-making this involves applying the Sequential Test, and where necessary the Exception Test to Local Plans, as described in Section 4. In decision-taking this involves applying the Sequential Test and if necessary the Exception Test for specific development proposals.
Manage and Mitigate	Where alternative sites in areas at lower risk of flooding are not available, it may be necessary to locate development in areas at risk of flooding. In these cases, HBC and developers must ensure that development is appropriately flood resilient and resistant, safe for its users for the lifetime of the development, and will not increase flood risk overall. HBC and developers should seek flood risk management opportunities (e.g. safeguarding land), and to reduce the causes and impacts of flooding (e.g. through the use of sustainable drainage systems).

1.4 Partner Organisations

There are several organisations involved in development and flood risk management across the study area. These are identified below.

Hertsmere Borough Council is the LPA for the study area, responsible for long term strategic planning of future development through the preparation of Local Plans, as well as for determining planning applications within the Borough. On 18 December 2014 Central Government issued a written statement in relation to sustainable drainage systems (SuDS) outlining the strengthening of existing planning policy to make it clear that the Government's expectation is that SuDS will be provided in new developments. To this effect, it is expected that, where planning applications are for major development, the Local Planning Authority must ensure that SuDS are put in place, unless demonstrated to be inappropriate. 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. HBC should work with LLFA to secure Local Plan policies compatible with the local flood risk management strategy. HBC is also the Land Drainage Authority for the study area. HBC published a set of Byelaws[3] under the Section 66 of the Land Drainage Act 1991, to secure the efficient working of the drainage system in their area, for preventing flooding or remedying or mitigating any damage caused by flooding. HBC have certain permissive powers to undertake flood defence works and powers of enforcement under the Land Drainage Act 1991 on watercourses which have not been designated as Main Rivers.

Hertfordshire County Council is designated as the Lead Local Flood Authority (LLFA) under the FWMA, and has a duty to lead and coordinate the management of local flood risk, which includes flood risk from surface water, groundwater and ordinary watercourses. However, HCC has permissive powers to manage flood risk from surface runoff and groundwater under S14A the Land Drainage Act 1991.

On 24 March 2015, Government laid a statutory instrument making the LLFA a statutory consultee in planning for all major development in relation to the management of surface water drainage from 15 April 2015.

Hertfordshire County Council (Highways Authority) maintains the local road network which are highway maintainable at public expense which includes provision of highway drainage and roadside ditches. The HCC Highways Authority also has permissive powers under the Highway Act 1980 to manage flooding of the highway. The Highways Authority must ensure that road projects do not increase flood risk.

Environment Agency has a strategic overview role for flood risk management associated with main rivers in the Borough and is a statutory consultee for any development proposed within Flood Zone 2 and 3 associated with these watercourses. The Environment Agency is continually improving and updating their flood map for main rivers and has permissive powers to carry out flood defence works, maintenance and operational activities for these main rivers. However, overall responsibility for maintenance lies with the riparian owner.

[3] Hertsmere Borough Council, Land Drainage Byelaws, 1998 https://www.hertsmere.gov.uk/Documents/04-Environment-Refuse--Recycling/Drainage/Land-Drainage-Bylaws.pdf

Thames Water Utilities Limited has the duty as a statutory body to provide waste water services to the whole of the study area and is responsible for the management, maintenance and operation of flood control structures. Water Companies are defined as an RMA within the FWMA and are responsible for flood risk management functions in accordance with the Water Resources Act 1991 and the Land Drainage Act 1991. Thames Water is responsible for surface water drainage from development via adopted sewers and for maintaining trunk sewers into which much of the highway drainage in the study area connects. To this extent Thames Water Utilities Limited are required to adequately drain the upstream infrastructure.

Highways England has responsibilities (under the Highways Act 1980) for the effectual drainage of surface water from motorways and major A roads, including the slip roads to and from trunk roads, insofar as ensuring that drains, including kerbs, road gullies, ditches and the pipe network which connect to the sewers (often Thames Water Utilities), are maintained.

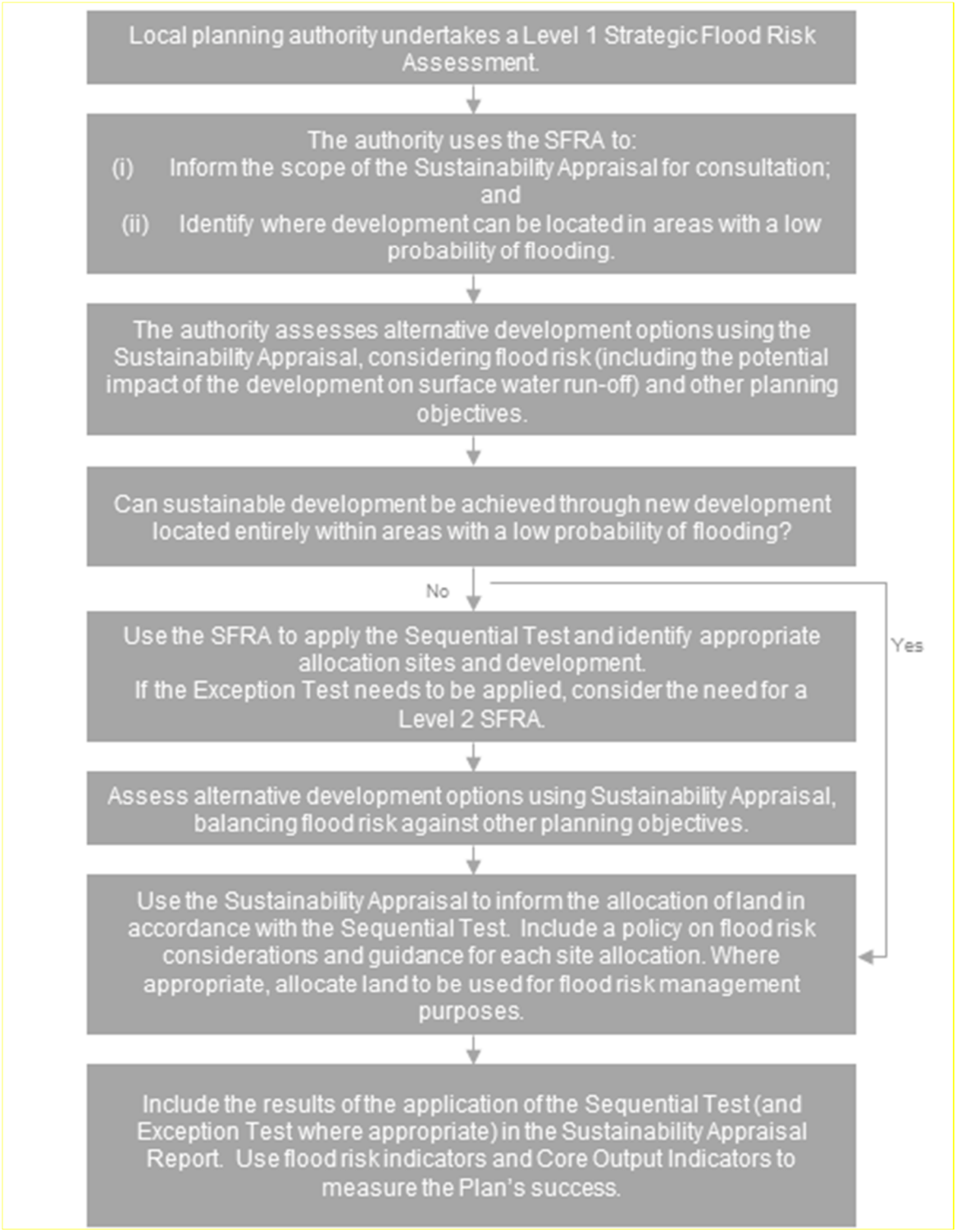


Figure 1-1 Taking flood risk into account in the preparation of a Local Plan (PPG, P6)

1.5 Level 1 SFRA Approach

The Level 1 SFRA is a desk-based study, using readily available existing information and datasets to enable the application of the Sequential Test and to identify where the Exception Test may be required. The main tasks in preparing the Level 1 SFRA are described below.

1.5.1 Gathering data and analysing it for suitability

Under Section 10 of NPPF, the risk of flooding from all sources must be considered as part of a Level 1 SFRA, including flooding from tidal sources, rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources.

In order to provide this assessment of all sources of flooding in the study area, an extensive set of datasets was requested from a number of organisations, including HBC, HCC (as the LLFA and Highways Authority), the Environment Agency, Thames Water and the Highways England.

Datasets and information gathered as part of the preparation of the first iteration of the SFRA in 2008 have been retained where appropriate. The datasets are described further in Section 3, including detail regarding appropriate uses and limitations, and how they have been used within the Level 1 SFRA.

1.5.2 Producing strategic flood risk maps, GIS deliverables and a technical report

A series of GIS maps have been produced using the data gathered during the study. The mapping deliverables are summarised in Table 1-2 and should be referred to when reading Section 3 'Assessing Flood Risk' which provides an overview of flood risk across the Borough.

Table 1-2 Strategic Flood Risk Maps

Figure No.	Figures Title and Content
Figure 01	Study Area (administrative boundaries, watercourses, water bodies)
Figure 02	Topography
Figure 03	Superficial Geology
Figure 04	Bedrock Geology
Figure 05.0 – 05.4	Flooding from Rivers (Flood Zone Map)
Figure 06.1 – 06.4	Modelled Fluvial Flood Risk
Figure 07.01	Flooding from Rivers Modelled Climate Change Outlines
Figure 07.02	Flooding from Rivers Modelled 1:1000yr Outlines
Figure 08	Flood Response Measures
Figure 09	Historic Flood Records
Figure 10.0 – 10.4	Map of Risk of Flooding from Surface Water (RoFSW)
Figure 11	Susceptibility to Groundwater Flooding
Figure 12	Sewer Flooding
Figure 13	Artificial Sources
Figure 14	British Geographic Survey (BGS) Infiltration Suds Suitability Mapping
Figure 15	Main Rivers Covered by Detailed Hydraulic Modelling

1.5.3 Providing suitable guidance

Based on Section 3 'Assessing Flood Risk', and the supporting mapping deliverables, the Level 1 SFRA Report provides specific guidance for HBC.

Section 4 provides guidance on 'Avoiding Flood Risk' through the appropriate application of the Sequential Test by HBC when allocating future development sites as part of the plan-making process, as well as by developers promoting development on windfall sites.

Sections 5 provides guidance for measures to 'Manage and Mitigate Flood Risk' on future development sites and to assist the preparation of site-specific FRAs.

Section 6 provides guidance for the application of SuDS and Section 7 guidance on the preparation of site-specific FRAs.

Section 8 outlines a number of flood risk management objectives and policy recommendations for consideration by HBC throughout the development of their strategic planning documents.

2 Legislative and Planning Policy Context

2.1 Introduction

This Section provides an overview of the legislative, national and local planning policy context specific to the Level 1 SFRA Update for HBC. The information presented in the SFRA should be used by HBC to establish robust policies in relation to flood risk as part of their emerging local plan.

2.2 Flood and Water Management Act

In response to severe flooding across large parts of England and Wales in summer 2007, the government commissioned Sir Michael Pitt to undertake a review of flood risk management. The Pitt Review – Learning Lessons from the 2007 Floods[4] and subsequent progress reviews outlined the need for change in the way the UK is adapting to the increased risk of flooding and the role different organisations have to deliver this function.

The FWMA[5], enacted by Government in response to the Pitt Review, designated county councils, such as HCC, as LLFA. As such, HCC has responsibilities to lead and co-ordinate local flood risk management. Local flood risk is defined as the risk of flooding from surface water runoff, groundwater and small ditches and watercourses (collectively known as ordinary watercourses).

The FWMA also formalises the flood risk management roles and responsibilities for other organisations including the Environment Agency, district councils, water companies and highway authorities. The responsibility to lead and co-ordinate the management of tidal and fluvial risk remains that of the Environment Agency.

2.2.1 National Strategy for Flood and Coastal Erosion Risk Management

In accordance with the FWMA, the Environment Agency has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England[6]. This strategy provides a framework for the work of all flood and coastal erosion risk management authorities. Hertsmere is not a coastal Borough; therefore for this area the National FCERM Strategy sets out the other long-term objectives for managing all other sources of flood risk and the measures proposed to achieve them.

It sets the context for, and informs the production of local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage local flood risk. It also aims to encourage more effective risk management by enabling people, communities, business and the public sector to work together to:

- Ensure a clear understanding of the risks of flooding, nationally and locally, so that investment in risk management can be prioritised more effectively;
- Set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risks;
- Encourage innovative management of risks taking account of the needs of the communities and the environment;
- Ensure the emergency responses to flood incidents are effective and that communities are able to respond properly to flood warnings; and,
- Ensure informed decisions are made on land use planning.

[4]Cabinet Office (2008) Sir Michael Pitt Report 'Learning lessons learned from the 2007 floods' http://www.environment-agency.gov.uk/research/library/publications/33889.aspx
[5] Environment Agency (2010) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities
[6] Defra, Environment Agency (2011) The National Flood and Coastal Erosion Risk Management Strategy for England.

The Environment Agency's 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities'[7] guidance is a supporting note for the National FCERM Strategy. The 2016 version of the document reflects an assessment completed by the Environment Agency between 2013 and 2015 using UKCP09 data to produce more representative climate change allowances for river flood flows and extreme rainfall for each of the river basin districts in England. It is essential that land use planning decisions consider the impact of a changing climate where appropriate.

2.2.2 Local Flood Risk Management Strategy

As LLFA, HCC has a statutory duty to develop, maintain, apply and monitor a strategy for local flood risk management in the administrative area. HCC has prepared a Local Flood Risk Management Strategy[8] (LFRMS) to enable flood risk across Hertfordshire to be managed more effectively and holistically.

The overall aim of the LFRMS is to "to work with organisations, businesses and communities to manage flood risks, and where it is practicable, affordable and sustainable to do so, to reduce risks to life, property and livelihoods that may arise from local surface runoff, ordinary watercourse and groundwater flooding". The LFRMS will seek to implement the following strategic objectives:

1. Determine and communicate Local Flood Risk – Undertake projects to determine and understand the risks of flooding from surface run-off, ordinary watercourses and groundwater. Increase public awareness through the publication of clear and consistent information about local flood risk.

2. Partnership working – work with all RMAs and other stakeholders to coordinate flood risk management roles, responsibilities and activities. Share best practice; raise the profile of RMAs working within Hertfordshire and assist organisations in ensuring their plans and projects take proper account of flood risk from all sources.

3. Partnership Programmes and Projects – Identify, secure and optimise resources to develop and deliver measures to manage flood risk. Assist organisations to establish and update long-term plans to manage flood risk.

4. Riparian Responsibilities - Work with RMAs to encourage and where necessary enforce the management and maintenance of privately owned flood management structures and ordinary watercourses and minimise unnecessary constrictions and obstructions within local drainage networks.

5. Flood Risk and Development – Ensure that planning authorities are properly informed about local flood risk, that there is a consistent approach to the consideration of flood risk management I the new development and that new developments seek to reduce existing flood risk and contribute to the achievement of sustainable development.

6. Water Framework Directive (WFD) – Support the implementation of the WFD by ensuring that watercourse morphology, water quality and ecological status are not harmed by activities that are controlled by, or undertaken by, owners, occupiers and managers of FCERM infrastructure. Facilitate measures to improve morphology, water quality and ecological status whenever it is practicable and necessary to do so.

7. Support Water and Sewerage Company infrastructure – Work closely with water and sewerage companies to minimise flood risks associated with their infrastructure and promote the development and management of sustainable water resources.

2.3 Flood Risk Regulations

As well as the duties under FWMA, LLFAs have legal obligations under the EU Floods Directive[9], which was transposed into UK Law through the Flood Risk Regulations 2009[10] ('the Regulations'). One of the requirements is the preparation of a Preliminary Flood Risk Assessment as outlined below.

[7] Environment Agency (2016) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516116/LIT_5707.pdf
[8] Hertfordshire County Council (2011) Local Flood Risk Management Strategy For Hertfordshire 2013 – 2016 http://www.hertsdirect.org/docs/pdf/f/hertslfrmsall.pdf
[9] European Union (2007) EU Floods Directive http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT
[10] HSMO (2009) The Flood Risk Regulations http://www.legislation.gov.uk/uksi/2009/3042/contents/made

2.3.1 Preliminary Flood Risk Assessment

Under the Regulations, all LLFAs were required to prepare a Preliminary Flood Risk Assessment (PFRA) report. This is a high level screen exercise to identify areas of significant risks as 'Indicative Flood Risk Areas' across England where 30,000 people or more are at risk from flooding, for reporting to Europe.

A PFRA was prepared for HCC in 2011[11]. A subsequent addendum was published on 3 April 2018[12]. This addendum by HCC (2017) updates the council's PFRA report. The PFRA seeks to provide a high level overview of flood risk from local flood sources and includes flooding from surface water (i.e. rainfall resulting overland runoff), groundwater, ordinary watercourses (smaller watercourses and ditches) and canals. It excludes flood risk from main rivers, the sea and reservoirs, as these are assessed nationally by the Environment Agency. The PFRA report looks at past flooding and where future flooding might occur across the area and the consequences it might have to people, properties and the environment. The report provides a useful baseline for Hertfordshire to inform their LFRMS as well as the preparation of this revised Level 1 SFRA.

2.4 Thames Catchment Flood Management Plan

Under the EU Floods Directive and UK Flood Risk Regulations, LLFAs must prepare Flood Risk Management Plans (FRMPs) in formally identified Flood Risk Areas where the risk of flooding from local sources is significant (i.e. surface water, groundwater, ordinary watercourses). The Environment Agency is required to prepare FRMPs for all of England covering flooding from main rivers, the sea and reservoirs.

As such, the Thames River Basin District Flood Risk Management Plan[13] has been published by the Environment Agency and set out the measures to manage flood risk in the Thames River Basin District from 2015 to 2021. These documents draw on existing reports and plans which have been prepared in the past such as the Catchment Flood Management Plans (CFMP) for the catchments in Hertfordshire identified in Table 2-1.

CFMP set out polices for the sustainable management of flood risk across particular catchments over the long-term (50 to 100 years) taking climate change into account. Of relevance to the Hertsmere study area is Sub-area 4 of the Thames River.

Table 2-1 Summary of CFMP Policies for HBC

Thames Catchment Flood Management Plan [14]
Sub-area 4: Colne tributaries and Wye, Middle Mole, Thame and Upper Lee – Policy 3 "Areas of low to moderate flood risk where we are generally managing existing flood risk effectively"
The issues in this sub-area The major source of flooding is rivers, sometimes in combination with high groundwater levels. Many of the river valleys across the Chilterns and northern Hertfordshire are quite steep with narrow floodplains. In many of the urban areas the river channels have been modified. Pinch points such as bridges and culverts can contribute to localised flooding. These sub-areas contain 11% (180km²) of the total area of floodplain in the Thames CFMP. There are approximately 4,000 properties with a 1% risk of flooding from rivers. This represents 3% of the total number at risk in the Thames CFMP area. This figure is estimated to increase by between 6% and 40% in the future due to the impacts of climate change. There are a few people and properties at risk in this large rural sub-area. People and properties are located in isolated towns and villages scattered throughout the rural region. River flooding is infrequent and the consequences of flooding are low. There are no formal flood defences in this sub-area. The Key Messages • Maintain the existing capacity of the river systems in developed areas to reduce the risk of flooding from more frequent events. Make the existing systems more efficient. • Retain the remaining floodplain for uses that are compatible with flood risk management and put in place polices that lead to long-term adaption of urban environments in flood risk areas. • Continue to increase public awareness, including encouraging people to sign-up for free Floodline Warnings Direct service.

