Brentwood
Borough Council

Brentwood Level 1 Strategic Flood Risk Assessment

Final Report

January 2011










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Brentwood Borough council

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Executive Summary

Flood risk has been characterised throughout the Borough of Brentwood based on a range of information sources. The risks associated with primary fluvial flooding have been predominantly based on the Environment Agency's flood zones supplemented where appropriate with data from historical sources. The flood zone maps in this report indicate that fluvial flood risk is of limited spatial extent within the Borough and that the majority of the area covered by flood zones 2 and 3 is largely rural. A few urban areas are shown to be at risk including Heybridge, Ingatestone and areas to the east and west of Brentwood town. This SFRA draws on site information given in Brentwood's Draft Strategic Housing Land Availability Assessment (SHLAA). This contains a dataset of potential and discounted sites put forward for consideration as part of the SHLAA process.

A strategic assessment of the impact of climate change on river flow has been undertaken by comparing the difference in extent between Flood Zone 2 and Flood Zone 3. The difference highlights areas which may be susceptible to flooding if increased rainfall, or rainfall of a greater intensity, result from changes to the global climate. This exercise suggests that climate change is unlikely to significantly change flood extents with the only notable increases in extent along the north western boundary to the Borough in the area associated with the floodplain of the River Wid.

Surface water, or 'pluvial' flooding, is likely to be the most significant cause of flooding in the Borough as demonstrated through recent recorded incidents of people being trapped in cars near Ingatestone (December 2009, February 2010 and March 2010). Such flooding occurs from intense rainfall events which results in large volumes of runoff in urban areas where the potential for infiltration is reduced due to man-made surfaces. The runoff may then exceed the capacity of road drains and sewers to convey the water away resulting in surface water ponding. Surface Water Management Plans are the vehicle for assessing such risk and identifying potential solutions.

As a minimum, all new development over 0.25 hectares in size (and all development in Flood Zones 2 and 3) should employ Sustainable Drainage Systems (SuDS) with the aim of reducing runoff from the site thereby reducing the risk of downstream fluvial or surface water flooding. The SFRA has identified that for much of the urban area of Brentwood the infiltration potential of soils is high, meaning that infiltration SuDS are likely to be suitable. Infiltration options control runoff at source and are high up in the SuDS hierarchy. The feasibility of infiltration on site will need to be determined through a site specific flood risk assessment, however.

Information to support application of the PPS25 Sequential Test is provided in Section 3 of the report and a set of accompanying maps in Appendix A. Together they form a toolkit which enables the Council to prioritise development to areas of lower flood risk taking into account the vulnerability to flood risk of the land use proposed. Guidance has been provided should the situation occur where the Sequential Test has revealed that no suitable alternative sites are available and that development is to be located in an area of flood risk in conflict with the vulnerability of the land use proposed. In this case the PPS25 Exception Test will need to be passed for the development to proceed. Sufficient data is provided in a set of maps which accompany this report to allow the Council to make informed decisions when processing windfall site applications.

List of Acronyms

Acronyms	Definition
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty
ASSWF	Areas Susceptible to Surface Water Flooding
CFMP	Catchment Flood Management Plan
DPD	Development Plan Document
FRA	Flood Risk Assessment
GIS	Geographical Information Systems
HOST	Hydrology of Soil Types
IFM	Indicative Flood Map
IfSAR	Infometric Synthetic Aperture Radar
RDA	Regeneration and Development Area
LLFA	Lead Local Flood Authority
LDD	Local Development Documents
LDF	Local Development Framework
LiDAR	Light Detecting and Ranging
LPA	Local Planning Authority
RFRA	Regional Flood Risk Assessment
RPB	Regional Planning Bodies
SDF	Strategic Development Framework
SFRA	Strategic Flood Risk Assessment
SPR	Surface Percentage Runoff
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
UCS	Urban Capacity Study
WFD	Water Framework Directive

Contents

1. Introduction

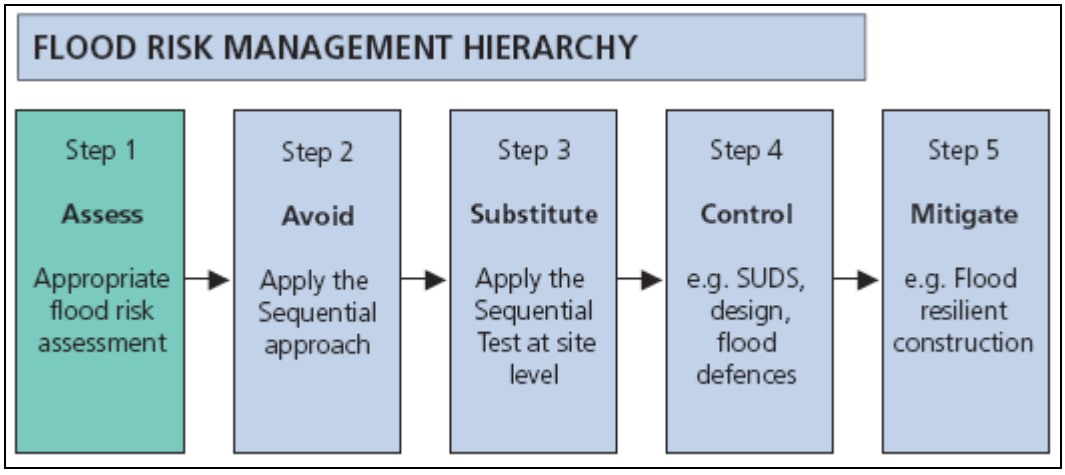
1.1 Overview

This report is a Level 1 Strategic Flood Risk Assessment (SFRA) of the Borough of Brentwood in the county of Essex.

National planning legislation and policy guidance has been considered throughout the preparation of this SFRA. The planning process is driven by legislation and guidance developed at a national, regional and local level, of which flood risk is just one of many factors needing to be considered when making decisions relating to land use and development. The challenge for a SFRA is to develop pragmatic principles for steering future development towards areas of lower flood risk within the context of other planning policies and local drivers.

Planning Policy Statement 25 – Development and Flood Risk (PPS25, March 2010) sets out government's national policy on development and flood risk on different aspects of land use planning in England. It is supported by a Practice Guide which promotes two levels of SFRA. A Level 1 SFRA is defined in the Practice Guide Companion to PPS25 as a desk-based study using existing information to allow application of the Sequential Test and to identify whether application of the Exception Test is likely to be necessary. Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitably available sites for development within zones of lower flood risk or due to possible increases in flood risk arising from climate change, the scope of the SFRA will need to be widened to a Level 2 assessment.

The Brentwood SFRA (Level 1) has been prepared so as to closely follow the flood risk management hierarchy advocated by PPS25. The diagram below illustrates this approach.



Taken from PPS25 Companion Guide December 2009, page 6

This SFRA forms a Level 1 assessment for the purpose of providing an evidence base to support spatial planning decisions at the Borough wide scale. This includes the delineation of PPS25 flood risk zones, an assessment of the implications of climate change, and a review of flood risks from all possible sources. The detail of the assessments has been determined by the availability of information and data.

1.2 Geographical Overview

Brentwood covers an area of 153 square kilometres (59 square miles) in South West Essex. Located in the metropolitan Green Belt, it has a population of around 73,000, the majority of whom live in the main urban centre of Brentwood itself. Other notable settlements within the Borough include Ingatestone, Doddinghurst, Kelvedon Hatch, Blackmore and West Horndon. Less than 20% of the Borough is built up and there is considerable pressure for development for both housing and employment and increasingly for leisure and recreational purposes.

Key road infrastructure in the Borough includes a 3km length of the M25 motorway in the west, the A127 and the A12 trunk road which crosses the Borough from north east to south west and routes to the north of Brentwood town.

Land elevation within Brentwood Borough typically ranges from over 100m AOD in the north and central area to below 10m AOD in the south. Due to its relatively high elevations, the Borough forms the headwaters of four key watercourse systems which drain the area:

- The catchment of the River **Wid** and associated tributaries covers over 50% of the total area of Brentwood Borough and is located in the east of the Borough. The River Wid itself forms much of the eastern boundary of the Borough. The Wid system flows approximately from south to north joining with the River Can in Chelmsford which itself joins the River Chelmer becoming the River Blackwater before entering the North Sea;
- The River **Roding** and associated tributaries drain the west of the Borough (approximately 15% of the total Borough area) and form its north western boundary. The river flows in an approximate south westerly direction eventually joining the River Thames via Barking Creek;
- The **Ingrebourne** system drains the south-western part of the Borough (approximately 15% of the total area of the Borough). The river flows south and joins the Thames at Rainham; and
- The River **Mardyke** system which drains the extreme south of the Borough via numerous small tributaries (approximately 15% of the total area of the Borough). The Mardyke flows south then to the west and joins the Thames near Purfleet.

Figure A1 in Appendix A provides an overview of the Borough and Figure A2 shows the key river catchments which drain the Borough. The topography based on airborne LiDAR survey is shown in Figure A3 although it should be noted that LiDAR coverage is not complete across the Borough

1.3 Relevant Planning Policy

1.3.1 Planning Policy 25: Development and Flood Risk

PPS25 specifies that Local Planning Authorities (LPAs) should adopt a risk-based approach to planned development through the application of a Sequential Test, which seeks to steer new development towards areas of lowest flood risk. PPS25 also sets out the need to consider other sources of flood risk (such as groundwater and surface water) in addition to the main fluvial and tidal sources. The implications of climate change for flood risk also need to be assessed.

PPS25 introduces the Exception Test which allows some scope for departures from the sequential approach. This is for circumstances where development is necessary to meet wider development needs and urban regeneration. Providing the evidence to support a departure from the sequential approach is only one part of the Exception Test. Development will only be permitted where it is demonstrated that flood risks are appropriately managed, the development is safe and flood risks elsewhere are not increased.

The Town and Country Planning (Flooding) (England) Direction 2006 has made the Environment Agency a Statutory Consultee on all applications for development in flood risk areas, including areas with critical drainage problems and for developments exceeding 1 hectare outside flood risk areas. After discussion with the Environment Agency, LPAs are required to notify the Secretary of State if they remain minded to approve a planning application contrary to a sustained objection from the Environment Agency.

This SFRA has been undertaken in accordance with PPS25 and its accompanying Practice Guide. Box 1 presents a Summary of the guidance presented in PPS25.

This SFRA describes (using Table 3.1 on page 20 and Figures A8 a-d in Appendix A) the land-uses that are considered appropriate for different areas within the Borough, drawing on site information in Brentwood's draft Strategic Housing Land Assessment (SHLAA) and adopting the sequential approach in doing so. This assessment is based upon the vulnerability classifications presented in PPS25, Annex D and the level of flood risk posed to each site.

Box 1 Summary of Guidance in PPS25

PPS25 Objectives

Through PPS25, the Government has sought to provide clarity on what is required at a regional and local level to ensure that appropriate and timely decisions are made to deliver sustainable planning for development. The key planning objectives as stated in PPS25 are that:

"Regional Planning Bodies (RPBs) and Local Planning Authorities (LPAs) should prepare and implement planning strategies that help to deliver sustainable development by:

- APPRAISING RISK

Identifying land at risk and the degree of risk of flooding from river, sea and other sources in their areas;

Preparing Regional Flood Risk Assessments (RFRAs) or Strategic Flood Risk Assessments (SFRAs) as appropriate, as freestanding assessments that contribute to the Sustainability Appraisal of their plans;

- MANAGING RISK

Framing policies for the location of development which avoid flood risk to people and property where possible, and manage any residual risk, taking account of the impacts of climate change;

Only permitting development in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and benefits of the development outweigh the risks from flooding

- REDUCING RISK

Safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water, and flood defences;

Reducing flood risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SuDS);

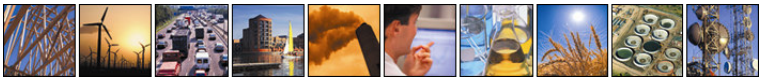
Using opportunities offered by new development to reduce the causes and impacts of flooding, e.g. surface water management plans, making the most of the benefits of green infrastructure for flood storage, conveyance and SuDS, re-creating functional floodplain and setting back defences;

- A PARTNERSHIP APPROACH

Working effectively with the Environment Agency and other operating authorities and other stakeholders to ensure that best use is made of their expertise and information so that plans are effective and decisions on planning applications can be delivered expeditiously and ensuring spatial planning supports flood risk management and emergency planning.

