

1 INTRODUCTION AND USER GUIDE

1.1 Introduction

1.1.1 The National Planning Policy Framework (NPPF)¹ and associated Planning Practice Guidance for Flood Risk and Coastal Change² emphasise the active role Local Planning Authorities (LPAs) such as the London Borough of Camden (LBC) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process.

1.1.2 LBC is distinctive in its lack of main rivers and resultant location entirely within Fluvial Flood Zone 1, where all areas have a less than 1 in 1000 annual probability of flooding from fluvial sources, as classified by the Environment Agency. However whilst the risk of flooding from fluvial sources is negligible within LBC, there is a risk of flooding from other sources such as surface water, groundwater, sewers and artificial sources such as reservoirs and canals.

1.1.3 The NPPF outlines that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA) and LPAs should use the findings to inform strategic land use planning. Figure 1.1 overleaf, reproduced from the Planning Practice Guidance, illustrates how flood risk should be taken into account in the preparation of the Local Plan for LBC.

1.1.4 The purpose of the SFRA is to collate and present the most up to date flood risk information for use by LBC to inform the preparation of robust planning documents as part of the Camden Local Plan and prudent decision-making by Development Management officers on a day-to-day basis.

1.1.5 As stated in the LBC Local Development Scheme³, the Local Plan is currently made up of the following adopted documents:

- Camden Core Strategy (adopted 2010);
- Camden Development Policies (adopted 2010);
- Site Allocations (adopted 2013);
- Statement of Community Involvement (2011);
- a range of supplementary guidance documents.

1.1.6 In order to achieve this, the SFRA will inform the application of the Sequential and Exception Tests in the allocation of future development sites, as required by the NPPF, taking into account all sources of flooding.