[11] Hertfordshire County Council (2011) Preliminary Flood Risk Assessment http://www.hertsdirect.org/docs/pdf/f/hccpfra.pdf
[12] Hertfordshire County Council (2017) Preliminary Flood Risk Assessment Addendum https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/691054/Hertfordshire_County_Council_PFRA_updated_2017.pdf
[13]Environment Agency (March 2016) Thames River Basin District Flood Risk Management Plan 2015-2021 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/507138/LIT_10229_THAMES_FRMP_PART_A.pdf
[14]Environment Agency (December 2009) Thames Catchment Flood Management Plan https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293903/Thames_Catchment_Flood_Management_Plan.pdf

2.5 National Planning Policy Framework

The NPPF is a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities. The overall approach of the NPPF to flood risk is broadly summarised in Paragraph 103:

"When determining planning applications, LPAs should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- Within the site the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and
- Development is appropriately flood resilient and resistant, including safe access and escape routes where required and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.

Further detail regarding the Sequential and Exception Tests is included in Section 4 of this report.

2.5.1 NPPF Guidance SuDS Policy (April 2015)

SuDS are an approach to managing rainwater and surface water that replicates natural drainage, the key objectives being to manage flow rate and volume of runoff to reduce risk of flooding and water pollution. From 6th April 2015, LPAs such as HBC are required to ensure that SuDS are implemented for all major developments where appropriate, and that 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.

As the LLFA, HCC is a statutory consultee for SuDS applications. HCC will need to be consulted on the drainage elements of planning applications for major development to ensure they conform to necessary national and local SuDS standards[15].

The most up to date and comprehensive information on planning, designing, constructing and maintaining SuDS can be found in CIRIA Report C753 – The Suds Manual.

2.6 Local Planning Policy

The HBC Core Strategy[16] adopted in 2013 is a key statutory Development Plan Document (DPD), which sets out HBC's vision and strategy for the Borough between 2013 and 2027. The document seeks to strike a balance between the borough's housing and economic development needs, social welfare and protection of the environment. It sets the framework for more detailed planning policies and provides the foundation for decisions on planning applications and development proposals.

The Core Strategy aligns to the national guidance laid out in NPPF:

- The promotion of sustainable development to meet community development needs and the promotion of high quality design
- The continued presumption against inappropriate development in the Green Belt
- The identification of a 'rolling' five year supply of housing sites
- Identification of housing land for a further 10 years to enable 15 years total supply
- Promotion of commercial activity within existing centres

The following Core Strategy objectives would directly or indirectly contribute to reduction of flood risk within HBC:

- To address issues arising from climate change, and all types of flooding and to take advantage of water and other natural recourses responsibly.

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

[16] Local Plan 2012-2027 Core Strategy, Hertsmere Borough Council, 2016 https://www.hertsmere.gov.uk/Planning--Building-Control/Planning-Policy/Local-Plan/Local-Plan-2012-27-Core-Strategy.aspx

- To protect the Green Belt and its role in preventing urban sprawl and the coalescence of towns.
- To maintain an adequate supply of suitable land, focused on brownfield sites within the principal towns, to accommodate expected development needs and supporting community infrastructure

The Core Strategy Policy CS16 - Environmental impact of development (see box below) is particularly relevant to the SFRA as it states any future development proposal needs take account of the policy recommendation of this SFRA.

> CS16 Environmental impact of development
>
> Council will work with key partners, including the Environment Agency and Natural England, to ensure that development proposals do not create an un acceptable level of risk to occupiers of a site, the local community and the wider environment. Development proposals should take account of the policy recommendations of the Council's SFRA and the guidance set out in the jointly produced guidance of the Hertfordshire Planning Authorities 'Building Futures' the Hertfordshire Guide to Promoting Sustainability in Development. Proposals will be required to incorporate sustainability principles, minimising their impact on the environment and ensuring prudent use of natural resources by measures including:
>
> i) avoiding development in the floodplain and close to river corridors unless the requirements of the sequential and exceptions tests have been met and flood prevention/mitigation measures are in place as required by the Environment Agency.

HBC adopted a Site Allocations and Development Management (SADM)[17] Policies Plan in November 2016 following an Examination in Public. This is now being given full weight in the determination of planning applications. One of the main purposes of SADM Policies Plan is to deliver the policies set out in the Hertsmere Core Strategy 2013. Several SADM policies directly relate to flood risk management and expands on the policy CS16. A summary of these policies is presented below, full policy text is available in SADM document found on HBC website[17].

- Policy SADM13 - The Water Environment
    - watercourses and areas of water will be improved
    - New built development will normally be directed to lands with lowest flood risk
    - attenuation areas that help reduce flood risk downstream will be retained
- Policy SADM14 - Flood Risk
    - application of sequential and exception tests to actively manage and reduce flood risk within HBC area
    - requirement for site specific flood risk assessments for new development plans in a flood risk area to take into account the risk associated with all types of flooding
    - sets out a list of principles that future developments must satisfy
- Policy SADM15 - Sustainable Drainage Systems
    - design of new development should include sustainable drainage measures
- Policy SADM16 – Watercourses
    - developments on sites that contain a watercourse or are situated next to a watercourse need to comply with as set of principles to protect watercourses

This SFRA will form part of the evidence base for the HBC's emerging New Local Plan – Planning for Growth that will replace the Core Strategy (2013).

[17] Site Allocations and Development Management Policies Plan, Hertsmere Borough Council, 2016 https://www.hertsmere.gov.uk/Planning--Building-Control/Planning-Policy/Local-Plan/Local-Plan-2012-27-SADM-main-page.aspx

2.6.1 Local Flood Risk Management Strategy

HCC as the LLFA, has the responsibility to develop, maintain, apply and monitor an LFRMS. The current LFRMS for HCC covers the period of 2013 – 2016[18]. The high level objectives of the strategy include the following:

- To reduce the potential impact and costs of flooding in the county.
- To better understand local flood risk and make best use of available information.
- To develop greater personal involvement in flood risk management amongst residents of Hertfordshire.
- To secure improvements to the water environment of Hertfordshire through the undertaking of actions associated with flood risk management.

The LFRMS identified the major sources of flooding in the county. Of these sources, those associated with main rivers are well documented through the Environment Agency. Therefore further assessment and collection of data undertaken by HCC focused on local sources of flood risk.

2.7 Water Cycle Strategy

The purpose of this study is to identify any water related issues that could present significant obstacles to new development. The study examines how much growth can be accommodated within the existing infrastructure. It examines whether sufficient water resources are available to supply the forecast demand, how much growth the existing drainage and Wastewater Treatment Works (WWTW) can accommodate and whether or not the watercourses in the surrounding area can handle the additional discharges without deteriorations in water quality or water dependent habitats.

While there was no HBC specific Water Cycle Strategy carried out, HBC undertook an Infrastructure Assessment[19] that concluded waste water infrastructure will be an important delivery issue for growth in the Borough between 2011 and 2027. The evidence presented in the assessment highlighted that:

- Growth proposed in the Borough and adjoining areas would lead to a requirement for significant upgrades to either Maple Lodge WWTW or Blackbirds WWTW, or both.
- Significant upgrades would also be required at Rye Meads WWTW in Ware. This view was also supported in water cycle strategy review of Rye Meads[20].

2.8 National Receptor Dataset

The National Receptor Dataset (NRD) is a collection of risk receptors primarily intended for use in FCERM[21]. A receptor is something that is affected by a hazard. For example, within FCERM, typical receptors of concern are homes, businesses or infrastructure, which could be flooded from a river, or if a defence were to breach. In the NRD not all records are properties, therefore, the features marked for exclusion from Environment Agency's National Flood Risk Assessment (NaFRA) property counts in Appendix B of NRD2014 guidance have also been excluded for this SFRA.

The version of NRD currently available and used for the purposes of this SFRA is NRD 2014. The frequency of NRD updates is not fixed and is based on how much the base information has changed or in response to a specific business need. A softcopy version of NRD2014 with information on different sources of flooding for each receptor has been delivered to HBC as part of the outcomes of this SFRA.

2.9 Summary

Figure 2-1 provides a summary of the documents that have been outlined in this section. The figure demonstrates that the main driver for the SFRA is the NPPF and that the documents and plans prepared by both the Environment Agency and HBC are under the requirements of the FWMA and the Flood Risk Regulations, which provide key inputs to inform

[18] Hertfordshire (2013) Local Flood Risk Management Strategy for Hertfordshire 2013 – 2016 http://www.hertsdirect.org/docs/pdf/f/hertslfrmsall.pdf
[19] Hertsmere Borough Council (February 2013), Local Development Plan Infrastructure Assessment, https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Planning-Publications/CD12-Hertsmere-Infrastructure-Assessment.pdf
[20] Stevenage Borough Council (September 2015), Rye Meads Water Cycle Strategy Review, http://www.stevenage.gov.uk/content/15953/26379/43876/Water-Cycle-Strateg-Review.pdf
[21] Environment Agency (September 2015) – NRD2014 Guidance

the preparation of the revised SFRA and new Local Plan.

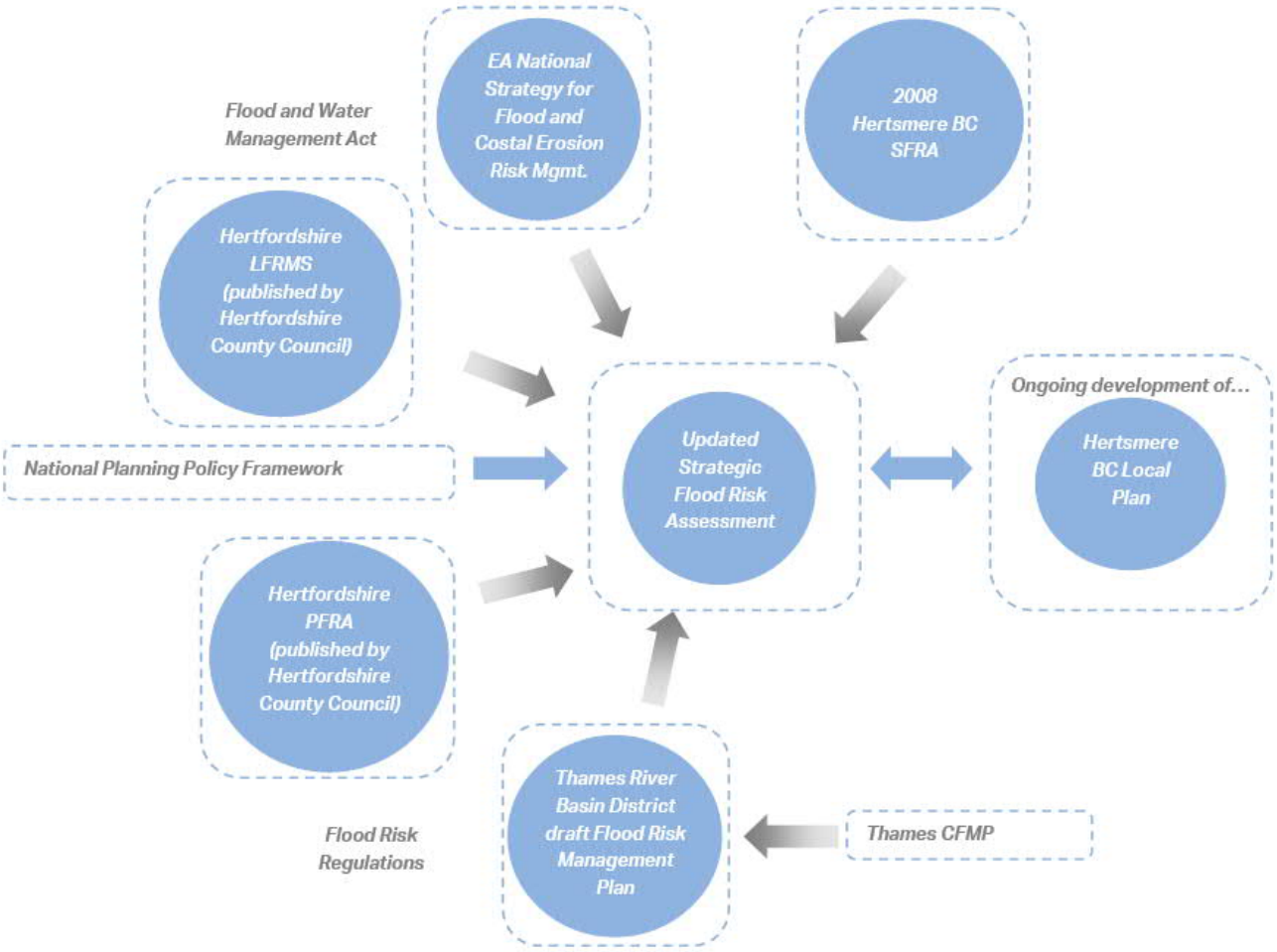


Figure 2-1 Summary of Legislative and Planning Context

3 Assessing Flood Risk

3.1 Introduction

This section provides a strategic assessment of flood risk across the Hertsmere study area from each of the sources of flooding outlined in the NPPF. For each source of flooding, details of any historic incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This Section should be read with reference to the figures in Appendix A.

3.2 Study Area

3.2.1 Location

The study area of HBC is shown in Appendix A Figure 01, together with the location of the principal watercourses and reservoirs. HBC forms part of the County of Hertfordshire, and is located in South West Hertfordshire, immediately adjoining the London Boroughs of Barnet and Enfield which lie to the south.

HBC covers an area of 100km^2 of which 80% is Green Belt and lies entirely in the River Thames Basin, River Colne catchment. The main settlements are Borehamwood & Elstree, Potters Bar, Bushey, Radlett and Shenley. There are several other smaller rural villages, including Aldenham, Letchmore Heath, Patchetts Green, Ridge and South Mimms which remain largely residential in character and land use, relying on larger settlements nearby for employment and local services. Parts of the M25 and A1(M), including the South Mimms motorway service area, are located within the study area. HBC has no coastline and therefore tidal flooding is not considered in this report.

The topography of the study area comprises of deep river valleys and upland areas (Appendix A Figure 02). The lowest lying areas fall within the River Colne valley towards the west and north, which includes sparsely populated settlements and farm lands. Radlett and Borehamwood towns, in the Radlett Brook valley, are at a slightly higher elevation. Other major settlements are located on higher uplands.

3.2.2 Hydrogeology

Hydrogeology is the branch of geology that considers the distribution and movement of groundwater in the soil and rocks of the Earth's crust (commonly in aquifers). It is important to understand the hydrogeology as it affects the rate of surface runoff and indicates where there is risk of groundwater flooding. Substantial areas of impermeable surface rock are likely to induce rapid runoff, leading to surface water flooding in downstream locations. Furthermore, the presence of aquifers is likely to promote the risk of groundwater flooding and therefore should be located.

The chalk outcrop which forms the Chiltern Hills to the west of Hertfordshire continues eastwards and then northwards into East Anglia. Hertsmere lies on the boundary between the chalk of Hertfordshire to the north and the London Clay and Reading Beds of the London Basin to the south (Appendix A Figures 03, and 04). As a result of the generally impervious nature of the valley slopes the catchment has a relatively rapid runoff response meaning that surface water runoff in the area is frequent.

There is a marked contrast in soil types across the Borough. In the headwaters of the catchment (southern end of Borough) across Borehamwood, Bushey, and Potters Bar the soils are generally clays with low permeability, seasonally waterlogged, with medium to high runoff producing potential. The soils in the lower part of the catchment (northern end of the Borough) across Radlett and Shenley are generally well-drained, loamy sandy soils which are permeable and produce relatively low amounts of runoff.

3.3 Summary of Flood Sources

Table 3-1 summarizes the range of potential flood sources and pathways in the study area. Where relevant, each source is discussed in further detail below.

Table 3-1 Potential flood sources and pathways

Flood Type	Source	Pathway	Consider further
Fluvial	Hilfield Brook, Radlett Brook, Tykeswater and Mimmshall Brook	Floodplain ponding / conveyance / breach and overtopping	Yes
Surface Water	Greenfield runoff Urban runoff	Flow paths merging from surrounding fields	Yes
Arterial Drainage Network	Urban runoff	Surcharged sewers or burst water mains (failure of infrastructure)	Yes
Tidal	HBC has no coastline, therefore there is no tidal flood risk	No coastline	No
Groundwater	Perched within alluvial deposits	Rising water level	Yes
Artificial Sources	Reservoir	Flow paths should a reservoir fail	Yes

3.4 Flooding from Rivers

3.4.1 Sources

The Environment Agency 'Detailed River Network' dataset has been used to identify watercourses in the study area and their designation (i.e. Main River or ordinary watercourse). However, the 'Detailed River Network' does not show all ordinary watercourses. An ordinary water includes all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices and passages, other than those excluded by virtue of being a Main River or Public Sewer, through which water flows according to the Land Drainage Act 1991.

There are several designated main rivers in the study area, the locations of which are shown in Appendix A Figure 05.0.

Main rivers are watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Flood and Rural Affairs (Defra). The Environment Agency has permissive powers to carry out works necessary for flood defence purposes on these rivers. The overall responsibility for maintenance however, lies with the riparian owner.

All of the Hertsmere study area falls within the catchment of the River Colne, a major tributary of the River Thames. The River Colne splits off into several separate branches on leaving Hertfordshire, a few of which re-join it, and flows into the River Thames on the reach above Penton Hook Lock at Staines-upon-Thames. The Colne catchment covers an area of 1014km^2 extending from southern Bedfordshire through western Hertfordshire, eastern Buckinghamshire and Surrey where it joins the River Thames.

The River Colne flows from northeast to southwest through Hertsmere, from Colney Heath through to Watford. Within the study area, the northern-most boundary is near the confluence of the River Colne and Tyttenhanger Stream with the southern-most boundary at Bushey Heath at the upstream end of the Hartsbourne Stream. The main tributaries of the Colne along this reach are the Hilfield Brook, Radlett Brook, Tykeswater and Mimmshall Brook with numerous other drains, ditches and brooks across the Borough.

Hilfield Brook flows east to west through North Bushey to its confluence with the Colne at Watford. The Radlett Brook, also known as Tykeswater, flows northwest to the confluence with the Colne near Colney Street. The Radlett Brook catchment is fairly heavily urbanised, relatively steep with an average gradient of 4.84m/km and is approximately 4.7km^2 in area. The Mimmshall Brook drains northwards to the Water End Swallow Holes (near Potters Bar) where it later confluences with the River Colne at Colney Heath. The Mimmshall Brook catchment is 53km^2 in area of which over 18% is urbanised (principally Potters Bar).