1.3.2 Planning Policy Statement 1: Delivering Sustainable Development

Published in February 2005, this document sets out the overarching planning policies for the delivery of sustainable development across the planning system. PPS1 explicitly states that development plan policies should take account of existing and future flood risk and proposes that new development in areas at risk of flooding should be avoided. Planning authorities are advised to ensure that developments are sustainable, durable and adaptable, and this should be achieved through taking into account natural hazards, such as flooding. PPS1 places an emphasis on *spatial planning* in contrast to the more rigid *land-use planning* approach which it supersedes. It is important for Brentwood's local development plan to recognise the contribution that non-structural measures can make to effective flood management, i.e. a risk avoiding approach advocated by PPS25.



1.3.3 Local Development Plan

Brentwood Replacement Local Plan (2005) guides decisions on planning applications in the Borough. However, the previous Government required the Local Plan to be replaced by a series of documents collectively called the Local Development Framework (LDF). These documents were introduced as a result of the Planning and Compulsory Purchase Act 2004 and accompanying Town and Country Planning Regulations 2004. The new Government has signalled a continued commitment to local plan-making and decision making based on the local development plan and strengthening local community planning powers.

Areas where flooding issues have been identified will require detailed policies and/or constraints in the local development plan. This SFRA will form part of the statutory evidence base to support planning policies and the application of the sequential approach in the context of flood risk.

1.4 The purpose of this Report

The Level 1 SFRA is intended to:

- Identify Main Rivers, ordinary watercourses and flood zones within Brentwood Borough;
- Assess the potential impact of climate change on flood risk;
- Identify areas at risk from other sources of flooding such as surface and ground water;
- Identify flood risk management measures including their location and standard;
- Consider the potential for new development to increase flood risk elsewhere through increased runoff;
- Provide guidance on the application of the Sequential Test; and
- Provide guidance on flood risk management through the design process.

This SFRA covers a relatively large geographic area, encompassing both areas of known flood risk and areas where flood risk is currently not perceived to be a restriction to planning. Nonetheless, Brentwood is a Borough facing significant development pressures, owing to its proximity to London, attractive environment, high quality of life and projected household growth. This SFRA has been prepared to provide guidance to inform the application of the Sequential Test for Brentwood, and sufficient data is provided in the mapping (Appendix A), see Section 1.6, to allow the Council to make informed decisions when processing windfall site applications.

1.5 Flood and Flood and Water Management Act 2010

The information provided in this section has been sourced from http://services.parliament.uk/bills/2009-10/floodandwatermanagement.html (Flood and Water Management Bill 2009-10).

The Flood and Flood and Water Management Act 2010 received Royal Ascent on the 08th April 2010 and is now an Act of Parliament. The Act responds to recent pressure to introduce legislation to address the threat of flooding and water scarcity, both of which are predicted to increase with climate change.

Key areas

- requires the Environment Agency to create a National Flood and Coastal Erosion Risk Management Strategy, which a number of organisations will have to follow
- Lead Local Flood Authorities (LLFAs) which, in this case is Essex County Council, are now responsible for the preparation of the County's Preliminary Flood Risk Assessment (PFRA)
- requires leading Local Flood Authorities to create local flood risk management strategies
- Lead Local Flood Authorities (Essex County Council) are responsible for consenting planning applications within 8m of bank top of Ordinary Watercourses
- enables the Environment Agency and local authorities more easily to carry out flood risk management works
- introduces a more risk-based approach to reservoir management
- changes the arrangements that would apply should a water company go into administration
- enables water companies more easily to control non-essential uses of water, such as the use of hosepipes
- enables water companies to offer concessions to community groups for surface water drainage charges
- requires the use of sustainable drainage systems in certain new developments
- introduces a mandatory building standard for sewers

1.6 Using the SFRA

The SFRA is a tool to inform the spatial planning process and guide safe development, from a flood risk perspective. The information has been presented in such a way to facilitate this objective. Appendix A is a key component of the report, it includes detailed mapping sufficient to inform the application of Sequential Test.

For the purposes of informing the Sequential Test the key pieces of information are:

- Figure A8 in Appendix A in conjunction with Table 3.1;
- Section 3 – Information to support the Sequential Test; and
- Section 4 and 5 – Guidance on appropriate flood risk management.

1.7 Report Structure

The structure of this report is aligned with delivering the key aim of providing information to perform the Sequential Test. As such, the report comprises the following sections:

- Section 1 – provides on overview of the SFRA and sets it within national planning policy. The introduction is also designed to provide guidance on how to extract the most information from the SFRA;
- Section 2 – provides an overview of all the sources of flood risk that have been identified within Brentwood;
- Section 3 – describes flood risk management in Brentwood through the planning process;
- Section 4 – details how flood risk can be managed through the design process;
- Section 5 – outlines the principals of sustainable surface water management in Brentwood;
- Section 6 – describes the need for Flood Risk Assessments (FRAs) and processing windfall site applications;
- Section 7 – summarises the key findings and implications of the SFRA and makes recommendations.

2. Overview of Flood Risks

2.1 Introduction

This section of the report provides the context for the Brentwood SFRA and associated assessments of flood risk undertaken for this study. Assessments undertaken as part of a Level-1 SFRA are not location or site-specific, rather they involve an assessment of each identified source of risk across the whole Borough.

2.2 Responsibility for Watercourses

In England and Wales the Environment Agency retains permissive powers to carry out maintenance and improvement works on watercourses classified as Main River. These are usually larger streams and rivers, but also include smaller watercourses of strategic drainage importance. A main river is defined as a watercourse shown as such on a main river map, and can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river.

All other watercourses are classified as non-main river and the responsibility lies with the riparian landowner although sometimes Councils or internal drainage boards assume responsibility.

A map showing the extent of main river and the associated catchment areas in Brentwood Borough is provided in Figure A2 of Appendix A.

2.3 Flood Zones

Flood Zones are described throughout this SFRA and they refer to flood extent datasets held by the Environment Agency. The Flood Maps are the successor to the Indicative Flood Plain Map (IFM) and have been in the public domain in their current format since October 7th 2004. Since their initial publication, the Agency has worked with consultants to refine these maps through the commissioning of detailed hydraulic modelling projects. Updates to the published datasets are made on a quarterly basis. This section outlines the different Environment Agency Flood Zones.

Figures A4a-4d (in Appendix A) illustrate the extent of the Environment Agency's Indicative Flood Zones 2 and 3 (supplied May 2010). This SFRA uses the Environment Agency's Flood Zone 2 and 3 outlines to represent PPS25 Flood Zone 2 and 3b respectively. PPS25 definitions of the Flood Zones are presented below, please note that in Brentwood Borough, Flood Zone 3b designations have been applied to the entire extent of Flood Zone 3a and to the exclusion buffer surrounding the unmodelled watercourses (See Figure 5 in Appendix A). Further details of the implications of the Flood Zone 3b designation in the Borough, are provided in Section 3.1.

- **Flood Zone 1** – This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (>0.1%). PPS25 considers all uses of land to be appropriate in this Zone; and

- **Flood Zone 2** – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

PPS25 subdivides Flood Zone 3 into Zone 3a and 3b, the PPS25 definitions are presented below:

- **Flood Zone 3a** – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (1%) or a 1 in 200 or greater annual probability of flooding from the sea (> 0.5% in any year; and

- **Flood Zone 3b** – This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone using the mapped flood extent, if available, of land which would flood with an annual probability 1 in 20 (5%) as a basis. In the absence of detailed hydraulic modelling all Flood Zone 3 should be considered 3b until demonstrated otherwise either through revisions to the Flood Map or through site specific flood risk assessments.

Flood Zones are determined without consideration to the presence of flood defences. However, there are no formal flood defence structures operated by the Environment Agency in Brentwood. The Flood Zones are intended to provide an appreciation of potential flood risks that exist, and indicate the areas which should be considered in the planning process.

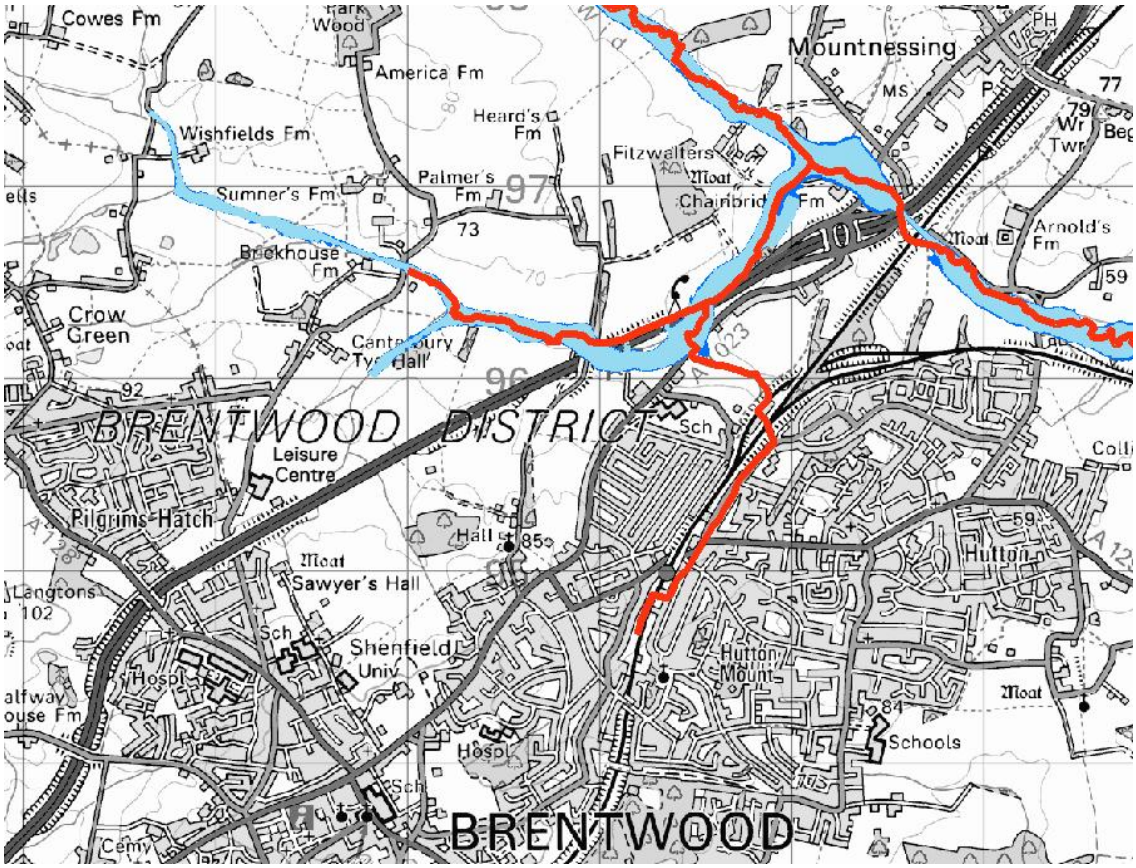
These flood zone extents are subject to change as part of the Environment Agency's ongoing programme of Flood Map improvements. Current Flood Zone extents are sufficient to inform spatial planning; however it is advised that for site specific applications, the Environment Agency always be consulted to ascertain the exact Flood Zone delineation at a given location.

Overall, the Flood Zones are confined close to the watercourses from which they originate and are not extensive in Brentwood Borough. It is possible, however, that there is a flood risk associated with other watercourses in the Borough, which are not currently mapped by the Environment Agency, an example of which is provided in Figure 2.1. Although there is no associated flood zone with this watercourse, it does drain through an urban area and is most likely subject to rapid surface water runoff during storms and channel constrictions such as culverts which may be prone to blockage.

Providing that the Council avoids allocating sites within this 'Exclusion Buffer Zone', there is no requirement for the Council to undertake a Level 2 SFRA in this area.

Windfall development within this 'Exclusion Buffer Zone' should be avoided unless the proposed development is informed by a hydraulic assessment of the watercourse which assessed the potential flood risk. The requirements of this modelling should be agreed with the Environment Agency in advance.

Figure 2.1 Main River (red) and Flood Zones (blue) in north Brentwood



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2.4 Historic Flood Events

Previous flood incidents in Brentwood are largely a result of rapid surface water runoff and ponding in areas such as low lying roads. The last few years in particular have seen numerous incidents of people becoming trapped in their cars due to floodwater in areas such as Ingatestone and on the A12 north of Brentwood. Figures A6 a-d primarily show surface water flood extents (see Section 2.5.4) but they also highlight areas that have been subjected to historic flooding.

It can be seen from Figures A6 a-d that historic flood incidents are distributed throughout the Borough although the majority are located outside Brentwood town itself.