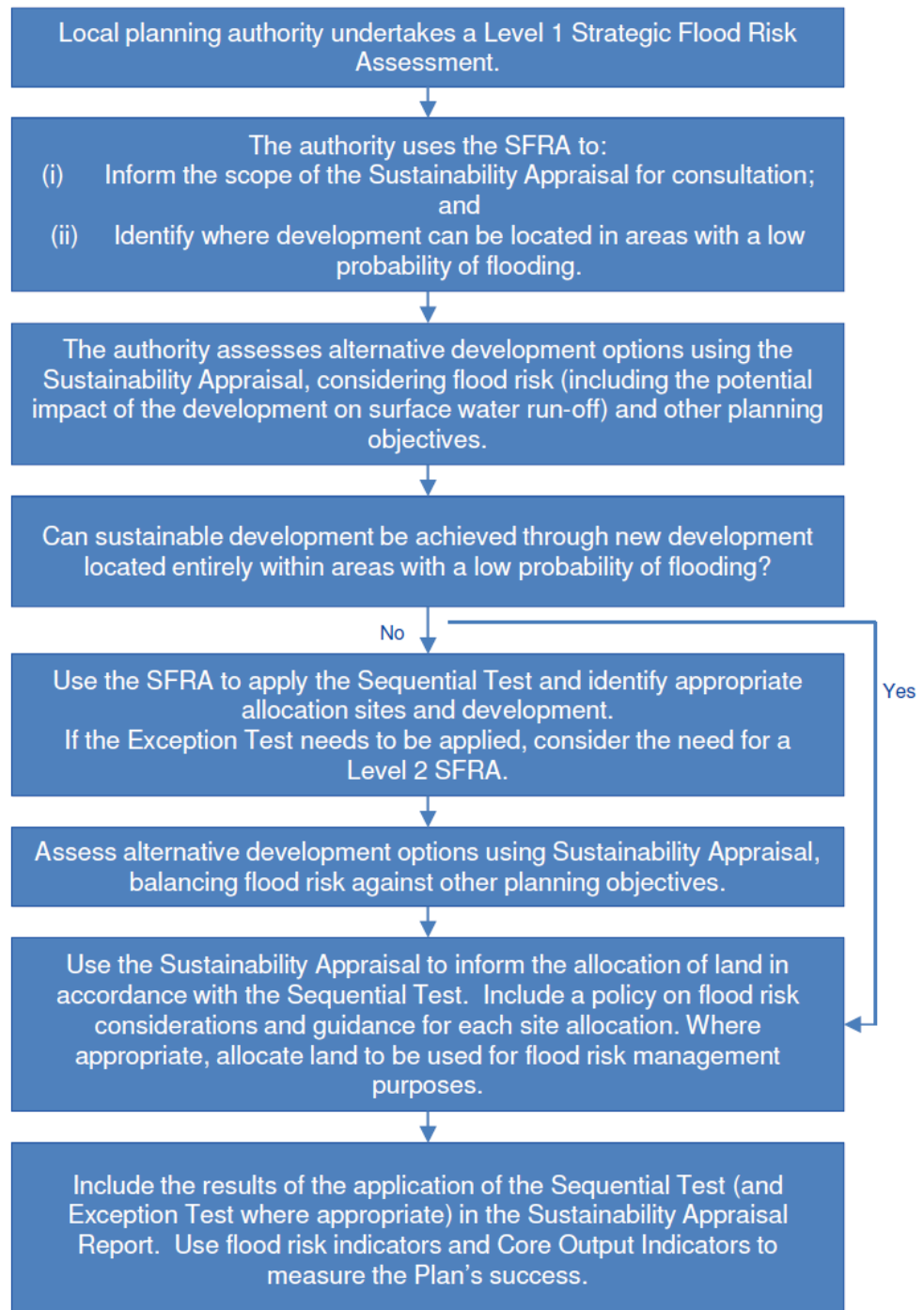


Figure 1.1- Taking flood risk into account in the preparation of a Local Plan (Planning Practice Guidance for Flood Risk and Coastal Change, p6)

1.2 User Guide

1.2.1 It is anticipated that the SFRA will have a number of end users, with slightly different requirements. This Section describes how to use the SFRA and how to navigate the report and mapping deliverables.

1.2.2 The LBC SFRA report is set out as follows:

- Section 2: Policy and Local Context
- Section 3: SFRA Methodology
- Section 4: Strategic Assessment of Flood Risk
- Section 5: Guidance on the application of the Sequential and Exception Tests
- Section 6: Guidance for preparing Site Specific FRAs
- Section 7: Sustainable Drainage Systems
- Section 8: Policy Options
- Appendix A: Data Register
- Appendix B: Flood Risk Mapping

Strategic Planning and Policy

1.2.3 The chief purpose of the SFRA for LBC, in accordance with the NPPF, is to provide a strategic overview of flood risk within the borough to enable effective risk-based strategic planning for the future through the preparation of the Local Plan.

1.2.4 The information presented in Section 4 should be used by LBC to inform their knowledge of flooding and flood risk from all sources, throughout the borough.

1.2.5 As part of the SFRA, a number of policy options have been developed for the borough and are presented in Section 8. These should be taken forward to inform the application of the Sequential Test and Exception Test during the process of allocating development within the borough.

1.3 Applying the Sequential Test

1.3.1 The NPPF sets strict tests to protect people and property from flooding which all LPAs are expected to follow. The aim of the Sequential Test under the NPPF is to steer new development to areas with the lowest probability of flooding. Section 4 provides the data required to undertake the Sequential Test and Section 5 provides specific guidance on applying both the Sequential and, where appropriate, Exception Tests.

1.4 Emergency Planning

1.4.1 LBC is a Category 1 Responder under the Civil Contingencies Act 2004⁴ and therefore has a responsibility, along with other organisations, for developing emergency plans to help reduce, control or ease the effects of an emergency.

1.4.2 The complex nature of flooding and the consequences that arise require a comprehensive and often sustained response from a wide range of organisations, and as such LBC has prepared a Multi-Agency Flood Plan (MAFP) to allow all responding parties to work together in a coordinated response to severe flooding.

1.4.3 The SFRA deliverables should be used by the LBC Emergency Planning team as a useful resource providing up to date information about flood risk. The SFRA should be reviewed by the team so that, where appropriate, the findings are incorporated into their understanding of flood risk and future revisions of the MAFP.

1.5 Preparing Site Specific FRAs

1.5.1 For those preparing site specific Flood Risk Assessments (FRAs) for individual development sites, the strategic review provided by the SFRA provides a useful starting point.

- Section 4 provides an overview of the key issues within the borough in relation to flood risk.
- Section 5 provides guidance on the application of the Sequential Test for sites that have not been tested by the LPA, as well as details on when the Exception Test is required and how to apply it.
- Section 6 provides specific guidance for preparing site specific FRAs in accordance with the checklist presented in the Planning Practice Guidance. Recommendations are provided for potential mitigation and resilience measures that may need to be addressed.

1.6 Assessing Planning Applications

1.6.1 Planning and development officers who are reviewing FRAs as part of the planning application process should consult Section 4 of the SFRA to provide the background for flood risk in the area relating to the planning application. Section 6 can also be used by those assessing applications as a checklist for issues that need to be addressed as part of site specific FRAs.