The numerous other drains, ditches and brooks across the Borough of which several are classified as 'Main River' and are the statutory responsibility of the Environment Agency. The catchment has extensive partially developed floodplain with development built up to the water's edge and narrow floodplains in the headwaters, with relatively few properties at risk of flooding. The main urban areas such as Borehamwood, Radlett and Potters Bar are at risk flooding from a number of sources and flooding mechanisms; examples of these include overtopping of river banks, in-channel blockages, and

constrictions causing the back-up of water, overflow of surface water and sewerage drainage infrastructure, rapid surface water runoff from urban areas, breach or overtopping of flood storage areas /reservoirs and groundwater flooding.

3.4.2 Structures

Throughout the river network there are hydraulic structures such as weirs, mills, bridges and culverts. These may elevate water level and hence exacerbate flood risk in the associated areas. Structures can promote debris dam formation which may reduce the capacity of the watercourse. Moreover, the existence of structures is likely to reduce watercourse capacity themselves. The locations of some of these structures are shown in Appendix A Figures 05.1 to 05.4.

3.4.3 Historic Records of River Flooding

The Environment Agency has provided an extract from the 'Recorded Flood Outlines' dataset for the study area[22] which details the following historic fluvial events in the Borough:

- River Colne: July 1987, October 1993, October 2000, December 2000, February 2009, February 2014.
- Radlett Brook: December 1979, September 1992.
- Mimmshall Brook: July 1987, September 1992, December 2000.

These are understood to be the most significant flood events to have occurred in the Borough since World War II. The total extent of historical flooding is shown in Appendix A Figures 05.1 to 05.4 under 'Recorded Flood Outlines'. However, it should be emphasised that not all floods that have occurred in every location have necessarily been recorded.

3.4.4 Existing Hydraulic models

A comprehensive hydrological and hydraulic model for the Upper Colne and its tributaries was undertaken by Halcrow for the Environment Agency in December 2010[23] to be used to produce peak water levels and flood maps for use in strategy studies including flood risk management or the update of previous Flood Zone flood maps.

The model covers key sections of the Upper Colne catchment where the Hertsmere area falls. This catchment can be split into three areas: the 'Colne', the 'Eastern Tributaries' and the 'Western Tributaries'. The 'Colne' and some of the 'Eastern Tributaries' flow within the Borough boundaries including Mimmshall Brook, Salisbury Hall Brook (upstream portion only), Radlett Brook (Tykes Water) and Hillfield Brook. The modelled flood maps from this study are presented in Appendix A Figure 06.1 to 06.4.

The output from this model is the basis for NPPF flood zones for the study area. It is important to note that some main rivers and all the ordinary watercourses are not included in the model and therefore no flood extents apart from Flood Zones 2 and 3 are available for those watercourses.

3.4.5 NPPF Flood Zones

The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The NPPF seeks to assess the probability of flooding from rivers by categorising areas within the fluvial floodplain into zones of low, medium and high probability, as defined in Table 3-2.

The 'Flood Map for Planning (Rivers and Sea)' is available on the Environment Agency website[24] and is the main reference for planning purposes as it contains Flood Zones 1, 2 and 3a which are referred to in the NPPF and presented in Table 3-2. The 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas that would flood if there were no flood defences or buildings in the "natural" floodplain.

The 'Flood Map for Planning (Rivers and Sea)' was first developed in 2004 using national generalised modelling and is now routinely updated and revised using the results from the Environment Agency's programme of catchment studies, entailing topographic surveys and hydrological and/or hydraulic modelling as well as previous flood events.

[22] The 'Recorded Flood Outlines' dataset identifies the flood extents associated with specific flood events. The 'Historic Flood Map' shows greatest extent of past flooding and does not identify individual flood events.
[23] Halcrow Group Limited (December 2010), Upper Colne SFRM Study (TH013 and TH031), Hydraulic Modelling and Mapping Final Technical Report

[24] Environment Agency Flood Map for Planning (Rivers and Sea) http://apps.environment-agency.gov.uk/wiyby/37837.aspx

Table 3-2 Fluvial Flood Zones (extracted from the NPPF, 2014)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1	Land having a less than 1 in 1,000 (0.1%) annual probability of river flooding. Shown as clear on the Flood Map – all land outside Flood Zones 2 and 3.	Low
Flood Zone 2	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (between 1% and 0.1% annual probability of flooding each year).	Medium
Flood Zone 3a	Land having a 1 in 100 or greater annual probability of river flooding (greater than 1% annual probability of flooding each year).	High
Flood Zone 3b	Land where water has to flow or be stored in times of flood, or land purposely designed to be flooded in an extreme flood event (0.1% annual probability). The identification of the functional floodplain takes into account local circumstances but for the purposes of this SFRA, land modelled to flood during a 5% AEP event or greater in any year has been mapped.	Functional Floodplain

The large majority of the Borough is defined as Flood Zone 1, low probability of flooding from fluvial sources. Flood Zones 2 and 3 are situated most heavily alongside the River Colne, Radlett Brook, Mimmshall Brook and Watery Lane. Appendix A Figure 05.1 to 05.4 illustrate the Flood Zone maps.

It should be noted that the scope of modelling studies typically covers flooding associated with main rivers and watercourses with a catchment of greater than 3km². In HBC, ordinary watercourses that form tributaries to the main rivers have not been included in the model. Modelling of ordinary watercourses available on the 'Flood Map for Planning (Rivers and Sea)' within HBC, are the result of the national generalised modelling carried out by the Environment Agency and needs to be refined when determining the probability of flooding for an individual site and preparing a site-specific FRA. Further detail regarding the scope of site specific FRAs is provided in Section 7.

It is noted that a separate map is available on the Environment Agency website which is referred to as 'Risk of Flooding from Rivers and Sea'[25]. This map takes into account the presence of flood defences and so describes the actual risk of flooding, rather than the residual risk if there were no defences present. While flood defences reduce the level of risk they don't completely remove it as they can be overtopped or fail in extreme weather conditions, or if they are in poor condition. As a result the maps may show areas behind defences which still have some risk of flooding – a residual risk. This mapping has been made available by the Environment Agency as the primary method of communicating flood risk to members of the public, however, for planning purposes the 'Flood Map for Planning (Rivers and the Sea)' and associated Flood Zones remains the primary source of information.

Functional Floodplain Flood Zone 3b

The Functional Floodplain is defined in the NPPF as 'land where water has to flow or be stored in times of flood'. The Functional Floodplain (also referred to as Flood Zone 3b), is not separately distinguished from Flood Zone 3a on the Flood Map for Planning (Rivers and Sea). Rather the SFRA is the place where LPAs should identify areas of Functional Floodplain in discussion with the Environment Agency.

The PPG states that the identification of Functional Floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. However, land which would naturally flood with an annual probability of 1 in 20 (5% AEP) or greater in any year, or is designed to flood (such as a flood attenuation scheme) in an extreme (0.1% annual probability) flood, should provide a starting point for consideration. The guidance goes on to say that 'areas which would naturally flood with an annual probability of 1 in 20 or greater, but are prevented from doing so by existing infrastructure or solid buildings will not normally be defined as functional floodplain'.

Specific to Hertsmere, this would be defined by the 5% annual probability defended flood extents as provided by the latest Environment Agency hydraulic modelling study of the Upper Colne catchment[23] and a recent review[26] of the model in the vicinity of Newberries car park in Radlett, as shown in Appendix A Figures 05.1 to 05.4. Further guidance on the Functional Floodplain Flood Zone 3b is provided in Section 8.3.1.

[25] Environment Agency 'Risk of Flooding from Rivers and Sea' http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?topic=floodmap#x=237038&y=161974&scale=1
[26] Newberries Car Park, Radlett – Hydrology and Modelling Refinements, Royal HaskoningDHV, October 2017

Receptors

The NRD described in Section 2.8 has been used to determine the number of properties that fall inside the boundaries of each Flood Zone. The total number of affected receptors has been divided into residential and non-residential and is presented in Table 3-3.

Table 3-3 Receptors at risk of flooding from rivers

Receptor type	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Residential	1263	889	6
Non residential	231	131	7

Climate Change

A considerable amount of research is being carried out worldwide in an endeavour to quantify the impacts that climate change is likely to have on flooding in future years. Climate change may increase peak rainfall intensity and river flow, which could result in more frequent and severe flood events. Climate change is perceived to represent an increasing risk to low lying areas of England, and it is anticipated that the frequency and severity of flooding will change measurably within our lifetime.

In February 2016 the Environment Agency published revised guidance on climate change allowances in an update to the document 'Adapting to Climate Change: Advice to Flood and Coastal Erosion Risk Management Authorities[27]. This version of the document reflects an assessment completed by the Environment Agency between 2013 and 2015 using UKCP09 data, to produce more representative climate change allowances for river basin districts across England. Hertsmere Borough falls within Thames River Basin District and the recommended climate change values are set out in Table 3-4.

Table 3-4 Revised climate change allowances for the Thames River basin

Allowance category	Total potential change anticipated for '2020s' (2015-39)	Total potential change anticipated for '2050s' (2040-2069)	Total potential change anticipated for the '2080s' (2070-2115)
Old NPPF allowance (all England) for comparison	10% (1990-2025)	20% (2025-2115)	20%
Upper end	25%	35%	70%
Higher central	15%	25%	35%
Central	10%	15%	25%

Applying Peak River Flow Climate Change Allowances

To understand if a land use allocation is appropriate in the context of likely future flood risk, the climate change allowance guidance states that Table 3-5 should be used to determine the appropriate allowance according to current flood zone and vulnerability for the type of development it is allocated for.

Table 3-5 Peak river flow allowances for flood risk assessments

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 2	Higher central and Upper	Higher central and Upper	Central and Higher central	Central	None
Zone 3a	Upper	X	Higher central and Upper	Central and Higher central	Central
Zone 3b	Upper	X	X	X	Central
X – development should not be permitted					

[27] Environment Agency, February 2016, Adapting to Climate Change: Advice to Flood and Coastal Erosion Risk Management Authorities. https://consult.environment-agency.gov.uk/engagement/bostonbarriertwao/results/appendix-15---adapting-to-climate-change-advice-to-fcerm-authorities--13-april-2016-.pdf

For the allowances identified in the Table 3-4, the site should be assessed as to whether it will move from FZ1 to FZ2 or FZ2 to FZ3. If so, it is recommended that the development be treated accordingly, referring to the flood risk vulnerability and flood zone compatibility table in PPG. Following which the site will need to be assessed if the development is still appropriate, or if the exception test is required.

If the development is still appropriate in Flood Zones 2 and 3, assessment of future flood risk will be needed for planning applications for the type of development allocated in site specific policies.

If the exception test is required, it is expected that site specific policies will advise the development and development proposal will include a detailed FRA using the appropriate climate change allowances. However, it may be that once the climate change allowances have been applied, a particular development may now not be suitable in a particular area, and accordingly the land allocations may need to be re-considered.

Existing Hydraulic Models and the Impact of Climate Change

The Upper River Colne modelling study (2010) predated the latest climate change guidance and did not include the revised climate change allowance values. The 1:100year return period scenario was run with flows increased by 20% to analyse the effects of climate change on the flood extents/depths. The results indicate that the Upper Colne Model is sensitive to climate change with an increase in maximum water levels of 225mm and significant changes to the flood extents. The mapping for this analysis is shown in Appendix A Figure 07. 1.

Since the allowance used in the modelling study is lower than the latest recommended values for '2080s', an analysis has been undertaken using the existing model outputs to identify a modelled flood event that better represents the climate change scenario.

The most extreme event modelled in the previous modelling study was 1:1000year event. In Table 3-6, the modelled flow and water level for this event have been compared against those of 1:100year event. Model nodes from different water courses near built up area at risk of flooding have been selected for the analysis.

Table 3-6 Comparison between 1:100yr and 1:1000yr model results

Location (model node)	Modelled flow			Modelled Water level			Comment
	1:100yr (m3/s)	1:1000yr (m3/s)	Difference	1:100yr (mAOD)	1:1000yr (mAOD)	Difference (m)	
Radlett Brook							
Borehamwood (RDB_5870u)	7.8	12.2	57%	80.18	80.42	0.24	All scenarios except 'Upper End' for '2080s' is covered
Radlett (RDB_1924u)	12.0	14.0	17%	68.67	68.88	0.21	Scenarios up to 'Higher Central' for '2020s' covered. Climate change scenario from existing model (2010) provides a better estimate of climate change impact at this location
Mimmshall Brook							
Near Warrengate Farm, north of South Mimms (MIM2104)	21.2	29.6	40%	80.24	80.52	0.28	All scenarios except 'Upper End' for '2080s' is covered
Hillfield Brook							
Gullimor Farm near M1 (HDB_2790)	4.4	6.8	52%	68.65	69.33	0.68	All scenarios except 'Upper End' for '2080s' is covered

This analysis suggests that the 1 in 1000 year event will provide a mid-range estimate of climate change impact. So the flood map of this event (Appendix A Figure 07.2) could be taken as an indication for a number of climate change impact scenarios as stated in Table 3-6. Updated climate change allowances need to be estimated by way of detailed hydraulic / hydrological analysis as part of site-specific FRA for future development proposals.

3.4.6 Flood Risk Management Measures

Flood risk management measures can consist of bunds, walls and other structures that manage flow in times of flooding and therefore reduce the risk of water from entering property. They generally fall into one of two categories; 'formal' or 'informal'.

A 'formal' flood risk management asset has been specifically built to control floodwater. It is maintained by its owner or statutory undertaker so that it remains in the necessary condition to function. In accordance with the FWMA, the Environment Agency has discretionary powers to construct and maintain defences to help protect against flooding.

An 'informal' flood risk management asset has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

A study of informal flood risk management assets has not been made as part of this assessment. Should any changes be planned in the vicinity of road or railway crossings over rivers in the study area it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal flood defences should be identified as part of site specific FRAs and the residual risk of their failure assessed.

In accordance with the scope of a Level 1 SFRA, a high level review of formal flood defences has been carried out using data from the Environment Agency Asset Information Management System (AIMS). This dataset contains details of flood defence assets associated with main rivers and provides a good starting point for identifying significant local defences and potential areas benefiting from defences, but the quantity and quality of information provided differs considerably between structures. The AIMS is intended to provide a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA or site specific FRA where the need arises). Flood defences in the study area are presented in Appendix A Figures 5.1 to 5.4.

The main flood defences in the Borough consist of culverts, weirs and natural banks. These can be seen along all of the main rivers as indicated through information provided by the Environment Agency. Furthermore, the Flood Storage Reservoir along Radlett Brook provides an additional, more sophisticated flood defence measure.

Any works in, over, under or within 8 metres of a designated main river or flood defence requires a Flood Risk Activity Permit, prior to the works commencing, from the Environment Agency under the Environmental Permitting Regulations.

Any works that could affect the flow of an ordinary watercourse (i.e. not designated as a Main River) require consent from the LLFA (HCC in the study area) prior to the commencement of works. This includes culverting, diverting, and can include outfalls and bridges depending on the likely affect to the flow of the watercourse. In addition, any work within 9m of any watercourse will need prior consent from HBC (HBC Byelaws no. 9).

3.4.7 Flood Warning Areas

The Environment Agency provides a free Flood Warning Service[28] for many areas at risk of flooding from rivers and the sea. In some parts of England the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency has provided a GIS layer of Flood Warning Areas in the study area which are presented in Appendix A Figure 08. There are four Environment Agency Flood Warning Areas in the Borough, namely

1. The Radlett and Borehamwood Brooks at Borehamwood
2. The Mimmshall Brook at Warrengate Road including Water End
3. The Radlett Brook at Radlett
4. The River Colne near Bushey Hill Farm

3.5 Flooding from Surface Water

Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. Overland flow of this nature has a short response time and results in localised flooding, particularly in urban areas. This has the potential to occur in Hertsmere as it is a largely

[28] Environment Agency Flood Warning Service http://apps.environment-agency.gov.uk/wiyby/37835.aspx

urban catchment. The NPPG states that an SFRA should identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk published by the Environment Agency as well other available information.

For practical purposes, flooding from drains and ditches has been considered in the same category as surface water flooding. Where ordinary watercourses are culverted, trash screens and culverts have the potential to become blocked by items such as plant debris and rubbish. Blockages can restrict the natural flow of water, increasing the chance of water flowing out of bank and causing local flooding due to the reduced conveyance potential of the associated watercourse. This may apply to some upper sections of the Hertsmere Brook, which is in effect a culverted watercourse.

The pathways of surface water will be defined by the local topography. Natural or unnatural features may influence the route that floodwater will take. In urban areas roads form a common pathway for surface water, helping dictate the area that will be affected by flooding. This is further exemplified where there are steep gradients in the hillslopes. On a site specific scale the risk from this flood source should be identified in a FRA.

Development of new sites could increase the risk of flooding from surface water if the runoff from rainfall is not controlled. This might also occur from developments outside the boundaries of HBC where the development catchment drains into the district.

3.5.1 Historic Records

Records of flooding from surface water, drains, ditches and ordinary watercourses have been provided from a number of sources. Reports and datasets included in the previous iterations of the SFRA report have been retained to provide a consistent record. Records of flooding which are georeferenced are presented in Appendix A Figure 9. Due to the topography most of these are concentrated in the southern half of Hertsmere.

HBC Records

HBC provided a flooding database (2002 – 2015) with records categorised by source of flooding, including surface water, foul and land drainage. A summary of this information is shown in Table 3-7 and presented in Appendix A Figure 09.

In summary, it shows different properties flooding during storm events in 2002, 2010, 2011, 2012, 2014 and 2015 and the actions taken after each event. They are located in different parts of the Borough. However, the most frequently affected areas are in the localities of Potters Bar, Bushey and Borehamwood.

Table 3-7 Hertsmere Borough Council Flood Records

Town	Source of flooding																
	L	S	P	H	F	MR	L/H	H/L	?	S/L	H/S	S/H	L/S	H/F	H	L/H/MR	Total
Barnet	5			3													8
Borehamwood	305	185	4	36	17	6	27	12			2		3				597
Bushey	237	195	2	71	59	97	1		2		4	1	3			2	674
Bushey heath	26	6	1	13	2												48
Elstree	46	10	1	10	1		2				1		1				72
London colney	1			1													2
Potters bar	494	133	4	54	51	4	1		2	2	6			1			752
Radlett	39	7	3	33	27	3	1								1		114
Shenley	14	2	1	9													26
South mimms	3	1		8	1	9		2	1								25
St Albans	1																1
Watford	5			7	1				1								14
Total	1176	539	16	245	159	119	32	14	6	2	13	1	7	1	1	2	2333

Key to Source
F: Foul sewer L: Land drainage S: Surface water sewer H: Highway drainage P: Private drainage
MR: Main river ?: Unknown

HCC Records

HCC has a role as LLFA to co-ordinate management of local flood risk in the county. As a LLFA it is required to carry out Section 19 Flood Investigations as defined in the FWMA. Flood investigation reports for HCC area available through the county website[29]. Flooding records from HCC database[3] are shown on Appendix A Figure 09.