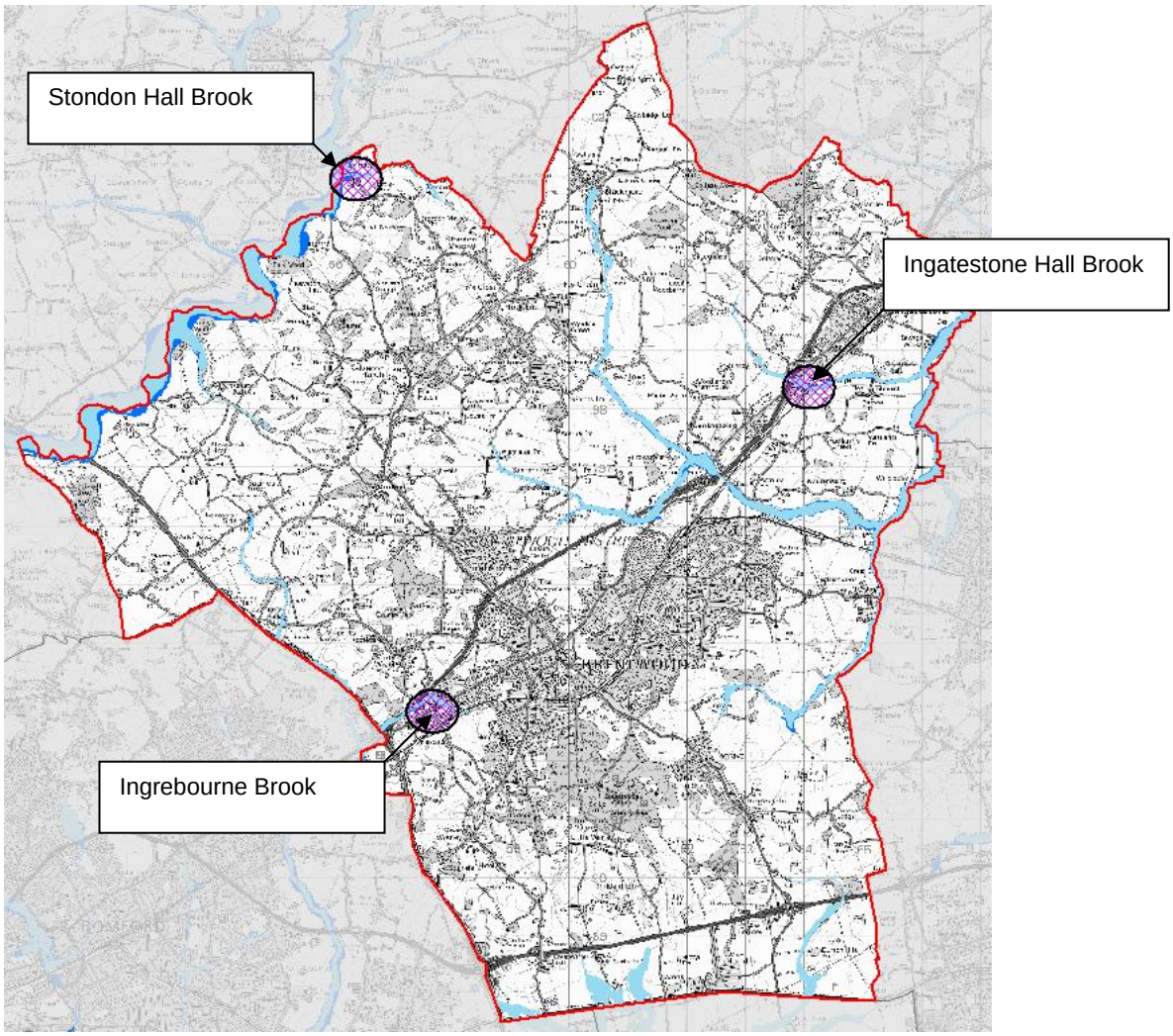
2.5 Source of Flood Risk

2.5.1 Fluvial Flooding

Environment Agency fluvial Flood Zones within Brentwood Borough generally do not extend far beyond the boundaries of the respective watercourses from where the flooding is shown to originate. This is typical for areas located in the headwaters of hydrological catchments where streams tend to be incised and peak flows are smaller than lower in the catchments. Selected locations where mapped Flood Zones coincide with existing development are listed below and shown in Figure 2.2:

- Small areas of Flood Zone area associated with Ingatestone Hall Brook are present near Heybridge, Ingatestone;
- Ingrebourne Brook in the western part of Brentwood town shows Flood Zone extents in the vicinity of London Road, and the A12; and
- Stondon Hall Brook (near confluence with River Roding) in the north west of the Borough shows some Flood Zone extent south of Chipping Ongar.

Figure 2.2 Flood Zones coinciding with existing development (purple hatching)



It should be noted that no detailed hydraulic models exist for watercourses within Brentwood Borough. The mapped Flood Zones are based on the relatively coarse JFLOW model runs undertaken by the Environment Agency, on a national scale for all catchments with an upstream area greater than 3km^2. JFLOW is a type of river model, which produces flood extent predictions without the inclusion of river channel features or structures. This approach was adopted for use in the Environment Agency's national mapping programme. Detailed modelling studies can be used to refine flood extents where the existing resolution is deemed too coarse. Such modelling may be undertaken on main rivers by the Environment Agency as part of their national Strategic Flood Risk Mapping programme. Site specific Flood Risk Assessments (FRAs) may also include detailed modelling at the local scale to refine flood risk information at the site.

Functional Floodplain (Zone 3b)

Flood Zone 3 is typically subdivided into Zones 3a and 3b through use of detailed hydraulic modelling to inform flood extents. As the Environment Agency do not hold any hydraulic river models in Brentwood, it has not been possible to delineate areas of functional floodplain. In line with PPS25 best practice this SFRA recommends that all Flood Zone 3 should be considered 3b until demonstrated otherwise either through revisions to the Flood Map or through site specific flood risk assessments. In line with PPS25 (Table D.3 – Annex D), this approach would exclude all but essential infrastructure (pending application of the Exception Test) and water compatible uses from Flood Zone 3. This designation should remain until that time when either a Level 2 SFRA or a site specific FRA Defines Flood Zones 3a and 3b in the affected sites. The definition of Flood Zones 3a and 3b will be necessary if development is proposed within areas of Flood Zone 3.

2.5.2 Tidal Flooding

Brentwood Borough is not at risk from tidal flooding and this is not considered further in this SFRA.

2.5.3 Groundwater Flooding

Historically, groundwater flooding has not always been considered in sufficient detail in the SFRA process, principally as a result of a lack of data to support strategic level decision making. However, the potential flood risk associated with groundwater flooding is increasingly being recognised.

The South Essex Catchment Flood Management Plan (CFMP) states that there have been no records of groundwater flooding in South Essex although it notes that the areas of Thurrock and Tilbury to the south of Brentwood Borough are at risk from groundwater flooding due to high groundwater levels in the underlying chalk.

Limited groundwater contour data is available for the extreme west of the Borough. These give groundwater levels typically between -10m and 10m AOD where ground levels range from 30m-70m AOD indicating that there is no risk from groundwater flooding.

2.5.4 Surface Water Flooding

Surface water flooding is the term applied to flooding when intense rainfall overwhelms the ability of the land to infiltrate water, or in urban areas for the sewers and road drains to drain the water away, resulting in surface water runoff and consequent flooding. It is a particular problem in urban areas where the excess water will often travel along streets and paths, between and through buildings and across open space. It can result in indiscriminate flooding to properties when not controlled. The high profile flooding across the UK in the summer of 2007 was largely attributed to excess runoff where the capacity of the drains was exceeded by intense summer rain storms and led to the Government commissioning an independent review (see Box 2).

The Environment Agency has produced a map showing 'Areas Susceptible to Surface Water Flooding' (ASSWF). The flood extents are based upon broad assumptions and have been created by simulating direct rainfall onto a digital model of the ground surface and allowing the water to flow and pond according to the terrain. The ASSWF map for Brentwood has been reproduced in Figures A6 a-d in Appendix A with areas known to have previously flooded also indicated. The map is strategic in nature and as such should not be used as the basis for any detailed site design. It does, however, provide a useful indicator as to which areas may be at risk from surface water. For example, where two equally suitable sites are identified for a development in the context of the fluvial flood zones but upon looking at the surface water flood map one of the sites is found to lie on a significant flow pathway then priority should be given to the alternative site. It should be noted that sites lying outside of fluvial flood zones but within surface water risk zones are not precluded from development under current guidance. If such development is to occur then intelligent site design can not only minimise any risk on site but should also be used as an opportunity to reduce and manage flood risk to the surrounding area.

From looking at Figures A6 a-d it can be seen that the settlements of Brentwood, Blackmore, Doddinghurst, Heybridge, Ingatestone may all contain areas which are potentially vulnerable to surface water flooding. Key infrastructure such as the A12 to the north west of Brentwood is also shown to be vulnerable in places and it is known that this road has been flooded by surface water in the past (e.g. March 2010).

Local newspapers report surface water flooding at Ingatestone in the Ingatestone Road and Stock Lane area in February 2010[1] with people becoming trapped in their cars.

Box 2	**The Pitt Review**
In response to widespread and severe flooding in the UK during the summer of 2007, much of it from surface water, the Government commissioned an independent review on the lessons to be learned. The Pitt Review was comprehensive and considered all stages of flooding - preparedness, response and recovery - as well as the coordination, responsibilities, and legislation necessary to ensure the United Kingdom can advance in the area of flood risk management. A total of 92 recommendations were made. Amongst other recommendations the Review emphasised the need to consider surface water flooding in more detail, and recommended that local authorities should take the lead in managing local flood risk. The basis for this should be through a Surface Water Management Plan.	

Requirements for Surface Water Management Plans

This SFRA has mapped the available surface water flood maps and locations where surface water flooding has been an historic issue. The available information on surface water flood risks is not considered to be sufficient to allow for areas requiring Surface Water Management Plans (SWMPs) to be identified. It is recommended that the Council continue to collate records of historic surface water flooding and then evaluate these locations against the

[1] http://www.thisistotalessex.co.uk/news/BRENTWOOD-Flood-rescue-Ingatestone/article-1854813-detail/article.html

Second Generation surface water flood maps which the Environment Agency are due to release before the end of 2010. It is also recommended that this updated mapping is assessed in conjunction with the 'National Receptor Dataset' which the Environment Agency has compiled. Areas where there is an overlap between predicted flood risk, historic records and vulnerable assets and infrastructure should be considered for SWMPs. Full guidance on undertaking a SWMP can be found at:

www.defra.gov.uk/environment/flooding/manage/surfacewater/plans.htm (Surface Water Management Plan Technical Guidance – March 2010. Surface Water Management Plan Technical Guidance (PDF 2.2 MB) and annexes).

2.5.5 Reservoirs

A visual survey of OS50k mapping data has shown that no significant water bodies exist either within Brentwood Borough or at any locations upstream. As outlined in Section 1.2, Brentwood is situated at the head of four river basin catchments and as such residual risk from reservoir failure does not feature as a consideration in this SFRA.

2.6 Flood Management Infrastructure

There are no formal flood defences owned and operated by the Environment Agency within Brentwood Borough, although there are sections of main river where the EA carries out maintenance activities such as along lengths of the River Wid and its associated tributaries.

If planning for future flood risk management infrastructure it is important to be aware of investment and maintenance plans under the wider flood risk management approach. The South Essex Catchment Flood Management Plan (CFMP) identifies long term flood risk management policy and strategy for the wider region with Brentwood Borough being located within an area to which Policy 6 is applied (see below).

'Take action to store water or manage runoff in locations that provide overall flood risk reduction or environmental benefits.'

Source http://publications.environment-agency.gov.uk/pdf/GEAN0909BPCB-e-e.pdf

2.7 Climate Change

Climate change is frequently cited as being one of the most significant threats to the long term sustainability of our environment. It is essential that the likely impact of climate change on the extent of the future Flood Zones is considered if development is to be sustainable over the long term.

PPS25 and Defra Guidance

Defra stated in October 2006 in their *Supplementary Note to Operating Authorities – Climate Change Impacts* that climate change impacts on flooding are a challenge to Local Authorities. Impacts are stated to include sea level rise and a potential increase in intensity and frequency of coastal storms. It is also predicted that rainfall events affecting flooding in fluvial catchments and urban surface water systems will increase in regularity and intensity. Defra's October 2006 supplementary note to Operating Authorities is designed to support the publication of PPS25. It states that:

'Defra's response to climate change impacts is to promote policy guidance based on appropriately precautionary allowances and sensitivity testing to enable Operating Authorities to take climate change impacts into account in planning appraisal, decision making and operations.'

Assessment of Climate Change Impacts

Managing climate change and the associated heightened flood risks are key components of PPS25. This SFRA assesses climate change at the strategic scale by considering its impacts resulting in increased flood extents. All Flood Risk Assessments to be undertaken within the Borough should take into account climate change, for at least the next 100 years, unless it can be demonstrated that the development will have lifespan of less than 100 years in which case a shorter horizon would be considered acceptable, upon agreement with the Environment Agency.

Figures A7 a-d provide an indicative assessment of how climate change may influence the extent of Flood Zone 3. It focuses on the residual difference between Flood Zone 3 and Flood Zone 2. The difference is highlighted to show that in these areas an increase in river flow may result in a notable difference in flood extent.

It can be seen that the only notable areas which may be susceptible to changes in flood extent resulting from climate change are areas associated with the floodplain of the River Roding in the north west of the Borough. There is little existing development in this area.

Spatial Planning Response

All flood risk assessments should factor in an assessment of climate change. If sites are located in or partially within Flood Zones 2 or 3 then the FRA should assess how the 1 in 100 year flood extent will be affected by climate change following guidance laid down in PPS25 and on advice from the Environment Agency. If no such assessment is made then a precautionary approach should be adopted whereby it should be assumed that Flood Zone 2 represents the extent of the 1 in 100 year with climate change design flood.

2.8 Summary of Flood Risks

Flood risk is Brentwood Borough is not extensive and is largely limited to areas in very close proximity to local watercourses. ASSWF maps present the more extensive zone of risk than the fluvial flood zones in Brentwood,

this is because the fluvial flood zones in Brentwood are relatively narrow owing to the 'headwater' nature of most of the watercourses. ASSWF maps are, however, indicative predictions and will be refined when the second generation surface water flood maps are issued by the Environment Agency (due for issue before the end of 2010). The most likely mechanism for surface water runoff generation is when heavy rainfall exceeds the capacity of the local drainage network and of the ground to infiltrate water.

Table 2.1 summarises the nature of flood risk in Brentwood.

Table 2.1 Summary of Flood Risks

Type/Source of Flooding	Risk?	Description
Fluvial Flooding	Yes	Some flooding along eastern boundary of Borough from the River Wid and from Stondon Hall Brook and the River Roding in the north west of the Borough.
Surface Water Flooding	Yes	Affects numerous areas across the Borough. Mostly consists of land drainage issues causing flooding to public highway most notably on the A12 north west of Brentwood and on roads around Ingatestone.
Groundwater Flooding	No	No historic records of this type of flooding within the Borough. Available data suggests this is not thought to be a source of flooding.
Tidal Flooding	No	Elevations put Borough outside of any tidal flood risk zone.

3. Flood Risk Management through Planning

Sections 3 and 4 discuss how flood risk can be managed. The approach outlined in this SFRA follows the sequential risk based approach advocated by PPS25. The SFRA outlines avoidance as the principal method of managing flood risk through the spatial planning process in Section 3. If, in exceptional circumstances, development is proposed in areas of flood risk, the SFRA provides guidance on managing the risk through site layout and building design.

3.1 Sequential Approach

Through the planning process, PPS25 aims to reduce the flood risks faced by future developments, and advocates a risk avoidance approach to spatial planning. Avoidance has always been an option for risk management, but in practice it was rarely deployed. There has recently been a paradigm shift which now prioritises the importance of avoidance. Annex D of PPS25 has been reproduced in Appendix C of this SFRA for reference purposes. A sequential risk-based approach to determining the suitability of land for development in flood risk areas is central to the Policy Statement and should be applied at all levels of the planning process.

Application of the sequential approach to spatial planning reinforces the most effective risk management measure – that of avoidance. PPS25 states that application the Sequential Test at the Local Development Document level, will help ensure that development can be safely and sustainably delivered.

The sequential approach offers a simple decision making tool that is designed to ensure that areas of little or no risk of flooding are developed in preference to areas at higher risk. PPS25 notes that LPAs should make the most appropriate use of land to minimise flood risk, by planning the most vulnerable development in the lowest known risk areas. However, it is recognised that there are cases when development within higher risk zones is unavoidable.

Sites which the Level 1 SFRA has identified as being in Flood Zone 1 should be assessed for delivering projected growth over the plan period, before sites within Flood Zones 2 and 3. Only if there are insufficient sites, or because other sites located within flood risk areas need to be developed for wider sustainability reasons, should sites within Flood Zones 2 and 3 be considered.

3.1.1 Sequential Test

The Sequential Test is a key component of the hierarchical approach to avoiding and managing flood risk. The SFRA has mapped flood risk zones in the Borough (Figures A8 a-d in Appendix A). Table 3.1 presents details of

land use types appropriate[2] for each zone. Further guidance on the appropriateness of land use types for each zone are presented in Table D.2 (in Appendix C) There are several key points that the Council should consider when applying the Sequential Test, these are outlined below.

- Increasing the vulnerability of a site by proposing an alternative use of a higher vulnerability (even if consistent with the risk) is considered an increase in flood risk and not in line with the principals of PPS25;
- The most vulnerable land uses should be allocated first, in areas of least risk; and
- Placing less vulnerable uses in low risk areas and thus reducing the amount of available space for more vulnerable uses in the lower risk zones is not appropriate. Such a situation can only be considered if it can be demonstrated that the only suitable site for the low vulnerability land-use, is in the area of low risk.

Data to Support Application of the Sequential Test

Flood risk classifications defined for Brentwood Borough are presented in Figures A8 a-d (in Appendix A). The Borough is coloured from orange (highest flood risk) to green (lowest flood risk). Table 3.1 presents guidance on appropriate land use guidance for each of the flood risk zones. Figures A8 a-d and Table 3.1 can be used to guide the decision making process when the Council is presented with windfall sites.

In the Borough the SFRA recommends that 'Functional Floodplain' status is applied to all of Flood Zone 3 extent (as described in Section 2.5.1). From a spatial planning and development control perspective, all areas of Flood Zone 3 should have the Flood Zone 3b planning restrictions applied, as per Table D.2 in Appendix C. This designation should remain in place until that time when it is proven otherwise through the use of detailed hydraulic models which adequately define the actual extent of the Functional Floodplain. It is recommended that a 1D-2D linked model would be the most appropriate modelling approach for this. As part of this modelling it is recommended that the model defines the flood depth, velocities and hazard rating associated with flood return periods up to and including the 1 in 100 year (plus climate change) event. This will enable a sequential approach to be applied to the spatial distribution of land uses within the floodplain.

The ASSWF maps can also be used in the application of the Sequential Test, if there are two otherwise equally suitable sites available for allocation in Flood Zone 1. The ASSWF map should be used to steer development away from areas potentially at risk of surface water flooding.

[2] appropriate = as defined by Table D.2 in PPS25

Table 3.1 Attribution of Flood Risk to Development Sites

Environment Agency Flood Zone Name (as per Figures A8 a-b)	Probability	Brentwood Flood Zone Designation	PPS25 Land use Guidance
Flood Zone 3*	Functional Flood Plain	Zone 3b	Only the water compatible uses and essential infrastructure listed in Table D.2 (Appendix D) should be permitted in this zone. Development should be designed and constructed in such a way to: remain operational and safe for users in times of flood; result in no net loss of floodplain storage; not impede water flows; and not increase flood risk elsewhere Essential Infrastructure in this zone should pass the Exception Test
Flood Zone 2	Medium	Zone 2	Water compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone. Subject to the Sequential Test being applied, the highly vulnerable uses in table D.2 are only appropriate in this zone if the Exception Test is passed. All development proposals in this zone should be accompanied by a FRA
Flood Zone 1	Low	Zone 1	All uses of land are appropriate in this zone. Other sources of flooding should be reviewed. FRAs are required for sites over 1ha and Drainage Impact Assessments are required for sites over 0.25 ha (See Section 5.1)

Guidance for zones 3b, 3a, 2 and 1 based on Table D.1 in PPS25

The colours in Table 3.1 reflect the colours illustrated on Figures A8 a-d (in Appendix A)

*The distinction between Flood Zone 3a and 3b has not been made. Therefore all of Flood Zone 3 has assumed the definition of Functional Floodplain – see section 2.5.1 for further details.

Other Sources of Flooding

When considering the Sequential Test, the potential extent of surface water flow routes and ponding areas (Figures A6 a-d, Appendix A) should be reviewed. If there are two otherwise equally suitable sites for development in Flood Zone 1, with one site identified as being potentially at risk of surface water flooding and the other site outside the potential zone of surface water flood risk, then the site outside the potential surface water flooding risk zone should be preferentially selected for development.

Figures A6 a-d (in Appendix A) can also be used to inform site specific FRAs as to where there may be a risk posed by surface water.

Implications for Brentwood Borough

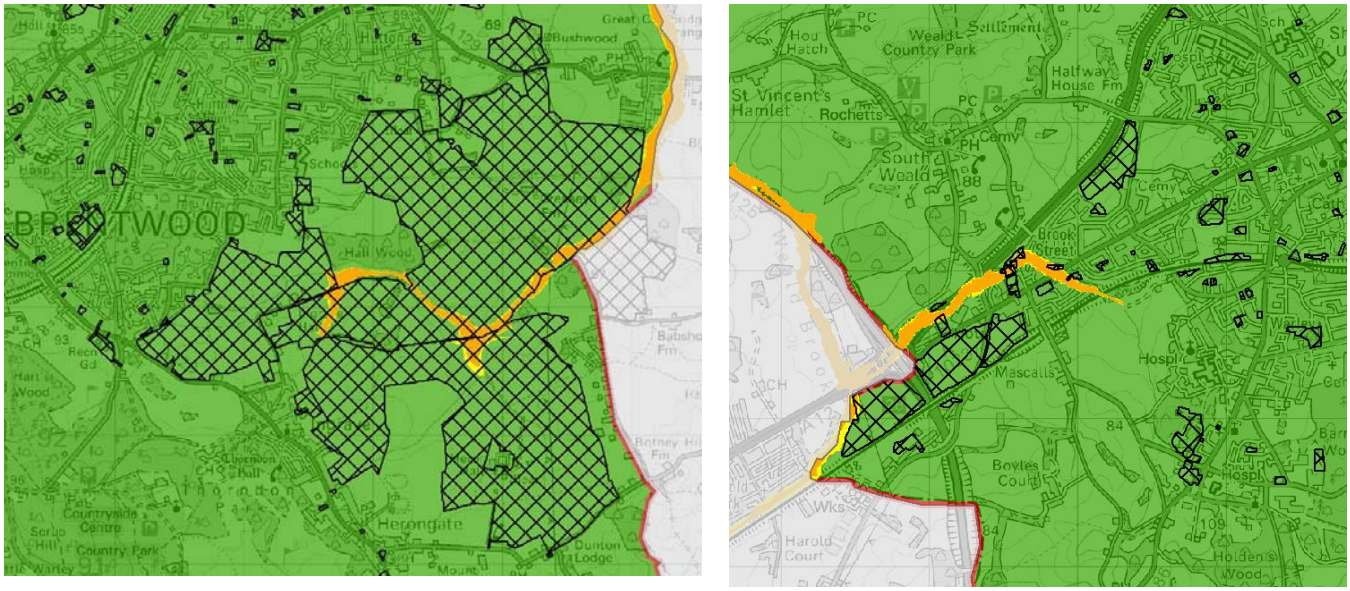
Figures A8 a-d (Appendix A) draw on information from Brentwood's draft Strategic Housing Land Availability Assessment regarding potential development sites and discounted sites. They show the vast majority of sites lie outside Flood Zones 2 and 3 meaning that all development is suitable at these locations with regard to fluvial flood risk.

Figure 3.1 also illustrates sites identified through the SHLAA on greenfield land to the east of Brentwood urban area which lie partly within Flood Zones 2 and 3 associated with Haveringsgrove Brook. These sites have the majority of land area in Flood Zone 1. In the event that these sites are taken forward, site selection and design should prioritise zone 1 development over development in Zones 2 and 3.

Some development sites to the west of the Brentwood urban area (River Road and London Road area) are shown to lie partly within Flood Zones 2 and 3, see Figure 3.1.