Highways England Records

Highways England keeps a record of flood incidents along the highways operated by them. Highways England has provided record of flood events since 2009 within the HBC area, which are also shown on Appendix A Figure 09.

3.5.2 Risk of Flooding from Surface Water

The Environment Agency along with HCC LLFA undertake modelling of surface water flood risk at a national and local scale and produced mapping to identifying those areas at risk of surface water flooding during three annual probability events: 1 in 30 year (3.33% annual probability), 1 in 100 year (1% annual probability) and 1 in 1,000 year (0.1% annual probability). The latest version of the mapping is referred to as the 'map of Risk of Flooding from Surface Water' (RoFSW) and the extents have been made available for the Level 1 SFRA as GIS layers. This dataset is also available on the Environment Agency website, and is referred to as 'Risk of Flooding from Surface Water'.

The RoFSW provides all relevant stakeholders, such as the Environment Agency, LPAs and the public access to information on surface water flood risk which is consistent across England and Wales[30]. The modelling helps the Environment Agency take a strategic overview of flooding, and assists LLFAs in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping allows an improved understanding of areas within the study area which may have a surface water flood risk.

The modelling represents a significant improvement on previous mapping, namely the FMfSW (2010) and the Areas Susceptible to Surface Water Flooding (AStSWF) (2009), for example:

- Increased model resolution to 2m grid,
- Representation of buildings and flow routes along roads and manual editing of the model for structural features such as flyovers,
- Use of a range of storm scenarios, and
- Incorporation of appropriate local mapping, knowledge and flood incident records.

However, it should be noted that this national mapping has the following limitations:

- Use of a single drainage rate for all urban areas,
- It does not show the susceptibility of individual properties to surface water flooding,
- The mapping has significant limitations for use in flat catchments,
- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses,
- In a number of areas, modelling has not been validated due to a lack of surface water flood records, and
- As with all models, the RoFSW is affected by a lack of, or inaccuracies, in available data.

The RoFSW shows that surface water flooding largely follows the fluvial pathways, yet is much more extensive, often originating upstream of the tributaries. There are also multiple localised surface water flood areas that follow some of the main streets of Hertsmere from north to south. The RoFSW for the study area is presented in Appendix A Figures 10.0 to 10.4.

[29] http://www.hertsdirect.org/services/envplan/water/floods/floodrisk/investigations/
[30] Environment Agency (2013) 'What is the updated Flood Map for Surface Water?'

Receptors

Table 3-8 presents the number of receptors from the NRD at risk of flooding from surface water flooding according to their risk level (3.3% AEP, 1% AEP or 0.1% AEP). This was calculated in GIS by determining the total number of receptors which fall within surface water flood extent for each AEP.

Table 3-8 Receptors at risk from surface water flooding

Receptor type	UMfSW 1 in 1000	UMfSW 1 in 100	UMfSW 1 in 30
Residential	1943	378	157
Non residential	262	50	23

Climate Change

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However, as an indicative dataset the 0.1% AEP is a reasonable proxy for 1% AEP plus climate change.

If additional surface water modelling is to be undertaken then climate change allowances for rainfall should be applied as show in Table 3-9. Depending on the design life of the development an allowance for climate change of between 20% and 40% on top of 1% AEP of surface water flooding would be expected. Further guidance on the application of the climate change requirements can be found through the HCC LLFA webpage[31] and on GOV.UK[32].

Table 3-9 Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)[33]

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%

3.6 Flooding from Groundwater

Groundwater flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. Low lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground.

The Borough is situated on chalk strata and chalk is associated with groundwater flooding. However, Hertsmere lies well upstream of the point where groundwater flooding would be expected to appear in typical chalk bourne or valley, even under extreme conditions. The risk from groundwater flooding is therefore considered to be low.

3.6.1 Areas Susceptible to Groundwater Flooding

Despite ground water flooding posing a low risk within HBC an assessment is required as part of the SFRA. However, a quantified assessment of risk from groundwater flooding is difficult to undertake, especially on a strategic scale. This is due to a lack of groundwater level records, the variability in geological conditions and the lack of predictive tools (such as modelling) that can be used to make assessments of groundwater flow and risk of groundwater flooding following rainfall events.

The British Geological Survey (BGS) Susceptibility to groundwater flooding dataset is a strategic scale map that can be used to identify areas where geological conditions could enable groundwater flooding to occur and where groundwater may come close to the ground surface on the basis of geological and hydrogeological conditions.

This dataset is presented in Appendix A Figure 11 and divided into three classes – high, medium and low. The highest risk areas are those with the potential for groundwater flooding to occur at the surface, medium risk are those which may experience groundwater flooding of property situated below the ground surface i.e. basements; and low risk are

[31] Hertfordshire County Council Lead Local Flood Authority https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/surface-water-drainage

[32]

[33] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

those with limited potential for groundwater flooding to occur. The dataset highlights that the majority of the Borough has a low susceptibility to groundwater flooding. However, there are some areas in the southeast where potential groundwater flooding might occur although there are no records of this type of flooding inside the Borough.

Receptors

Table 3-10 presents the number of receptors from the NRD located in areas of high and medium susceptibility to groundwater flooding according to the dataset from the BGS.

Table 3-10 Receptors at areas susceptible to groundwater flooding

Receptor type	Medium susceptibility to Groundwater flooding	High susceptibility to Groundwater flooding
Residential	896	298
Non residential	106	81

3.7 Flooding from Sewers

Sewerage infrastructure in HBC is a separate surface and foul water system owned and operated by Thames Water Utilities Limited (TWUL). However, some surface water runoff will inevitably find its way into foul sewers during heavy rainfall. Though the volume of this runoff will be small, it should also be regarded as a possible source of flooding along the route of sewer network.

During heavy rainfall, flooding from the sewer system may occur if:

(1) The rainfall event exceeds the capacity of the sewer system/drainage system:

> New sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While the impact that more extreme rainfall events may have is recognised, it is not cost beneficial to construct sewers that could accommodate every extreme rainfall event. However, many of the sewer systems in England date back to Victorian times, where the capacity could be significantly less than the 1:30 year. This could result in sewer flooding occurring much more frequently in these older systems.

(2) The system becomes blocked by debris or sediment:

> Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter).

(3) The system surcharges due to high water levels in receiving watercourses:

> Within the study area there is potential for surface water outlets to become submerged due to high river levels. When this happens, water is unable to pass downstream. Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses. Where the local area is served by 'combined' sewers i.e. containing both foul and storm water, if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

This flood occurrence is likely to become a more common occurrence in the future due to climate change and an increase in the number and intensity of convective storms. It is now a widely accepted phenomenon that one of the main effects of climate change in the south east of England will be higher intensity rainfall events and more frequent winter storms, all of which will increase the risk of flooding from all sources.

3.7.1 Historic Records of Sewer Flooding

All water companies, who operate the sewerage systems in England and Wales, are required to record all instances of internal flooding to properties. This record is usually know as a DG5 register. TWUL has provided an extract from their DG5 register for the study area. Due to data protection requirements the data has not been provided at individual

property level; rather the register comprises the number of properties within 4 digit postcode areas that have experienced flooding either internally or externally within the last 10 years (Appendix A Figure 12).

It should be noted that the records only appear on the DG5 register where they have been reported to TWUL, and as such they may not include all instances of sewer flooding. Furthermore given that TWUL target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding in the future.

3.8 Reservoirs, Canals and Other Artificial Sources

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPF encourages LPAs to identify any at risk reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a managed risk. HBC is responsible for working with members of the Local Resilience Forum (LRF) to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

The Environment Agency dataset 'Risk of Flooding from Reservoirs' available online identifies areas that could be flooded if a large[34] reservoir were to fail and release the water it holds. The mapping shows areas at risk of flooding downstream of the Hilfield Park Reservoir and Aldenham Reservoir which are classified as large reservoirs. It should be noted that reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925 and all large reservoirs must be inspected and supervised by reservoir panel engineers.

The Large Reservoirs and Flood Storage Reservoirs (FSRs) present in the HBC are listed in Table 3-11 and shown on (Appendix A Figure 13). There is no previous record of reservoir flooding and none of the reservoirs present have been classified in terms of risk severity.

Table 3-11 Reservoirs in HBC

Name	FSR/Large Reservoir	OS Grid
Hilfield Park Reservoir	Large Reservoir	TQ 1572 9595
Aldenham Reservoir	Large Reservoir	TQ 1694 9543
Radlett FSA	FSR	TQ 1705 9914

[34] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

4 Avoiding Flood Risk – Applying the Sequential Test

4.1 Sequential Approach

This Section guides the application of the Sequential Test and Exception Test in the Plan-making and planning application processes. Not all development will be required to undergo these tests, as described below, but may still be required to undertake a site specific FRA, guidance about which is included in Section 7.

The sequential approach is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. This will help avoid the development of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test, where required, will ensure that new developments in areas of particular flood risk will only occur where flood risk is clearly outweighed by other sustainability drivers and where development can be made safe from flooding and not increase the risk of flooding elsewhere.

The sequential approach can be applied at all levels and scales of the planning process, both between and within Flood Zones. All opportunities to locate new developments (except Water Compatible) in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

4.2 Applying the Sequential Test – Plan-Making

As the LPA, HBC must demonstrate that throughout the site allocation process a range of possible sites have been considered in conjunction with the flood risk and vulnerability information from the SFRA. Any proposed development sites needs to be assessed against the flood risk posed to each site. Table 4-1 presents a framework for assessing overall flood risk for individual sites based on source and severity of flood risk. This enables direct comparison of sites during Sequential Test. However, it should be noted that sources of flood risk in this table are not directly comparable and represent data which have varying degrees of confidence.

The Sequential Test should be undertaken by HBC and accurately documented to ensure decision processes are consistent and transparent. Figure 4-1 illustrates an approach for applying the Sequential Test that HBC could adopt in the development of future local plans.

Table 4-1 Flood Risk Classifications for Sequential Test

Risk	Source of Flooding				
	Fluvial	Surface Water	Historic Records	Groundwater	Sewer flooding record
Low	Flood Zone 1	RoFSW Very Low	No	Low (Limited potential for groundwater flooding to occur)	0-5
Medium	Flood Zone 1	RoFSW Very Low	Yes	Low (Limited potential for groundwater flooding to occur)	> 5
	Flood Zone 2	RoFSW Low	N/A	Medium (Potential for groundwater flooding of property situated below ground level)	> 5
High	Flood Zone 3a	RoFSW Medium	N/A	High (Potential for groundwater flooding to occur at surface)	> 5
Very High	Flood Zone 3b	RoFSW High		N/A	N/A

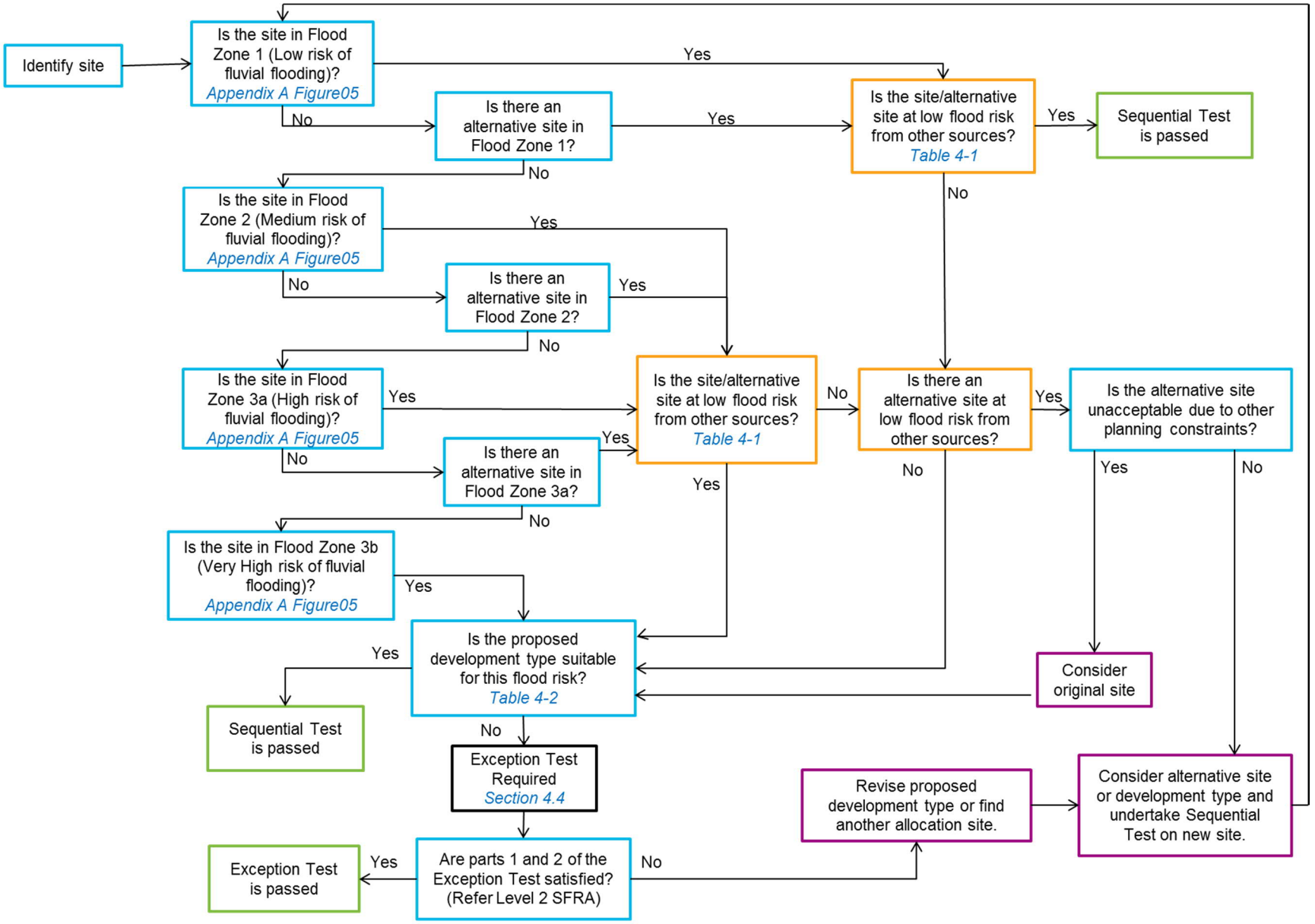


Figure 4-1 Application of Sequential Test for Plan-Making

The Sequential Test requires an understanding of the Flood Zones in the study area, the risk from other sources of flooding, and the vulnerability classification of the proposed developments. Flood Zone definitions are provided in Table 3-2 and mapped in the figures in Appendix A (and the Flood Map for Planning (Rivers and Sea) on the Environment Agency website). Flood risk vulnerability classifications, as defined in the NPPG are presented in Table 4-2. The NPPF acknowledges that some areas will also be at risk of flooding from sources other than fluvial. All sources must be considered when planning for new development including: flooding from land or surface water runoff; groundwater; sewers; and artificial sources.

Table 4-2 Flood Risk Vulnerability Classification (PPG, 2014)

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water Compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • MOD defense installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test. The recommended steps in undertaking the Sequential Test are detailed below. This is based on the Flood Zone and Flood Risk Vulnerability. Table 4-3 indicates the compatibility of different development types with the Flood Zones.

Table 4-3 Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG, 2014)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3a	Exception Test Required	✓	×	Exception Test Required	✓
	3b	Exception Test Required	✓	×	×	×
✓ - Development is appropriate × - Development should not be permitted						

4.2.1 Recommended stages for LPA application of the Sequential Test in Plan-Making

The information required to address many of these steps is provided in the accompanying GIS layers and maps presented in Appendix A. It is to be noted the Appendix A maps are present a snapshot of the available data as of the publication date of this SFRA report. The original sources of these data (as noted in the maps) are needed to be checked for any updates on a regular basis.

a. Assign potential developments with a vulnerability classification (Table 4-2). Where development is mixed, the development should be assigned the highest vulnerability class of the developments proposed.

b. The location and identification of potential development should be recorded.

c. The Flood Zone classification of potential development sites should be determined based on a review of the Flood Map for Planning (Rivers and Sea) - Appendix A Figures 05.0 to 05.4. Where these span more than one flood zone, all zones should be noted.

d. The risk of flooding from other sources should also be identified, based on readily available datasets and local information - Appendix A Figures 10 to 13.

e. Identify existing flood defences serving the potential development sites. (However, it should be noted that for the purposes of the Sequential Test, flood zones ignoring defences should be used).

f. The design life of the development should be considered with respect to climate change:

- 100 years – up to 2116 for residential developments; and
- Design life for commercial / industrial developments will be variable, however a 75 year design life may be assumed for such development, unless demonstrated otherwise.

g. Highly Vulnerable developments to be accommodated within the LPA area should be located in those sites identified as being within Flood Zone 1 (Appendix A Figures 05.0 to 05.4) and at low risk of flooding from other sources. If these cannot be located in areas of low flood risk, because the identified sites are unsuitable or there are insufficient sites in areas of low risk, sites in Flood Zone 2 can then be considered. Highly Vulnerable developments in Flood Zone 2 will require application of the Exception Test. If sites in Flood Zone 2 are inadequate then the LPA may have to identify additional sites in Flood Zones 1 or 2 to accommodate development or seek opportunities to locate the development outside their administrative area. Within each flood zone Highly Vulnerable development should be directed, where possible, to the areas at lowest risk from all sources of flooding. It should be noted that Highly Vulnerable development is not appropriate in Flood Zones 3a and 3b.

h. Once all Highly Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as More Vulnerable. In the first instance More Vulnerable development should be located in any unallocated sites in Flood Zone 1 and at low risk of flooding from other sources. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments in Flood Zone 3a will require application of the Exception Test. As with Highly Vulnerable development,

within each flood zone More Vulnerable development should be directed to areas at lowest risk from all sources of flooding. It should be noted that More Vulnerable development is not appropriate in Flood Zone 3b.

i. Once all More Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as Less Vulnerable. In the first instance Less Vulnerable development should be located in any remaining unallocated sites in Flood Zone 1 and at low risk of flooding from other sources, continuing sequentially with Flood Zone 2, then Flood Zone 3a. Less Vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.

j. Essential Infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is satisfied.

k. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed in the selection of sites; however it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies.

l. Where the development type is Highly Vulnerable, More Vulnerable, Less Vulnerable or Essential Infrastructure and a site is found to be impacted by a recurrent flood source (other than fluvial), the site and flood sources should be investigated further regardless of any requirement for the Exception Test.

4.2.2 Windfall Sites

Windfall sites are those which have not been specifically identified as available in the Local Plan process. They comprise previously-developed sites that have unexpectedly become available. In cases where development cannot be fully met through the provision of site allocations, LPAs are expected to make a realistic allowance for windfall development, based on past trends and expected future trends. It is recommended that the acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

4.3 Applying the Sequential Test – Individual Applications

If development is proposed in Flood Zone 2 or 3, and the Sequential Test has not already been carried out for the site for the same development type at the Local Plan level, then it is necessary to undertake a Sequential Test for the site. The Environment Agency publication 'Demonstrating the Flood Risk Sequential Test for Planning Applications'[35] sets out the procedure as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the Borough area, or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area identified for regeneration in Local Plan policies).
- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan.
- State the method used for comparing flood risk between sites; for example the Environment Agency Flood Map for Planning (Rivers and Sea), the SFRA mapping, site-specific FRAs if appropriate, other mapping of flood sources. Default preferred source is the online Environment Agency Flood Map for Planning, the latest version of which is presented in Appendix A Figures 05.0 to 05.4. Environment Agency online version needs to be checked for updates regularly. Site specific FRA will provide more detail at site level and any discrepancy with Environment Agency or SFRA maps will have to be explained in the FRA.
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, as indicated by Table 4-3, apply the Exception Test.
- Apply the Sequential approach to locating development within the site (as described in Section 5.2).

It should be noted that it is for LPAs, and in the case of surface water management arrangements and local flood risk for major planning applications the LLFA, both taking advice from the Environment Agency as appropriate, to consider the extent to which Sequential Test considerations have been satisfied, taking into account the particular circumstances in any given case.

[35] Environment Agency, April 2012, 'Demonstrating the flood risk Sequential Test for Planning Applications', Version 3.1

The developer should justify with evidence to the LPA and the LLFA, as appropriate, what area of search has been used when making the application. Ultimately HBC and HCC LLFA, as appropriate, need to be satisfied in all cases that the proposed development would be safe and not lead to increased flood risk elsewhere.

4.3.1 Sequential Test Exemptions

It should be noted that the Sequential Test does not need to be applied in the following circumstances:

- Individual developments proposed on sites which have been allocated in development plans through the Sequential Test.
- Minor development, which is defined in the NPPF as:
    - minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2;
    - alterations: development that does not increase the size of buildings e.g. alterations to external appearance;
    - Householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats;
- Change of Use applications, unless it is for a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site;
- Development proposals in Flood Zone 1 (land with a low probability of flooding from rivers or the sea) unless the SFRA, or other more recent information, indicates there may be flooding issues now or in the future (for example, through the impact of climate change) from rivers, surface water, groundwater and/or sewers.

4.4 Exception Test

The purpose of the Exception Test is to ensure that where it may be necessary to locate development in areas at risk of flooding, new development is only permitted in Flood Zone 2 and Flood Zone 3 where the flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

The NPPF states that for the Exception Test to be passed:

– Part 1 - “It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared; and

– Part 2 - A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.”

Both elements of the test will have to be passed for development to be allocated or permitted.

In order to determine Part 1) of the Exception Test, applicants should assess their scheme against the objectives as set out in the latest Hertsmere Borough Local Plan Sustainability Appraisal Scoping Report which can be found on the council’s website.

In order to demonstrate satisfaction of Part 2) of the Exception Test, relevant measures, such as those presented within Section 5, should be applied and demonstrated within a site-specific FRA as detailed in Section 7.

5 Managing and Mitigating Flood Risk

5.1 Overview

The NPPF appreciates that it may not always be possible to avoid locating development in areas at risk of flooding. This Section provides guidance and policy recommendations on the range of measures that could be considered in order to manage and mitigate flood risk. These measures should be considered when preparing a site-specific FRA as described in Section 7.

As noted in Section 3, it is essential that the development control process influencing the design of future development within the Borough carefully mitigates the potential impact that climate change may have upon the risk of flooding. As a result mitigation measures should be designed with an allowance for climate change over the lifetime of the proposed development as follows:

- 100 years (up to 2115) for residential developments; and
- 75 years (up to 2090) for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.

5.2 Development Layout and Sequential Approach

Policy Recommendation 1: A sequential approach to site planning should be applied within new development sites.

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas (considering all sources of flooding) e.g. residential elements should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding.

5.3 Riverside Development (Main Rivers and Ordinary Watercourses)

Policy Recommendation 2: Retain an 8 metre wide undeveloped buffer strip alongside Main Rivers and explore opportunities for riverside restoration. New development within 8m of a Main River will require consent from the Environment Agency.

The Environment Agency is likely to seek an 8 metre wide undeveloped buffer strip alongside main fluvial rivers for maintenance purposes, and would also ask developers to explore opportunities for riverside restoration as part of any development. Whilst HCC will work with developers to improve the functioning of ordinary watercourses where possible, there is no specific requirement for a buffer strip.

As of 6th April 2016, the Water Resources Act 1991 and associated land drainage byelaws have been amended and flood defence consents will now fall under the Environmental Permitting (England and Wales) Regulations 2010. Any works within 8m of a Main River will be subject to the Environmental Permitting Regulations (EPR). Further details and guidance are available on the GOV.UK website: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits. The Environment Agency can be consulted regarding permission to do work on or near a river, flood or sea defence by contacting enquiries@environment-agency.gov.uk. In addition, any work within 9 metres of any watercourse will need prior consent from HBC (HBC Byelaws no. 9).

HCC, as the LLFA, and the Environment Agency will be minded to reject applications for culverting in areas identified as being in Flood Zone 2 or 3a/3b and/or in an area of surface water flooding identified within the

Environment Agency Flood Map for Surface Water (Appendix A Figures 10.0 to 10.4), due to the potential of proposed works increasing flood risk. Exceptions to this policy will only be considered if the applicant is able to demonstrate that, all alternative options have been explored and are proven to be unachievable and on the balance of probabilities, the proposed development would not increase flood risk.

The Environment Agency also is unlikely to permit building on top of culverts, as it precludes maintenance and the future possibility of opening up culverts. In addition, the Environment Agency encourages developers to seek options to open up existing culverts.

Where HBC and/or HCC are made aware of breaches to other legislation then it will make the appropriate organisation aware of this.

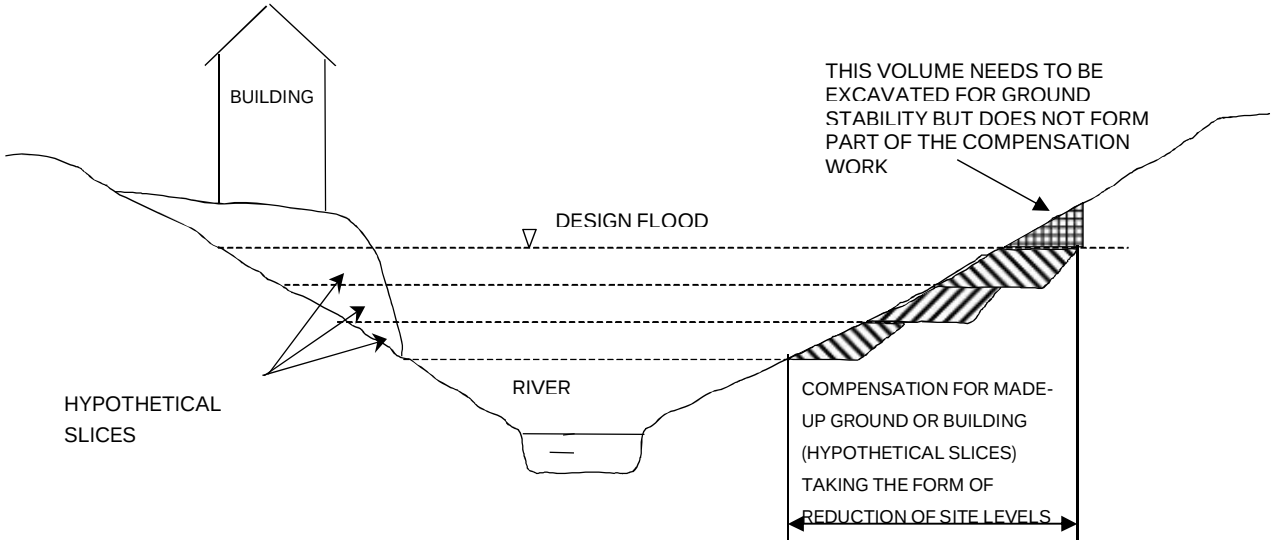
5.4 Floodplain Compensation Storage

Policy Recommendation 3: All new development within Flood Zones 2 and 3 must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.

Where proposed development results in a change in building footprint, the developer must ensure that it does not impact upon the ability of the floodplain to store water, and should seek opportunities to provide betterment with respect to floodplain storage. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.

As depicted in Figure 5-1, floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it should be in the immediate vicinity, in the applicant's ownership and linked to the site. Floodplain compensation must be considered in the context of the 1% annual probability (1 in 100 year) flood level including an allowance for climate change. When designing a scheme flood water must be able to flow in and out and must not pond. An FRA must demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624[36].

Figure 5-1 Example of Floodplain Compensation Storage (Environment Agency 2009)



The requirement for no loss of floodplain storage means that it is not possible to modify ground levels on sites which lie completely within the floodplain (when viewed in isolation), as there is no land available for lowering to bring it into the floodplain. It is possible to provide off-site compensation within the local area e.g. on a neighbouring or adjacent site, or indirect compensation, by lowering land already within the floodplain, however, this would be subject to detailed investigations and agreement with the Environment Agency to

[36] CIRIA January 2004, CIRIA Report 624: Development and Flood Risk - Guidance for the Construction Industry

demonstrate (using an appropriate flood model where necessary) that the proposals would improve and not worsen the existing flooding situation or could be used in combination with other measures to limit the impact on floodplain storage.

5.5 Finished Floor Levels

Policy Recommendation 4: All More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an allowance for climate change.

Where developing in Flood Zones 2 and 3 is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) and Highly Vulnerable land uses, is to ensure internal floor levels are raised a freeboard level above the design flood level.

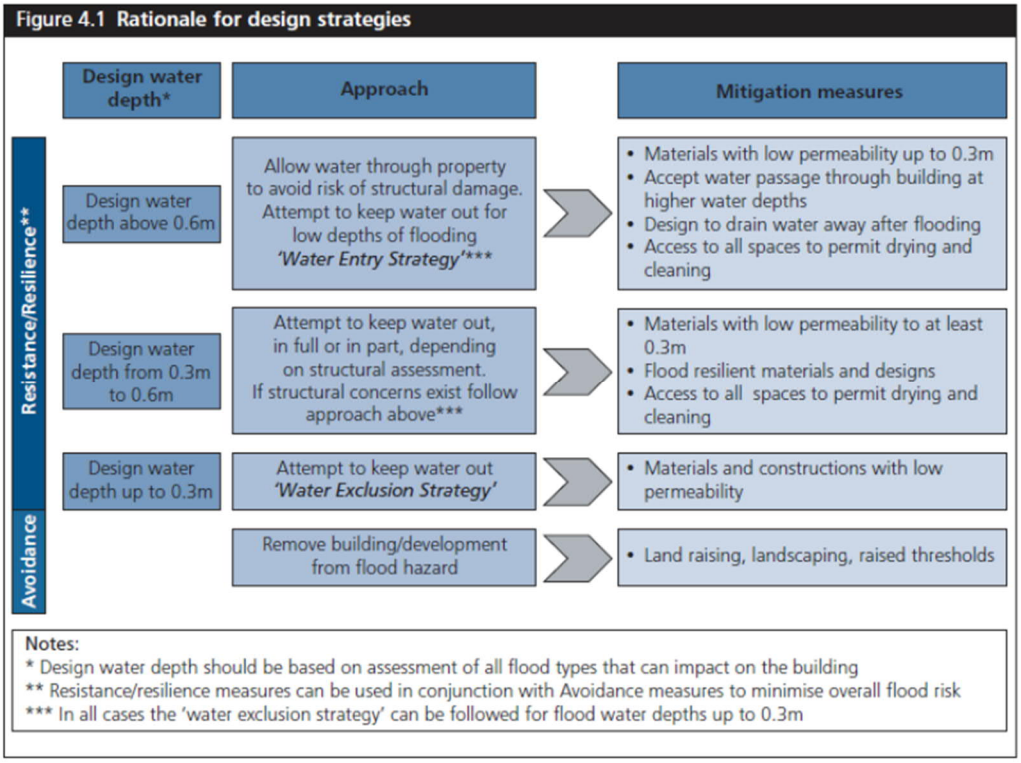
In certain situations (e.g. for proposed extensions to buildings with a lower floor level or conversion of existing historical structures with limited existing ceiling levels), it could prove impractical to raise the internal ground floor levels to sufficiently meet the general requirements. In these cases, the Environment Agency and/or HBC should be approached to discuss options for a reduction in the minimum internal ground floor levels provided flood resistance measures are implemented up to an agreed level. There are also circumstances where flood resilience measures should be considered first. These are described further below. For both Less and More Vulnerable developments where internal access to higher floors is required, the associated plans showing the access routes and floor levels should be included within any site-specific FRA.

5.6 Flood Resistance 'Water Exclusion Strategy'

There are a range of flood resistance and resilience construction techniques that can be implemented in new developments to mitigate potential flood damage. The Ministry of Housing Communities and Local Government (MHCLG) have published a document 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[37], the aim of which is to provide guidance to developers and designers on how to improve the resistance and resilience of new properties to flooding through the use of suitable materials and construction details. Figure 5-2 provides a summary of the Water Exclusion Strategy (flood resistance measures) and Water Entry Strategy (flood resilience measures) which can be adopted depending on the depth of floodwater that could be experienced.

[37] MHCLG (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction

Figure 5-2 Flood Resistant/Resilient Design Strategies, Improving Flood Performance, MHCLG 2007



Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy); they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will probably only be effective for short duration, low depth flooding, i.e. less than 0.3m, although these measures should be adopted where depths are between 0.3m and 0.6m and there are no structural concerns.

Policy Recommendation 5: In areas at risk of flooding of low depths (<0.3m), the following flood resistance measures could be considered:

- Using materials and construction with low permeability.
- Land raising. (An applicant intending to do this must prove that this will not increase flood risk to neighboring properties.)
- Landscaping e.g. creation of low earth bunds (An applicant intending to do this must prove that this will not increase flood risk to neighboring properties.)
- Raising thresholds and finished floor levels e.g. porches with higher thresholds than main entrance.
- Flood gates with waterproof seals.

Property flood protection devices are available on the market, designed specifically to resist the passage of floodwater (Figure 5-3 and Figure 5-4). Change to physical features of properties need to be considered against the accessibility requirements and duties of the Equality Act 2010. These include removable flood barriers and gates designed to fit openings, vent covers and stoppers designed to fit WCs. These measures can be appropriate for preventing water entry associated with fluvial flooding as well as surface water and sewer flooding. The efficacy of such devices relies on their being deployed before a flood event occurs. It should also be borne in mind that devices such as air vent covers, if left in place by occupants as a precautionary measure, may compromise safe ventilation of the building in accordance with Building Regulations.

Figure 5-3 Examples of flood barriers, air bricks and on-return valves

Figure 5-4 Example of flood gates

5.7 Flood Resilience 'Water Entry Strategy'

Policy Recommendation 6: In areas at risk of frequent or prolonged flooding, the following flood resilience measures could be implemented:

- Use materials with either, good drying and cleaning properties, or, sacrificial materials that can easily be replaced post-flood.
- Design for water to drain away after flooding.
- Design access to all spaces to permit drying and cleaning.
- Raise the level of electrical wiring, appliances and utility metres.
- Coat walls with internal cement based renders; apply tanking on the inside of all internal walls.
- Ground supported floors with concrete slabs coated with impermeable membrane.
- Tank basements, cellars or ground floors with water resistant membranes.
- Use plastic water resistant internal doors.

For flood depths greater than 0.6m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, but to implement careful design in order to minimise damage and allow rapid re-occupancy. This is referred to as the Water Entry Strategy. These measures are appropriate for uses where temporary disruption is acceptable and suitable flood warning is received.

Materials should be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 0.1m above the design flood level. Resilience measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[38].

5.8 Structures

Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground and designed in such a way as to prevent entrainment of debris which in turn could increase flood risk and/or breakaway posing a danger to life during high flows.

5.9 Safe Access and Egress

Policy Recommendation 7: For developments located in areas at risk of fluvial, surface water and groundwater flooding, safe access / egress must be provided for new development as follows in order of preference:

- Safe dry route for people and vehicles.
- Safe dry route for people.
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people.
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater.

In all these cases, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for climate change.

Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area (e.g. within Flood Zone 1) using public rights of way without the intervention of emergency services or others during design flood conditions, including climate change allowances. This is of particular importance when contemplating development on sites located on dry islands.

Guidance prepared by the Environment Agency[39] uses a calculation of flood hazard to determine safety in relation to flood risk. Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain along with a suitable debris factor to account for the hazard posed by any material entrained by the floodwater. The derivation of flood hazard is based on the methodology in Flood Risks to People FD2320, the use of which for the purpose of planning and development control is clarified in the abovementioned publication.

With respect to other sources of flooding, consideration should be made of likely surface water ponding. As recommended in the CIRIA 635 Designing for Exceedance in Urban Drainage – Good Practice (Table 12.3), provision should be made to ensure that flood depths do not exceed 100mm to keep water within a kerb height and to reduce the likelihood of bow waves from vehicles driving through water affecting others, for example housing to the side of a car park.

Table 5-1 Hazard to People Rating (HR=d x (v +0.5) + DF) (Table 13.1 FD2320/TR2)

Flood Hazard	Hazard Rating	Description

[38] CLG (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction. http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf?bcsi_scan_E956BCBE8ADBC89F=0&bcsi_scan_filename=flood_performance.pdf

[39] Environment Agency (2008) Supplementary note on Flood hazard ratings and thresholds for development planning and control purpose. Clarification of Table 13.1 FD2320/TR2 and Figure 3.2 FD2321/TR1. http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2321_7400_PR_pdf.sflb.ashx

Flood Hazard	Hazard Rating	Description
Low	Less than 0.75	Very low hazard – Caution
Moderate	0.75 to 1.25	Dangerous for some – includes children, the elderly and the infirm
Significant	1.25 to 2.0	Dangerous for most – includes the general public
Extreme	More than 2.0	Dangerous for all – includes the emergency services

5.10 Safe Refuge

In exceptional circumstances, dry access above the 1% annual probability (1 in 100 year) flood level including climate change may not be achievable. In these circumstances the Environment Agency and HBC should be consulted to ensure that the safety of the site occupants can be satisfactorily managed. This will be informed by the type of development, the number of occupants and their vulnerability and the flood hazard along the proposed egress route. A suggested definition of a safe place of refuge is a dry, habitable space, internally accessible and accessible at all times. For example, this may entail the designation of a safe place of refuge on an upper floor of a building, from which the occupants can await the flood levels to subside or be rescued by emergency services. It should be noted that sole reliance on a safe place of refuge is a last resort, and all other possible means to evacuate the site should be considered first. Provision of a safe place of refuge will not guarantee that an application will be granted.