With all of Flood Zone 3 being classified as functional floodplain this imposes limitations on the types of development which are appropriate in this zone. All development proposed in Zone 3 will need to undergo a Flood Risk Assessment which will delineate Flood Zones 3a and 3b and determine what proportion of the site falls within each one. Where a single development site spans multiple Flood Zones then a sequential approach should be sought within the site whereby development is allocated firstly to areas of lower risk. This is covered in further detail in Section 4.2.

Figure 3.1 SHLAA Sites potential and discounted (hatched on map) east and west of Brentwood which coincide with Flood Zones 2 and 3. These examples of affected sites are intended to illustrate how the mapping and Table 3.1 can be used in conjunction with one another.



3.1.2 Exception Test

The PPS25 Exception Test recognises that there will be some exceptional circumstances when development within higher risk zones is unavoidable, although this is unlikely to be the case in Brentwood. The allocation of necessary development must still follow the sequential approach and where exceptions are proposed, the Exception Test must be satisfied.

Instances where FRAs are required to support the planning applications are discussed in Section 6. Flood mitigation measures should be considered as early as possible in the design development process to reduce and manage the flood risks associated with development. Section 4 describes how flood risk can be managed through development design.

Passing the Exception Test

To pass the Exception Test three key criteria must be met. These criteria and the sources of supporting information are presented in Table 3.2.

Table 3.2 Exception Test Guidance

Part	Criteria	Guidance
A	It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the DPD has reached the 'submission stage' – the benefits of the development should contribute to the Core Strategy.	Review site against aims and objectives of SA and LDD
B	The development should be on previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land	Planning Policy Statement 3
C	A FRA must demonstrate that the development will be safe, without increasing flood risk else where, and where possible reduce the overall flood risk.	Refer to Section 6 of this report.

Criteria based on paragraph D9 of PPS25

PPS25 states that the Exception Test should be undertaken but only after the Sequential Test has been applied. The Sequential Test successively applied must demonstrate that there are no other reasonably alternative sites available in zones of lower flood risk. This is an essential evidence base and should be considered a prerequisite for any development proposed in a zone of flood risk. Once the Sequential Test has been applied and passed, PPS25 requires the Exception Test to then demonstrate that the development provides wider sustainability benefits to the community that outweigh the flood risks. Where development is essential in a flood risk zone, PPS25 requires it to be on previously developed land, if this is not possible it must be demonstrated that there are no reasonable

alternative sites on developable previously developed land. The final requirement of the Exception Test states that the development must be safe, without increasing the flood risk elsewhere and where possible reduce overall flood risk. This is expanded on below and Section 4 of this SFRA provides design principals to inform safe development.

Part C of the Exception Test

Part C of the Exception Test requires a FRA, demonstrating that the proposed development will be safe, without increasing the flood risk elsewhere. To achieve this, PPS25 identifies a number of factors which need to be considered:

- Safe access and egress;
- Operation and maintenance;
- Design of development to manage and reduce flood risk wherever possible;
- Resident awareness;
- Flood warning; and
- Evacuation procedures and funding arrangements.

These key aspects are expanded in Section 4, where flood risk management is discussed in terms of design and emergency responses.

4. Flood Risk Management through Design

This section only applies to development within Flood Zones 2 and 3. As outlined in Section 2.5.1, all of Flood Zone 3 is designated 'Functional Floodplain'. This designation should be observed as part of any development proposal. Any development within Flood Zone 3 must be supported with hydraulic modelling which assesses the flood hazard, depths and velocities associated with a range of return periods up to and including the 1 in 100 year plus climate change return period. The hydraulic modelling should define the extent of Flood Zone 3b. The requirements of the modelling should be agreed with the Local Planning Authority (LPA) and the Environment Agency in advance.

Only when the flood risks are fully understood and where the principal of avoidance has been first applied, should flood risk management be attempted through design. This section of the SFRA presents flood risk management measures appropriate in Flood Zones 2 and 3. This is supplementary guidance to that provided in PPS25 and the PPS25 Companion Guide. In all instances where development is proposed in areas of flood risk, it is recommended that the LPA and the Environment Agency are consulted early in the process to establish any site specific issues and requirements. Guidance on the scope of FRAs and useful sources of additional information are provided in Section 6 of this SFRA.

4.1 Approach

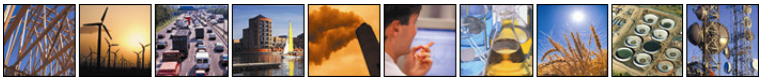
Flood risk management by design should only be considered after the sequential approach has been applied to development proposals. The sequential approach is applicable both in terms of site allocation and site layout. Only when it has been established that there are no suitable alternative options in lower risk areas, should building design solutions be considered to facilitate development in flood risk areas.

The sequential approach to land use planning on sites can mitigate some of the flood risks. However, there will be instances where a level of risk remains. In these circumstances, flood risk management through design is required. This would need to be addressed as part of site-specific FRA. The following sections provide some over-arching guidance when considering planning applications.

4.2 Site Layout

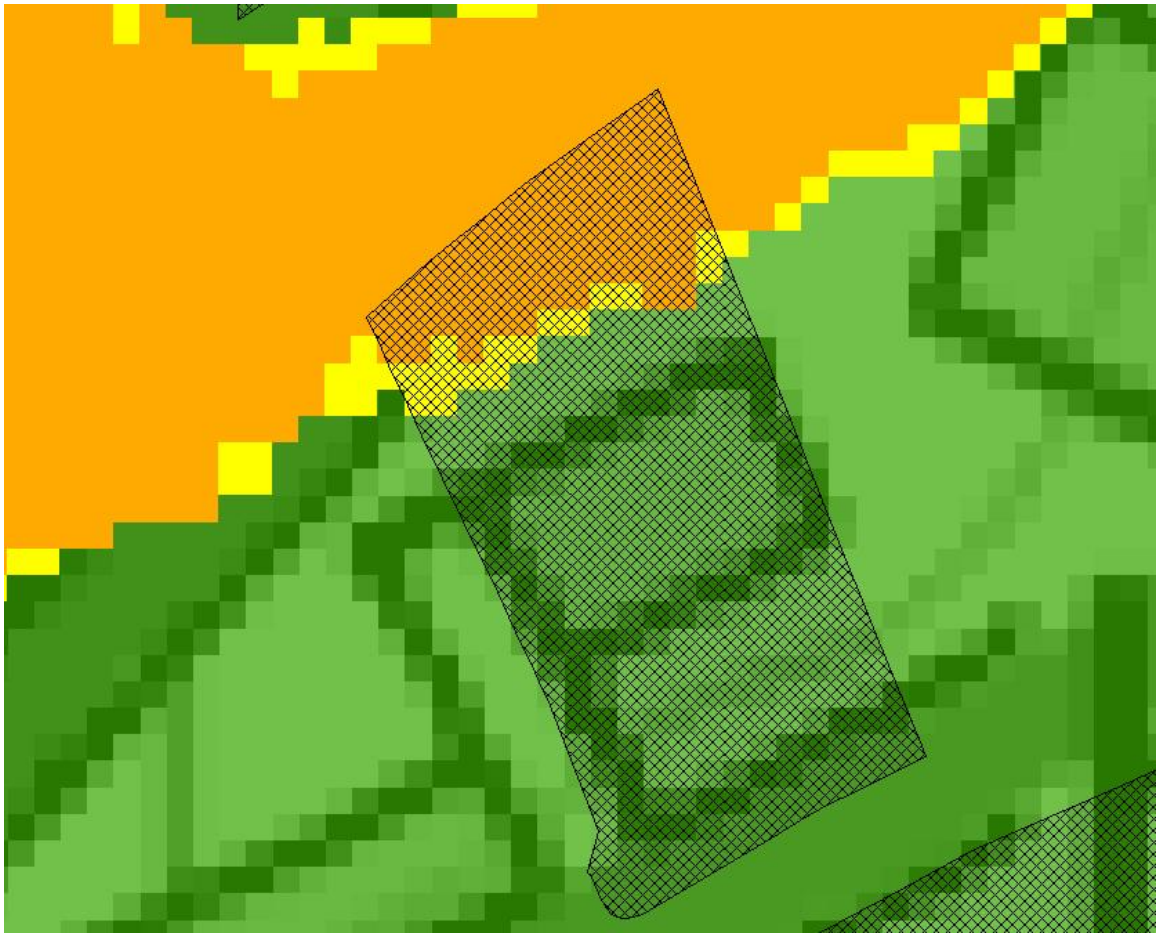
Following the full application of the Sequential Test, a site may be proposed for development within a medium to high flood risk zone. The sequential approach to the spatial distribution of land uses on site should be deployed ahead of building design solutions (See Sections 6.6 to 6.14 in the PPS25 Practice Guide).

Figure 4.1 can be used to illustrate the sequential approach to site design in the context of flood risk for one of the SHLAA sites to the west of Brentwood which lies partially within Flood Zones 2 and 3. It can be seen from Figure 4.1 that the majority of the site lies outside the higher risk Zones 2 and 3 (shown in yellow and orange



respectively). The northern part of the site falls within an area of identified risk. Detailed modelling undertaken as part of a site specific Flood Risk Assessment would allow refinement of the predicted flood extents, however it is likely that the pattern of flood zoning will be broadly similar. Land use planning at the site level should aim to reflect the differing degrees of flood risk in the vulnerability classifications of proposed land uses (see Table D.2. – Annex D PPS25), Based on the existing flood zoning, depicted in Figure 4.1, where identified flood risk decreases from north to south, this would ideally see water compatible uses placed in the north of the site, less vulnerable uses occupying the Flood Zone 2 areas and any more or highly vulnerable uses being placed in the area of low flood risk in the middle and south of the site. In this instance, water compatible uses may include public open space which could be designed to form a dual function and also provide a local surface water management function, e.g. attenuation.

Figure 4.1 Example site identified in the draft SHLAA*



Flood Zone 3 shown in orange (Functional Flood Zone designations to be applied), Flood Zone 2 in yellow. All land in Flood Zone 1 is shown in green.

*As defined in Brentwood Draft SHLAA

4.3 Evacuation Routes

In exceptional circumstances, pending successful application of the Sequential Test, development may be proposed in areas of flood risk. In such an event, safe escape routes to outside the flood risk zone should be incorporated into site designs to facilitate safe evacuation of the site. Additional detailed modelling of watercourses may be required to provide the necessary flood levels and speeds of onset and flood hazard classifications needed to inform safe evacuation routes. Safe routes should be identified both inside and beyond the site boundary of the new development. Even where a new development is above the floodplain and is considered to be acceptable with regard to its impact on flood flows and flood storage, it should be demonstrated that the routes to and from the development are also safe to use. Safe escape routes should be intuitively designed, so that they remain logical routes of escape during a flood event. In many cases, the adaptation of the *normal* access and egress routes, so that they remain safe during a flood event, may be the preferable option. This would remove the need for engineering additional access and egress routes specifically for use in flood events. The evaluation of 'safe' should be determined in consultation with the LPA and the Environment Agency and following a review of the Defra FD2320/TR1[3] report which provides a classification of flood hazard and risk to people. Where possible, new development should aim to provide dry escape for the lifetime of the development.

4.4 Development Controls

Under exceptional circumstances, following the application of the Sequential Test, where development is proposed in areas of flood risk, it will be necessary for the design to incorporate certain flood risk management elements. The following paragraphs describe some of these control measures.

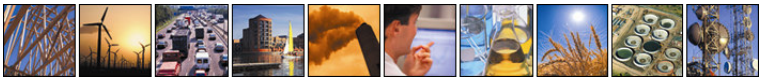
Development in Fluvial Flood Risk Areas

Figure A2 (in Appendix A), illustrates the extent of the Environment Agency's main rivers. To ensure that flood risk is considered as part of a development along the banks of any of these watercourses, a buffer zone along both banks has been implemented by the Environment Agency. The Environment Agency's policy is that any proposed development within 8 metres of the bank of a main river, or 16 metres from the landward toe of any fluvial flood defence requires Environment Agency consultation. All development proposals within this zone should involve consultation with the Environment Agency.

Development Controls may include

- The FD2320/TR1 Report Section 7.5.3. This states that 'New developments are required to provide **safe access and exit during a flood**'. Measures by which this will be achieved should be clear in the

[3] Flood Risk Assessment Guidance for New Development, Phase 2, R&d Technical Report FD2320/TR1, Defra/Environment Agency, October 2005.



site-specific FRA. Safe access and exit is required to enable the evacuation of people from the development, provide the emergency services with access to the development during a flood and enable flood defence authorities to carry out necessary duties during the period of flood. A safe access or exit route is a route that is safe for use by occupiers without the intervention of the emergency services. FD2320/TR1 emphasises that a route can only be completely safe in flood risk terms if it is dry at all times. However it is recognised that this is not always practicable, necessitating more detailed analysis.

- **Finished floor levels** of more vulnerable uses should be above the predicted 1 in 100 year water levels plus climate change and inclusive of a freeboard allowance. The freeboard allowance used may be site specific and will depend on developers' discussions with the LPA and the Environment Agency. Typically freeboard is 300mm if the site is behind hard defences and 600mm if not. Ideally less vulnerable land uses should also have floor levels that do not flood and this arrangement should be sought where ever possible.

- **The footprint of buildings** should not be increased post re-development without mitigation to compensate for lost floodplain storage space. Such schemes should be discussed in detail with the LPA and the Environment Agency.

- **Compensatory storage** will be required if the proposed development increases the built footprint in the floodplain. The resulting loss of floodplain storage will require compensation, through the lowering of land levels elsewhere within the site. Compensation should be provided for flood events less than and including the 1 in 100 year plus climate change event. Storage should be provided on a level for level and volume for volume basis, so that the behaviour of the floodplain during a flood event remains unchanged. All proposals requiring compensatory storage should be discussed with the LPA and the Environment Agency.

Development in Areas Designated as Functional Floodplain (Zone 3b)

- **Development in the functional floodplain should be avoided in line with the Sequential Approach presented in PPS25**. Only water compatible uses will be permitted providing there is no reduction on flood conveyance or flood storage. Less vulnerable, More vulnerable and Highly vulnerable uses are not permitted in Zone 3b. Essential Infrastructure may be permitted providing the Exception Test is satisfied.

Development in Surface Water Flood Risk Areas

- **In accordance with PPS25, any new development proposed in Flood Zones 2 and 3, or on sites greater than 1 hectare, must include a site-specific FRA**, which will be reviewed by the Environment Agency. It is recommended that the site threshold for triggering a **Drainage Impact Assessment as part of a Planning Application is 0.25 hectares**. These Drainage Impact Assessments should be inclusive of a consideration of surface water drainage and measures to mitigate against any potential increase in run off. In addition to this, Figures A6 a-d should be reviewed to assess whether the site is within a zone of potential surface water flood risk. As part of these assessments, the respective water company (Anglian Water or Thames Water) should be contacted to discuss the proposed method of managing surface water;

- **Site specific FRAs should consider the local drainage infrastructure in detail**. When preparing site specific FRAs the impact of blocked drains and the likely consequences should be established. If necessary it might be appropriate to slightly raise ground floor levels to reduce potential damages. This is not a requirement of PPS25, it is just a means of reducing the impact of a potential risk. Such mitigation should be supported by evidence to demonstrate that surface water flow routes are not altered to the extent that the risk of flooding is made worse elsewhere;

- **An area identified at risk from surface water flooding** – either from flood mapping or from historical records – should not be excluded from development solely on that basis. Surface water flooding can often be carefully managed and good site design may not only reduce the risk of flooding on site but could also help alleviate flooding problems downstream from the development. Such opportunities for a strategic drainage approach are being developed as part of emerging Surface Water Management Plans; and

- **The management of runoff during the construction period** is an important consideration, particularly for large sites and details of measures to mitigate for this phase of development are required as part of an FRA. The Water Framework Directive (WFD) places specific requirements on the management of non-point source pollution such as that from construction site silts. Methods to reduce the volume of solids (and runoff) leaving the site include:

  - Phased removal of surface vegetation at the appropriate construction phase;
  - Provision of a grass buffer strip around the construction site and along watercourses;
  - The covering of stored materials;
  - Ensuring exposed soil is re-vegetated as soon as feasibly possible;
  - Protection of storm water drain inlets; and
  - Silt fences, siltation ponds and wheel washes.

4.4.1 Consideration of Climate Change

Managing climate change and the associated heightened flood risks are key components of PPS25. Site specific FRAs should take into account climate change, for at least the next 100 years, unless it can be demonstrated that the development will have lifespan of less than 100 years in which case a shorter horizon would be considered acceptable, upon agreement with the LPA and the Environment Agency.

The potential impacts of climate change on river flows in Brentwood have been strategically assessed as part of this Level 1 SFRA. Further detail is provided in Section 2.

4.4.2 Basements

It is recommended that habitable rooms in basements should not be permitted in Flood Zones 2 or 3. Adaptation of existing properties, to include a basement for habitable rooms should be discouraged in Flood Zones 2 and 3. It is however recognised that the implementation of this may be challenging, as basement development is sometimes classified as Permitted Development when within the bounds of the existing building.

Basements for less vulnerable uses or non habitable rooms must be designed with safe internal escape. Each application should be discussed with the LPA and the Environment Agency. Site specific analysis should accompany any proposal, to demonstrate that a proposed basement would not impede the flow of groundwater in such a way that the risk of groundwater flooding elsewhere is increased.

4.5 Building Design

The final step in the flood risk management hierarchy is to mitigate through building design. PPS25 considers this as the least preferred option and should not be used in place of the sequential approach to land use planning on a site.

The Department for Communities and Local Government[4] has published guidance on improving the flood performance of New Buildings. The guide identifies a hierarchy of building design which fits within step 5 of the flood risk management hierarchy of PPS25 Practice Guide (June 2008). The other steps in the Practice Guide are assess, avoid, substitute and control, and need to have been considered first before using the building design hierarchy. This is set out below:

Flood Avoidance

Constructing a building and its surrounds (at site level) to avoid it being flooded (e.g. by raising it above the flood level).

Flood Resistance

Constructing a building in such a way to prevent flood water entering the building and damaging its fabric.

[4] Improving the Flood Performance of New Buildings – Flood Resilient Construction', *Communities and Local Government* (2007)

Flood Resilience

Constructing a building in such a way that although flood water may enter the building its impact is reduced (i.e. no permanent damage is caused, structural integrity is maintained and drying and cleaning are facilitated).

Flood Reparable

Constructing a building in such a way that although flood water enters a building, elements that are damaged by flood water can be easily repaired or replaced.

The Flood Resilient Construction Report, sets out to help the designer determine the best option or design strategy for flood management at the building site level, based on knowledge of basic flood parameters (e.g. depth, duration and frequency), these factors would normally be determined by the site specific FRA during the planning application process. Depending on these parameters (in particular depth) and after utilising options for flood avoidance at site level, designers may opt for a water exclusion strategy or a water entry strategy, as illustrated in Figure 4.2.

Figure 4.2 Flexible and risk averse approaches to flood risk management and safe development

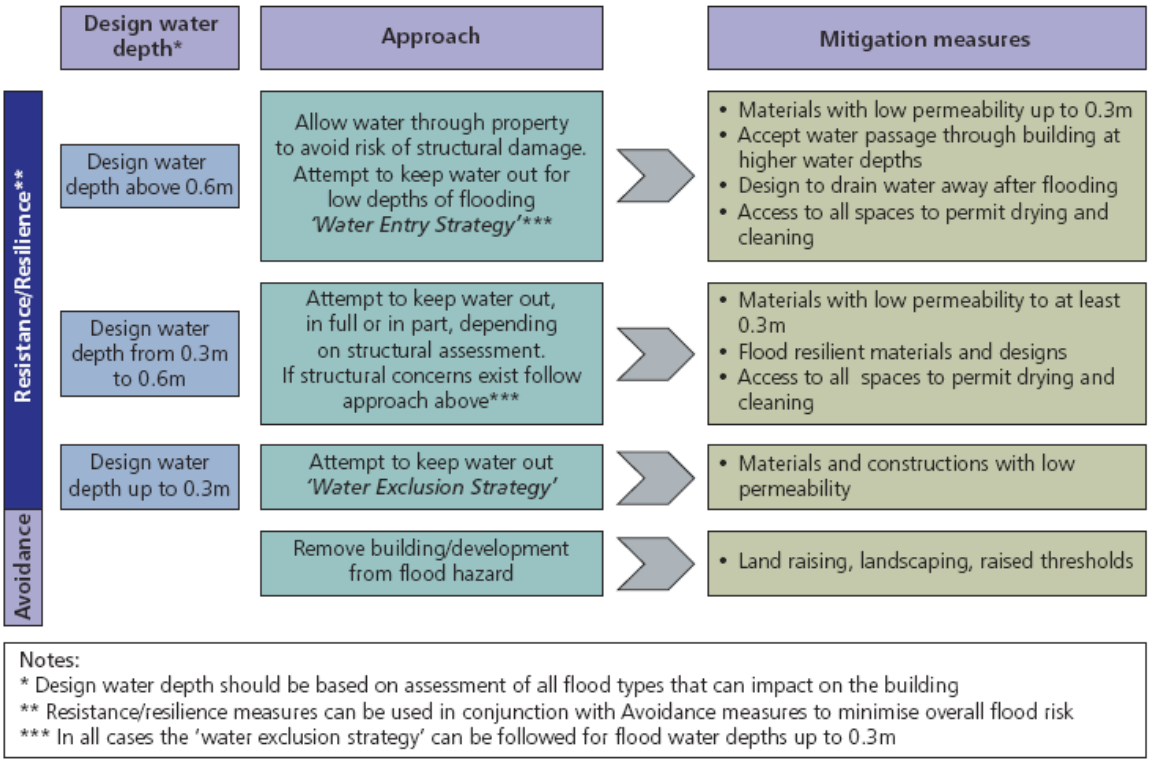


Figure Taken from 'Improving the Flood Performance of New Buildings – Flood Resilient Construction', Communities and Local Government (2007)

In a **Water Exclusion Strategy**, emphasis is placed on minimising water entry whilst maintaining structural integrity, and using materials and construction techniques to facilitate drying and cleaning. This strategy is favoured when low flood water depths are involved (up to a possible maximum of 0.6m).

In a **Water Entry Strategy**, emphasis is placed on allowing water into the building facilitating draining and consequent drying. Standard masonry buildings are at significant risk of structural damage if there is a water level difference between outside and inside the building of about 0.6m or more. This strategy is therefore favoured when high flood water depths are involved.

5. Sustainable Surface Water Management

PPS25 states that surface runoff is an important consideration in the assessment of flood risk and must be addressed at the SFRA and FRA level. Historically surface water drainage, in urban areas, utilised underground piped systems to remove excess water from the surface as rapidly as possible. The sole reliance on piped networks is now recognised as no longer the most sustainable means of managing surface water. The free discharge of storm water into the piped network has the potential to increase flooding in downstream areas. Additionally, pipe systems are not designed for extreme floods (greater than the 1 in 30 year) and combined with the potential for blockage, often result in surface water flooding issues. Furthermore, this traditional approach creates direct pathways by which pollutants from urban areas may discharge directly into watercourses or percolate into aquifers.

Recent policy changes now place a far greater emphasis on sustainable management of surface water, different approaches are therefore required. PPS25 identifies the sustainable management of surface water as an opportunity to reduce flood risk, manage water quality and provide integrated amenity and ecological benefits, through the use of Sustainable Drainage Systems (SuDS) within developments.

5.1 Surface Water Management and SuDS in Brentwood

PPS25 requires surface runoff to not be increased post development. For those sites where there is currently a large amount of hard standing, the attenuation volumes to meet the requirements of PPS25 will be small. Nevertheless, the SFRA recommends that in all instances, opportunities to seek a betterment of existing runoff rates and volumes should be encouraged by the LPA. Creative site and building design should allow for the incorporation of sustainable surface water management measures to attenuate runoff rates and volumes, regardless of the scale of the development.

Sites greater than 1 hectare in size in Flood Zone 1, and all development within Flood Zones 2 and 3 are covered by the legislation presented in PPS25, which dictates a FRA must accompany a planning application. This SFRA also recommends that planning applications for sites over 0.25 hectares in Flood Zone 1 are supported by drainage impact assessments. From a drainage perspective, these FRAs and Drainage Impact Assessments needs to detail how surface water is currently managed on site and how it is proposed to be managed post development. The discharge route (e.g. surface water drains or an open watercourse) should be detailed and it is important that there is evidence of either water company or Environment Agency consultation which includes approval of the discharge. These assessments should describe how current run off rates and volumes are managed, for brownfield site development this should include details of how rates and volumes will be reduced. If a reduction in runoff rates and volumes is not proposed the assessment must provide evidence to explain why this cannot be achieved.

Essex County Council are the Lead Local Flood Authority and in this role they will be required to act as SuDS approval body. The mechanism for this approval process should be established between Brentwood Borough Council and the County Council.