5.11 Car Parks

Where car parks are specified as areas for the temporary storage of surface water and fluvial floodwaters, flood depths should not exceed 300mm given that vehicles may be moved by water of greater depths. Where greater depths are expected, car parks should be designed to prevent the vehicles from floating out of the car park. Signs should be in place to notify drivers of the susceptibility of flooding and flood warning should be available to provide sufficient time for car owners to move their vehicles if necessary.

5.12 Flood Routing

Policy Recommendation 8: All new development, whether in Flood Zones 2 and 3 at risk of fluvial flooding, at risk of surface water flooding or at risk of groundwater flooding at the surface, should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities should be sought within the site design to make space for water and therefore reduced flood risk elsewhere, such as:

- Removing boundary walls or replacing with other boundary treatments such as hedges, fences (with gaps).
- Considering alternatives to solid wooden gates, or ensuring that there is a gap beneath the gates to allow the passage of floodwater.
- On uneven or sloping sites, consider lowering ground levels to extend the floodplain without creating ponds. The area of lowered ground must remain connected to the floodplain to allow water to flow back to river when levels recede.
- Consider reducing ground floor footprint
- Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.
- Maintain or improve existing flow paths in greenfield areas within the new development.

In order to demonstrate that 'flood risk is not increased elsewhere', development in the floodplain will need to prove that flood routing is not adversely affected by the development, for example giving rise to backwater affects or diverting floodwaters onto other properties.

Potential overland flow paths should be determined and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere. Flow paths in greenfield areas should be maintained. Where this is not the case, developers should assess the increased risk of flooding through the change in flow path, i.e. through the consideration of change

in surface roughness resulting in increased velocity of floodwater and increase in the hazard rating associated with the potential flooded area.

Careful consideration should be given to the use of fences and landscaping walls so as to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

It will also be necessary to consider how these areas or features will be maintained over the lifetime of the development, which may require the removal of permitted development rights in certain locations.

5.13 Flood Warning and Evacuation Plans

Policy Recommendation 9: For all developments (excluding minor developments and change of use) proposed in Flood Zone 2 or 3, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population.

The Environment Agency has a tool on their website to create a Personal Flood Plan[1]. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.

Flood Evacuation Plans should also be prepared for sites located next to surface water flow, or where there is another source of flood risk affecting the site.

Evacuation is where flood alerts and warnings, such as those provided by the Environment Agency associated with fluvial flooding, enable timely actions by residents or occupants to allow evacuation to take place unaided, i.e. without the deployment of trained personnel to help people from their homes, businesses and other premises. Rescue by the emergency services is likely to be required where flooding has occurred and prior evacuation has not been possible.

Flood Warning and Evacuation Plans should include:

<u>How flood warning is to be provided, such as:</u>

- availability of existing flood warning systems (refer Appendix A Figure 08);
- where available, rate of onset of flooding and available flood warning time; and
- how flood warning is given.

<u>What will be done to protect the development and contents, such as:</u>

- How easily damaged items (including parked cars) or valuable items (important documents) will be relocated;
- How services can be switched off (gas, electricity, water supplies);
- The use of flood protection products (e.g. flood boards, airbrick covers);
- The availability of staff/occupants/users to respond to a flood warning, including preparing for evacuation, deploying flood barriers across doors etc.; and
- The time taken to respond to a flood warning.

<u>Ensuring safe occupancy and access to and from the development, such as:</u>

- Occupant awareness of the likely frequency and duration of flood events, and the potential need to evacuate;
- Safe access route to and from the development;
- If necessary, the ability to maintain key services during an event;
- Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible; and
- Expected time taken to re-establish normal use following a flood event (clean-up times, time to re-establish services etc.)

There is no statutory requirement for the Environment Agency or the emergency services to approve evacuation plans. HBC is accountable via planning condition or agreement to ensure that plans are suitable. This should be done in consultation with emergency planning staff.

6 Guidance for the Application of Sustainable Drainage Systems (SuDS)

6.1 What are SuDS?

Policy Recommendation 10: Suitable surface water management measures should be incorporated into new development designs in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should be achieved by incorporating Sustainable Drainage Systems (SuDS).

SuDS are surface water drainage solutions designed to manage surface water runoff and mitigate the adverse effects of urban storm water runoff by reducing flood risk and controlling pollution[40]. SuDS techniques allow surface water runoff from development to be controlled in ways that imitate natural drainage by controlling the rate of discharge to a receiving watercourse. SuDS may also provide valuable habitat and amenity value when carefully planned for in development.

The SuDS Manual[41] identifies four processes that can be used to manage and control runoff from developed areas. Each option can provide opportunities for storm water control, flood risk management, water conservation and groundwater recharge:

A. Infiltration: the soaking of water into the ground. This is the most desirable solution as it mimics the natural hydrological process. The rate of infiltration will vary with soil type and condition, the antecedent conditions and with time. The process can be used to recharge groundwater sources and feed baseflows of local watercourses, but where groundwater sources are vulnerable or there is risk of contamination, infiltration techniques are not suitable. Suitability of infiltration SuDS techniques across HBC area is shown in Appendix A Figure 14.

   The use of traditional infiltration techniques that infiltrate to the ground is dependent on the underlying ground conditions. However, it is also possible to use shallow infiltration techniques in combination with storage techniques on sites which have impermeable geology, and therefore these techniques should not be overlooked.

B. Detention/Attenuation: the slowing down of surface flows before their transfer downstream, usually achieved by creating a storage volume and a constrained outlet. In general, though the storage will enable a reduction in the peak rate of runoff, the total volume will remain the same, just occurring over a longer duration.

   Detention measures are not constrained by geology, though in areas of permeable geology, there will also be a degree of infiltration of runoff taking place.

C. Conveyance: the transfer of surface runoff from one place to another, e.g. through open channels, pipes and trenches.

D. Water Harvesting: the direct capture and use of runoff on site, e.g. for domestic use (flushing toilets) or irrigation of urban landscapes. The ability of these systems to perform a flood risk management function will be dependent on their scale, and whether there will be a suitable amount of storage always available in the event of a flood.

As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development. Table 6-1 has been reproduced from the SuDS Manual, CIRIA C697 and outlines typical SuDS techniques.

[40] Defra, Environment Agency (March 2015) Cost Estimation for SuDS – Summary of Evidence
[41] CIRIA C697 (2015) SuDS Manual http://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

Table 6-1 Typical SuDS Components (Y; primary process. * some opportunities, subject to design)

Technique	Description	Conveyance	Detention	Infiltration	Harvesting
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.		Y	Y	*
Filter Drains	Linear drains/trenches filled with a permeable material, often with perforated pipe in the base of the trench. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site.	Y	Y		
Filter Strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and particulates.	*	*	*	
Swales	Shallow vegetated channels that conduct and/or retain water, and can permit infiltration when unlined.	Y	Y	*	
Ponds	Depressions used for storing and treating water.		Y	*	Y
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds. Based on geology these measures can also incorporate some degree of infiltration.	*	Y	*	Y
Detention Basin	Dry depressions designed to store water for a specified retention time.		Y		
Soakaways	Sub-surface structures that store and dispose of water via infiltration.			Y	
Infiltration Trenches	As filter drains, but allowing infiltration through trench base and sides.	*	Y	Y	
Infiltration Basins	Depressions that store and dispose of water via infiltration.		Y	Y	
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water. This is because the hydraulic performance during extreme events is similar to a standard roof (CIRIA C697).		Y		
Rainwater Harvesting	Storage and use of rainwater for non-potable uses within a building, e.g. toilet flushing. It is noted that storage in these types of systems is not usually considered to count towards the provision of on-site storage for surface water balancing because, given the sporadic nature of the use of harvested water, it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event.	*	*	*	Y

The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS. It should be noted, each development site must offset its own increase in runoff and attenuation cannot be "traded" between developments.

Other measures may also be required in relation to water and sewerage infrastructure that might include pipes and below ground storage required as part of a wider strategic scheme, to deal with surface water flood risk. Options may include:

- Increasing capacity in drainage systems;
- Separation of foul and surface water sewers;
- Improved drainage maintenance regimes; and,
- Managing overland flows.

6.2 Management Train

The concept used in the development of drainage systems is the surface water 'management train'[42] whereby different techniques can be used in series to change the flow and quality characteristics of runoff in stages that attempt to mimic natural drainage. The hierarchy of techniques that should be considered in developing the management train are[49]:

1. Prevention – the use of good site design and site housekeeping measures to prevent runoff and pollution (e.g. sweeping to remove surface dust and detritus from car parks), and rain water reuse/harvesting. Prevention policies should generally be included within the site management plan.
2. Source controls – control of runoff at or very near its source (e.g. soakaways, other infiltration methods, green roofs, pervious pavements).
3. Site controls – management of water in a local area or site (e.g. routing water from building roofs and car parks to a large soakaway, infiltration or detention basin.)
4. Regional controls – management of runoff from a site or several sites, typically in a balancing pond or wetland.

Generally the aim should be to discharge surface water run-off as high up the following hierarchy of drainage options as reasonably practicable:

- Into the ground (shallow infiltration)
- To a surface water body
- To a surface water sewer, highway drain, or another drainage system
- To a combined sewer

Where possible, stormwater should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas. The techniques that are higher in the hierarchy are preferred to those further down so that prevention and control of water at the source should always be considered before site or regional controls. However, where upstream control opportunities are restricted, a number of lower hierarchy options should be used in series. Water should only be conveyed elsewhere if it cannot be dealt with at the site[49].

The passage of water between stages of the management train should be considered through the use of natural conveyance systems (e.g. swales and filter trenches) wherever possible. Pipework and sub-surface proprietary produce may still be required, especially where space is limited. Pre-treatment (i.e. the removal of silt and sediment loads) and maintenance is vital to ensure the long-term effectiveness of SuDS. Overland flow routes will also be required to convey and control floodwaters safely and effectively during extreme flood events. Generally, the greater the number of techniques used in a series the better the performance is likely to be and the lower the risk of overall system failure.

SuDS can be applied in all development situations, although individual site constraints may limit the potential of some sites achieving full benefits for all functions. The variety of SuDS available allows planners and designers to make full potential of the local land and consider the needs of local people when implementing the drainage design. The wishes of all the relevant stakeholders needs to be balanced in additional to the risk associated with each design option.

6.3 SuDS Costs

6.3.1 Whole Life Costs

Identifying whole life costs associated with SuDS is a complex process, and involves consideration of the following: Procurement and design costs; Capital construction costs; Operation and maintenance costs; Monitoring costs; and Replacement or decommissioning costs. If the incorporation of SuDS is considered early in the design, as part of the wider landscaping and site planning phase, there is greater potential to manage the costs of SuDS effectively.

Information on typical capital costs and maintenance costs are provided below. For further detail, and information on the other associated costs noted above, reference can be made to industry guidance such as

[42] ttp://www.ciria.org.uk/suds/suds_management_train.htm

the Defra and Environment Agency publication 'Cost Estimation for SuDS- Summary of Evidence' (Defra Environment Agency, March 2015 and Ciria Report C753, The SuDS Manual.)

6.3.2 Capital Costs

Defra and the Environment Agency have prepared a document containing unit costs for particular SuDS components based on a number of industry references. These have been compiled in Table 6-1. It is noted that these costs are based on actual costs from a number of projects from within the UK and from a wider literature review. If used for cost estimating purposes these costs should be increased to allow for inflation to present day values.

It should be noted that these costs are provided as an indicative cost for each type of SuDS. Whilst they provide a range of costs for each type and a relative assessment between SuDS features, the costs associated with any specific site will depend on a number of factors as follows:

- Scale and size of development;
- Hydraulic design criteria (design event, volume of storage required and impermeable catchment area);
- Inlet/outlet infrastructure design (volume and velocity of anticipated flows and the capacity of drainage system beyond site boundary);
- Water quality design criteria;
- Soil types (permeability and depth of water table), porosity and load bearing capacity;
- Materials availability;
- Density of planting;
- Specific Utilities requirements;
- Proximity to receiving watercourse;
- Amenity / public education / safety requirements

Table 6-2 Indicative costs for SuDS options (Defra, Environment Agency 2015)

Option	Unit cost (as published in the corresponding sources)	Source
Green roofs	£90/m^2 - covered roof with sedum mat £80/m^2 - biodiverse roof (varied covering of plants, growing medium and aggregates) Variable costs for Sedum blanket , turf and growing medium roof options	Bamfield, 2005. Bamfield, 2005. Rawlinson, 2006
Simple rainwater harvesting (water butts)	£100 - £243 per property (includes installation and connection pipe)	Stovin & Swan 2007
Advanced rainwater harvesting	£2,100 - £2,400 per residential property £2,500 - £6,000 per residential property £2,600 - £3,700 per residential property £6,300 - £21,000 per commercial / industrial property £45 per m^2 for residential properties £9 per m^2 for non-residential properties	Woking BC Environment Agency, 2007 RainCycle, 2005 RainCycle, 2005 Environment Agency, 2007 Environment Agency, 2007
Greywater re-use	£1,900 - £3,500 per residential property £3,000 per property	Woking BC Environment Agency, 2007
Permeable paving	£30-£40 per m^2 of permeable surface £27 per m^2 of replacement surface £54 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Filter drain / perforated pipes	£100 - £140 per m^3 stored volume £61 per m £120 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Swales	£10-£15 per m^2 swale area £18-£20 per m length using an excavator £12.5 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Infiltration basin	£10-£15 per m^3 stored volume	CIRIA, 2007

Option	Unit cost (as published in the corresponding sources)	Source
Soakaways	>£100 per m^3 stored volume £454 -£552 per soakaway	CIRIA, 2007 Stovin & Swan 2007
Infiltration trench	£55-£65 per m^3 stored volume £74-£99 per m length £60 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Filter strip	£2-£4 per m^2 filter strip area	CIRIA, 2007
Constructed wetland	£25-£30 per m^3 treated volume	CIRIA, 2007
Retention (wet) pond	£15-£25 per m^3 treated volume £80,000 per 5000m^3 pond (£16 per m3)	CIRIA, 2007 SNIFFER, 2007
Detention basin	£15-£20 per m^3 detention volume £35-£55 per m^3 stored volume £18 per m^3	CIRIA, 2007 Stovin & Swan 2007 SNIFFER, 2007
Onsite attenuation and storage	£449-£518 per m^3 for reinforced concrete storage tank. No data available for oversized pipes	Stovin & Swan 2007

6.3.3 Operation and Maintenance Costs

As with any other flood risk management structure, SuDS require ongoing maintenance to ensure the system remains in good working order and the design life of the system is extended as long as possible. Operation and maintenance activities will include the following:

- Monitoring and post-construction inspection;
- Regular, planned maintenance (annual or more frequent); and,
- Intermittent, refurbishment, repair/remedial maintenance;

Additional costs may include the allocation of resources and materials as a result of maintenance activities.

The long-term maintenance costs associated with SuDS are relatively unknown as they are usually absorbed by operators responsible for maintaining the infrastructure as part of their wider asset base.

Whilst the construction of SuDS (e.g. storage ponds) and wetlands are relatively straightforward to calculate, however, maintenance costs are slightly more difficult to estimate due to the lack of information regarding who is responsible for this ongoing maintenance. The key factors that will influence maintenance costs include:

- Type and frequency of maintenance required (e.g. sediment removal, inlet/outlet maintenance, landscaping, and litter removal).
- The costs of maintenance (materials, labour and equipment costs);
- The availability and source of materials and disposal costs; and,
- The responsibility for maintenance (e.g. LA, highways authorities, residents, developer).

Table 6-3 outlines some generic SuDS costs based on review of literature and some UK case studies undertaken by HR Wallingford (2004). If used for cost estimating purposes these costs should be increased to allow for inflation to present day values.

Table 6-3 Indicative annual maintenance costs for key SuDS options[43]

Option	Annual Maintenance costs	
Green roofs	£2,500/yr. for first 2 years for covered rood with sedum mat, £600/yr. after. £1,250/yr. for first 2 years for covered rood with biodiverse roof, £150/yr. after.	Bamfield (2005) Bamfield (2005)
Simple rainwater harvesting (water butts)	Negligible	
Advanced rainwater harvesting	£250 per year per property for external maintenance contract	RainCycle

[43] Defra, Environment Agency (March 2015) Cost Estimation for SuDS – Summary of Evidence.

Option	Annual Maintenance costs	
Permeable paving	£0.5 - £1/m^3 storage volume	HR Wallingford, 2004
Filter drain/perforated pipes	£0.2 - £0.1/m^2 of filter surface area	HR Wallingford, 2004
Swales	£0.1/m^2 of swale surface area £350/yr.	HR Wallingford, 2004 Ellis, 2003
Infiltration basin	£0.1 - £0.3/m^2 of detention basin area £0.25 - £1/m^3 of detention volume	HR Wallingford, 2004
Soakaways	£0.1/m^2 of treated area	HR Wallingford, 2004
Infiltration trench	£0.2 - £1/m^2 of filter surface area	HR Wallingford, 2004
Filter strip	£0.1/m^2 of filter surface area	HR Wallingford, 2004
Constructed wetland	£0.1/m^2 of wetland surface area. Annual maintenance of £200-250/yr. for first 5 years (declining to £80 - £100/yr. after 3 year)	HR Wallingford, 2004 Ellis, 2003
Retention (wet) pond	£0.5 - £1.5/m^2 of retention pond surface area £0.1 - £2/m^3 of pond volume	HR Wallingford, 2004 HR Wallingford, 2004 Ellis, 2003
Detention basin	£0.1 - £0.3/m^2 of detention basin area £0.25 - £1/m^3 of detention volume £250-£1000 per basin	HR Wallingford, 2004 HR Wallingford, 2004 Ellis, 2003

6.4 Infiltration SuDS Specific to Hertsmere

In Hertsmere the generally permeable nature of the soil, subsoil and underlying strata makes the disposal of runoff to groundwater by means of SuDS incorporating soil infiltration processes a desirable and potentially feasible option. However, HCC LLFA have found that infiltration SuDS suitability is highly variable and location specific. Therefore, infiltration testing is required to identify the potential and detailed location within a site for infiltration SuDS features. Variability of ground conditions across large sites means that the infiltration potential cannot be assumed across the whole site. Specific areas for infiltration SuDS need to be identified early in the site planning and design process so that they can be integrated to best effect.

Developers should be made aware of the presence of a number of groundwater source protection zones[44] in the area and it is essential that the chemical and bacteriological quality of the runoff disposed of by infiltration is fully taken into account.

As part of this SFRA, an assessment of the suitability of using infiltration SuDS techniques across the Borough has been undertaken. The BGS infiltration SuDS suitability map shown on Appendix A Figure 14 is largely based on the BGS infiltration SuDS suitability dataset. It is understood from the BGS guidance notes that the dataset is derived from the following data:

- Infiltration constraints summary level.
- Superficial deposits permeability.
- Superficial deposits thickness.
- Bedrock permeability.
- Depth to groundwater level.
- Geological indicators of flooding.

Four categories have been identified by the BGS for suitability for infiltration SuDS:

- Highly compatible for infiltration SuDS: The subsurface is likely to be suitable for free-draining infiltration SuDS.
- Probably compatible for infiltration SuDS: The subsurface is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions.
- Opportunities for bespoke infiltration SuDS: The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions.