5.1.1 Surface Water Runoff Rates in Brentwood

A minimum requirement of PPS25 is that post development rates of runoff must not exceed pre-development runoff rates. Furthermore, the Environment Agency and the Council should seek to reduce runoff rates wherever possible. Given the wider sustainability aims of PPS1 and specific requirements of PPS25, particular attention should be paid to the use of SuDS.

5.2 Selecting Appropriate SuDS Techniques

The applicability of SuDS techniques for use on potential development sites should based on an assessment of the following key influences, put forward by CIRIA (2007)[5]:

- **Land use characteristics** favour different SuDS techniques. For example, industrial sites where pollution could be an issue are best managed with attenuation SuDS over infiltration SuDS, with multiple treatment stages;
- **Catchment characteristics** may have a bearing of the choice of SuDS, as particular catchments may be regulated for a sensitivity to flooding or pollution and may potentially be aggravated by one SuDS technique compared to another; and
- **Quantity and quality performance** would guide the choice of a particular SuDS technique and is dependant upon the requirements.

Chapter 5 of the SuDS Manual by CIRIA (2007) provides further details regarding these key influences, and is recommended as a supporting document to this SFRA. Proposed and existing land-uses are thought to be a significant factor, as these influence the volume of water required to be attenuated. Existing or historic land uses have the potential to influence the choice of SuDS techniques by informing the likelihood of pollution and potential contamination issues. Indications of the most suitable techniques for individual sites cannot be made at a strategic level, however, since these will be governed by site specific characteristics and other considerations. Therefore, site specific FRAs and Surface Water Drainage Assessments will provide the required recommendations. The applicability of SuDS techniques can only be assessed in the SFRA through the consideration of regional characteristics relating to the underlying geology.

The selection of the appropriate technique(s) is/are dependant on various factors. These include the following (CIRIA, 2007):

- ***Soils*** – soil permeability has a significant bearing on the choice of infiltration SuDS techniques;

[5] The Construction Industry Research and Information Association (CIRIA). *The SuDS Manual - CIRIA Report C697*. (2007). CIRIA London, UK.

- ***Groundwater*** – infiltration techniques require several metres of soil depth between the base of the device and the maximum expected groundwater level;
- ***Area draining to single SuDS component*** – vegetative or filtering SuDS can attenuate smaller volumes of runoff than ponds which can handle larger volumes generated from a bigger area;
- ***Slope of drainage area*** – steeper slopes reduce the suitability of some SuDS techniques, such as infiltration, which require longer residence times; and
- ***Head*** – SuDS that require gravity to operate will require a positive head between inflow and outflow.

Table B1 (in Appendix B) CIRIA (2007) provides a summary of influential site characteristics which should be assessed at the site specific level.

5.2.1 Source Protection Zones

The Environment Agency has defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply[6]. SPZs are further subdivided into the following categories:

- SPZ1 (Inner SPZ – 50 day travel time or 50 metres): designed to protect against the effects of human activity which might have an immediate effect upon the source. SPZ1 was originally based on the need to protect against biological contaminants;
- SPZ2 (Outer SPZ – 400 day travel time or at least 25% of the recharge catchment area): designed to provide protection against slowly degrading pollutants; and
- SPZ3 (Catchment SPZ): covers the complete catchment area of the groundwater source.

In Brentwood Borough there are no SPZs and so there is no associated constraint on use of infiltration SuDS.

5.2.2 Groundwater Vulnerability in Brentwood

Groundwater Vulnerability is a dataset held by the Environment Agency which maps the presence of aquifers and assesses the overlying soil type to determine infiltration potential. As of 01 April 2010 the aquifer categories ‘major’ and ‘minor’ have been replaced by ‘principal’ and ‘secondary’ to be consistent with the Water Framework Directive.

[6] Environment Agency, Groundwater Protection: Policy and Practice, Part 4: Legislation and Policies Public Consultation 2007.

Principal Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Secondary Aquifers include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage.

Figure A9 (in Appendix A) outlines Groundwater Vulnerability classifications in Brentwood Borough. This dataset indicates that there are no areas underlain by principal (major) aquifers with secondary (minor) aquifiers covering the majority of the area of Brentwood Borough. Soil classes indicate that there is a high potential for leachate infiltration for much of the urban area of Brentwood and for smaller areas along the north western border of the Borough. The majority of the Borough has medium to low infiltration potential or does not contain aquifers.

The groundwater vulnerability classification has been used as a surrogate for identifying land where infiltration potential is likely to be high and therefore where infiltration SuDS may be appropriate. The resulting map is shown in Figure A10 (Appendix A). Areas identified as being of 'high' suitability correspond to areas containing more permeable soil types which have the potential to receive more infiltration. Areas identified as being of 'low' suitability are likely to contain clayey soils or soils of a shallow nature which may reduce the volume and/or rate at which water can be infiltrated. The areas of 'no data' are characterised by London Clay, according to the 1:50,000 scale BGS Geology mapping. London Clay typically has low infiltration rates.

5.2.3 Restrictions and Controls on the use of SuDS

In locations where infiltration techniques are not appropriate, solutions that attenuate runoff and discharge to surface water (the fluvial water bodies or surface water sewers) are likely to be the most appropriate. Such schemes will require consultation with the sewage undertaker (Anglian Water or Thames Water) to determine discharge rates and with the Environment Agency if it is proposed to discharge into a fluvial water body.

5.3 Using the SFRA to Inform SuDS suitability

Infiltration/discharge to groundwater SuDS techniques are considered amongst the most sustainable solutions as maintenance requirements are comparatively low and the systems do not discharge to watercourses or the sewage undertakers piped drainage network. When considering the suitability of infiltration techniques the following Figures (in Appendix A) should be consulted.

- **Figure A9 – Groundwater Vulnerability**. Less suitable in areas of high vulnerability, pollution control measures will be required; and
- **Figure A10 – Infiltration Potential**. This map is based upon the infiltration potential of soils according to the EA groundwater vulnerability map which itself is derived from the HOST (Hydrology Of Soil Types) database. Higher potentials are areas where the soils/geology will more likely allow

greater rates of infiltration. The areas of 'no data' are characterised by London Clay, according to the 1:50,000 scale BGS Geology mapping. London Clay typifies by low infiltration rates.

The SFRA mapping does not preclude the need to undertake site specific investigations and consultation with the Environment Agency. Issues of ground contamination, ground water pollution and technical feasibility will all have to be addressed at the site specific level.

5.4 Choice of SuDS

Appendix B outlines the range of possible SuDS options available, each offering different benefits. In selecting the most appropriate SuDS scheme for a new development consideration should be given to:

- The long term sustainability of the design;
- How water quality can be improved; and
- How biodiversity can be enhanced.

Oversized pipes and underground storage cells should be considered only when all other, more beneficial solutions, have been exhausted.

6. Flood Risk Assessments and Windfall Sites

6.1 Site Specific Flood Risk Assessments

Table 6.1 provides a clear instruction to developers and planning officers as to where a Flood Risk Assessment (FRA) is required in Brentwood. The decision process is shown as a flowchart in Figure 6.1. Should any one of the criteria listed in Table 6.1 apply to the site in question then, a FRA needs to be prepared to accompany a planning application. PPS25 should then be referred to, to establish the scope of the FRA and the Environment Agency should also be consulted.

Figure A8 (in Appendix A) should be reviewed in consultation with Table 6.1, as it defines the zones of flood risk that are referred to.

The following links to the Environment Agency provide additional information:

www.environment-agency.gov.uk/research/planning/82587.aspx (FRSA for use by planning applicants and their agents)

http://www.environment-agency.gov.uk/research/planning/82584.aspx (Flood Risk Standing Advice for England - PPS25 National Version 2.0)

http://www.environment-agency.gov.uk/static/documents/Research/pps25factsheet_1657913.pdf (Environment Agency summary note on PPS25)

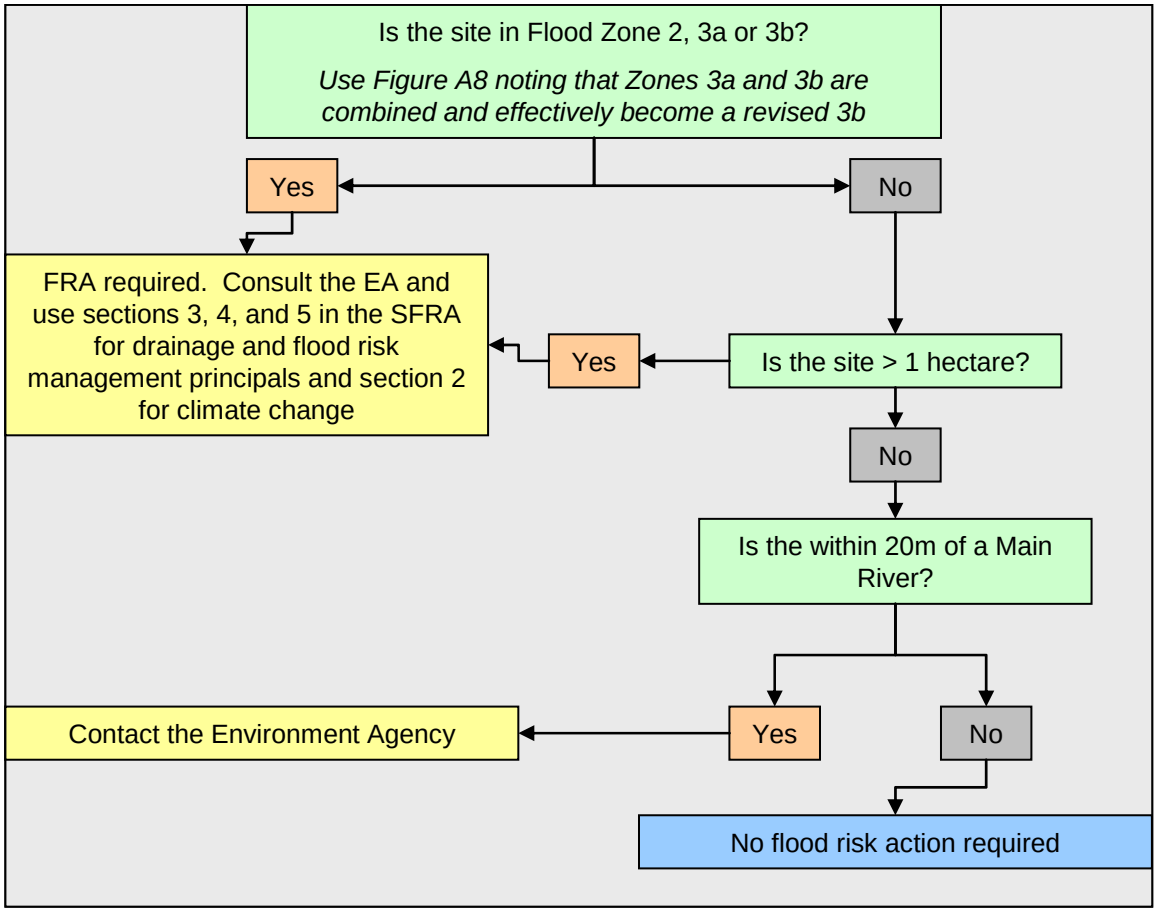
Table 6.1 When is a FRA required?

Criteria Requiring a FRA	FRA Required (Yes/No)	Scope of the FRA
In Flood Zone 3b[1]	Yes	Follow the requirements of PPS25
In Flood Zone 3a	Yes	Follow the requirements of PPS25
In Flood Zone 2	Yes	Follow the requirements of PPS25
Greater than 1 hectare in Flood Zone 1	Yes	Follow the requirements of PPS25.

1 Zone 3b has not been delineated as part of this study. Assume all Flood Zone 3 is 3b until proved otherwise.

In all cases, the FRA or Drainage Assessment must follow the SuDS hierarchy in the selection of an appropriate SuDS technique. A piped solution will only be acceptable if it can be demonstrated that more sustainable SuDS techniques are not feasible.

Figure 6.1 Determining if an FRA is required



6.2 Windfall Sites

It is highly likely that there will always be windfall development, and these sites will need to be assessed. Brentwood's emerging local development plan will identify the target areas for growth and redevelopment. The appropriateness for sites outside these areas will need to be addressed on a site by site basis. Proposed windfall development should pass the Sequential Test and Exception Test if required. Additionally, the sequential approach to flood risk management will be required within the development site, and this will need to be addressed within the development proposals and accompanying FRAs.

For windfall sites, and sites not included in the SFRA assessment, the Environment Agency Flood Zones should be used in conjunction with Table 3.1.

7. Recommendations for the Local Development Plan or Framework

The Level 1 SFRA has assessed flood risks from all sources and advocated a sequential risk based approach to managing flood risk, which is in line with the guiding principals presented in PPS25, the primary objective of which is to steer new development towards areas of least flood risk. This section summarises the recommendations for consideration in the spatial planning process and in the management of flood risks, it also identifies situations/events which might trigger the need to either update the SFRA or undertake additional flood risk assessment work.

7.1 Recommendations

Throughout the SFRA there are a number of recommendations relating to the management of flood risk within the Borough of Brentwood. These key recommendations, for inclusion in the Local Development Plan or Framework, are summarised below:

- Aim to reserve land in Flood Zone 1 for essential infrastructure and where possible highly vulnerable and more vulnerable land uses;
- Should the Council wish to allocate sites with an identified flood risk, then the policy should either be to avoid the areas of flood risk or to assess the risk in more detail through either Level 2 SFRA work or on a site specific level. This more detailed review should include identification of Flood Zone 3b and it should assess flood hazard and depth for return periods up to and including the 1 in 100 year plus climate change event;
- In the absence of a Level 2 Assessment, windfall sites in Flood Zones 2 and 3 should not be accepted unless they include a detailed review of potential flood risks. This will need to include detailed hydraulic modelling;
- Sites within the 'Exclusion Buffer Zone' around unmodelled watercourses should be avoided. The development of such sites should only be conceded following a hydraulic assessment of the likely flood risks from these currently unmodelled watercourses;
- Manage flood risk through avoidance of risk where possible;
- Follow the Sequential approach advocated in PPS25 and Section 3 of the SFRA;
- Site design in fluvial floodplains should facilitate safe escape;
- An emergency evacuation procedure should be implemented for those sites which can feasibly be designed to allow for evacuation out of the flood risk zone. Evacuation procedures should be reviewed and approved by the LPA prior to the issue of planning consent;

- All new development should attempt to reduce surface water runoff by sustainably managing runoff on site. Flood risk must not increase post development; and
- All new development greater than 1 hectare in size and all new development in Flood Zones 2 and 3 are required to undertake a Flood Risk Assessment. This should consider flood risk from all sources and include an assessment of climate change.

7.2 Triggers for Re-visiting the SFRA Process

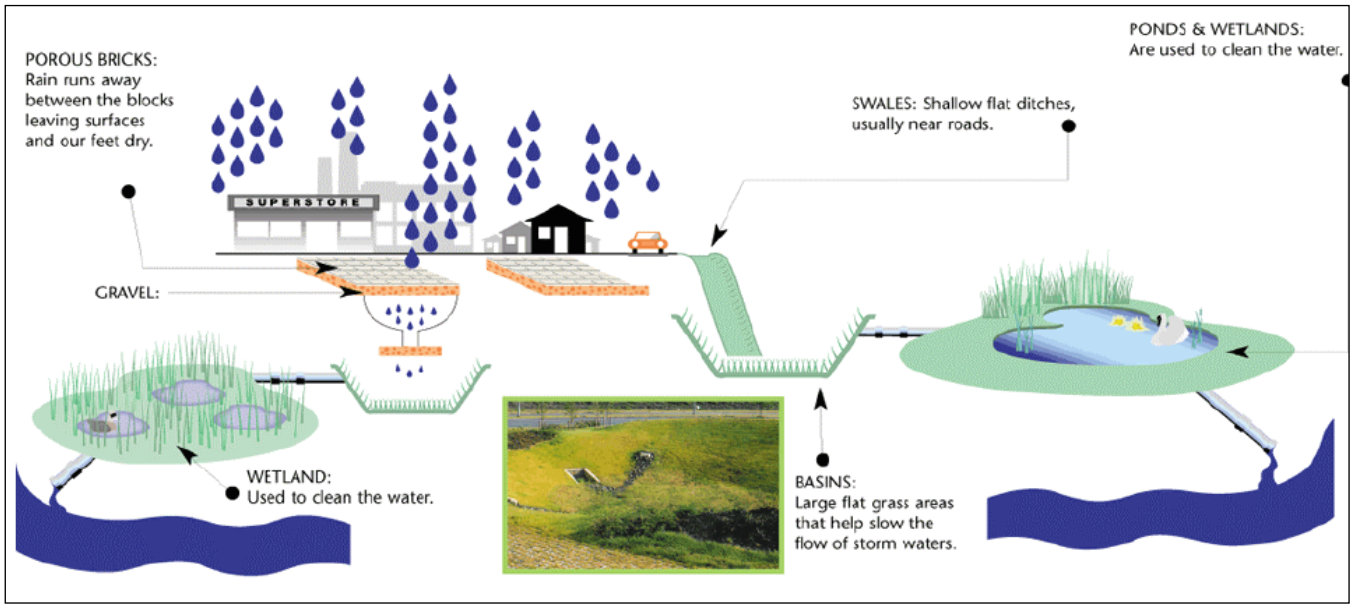
The list below identifies key events which could trigger the need for an SFRA update or additional flood risk assessment. This list is not exhaustive and it is recommended that the Council undertakes regular consultation with the Environment Agency so as to ensure that an up to date evidence base is maintained. The following ought to be considered:

- An update of the National Flood Zones in Brentwood;
- A significant revision or replacement of PPS25;
- The Final SHLAA produces a significantly different set of sites to those assessed in this SFRA; and
- A shift away from the policy of 'avoidance' resulting in development being planned for areas of flood risk, or if development is planned in the areas adjacent to unmodelled watercourses.

Appendix A
Mapping Appendix – Supplied in separate document

Appendix B
SuDS Guidance

Figure B1 Likely Implementation of SuDS Management Train



Source of this Graphic = Greater Dublin Strategic Drainage Strategy (2005)

http://www.dublincity.ie/WaterWasteEnvironment/WasteWater/Drainage/GreaterDublinStrategicDrainageStudy/Pages/RegionalDrainagePolicies-OverallPolicyDocument.aspx

Table B1 Influential site characteristics on the applicability of SuDS (Modified after CIRIA 2007)

SuDS Group	Technique	Soils		Area draining to a single SuDS component		Minimum depth to water table		Site slope		Available head	
		Impermeable	Permeable	0 – 2 ha	> 2 ha	0 – 1 m	> 1 m	0 – 5%	> 5 %	0-1 m	1 – 2 m
Retention	**Retention pond**	Y	Y[1]	Y	Y[5]	Y[2]	Y[2]	Y	Y	Y	Y
	Subsurface storage	Y	Y	Y	Y[5]	Y[2]	Y[2]	Y	Y	Y	Y
Wetland	**Shallow wetland**	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y
	Extended detention wetland	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y
	Pond/wetland	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y
	Pocket wetland	Y[2]	Y[4]	Y[4]	N	Y[2]	Y[2]	Y	N	Y	Y
	Submerged gravel wetland	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y
	Wetland channel	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y
Infiltration	**Infiltration trench**	N	Y	Y	N	N	Y	Y	Y	Y	N
	Infiltration basin	N	Y	Y	Y[5]	N	Y	Y	Y	Y	N
	Soakaway	N	Y	Y	N	N	Y	Y	Y	Y	N
Filtration	**Surface sand filter**	Y	Y	Y	Y[5]	N	Y	Y	N	N	Y
	Sub-surface sand filter	Y	Y	Y	N	N	Y	Y	N	N	Y
	Perimeter sand filter	Y	Y	Y	N	N	Y	Y	N	Y	Y
	Bioretention/filter strips	Y	Y	Y	N	N	Y	Y	N	Y	Y
	Filter trench	Y	Y[1]	Y	N	N	Y	Y	N	Y	Y
Detention	**Detention basin**	Y	Y[1]	Y	Y[5]	N	Y	Y	Y	N	Y
Open channels	**Conveyance swale**	Y	Y	Y	N	N	Y	Y	N[3]	Y	N
	Enhanced dry swale	Y	Y	Y	N	N	Y	Y	N[3]	Y	N
	Enhanced wet swale	Y[2]	Y[4]	Y	N	Y	Y	Y	N[3]	Y	N
Source control	**Green roof**	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
	Rainwater harvesting	Y	Y	Y	N	Y	Y	Y	Y	Y	
	Permeable pavement	Y	Y	Y	Y	N	Y	Y	N	Y	Y

Y = Yes

N = No

Y1 = with liner

Y3 = Unless follows contours

Y4 = With liner and constant surface baseflow, or high ground water table

Y5 = possible, but not recommended (appropriate management train not in place)

Y2 = with surface baseflow Y6 = Where high flows are diverted around SuDS component

Additional policy and general guidance on SuDS and drainage include the following:

- PPS25 Practice Guide, 2007;
- Water Framework Directive (200/60/EC);
- Highways Act, 1980;
- Town and Country Planning Act, 1990;
- Town and Country Planning Act, 1990 (amended) NB covers S106 Agreements;
- Town and Country Planning Act, 1991;
- Construction, Design and Management Regulations, 1994;
- Building Regulations Part C Approved Document H – Drainage and Waste Disposal of the Building Regulations 2002 Amendment;
- ODPM 2004. Planning Policy Statement 1: *Delivering Sustainable Development*;
- Communities and Local Government, 2006. Planning Policy Statement 25: *Development and Flood Risk*;
- Communities and Local Government, 2007. *Development and Flood Risk: A practice guide companion to PPS25*;
- BRE Digest 365 Soakaway Design BSE EN 752-4: 1998 Drain and Sewer Systems outside buildings, part 4;
- CIRIA. Sustainable Drainage Systems – Hydraulic, Structural and water quality advice (CIRIA 609);
- CIRIA. The SUDS Manual (CIRIA C697);
- CIRIA. *Source control using constructed previous surfaces. Hydraulic, structural and water quality performance issues* (CIRIA 582);
- CIRIA. *Infiltration Drainage – manual of good practice* (CIRIA R156);
- CIRIA. *Review of the design and management of constructed wetlands* (CIRIA R180);
- CIRIA. *Control of pollution from highway drainage discharge* (CIRIA R142);
- CIRIA. *Design of flood storage reservoirs* (CIRIA Book 14);
- CIRIA. *Designing for exceedance in urban drainage systems – good practice* (CIRIA C635);

- CIRIA. *Rainwater and grey-water use in buildings* (CIRIA C539);
- Defra, 2004. *Making Space for Water – Developing a new Government strategy for flood and coastal erosion risk management in England: A Consultation Exercise;*
- Defra, 2005. *Making Space for Water – Taking forward a new Government strategy for flood and coastal erosion risk management in England: First Government response to the Autumn 2004;*
- Defra, 2006. *Urban Flood Risk and Integrated Drainage*. Scoping report and pilot studies;
- Environment Agency, 2003. Harvesting rainwater for domestic uses: an information guide;
- HR Wallingford. Use of SUDS in high density development;
- National SUDS Working Group, 2006. Interim Code of Practice for SUDS; and
- WRc. Sewers for Adoption 6th Edition (SfA6) (published by Water UK).

Appendix C
Tables D.1, D.2 & D.3 – Reproduced from Annex D PPS25

Table D.1: Flood Zones

(Note: These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences)

Zone 1 Low Probability

Definition

This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

Appropriate uses

All uses of land are appropriate in this zone.

FRA requirements

For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Table D.1: contd.

Zone 2 Medium Probability

Definition

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Appropriate uses

The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone.

Subject to the Sequential Test being applied, the highly vulnerable uses in Table D.2 are only appropriate in this zone if the Exception Test (see para. D.9.) is passed.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to 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.

Zone 3a High Probability

Definition

This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Appropriate uses

The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone.

The highly vulnerable uses in Table D.2 should not be permitted in this zone.

The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.9) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Table D.2: Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
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.[19]
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.[20] • Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.
Less Vulnerable	• 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 plants. • Sewage treatment plants (if adequate pollution control measures are in place).

[19] DETR Circular 04/00 – para. 18: *Planning controls for hazardous substances.* www.communities.gov.uk/index.asp?id=1144377

[20] See *Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10* for definition. www.communities.gov.uk/index.asp?id=1500757

Table D.2: contd.

Water-compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence 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**.

Notes:

1) This classification is based partly on Defra/Environment Agency research on Flood Risks to People (FD2321/TR2)[21] and also on the need of some uses to keep functioning during flooding.

2) Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

3) The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

Table D.3[22]: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Floodplain'	Exception Test required	✔	✗	✗	✗

Key:

✔ Development is appropriate

✗ Development should not be permitted