[44] Groundwater Source Protection Maps are available from Environment Agency website - http://apps.environment-agency.gov.uk/wiyby/37833.aspx

- Very significant constraints are indicated: There is a very significant potential for one or more geohazards associated with infiltration.

The majority of areas inside the Borough have been designated as 'Probably compatible for infiltration SuDS' in the eastern half and 'Opportunities for bespoke infiltration SuDS in the west. 'Very significant constraints' are shown in approximately 11% of the Borough and the percentage of land identified as 'Highly compatible for infiltration SuDS' is 16%. A range of other types of SuDS measures (Table 6-2) can be adopted in sites where infiltration SuDS is not particularly suitable.

6.5 What is the role of the HCC?

HCC is a statutory consultee for surface water drainage as part of their role as LLFAs. All major development should include provision for SuDS and a Sustainable Drainage Strategy will need to be completed and signed by a competent drainage engineer to verify that the proposals conform to the Government's 'Sustainable Drainage Systems: Non-Statutory Technical Standards[45].

The following sections provide an overview of the Technical Standards and items which applicants should include when preparing a Sustainable Drainage Strategy for submission to HCC. Further information and guidance is available on the HCC website:

http://www.hertsdirect.org/services/envplan/water/floods/surfacewaterdrainage/sudsguidance/.

The SuDS information and policies are part of the adopted LFRMS for Hertfordshire.

6.5.1 What are the Technical Standards?

A set of non-statutory Technical Standards have been published, which set the requirements for the design, construction, maintenance and operation of SuDS. The Technical Standards that are of chief concern in relation to the consideration of flood risk to and from development relating to peak flow control and volume control are presented below. These Technical Standards shall be used to support the Local Plan SuDS policies in consultation with the HCC LLFA.

LASOO is the Local Authority SuDS Officer Organisation which is a professional association of local authority officers that have involvement in SuDS. LASOO are the owners and writers of a Practice Guidance document which sits alongside the Non-Statutory Technical Standards for SuDS[45].

Non-statutory technical standards for sustainable drainage systems, March 2015

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 large estuary) the peak flow control standards (S2 and S3 below) and volume control 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.

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

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.

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.

All major developments and other development should not result in an increase in surface water runoff, and where possible, should demonstrate betterment in terms of rate and volumes of surface water runoff.

Sustainable Drainage Systems (SuDS) should be used to reduce and manage surface water run-off to and from proposed developments as near to source as possible in accordance with the requirements of the Technical Standards and supporting guidance published by DCLG and Defra.

6.5.2 What should a Sustainable Drainage Strategy include?

The following provides an indication of the type of information that would be required as part of a Sustainable Drainage Strategy. These requirements are not exhaustive and are subject to change. The requirements should be checked against the most up to date requirements as published by the LLFA[46].

- A plan of the existing site.
- A topographical level survey of the area to metres Above Ordnance Datum (mAOD).
- Demonstration of a clear understanding of how surface water flows across the site and surrounding area. This could use the topographic survey and the information presented on the 'Flood Map for Surface Water' on the Environment Agency website.
- Plans and drawings of the proposed site layout identifying the footprint of the area being drained (including all buildings, access roads and car parks).
- Calculations of:
    - Changes in permeable and impermeable coverage across the site.
    - The existing and proposed controlled discharge rate for a 1 in 1 year event, 1 in 30 year and a 1 in 100 year event (with an allowance for climate change), which should be based on the estimated greenfield runoff rate.
    - Proposed storage volume (attenuation) including the water storage capacity of the proposed drainage features, with demonstration that they meet the requirements of the Technical Standards.

[46] SuDS Design Guidance for Hertfordshire https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/water/surface-water-drainage/guidance-for-developers.pdf

- Plans, drawings and specification of proposed SuDS measures. This should include detail of hard construction, soft landscaping and planting. A drainage design can incorporate a range of SuDS techniques.
- A design statement describing how the proposed measures manage surface water as close to its source as possible and follow the drainage hierarchy described in Section 6.2.
- Geological information including borehole logs, depth to water table and/or infiltration test results in accordance with BRE365.
- Details of overland flow routes for exceedance events.
- Details of any offsite works required, together with necessary consents (where relevant).
- A management plan for future maintenance and adoption of drainage system for the lifetime of the development.

Applicants are encouraged to discuss their proposals with HCC LLFA at the pre-application stage and in due course the Flood Risk Management Team at HCC will offer pre-application advice to developers on a chargeable basis. Details on the charging schedule are presented in the pre-application guide and the HCC LLFA webpage:

http://www.hertsdirect.org/docs/pdf/p/preeappguide.pdf

https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/managing-flood-risks.aspx

7 Guidance for preparing site-specific FRAs

7.1 What is a Flood Risk Assessment?

A site-specific FRA is a report suitable for submission with a planning application which provides an assessment of flood risk to and from a proposed development, and demonstrates how the proposed development will be made safe, will not increase flood risk elsewhere and where possible will reduce flood risk overall in accordance with paragraph 100 of the NPPF and PPG. An FRA must be prepared by a suitably qualified and experienced person and must contain all the information needed to allow HBC to satisfy itself that the requirements have been met.

7.2 When is a Flood Risk Assessment required?

The NPPF states that a site-specific FRA is required in the following circumstances:

- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).
- Proposals of 1 hectare or greater in Flood Zone 1.
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

In addition to the above it should be noted that when determining whether a FRA is required HBC should be consulted to determine whether there are any specific criteria they wish to apply in the assessment.

7.3 How detailed should a FRA be?

The PPG states that site-specific FRAs should be proportionate to the degree of flood risk, the scale and nature of the development, its vulnerability classification (Table 4-2) and the status of the site in relation to the Sequential and Exception Tests. Site-specific FRAs should also make optimum use of readily available information, for example the mapping presented within this SFRA and available on the Environment Agency website, although in some cases additional modelling or detailed calculations will need to be undertaken. For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, HBC would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater HBC may require a more detailed assessment, for example, the preparation of site-specific hydraulic modelling to determine the flood risk to and from the site pre and post-development, and the effectiveness of any management and mitigation measures incorporated within the design.

As a result, the scope of each site-specific FRA will vary considerably. Table 7-1 presents the different levels of site-specific FRA as defined in the CIRIA publication C624[47] and identifies typical sources of information that can be used. Sufficient information must be included to enable the Council and where appropriate, consultees, to determine that the proposal will be safe for its lifetime, not increase flood risk elsewhere and where possible, reduce flood risk overall. Failure to provide sufficient information will result in applications being refused.

[47] CIRIA (2004) Development and flood risk – guidance for the construction industry C624.

Table 7-1 Levels of Site-Specific Flood Risk Assessment

Description
Level 1 Screening study to identify whether there is any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information. The screening study will ascertain whether a FRA Level 2 or 3 is required. Typical sources of information include: • SFRA • Flood Map for Planning (Rivers and Sea) • Environment Agency Standing Advice • NPPF Tables 1, 2 and 3
Level 2 Scoping study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or the site may increase flood risk due to increased run-off. This study should confirm the sources of flooding which may affect the site. The study should include: • An appraisal of the availability and adequacy of existing information; • A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; and • An appraisal of the scope of possible measures to reduce flood risk to acceptable levels. • The scoping study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development. Typical sources of information include those listed above, plus: • Local policy statements or guidance. • CFMP. • HCC PFRA and LFRMS. • Data request from the Environment Agency to obtain result of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth and velocity. • Consultation with Environment Agency/HCC/sewerage undertakers and other flood risk consultees to gain information and to identify in broad terms, what issues related to flood risk need to be considered including other sources of flooding. • Historic maps. • Interviews with local people and community groups. • Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition. • Site survey to determine general ground levels across the site, levels of any formal or informal flood defences.
Level 3 Detailed study to be undertaken if a Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The study should include: • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of the development site on flood risk elsewhere; and • Quantitative demonstration of the effectiveness of any proposed mitigations measures. Typical sources of information include those listed above, plus: • Detailed topographical survey. • Detailed hydrographic survey. • Site-specific hydrological and hydraulic modelling studies which should include the effects of the proposed development. • Monitoring to assist with model calibration/verification. • Continued consultation with the HBC, Environment Agency and other flood risk consultees.

7.3.1 Environment Agency Data Requests

The Environment Agency offers a series of 'products' for obtaining flood risk information suitable for informing the preparation of site-specific FRAs as described on their website https://www.gov.uk/planning-applications-assessing-flood-risk.

- Products 1 – 4 relate to mapped deliverables including flood level and flood depth information and the presence of flood defences local to the proposed development site;
- Product 5 contains the reports for hydraulic modelling of the Main Rivers;
- Product 6 contains the model output data so the applicant can interrogate the data to inform the FRA.
- Product 7 comprises the hydraulic model itself.

Products 1 – 6 can be used to inform a Level 2 FRA. In some cases, it may be appropriate to obtain Product 7 and to use as the basis for developing a site-specific model for a proposed development as part of a Level 3 FRA. This can be requested via either their National Customer Contact Centre via enquiries@environment-agency.gov.uk or the Hertfordshire and North London Customer and Engagement Team via HNL.Enquiries@environment-agency,gov.uk.

7.3.2 Modelling of Ordinary Watercourses

It should be noted that the scope of modelling studies undertaken by the Environment Agency typically cover flooding associated with Main Rivers, and therefore Ordinary Watercourses that form tributaries to the Main Rivers may not always be included in the model. Where a proposed development site is in close proximity to an Ordinary Watercourse and either no modelling exists, or the available modelling is considered to provide very conservative estimates of flood extents (due to the use of national generalised JFLOW modelling), applicants may need to prepare a simple hydraulic model to enable more accurate assessment of the probability of flooding associated with the watercourse and to inform the site-specific FRA. This should be carried out in line with industry standards and in agreement with the Environment Agency and HCC (as the LLFA).

7.4 What needs to be addressed in a Flood Risk Assessment?

The PPG states that the objectives of a site-specific flood risk assessment are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for HBC to apply (if necessary) the Sequential Test, and;
- whether the development will be safe and pass the Exception Test, if applicable.

7.5 Flood Risk Assessment Checklist

Appendix B provides a checklist for site-specific FRAs including the likely information that will need to be provided along with references to sources of relevant information. As described in Section 7.3, the exact level of detail required under each heading will vary according to the scale of development and the nature of the flood risk.

7.6 Pre-application Advice

At all stages, HBC, and where necessary the Environment Agency, HCC and/or the Statutory Water Undertaker may need to be consulted to ensure the FRA provides the necessary information to fulfil the requirements for planning applications.

The Environment Agency, HCC and HBC each offer pre-application advice services which should be used to discuss particular requirements for specific applications.

- HBC offer pre-application advice. Enquiries can be submitted by completing the Preliminary Enquiries Form available online at https://www.hertsmere.gov.uk/planning--building-control/planning/development-management/pre-application-advice.aspx

- Environment Agency https://www.gov.uk/government/publications/planning-advice-environment-agency-standard-terms-and-conditions _The following government guidance sets out when LPAs should consult with the Environment Agency on planning applications https://www.gov.uk/flood-risk-assessment-local-planning-authorities. Local guidance for Hertfordshire can be found here - https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/planning/planning-applications-decisions/environment-agency-%E2%80%93-pre-application-and-post-permission-advice-august-16.pdf

- HCC offer pre-application advice to developers on a chargeable basis. Details on the charging schedule are presented in the pre-application guide and the HCC LLFA webpage - https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/managing-flood-risks.aspx

8 Flood Risk Management Policy Considerations

8.1 Overview

In order to encourage a holistic approach to flood risk management and ensure that flooding is taken into account at all stages of the planning process, this Section builds on the findings of the SFRA to set out key recommendations for consideration by HBC in relation to flood risk planning policy and with respect to development management decisions on a day-to-day basis.

8.2 Policy Considerations

It is recommended that the following flood risk objectives are taken into account by HBC during the policy making process. Guidance on how these objectives can be met throughout the development control process for individual development sites is included within Section 5.

8.2.1 Seeking Flood Risk Reduction through Spatial Planning and Site Design

- Use the Sequential Test to locate new development in areas of lowest risk, giving highest priority to areas within Flood Zone 1. Locating new development away from the most vulnerable flood risk areas would minimise the cost of installing and maintaining new flood defences and land drainage measures.
- Use the Sequential Test within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.
- Avoid development immediately downstream of FSRs which will be at high hazard areas in the event of failure.
- Seek opportunities for new development to achieve reductions to wider flood risk issues where possible, e.g. larger developments may be able to make provisions for flow balancing within new attenuation SuDS features.
- Identify long-term opportunities to remove development from the floodplain through land swapping.
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels).
- Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible. Dry pedestrian access/egress should be possible for the 1 in 100 year return period event including an allowance for climate change associated with fluvial flooding.

8.2.2 Reducing Surface Water Runoff from New Developments

- All development should seek to reduce surface water runoff from new developments
- All sites require the following:
    - Use of SuDS (where possible use of strategic SuDS should be made).
    - Discharge rates should be restricted to Greenfield runoff rates.
    - 1 in 100 year attenuation of surface water, including an allowance for climate change.
- Space should be specifically set aside for SuDS and used to inform the overall layout of development sites.
- Surface water drainage proposals should have a clear plan for the long term maintenance and adoption of the systems, prior to approval of any planning permission in line with national planning policy.
- Large potential development areas with a number of new allocation sites will be required to develop a strategy for providing a joint SuDS scheme. This will need to be on an integrated and strategic scale

and where necessary will require the collaboration of all developers involved in implementing a specific expansion area or site.

- Careful assessment of the potential impact of surface water drainage from new developments will be necessary in areas with constrained drainage networks, particularly those networks that are dependent upon sewers and culverted watercourses with limited capacity.
- Further work is necessary to understand the full extent of risk from surface water flooding in Hertsmere, including the preparation of SWMPs.
- Reducing the potential impacts of sewer flooding may require the installation of SuDS in both new and existing developments. The risk of foul sewer flooding that result from the misconnection of surface water drainage to the foul sewer network could be addressed if opportunities to disconnect surface water from foul sewers are taken.
- Consideration may need to be given to further use of rural SuDS to reduce both the risk of flooding and the risk of rivers drying out (smoothing out the peaks and troughs of local rainfall).

8.2.3 Enhancing and Restoring the River Corridor (Main Rivers and Ordinary Watercourses)

- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made by developers in consultation with asset owners. Refurbishment and/or renewal of the asset should ensure that the design life is commensurate with the design life of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. de-culverting, the use of bio-engineered river walls, raising bridge soffits to take into account climate change).
- Avoid further culverting and building over culverts. Where practical, all new developments with culverts running through their site should seek to de-culvert main rivers and ordinary watercourses for flood risk management and conservation benefit. Any culverting or works affecting the flow of a watercourse requires the prior written consent of either the Environment Agency (for main rivers), or HCC (for ordinary watercourses) under the terms of the Land Drainage/Water Resources Act 1991 and Flood and Water Management Act 2010. These regulatory bodies seek to avoid culverting, and their consent for such works will not normally be granted except as a means of access.
- Set development back from rivers, seeking an 8 metre wide undeveloped buffer strip for development by all watercourses including those where the Flood Zone does not exist. Under the terms of the Water Resources Act 1991 and the Land Drainage Byelaws, any works in, over, under or within 8 metres of a designated main river or flood defence requires formal written consent from the Environment Agency prior to the works commencing. This includes the construction of any buildings, culverts, bridges, footways and outfalls. In addition, any works that could affect the flow of an ordinary watercourse (i.e. not designated as a Main River) require consent from the LLFA (HCC in the study area) prior to the commencement of works. This includes culverting, diverting, and can include outfalls and bridges depending on the likely affect to the flow of the watercourse. In addition, any work within 9m of any watercourse will need prior consent from HBC (HBC Byelaws no. 9).

8.2.4 Protecting and Promoting Areas for Future Flood Alleviation Schemes

- Protect Greenfield functional floodplain from future development (our greatest flood risk management asset) and reinstate areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones).
- Identify sites where developer contributions could be used to fund future flood risk management schemes or can reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

8.2.5 Improving Flood Resilience and Emergency Planning

Due to this high level of flood risk affecting numerous properties it is recommended that funding is invested in flood mitigation infrastructures, especially those that reduce the risk of surface water flooding. Where funding is not viable for flood-related purposes it is necessary to consider flood resilience measures, including:

- Seek to improve the emergency planning process using the outputs from the SFRA.

- Encourage all those within existing Flood Zone 3a and 3b (residential and commercial occupiers) to sign up to Flood Warning Service operated by the Environment Agency.
- Ensure robust emergency (evacuation) plans are implemented for new developments.

8.3 Development Management Considerations

8.3.1 Flood Zone 3b Functional Floodplain

The Functional Floodplain as defined in this SFRA by Hertsmere BC compromises of undeveloped land within the 5% annual probability (1 in 20 year) flood outline. These areas should be safeguarded from any development. Where Water Compatible or Essential Infrastructure cannot be located elsewhere, it must:

- Remain operational and safe for users in times of flood;
- Result in no net loss of flood storage;
- Not impede water flows; and
- Not increase flood risk elsewhere.

Within the outline of the 5% annual probability (1 in 20 year) flood outline, there could be areas of existing development which are prevented from flooding by the presence of existing infrastructure or solid buildings. In these developed areas, existing building footprints, where it can be demonstrated that they exclude floodwater, will not be defined as Functional Floodplain and the planning requirements associated with Flood Zone 3b will not apply.

Where redevelopment is proposed in developed areas, schemes should not increase the vulnerability classification of the site. All schemes must result in a net reduction in flood risk and ensure that floodplain storage and flow routes are not affected. This can be achieved through a combination of on and off-site measures including, but not limited to:

- Reducing the land use vulnerability;
- Raising finished floor levels;
- Reducing surface water runoff rates and volumes from the site;
- Increasing floodplain storage capacity and creating space for flooding to occur by restoring functional floodplain;
- Reducing impedance to floodwater flow and restoring flood flow paths;
- Incorporating flood resilient and/or resistance measures;
- Ensuring development remains safe for users in time of flood (this may refer to the timely evacuation of properties prior to the onset of flooding in accordance with an individual Flood Warning and Evacuation Plan for the site).

Proposals for the change of use or conversion to a use with a higher vulnerability classification will not be permitted.

Basement, basement extensions or conversions of basements to a higher vulnerability classification will not be permitted.

Where minor development is proposed, schemes should not affect floodplain storage or flow routes through the incorporation of raised finished floor levels, voids, and where possible the provision of direct or indirect floodplain compensation, flood resilience measures, the removal of other non-floodable structures or replacement of impermeable surfaces with permeable and improved surface water drainage through the implementation of SuDS features such as water butts/rainwater harvesting, living roofs, infiltration trenches/soakaways and below ground attenuation tanks in line with CIRIA guidance on SuDS.

Approach to un-modelled Main Rivers and Ordinary Watercourses

Hydraulic modelling data (used to delineate Flood Zones) is not available from the Environment Agency for all main rivers and ordinary watercourses within the study area and in some cases the Environment Agency have

modelling data, but only for the lower return periods and not for the 1 in 20 (5%) event. The extent of modelled main rivers and ordinary watercourses within Hertsmere are shown on Figure 15 in Appendix A.

The Environment Agency 2010 modelled main rivers and ordinary watercourses were chosen based on their assessed flood risk, level of urbanisation, proposed/potential future development, presence of slow structures which have significant impacts on the conveyance of flood flows and availability of data at the time of the study. As such, the following main rivers and ordinary watercourses were modelled by the Environment Agency in the 2010 Hydraulic Study:

- Mimmshall Brook
- Salisbury Hall Brook (upstream portion only)
- Radlett Brook (updated and subsequent update[48])
- Hilfield Brook.

It should be noted there may be subsequent updates to the Environment Agency model resulting in the addition of modelled reaches and/or watercourses in response to future development demands.

Main Rivers and Ordinary Watercourses where modelling data for the 5% (1 in 20 year) is not available – Development within 20m of any un-modelled main river and ordinary watercourses would be permissible if the developer is able to demonstrate, subject to the approval of HBC and meeting other Development Plan Document (DPD) policy considerations, that the proposed development lies outside the 1 in 20 year flood extents where the land is greenfield or complies with the requirements stated above where the land is in brownfield.

The prospective developer may need to develop a simple hydraulic model to enable more accurate assessment of the probability of flooding associated with the watercourse and to inform the site-specific FRA. This should be carried out in line with industry standards and in agreement with the HBC, Environment Agency and HCC (as the LLFA).

Schemes proposed in brownfield Flood Zone 3b sites will be subject to the completion of both the Sequential and Exception Tests as per Environment Agency and NPPF guidance.

The above considerations related to Flood Zone 3b is summarised in Figure 8-1.

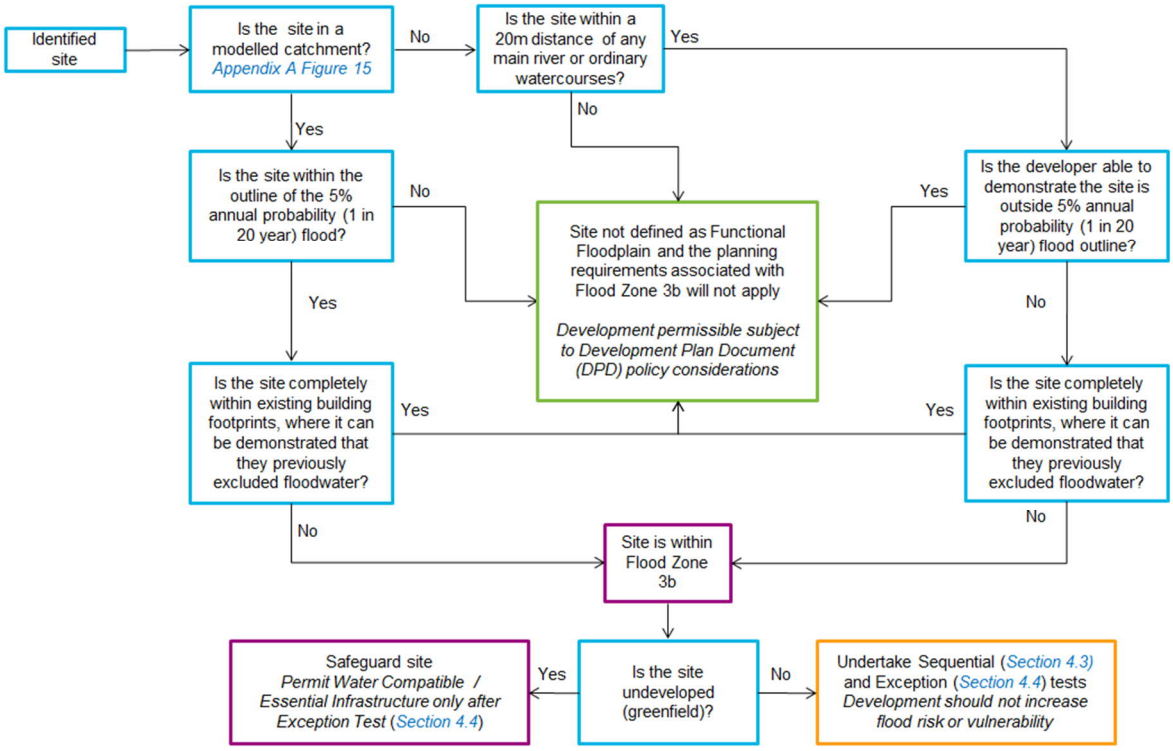


Figure 8-1 Development Management Considerations for Flood Zone 3b

[48] Newberries Car Park, Radlett – Hydrology and Modelling Refinements, Royal HaskoningDHV, October 2017

8.3.2 Flood Zone 3a High Probability

Flood Zone 3a High Probability comprises land having a 1% (1 in 100 year) annual probability or greater risk of flooding from main rivers and ordinary watercourses. Water Compatible and Less Vulnerable developments are permitted in Flood Zone 3a; Essential Infrastructure and More Vulnerable developments require the Exception Test and Highly Vulnerable development is not permitted in this flood zone (see Table 4-3). Where development is proposed opportunities should be sought to:

- Relocate existing development to land in zones with a lower probability of flooding;
- Reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
- Ensure it remains safe for users in times of flood; and
- Create space for flooding to occur by restoring natural floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

8.3.3 Flood Zone 2 Medium Probability

Flood Zone 2 Medium Probability comprises land having between a 1% (1 in 100 year) and 0.1% (1 in 1000) annual probability of flooding from main rivers and ordinary watercourses. Water Compatible, Essential Infrastructure, Less Vulnerable and More Vulnerable developments are permitted in the Flood Zone 2 and Highly Vulnerable development requires the Exception Test (see Table 4-3). Where development is proposed in areas of Flood Zone 2, the planning policy approach is similar to Flood Zone 3a. Opportunities should be sought to:

- Relocate existing development to land in zones with a lower probability of flooding;
- Reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
- Ensure it remains safe for users in times of flood; and
- Create space for flooding to occur by restoring natural floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

8.3.4 Flood Zone 1 Low Probability

Flood Zone 1 Low Probability comprises land having a less than 0.1% (1 in 1000 year) annual probability of flooding from main rivers and ordinary watercourses. All development vulnerability classifications are permitted in Flood Zone 1 (see Table 4-3). Where development over 1ha is proposed or there is evidence of flooding from another localised source in areas of Flood Zone 1, opportunities should be sought to:

- Ensure that the management of surface water runoff from the site is considered early in the site planning and design process;
- Ensure that proposals achieve an overall reduction in the level of flood risk to the surrounding area, through the appropriate application of sustainable drainage techniques.

8.3.5 Climate Change Consideration

As explained in section 3.4.5, the existing Upper Colne model (2010) predates the latest Environment Agency climate change guidance (2016) and does not include most up to date climate change allowance. Updating the model with climate change scenarios is within the remit of this SFRA Level 1. For the Development Management or site allocation purposes, the recommended process is set out below.

1. Sites along ***Mimmshall Brook,*** or ***Hillfield Brook*** or ***Radlett Brook*** downstream of Radlett FSA – The 1 in 1000 year flood event covers all climate change scenarios (Table 3-6) except 'Upper End 2080s'. So sites outside the flood map for this event (Appendix A Figure 07.2) can be allocated in the following way -
    - more vulnerable or highly vulnerable non-residential properties – sites can be allocated with the condition that site-specific Sequential Test and FRA to be carried out to assess climate change impact for consideration during planning application
    - other types of properties – no additional condition for climate change impact assessment – site-specific FRA may still be needed as per NPPF depending on type or size of the development (refer to section 7.2)

2. For other locations, a site can be allocated in local plan for future development if the following conditions are met:
    - it comprises of less vulnerable development
    - it is assessed as at low risk from other sources of flooding (Table 4-1), and
    - it is outside the 1:100yr + 20% flood map (Appendix A Figure 07.1), and
    - it is outside the 1:1000yr flood map (Appendix A Figure 07.2) and
    - it is 100m away from a main river or ordinary watercourse

    Site-specific FRA may still be needed as per NPPF depending on type or size of the development

3. For sites not covered above, an SFRA level 2 or site-specific FRA needs to be undertaken ***before*** site allocation

8.3.6 Changes of Use

Where a development undergoes a change of use and the vulnerability classification of the development changes, there may be an increase in flood risk. For example, changing from industrial use to residential use will increase the vulnerability classification from Less to More Vulnerable (Table 4-2).

For change of use applications in Flood Zone 2 and 3, applicants must submit a FRA with their application. This should demonstrate how the flood risks to the development will be managed so that it remains safe through its lifetime including provision of safe access and egress and preparation of Flood Warning and Evacuation Plans where necessary. Further guidance will be provided within the Level 2 SFRA Report.

As changes of use are not subject to the Sequential or Exception Tests, HBC could consider when formulating policy what changes of use will be acceptable, having regard to paragraph 157 (6th bullet) of the NPPF and taking into account the findings of this SFRA. This is likely to depend on whether developments can be designed to be safe and that there is safe access and egress.

8.4 Summary of Policy Recommendations

Policy Recommendation	Description
1	A sequential approach to site planning should be applied within new development sites.
2	Retain an 8m wide undeveloped buffer strip alongside Main Rivers and explore opportunities for riverside restoration. Retain an 8m wide buffer strip alongside Ordinary Watercourses. New development within 8m of a Main River or Ordinary Watercourse will require environmental permitting from the Environment Agency, or consent from HCC (as LLFA). any work within 9 metres of any watercourse will need prior consent from HBC (as LPA).
3	All new development within Flood Zone 3 must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.
4	All More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) flood level including an allowance for climate change.
5	In areas at risk of flooding of low depths (<0.3m), the following flood resistance measures could be considered: • Using materials and construction with low permeability. • Land raising. • Landscaping e.g. creation of low earth bunds (subject to this not increasing flood risk to neighbouring properties). • Raising thresholds and finished floor levels e.g. porches with higher thresholds than main entrance. • Flood gates with waterproof seals.

Policy Recommendation	Description
6	In areas at risk of frequent or prolonged flooding, the following flood resilience measures could be implemented: • Use materials with either, good drying and cleaning properties, or, sacrificial materials that can easily be replaced post-flood. • Design for water to drain away after flooding. • Design access to all spaces to permit drying and cleaning. • Raise the level of electrical wiring, appliances and utility meters. • Coat walls with internal cement based renders; apply tanking on the inside of all internal walls. • Ground supported floors with concrete slabs coated with impermeable membrane. • Tank basements, cellars or ground floors with water resistant membranes. • Use plastic water resistant internal doors.
7	For developments located in areas at risk of fluvial flooding, safe access / egress must be provided for new development as follows in order of preference: • Safe dry route for people and vehicles. • Safe dry route for people. • If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people. • If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater. In all these cases, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for climate change.
8	All new development in Flood Zones 2 and 3 should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities should be sought within the site design to make space for water, such as: • Removing boundary walls or replacing with other boundary treatments such as hedges, fences (with gaps). • Considering alternatives to solid wooden gates, or ensuring that there is a gap beneath the gates to allow the passage of floodwater. • On uneven or sloping sites, consider lowering ground levels to extend the floodplain without creating ponds. The area of lowered ground must remain connected to the floodplain to allow water to flow back to river when levels recede. • Create under-croft car parks or consider reducing ground floor footprint and creating an open area under the building to allow flood water storage. Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.

Policy Recommendation	Description
9	For all developments (excluding minor developments and change of use) proposed in Flood Zones 2 or 3, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population. The Environment Agency has a tool on their website to create a Personal Flood Plan. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.
10	Suitable surface water management measures should be incorporated into new development designs in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should be achieved by incorporating SuDS.

9 Next Steps

9.1.1 Sequential Test

Using the flood risk information presented within this report, HBC should undertake the Sequential Test for development sites identified in Local Plan to confirm their levels of risk and document the process. HBC needs to make sure any future development is steered towards areas of lowest flood risk.

9.1.2 Level 2 SFRA

A Level 2 SFRA or site specific FRA will be required to provide information to support any application of the Exception Test for future development sites at risk of flooding. The scope of the Level 2 SFRA would need to consider the detailed nature of the flood characteristics within a flood zone.

The Level 2 SFRA would provide a more detailed assessment of the flood risk for specific development sites which may require the application of the Exception Test.

9.1.3 Future Updates to the SFRA

This SFRA has been updated building heavily upon existing knowledge and newly available datasets with respect to flood risk within HBC, made available by the Environment Agency. In the future, new modelling studies or new information may influence future development management decisions within HBC. Therefore it is important that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives, flood risk datasets and an improving understanding of flood risk within HBC.

Appendix A Maps

Appendix B Flood Risk Assessment (FRA) Checklist

What to Include in the FRA		Source(s) of Information
1.Site Description		
Site address	-	-
Site description	-	-
Location plan	Including geographical features, street names, catchment areas, watercourses and other bodies of water	SFRA Appendix A
Site plan	Plan of site showing development proposals and any structures which may influence local hydraulics e.g. bridges, pipes/ducts crossing watercourses, culverts, screens, embankments, walls, outfalls and condition of channel	OS Mapping Site Survey
Topography	Include general description of the topography local to the site. Where necessary, site survey may be required to confirm site levels (in relation to Ordnance datum). Plans showing existing and proposed levels.	Site Survey
Geology	General description of geology local to the site.	BGS geological data Ground Investigation Report
Watercourses	Identify Main Rivers and Ordinary Watercourses local to the site.	SFRA Appendix A, Figure 1
Status	Is the development in accordance with the Council's Spatial Strategy?	SBC website
2. Assessing Flood Risk		
The level of assessment will depend on the degree of flood risk and the scale, nature and location of the proposed development. Refer to Table 4-2 regarding the levels of assessment. Not all of the prompts listed below will be relevant for every application.		
Flooding from Rivers	Provide a plan of the site and Flood Zones. Identify any historic flooding that has affected the site, including dates and depths where possible. How is the site likely to be affected by climate change? Determine flood levels on the site for the 1% annual probability (1 in 100 chance each year) flood event including an allowance for climate change. Determine flood hazard on the site (in terms of flood depth and velocity). Undertake new hydraulic modelling to determine the flood level, depth, velocity, hazard, rate of onset of flooding on the site.	SFRA Appendix A Environment Agency Flood Map for Planning (Rivers and Sea). New hydraulic model.
Flooding from Land	Identify any historic flooding that has affected the site. Review the local topography and conduce a site walkover to determine low points at risk of surface water flooding. Review the Risk of Flooding from Surface Water mapping. Where necessary, undertake modelling to assess surface water flood risk.	SFRA Area Assessments. Topographic survey. Site walkover. Risk of Flooding from Surface Water mapping (Environment Agency website). New modelling study.
Flooding from Groundwater	Desk based assessment based on high level BGS mapping in the SFRA. Ground survey investigations. Identify any historic flooding that has affected the site.	SFRA Appendix A, Figure 5. Ground Investigation Report
Flooding from Sewers	Identify any historic flooding that has affected the site.	Refer SFRA Section 3.7.
Reservoirs, canals and other artificial	Identify any historic flooding that has affected the site.	Risk of Flooding from Reservoirs mapping

What to Include in the FRA		Source(s) of Information
sources	Review the Risk of Flooding from Reservoirs mapping.	(Environment Agency website). Refer SFRA Section 3.8.
3. Proposed Development		
Current use	Identify the current use of the site.	-
Proposed use	Will the proposals increase the number of occupants / site users on the site such that it may affect the degree of flood risk to these people?	-
Vulnerability Classification	Determine the vulnerability classification of the development. Is the vulnerability classification appropriate within the Flood Zone?	SFRA Error! Reference source not found. SFRA Table 4-2
4. Avoiding Flood Risk		
Sequential Test	Determine whether the Sequential Test is required. Consult SBC to determine if the site has been included in the Sequential Test. If required, present the relevant information to SBC to enable their determination of the Sequential Test for the site on an individual basis.	SFRA Section 4.
Exception Test	Determine whether the Exception Test is necessary. Where the Exception Test is necessary, present details of: Part 1) how the proposed development contributes to the achievement of wider sustainability objectives as set out in the SBC Sustainability Appraisal Report. (Details of how part 2) can be satisfied are addressed in the following part 5 'Managing and Mitigating Flood Risk'.)	SFRA Table 4-3 Refer to Section 4.4
5. Managing and Mitigating Flood Risk		
Section 6 of the SFRA presents measures to manage and mitigate flood risk and when they should be implemented. Where appropriate, the following should be demonstrated within the FRA to address the following questions: How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime? How will you ensure that the proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere? Are there any opportunities offered by the development to reduce flood risk elsewhere? What flood-related risks will remain after you have implemented the measures to protect the site from flooding (i.e. residual risk) and how and by whom will these be managed over the lifetime of the development (e.g. flood warning and evacuation procedures)?		
Development Layout and Sequential Approach	Plan showing how sensitive land uses have been placed in areas within the site that are at least risk of flooding.	SFRA Section 5.2
Riverside Development Buffer Zone	Provide plans showing how a buffer zone of relevant width will be retained adjacent to any Main River or Ordinary Watercourse in accordance with requirements of the Environment Agency or HCC.	SFRA Section 5.3
Floodplain Compensation Storage	Provide calculations or results of a hydraulic modelling study to demonstrate that the proposed development provides compensatory flood storage and either will not increase flood risk to neighboring areas or will result in an overall improvement. This should be located and designed to achieve level for level and volume for volume compensation, should be provided on land that is in hydrological continuity with the site within the applicant's ownership and subject to appropriate maintenance regimes for its lifetime. Include cross sectional drawings clearly showing existing and	SFRA Section 5.4

What to Include in the FRA		Source(s) of Information
	proposed site levels.	
Finished Floor Levels	Plans showing finished floor levels in the proposed development in relation to Ordnance Datum taking account of indicated flood depths.	SFRA Section 5.5
Flood Resistance	Details of flood resistance measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 5.6
Flood Resilience	Details of flood resilience measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 5.7
Safe Access / Egress	Provide a figure showing proposed safe route of escape away from the site and/or details of safe refuge. Include details of signage that will be included on site. Where necessary this will involve mapping of flood hazard associated with river flooding. This may be available from Environment Agency modelling, or may need to be prepared as part of hydraulic modelling specific for the proposed development site.	SFRA Section 5.9
Flow Routing	Provide evidence that proposed development will not impact flood flows to the extent that the risk to surrounding areas is increased. Where necessary this may require modelling.	SFRA Section 5.12
Flood Warning and Evacuation Plan	Where appropriate reference the Flood Warning and Evacuation Plan or Personal Flood Plan that has been prepared for the proposed development (or will be prepared by site owners).	SFRA Section 5.13
Surface Water Management	Completion of SuDS Drainage Statement, as described in Section 7.	SFRA Section 6. HCC website - http://www.hertsdirect.org/docs/pdf/s/hertssudsguide.pdf