2 POLICY AND LOCAL CONTEXT

2.1 National Policy

The Flood Risk Regulations (December 2009)

2.1.1 The Flood Risk Regulations⁵ came into force on the 10th December 2009 and sets out duties for the Environment Agency and LLFAs in the preparation of a range of reports and mapping outputs.

2.1.2 The Flood Risk Regulations (2009) transpose the EU Floods Directive (2007/60/EC)⁶ into UK Law. One of the main impacts on LLFAs in England and Wales is that they are required to complete Preliminary Flood Risk Assessments (PFRAs). Where Flood Risk Areas were defined within the PFRA it is required that Flood Risk maps showing the extents and hazards of flooding are produced alongside the Flood Risk Management Plans. The LBC is a LLFA and is responsible for preparing the following:

- A PFRA report for flooding from sources other than from the sea, main rivers and reservoirs, which was completed in 2011;
- Determining whether there is a significant flood risk in the LLFA area in line with the Environment Agency's guidance⁷ and identify the part of the area, if any, where this risk exists (for sources other than that from sea, main rivers and reservoirs); and
- Where a Flood Risk Area is identified there is a requirement to prepare flood hazard and flood risk maps for these areas for publication by the Environment Agency. In addition, for these areas, a Flood Risk Management Plan must be prepared for publication by the Environment Agency by 22nd December 2015.

The Flood and Water Management Act (2010)

2.1.3 Following the devastating national floods of 2007, one of the recommendations from Sir Michael Pitt's review⁸ was that *"the role of local authorities should be enhanced so that they take on responsibility for leading the co-ordination of flood risk management in their areas"*.

2.1.4 The Flood and Water Management Act (FWMA) (2010)⁹ brings in new roles and responsibilities for local authorities. In particular, the Act defines the role of the LLFA, which includes Unitary Authorities or County Councils. LLFAs are encouraged to bring together relevant bodies and stakeholders to effectively manage local flood risk, which may include County, City and District/Borough Councils, Internal Drainage Boards (IDBs), highways authorities, water companies and the Environment Agency.

2.1.5 The new responsibilities the Act assigns to LLFAs include:

- Coordinated management of flooding from surface water, ground water and ordinary watercourses;
- Development, maintenance and implementation of a Flood Risk Management Strategy;
- Investigation and recording of local flood events;
- Establishment and maintenance of a Flood Risk Asset Register; and,
- Ordinary watercourse regulation.

2.1.6 The Act gives LLFAs the role of Sustainable Drainage Systems (SuDS) Approval Body (SAB) where the LLFA is responsible for adopting and maintaining SuDS. This means that planning applications which have drainage implications will need to be approved by the SAB before work can commence.

Draft National Standards for Sustainable Drainage Systems (SuDS) – Designing, constructing, operating and maintaining drainage for surface runoff (2011)

2.1.7 Schedule 3 (Sustainable Drainage) of the Flood and Water Management Act 2010 contains new regulations which have implications on the design, approval and adoption of sustainable drainage. The Draft National Standards for SuDS¹⁰ were published for consultationⁱ in December 2011. The Draft Standards have been developed in order to define a standardised approach to management of surface water runoff from the design stage all the way through to maintenance of such schemes, in accordance with Schedule 3 to the Flood and Water Management Act 2010. Further to the consultation, the Government plans to implement the sustainable drainage provisions i.e. publish the National Standards for SuDS and associated guidance with a proposed commencement of the statutory instruments by the end of 2014. At the time of writing this SFRA, the final National Standards are yet to be published.

2.1.8 Once finalised, the Government will ensure that the National Standards (currently in draft) for SuDS are consistent with the Building Regulations and Code for Sustainable Homes.

ⁱ The consultation on the Implementation of the Sustainable Drainage Systems provisions in Schedule 3 – Flood and Water Management Act 2010 closed on 13th March 2012.

- 2.1.9 Future developments will have to comply with the National Standards (currently in draft) with a requirement for the submission of a separate drainage application to the LLFA who also act as the SAB. It is the intention that where SuDS serve more than a single propertyⁱⁱ and are designed to new national standards, the LLFA will adopt the approved drainage system provided that three conditions are met:
- The drainage system is constructed in pursuance of approval;
 - The drainage system is constructed and functions in accordance with approval; and
 - The drainage system is a sustainable drainage system.
- 2.1.10 The Summary of Consultation Responses¹¹ (2012) indicated that the majority of respondents to the consultation exercise carried out for the Draft National Standards for SuDS document thought that the definition of 'single property' with regards to adoption of SuDS was either unclear or incorrect. Defra will therefore look to clarify this definition when the final National Standards are published.
- 2.1.11 The Draft National Standards define SuDS for adoption as those parts of a drainage system that are not vested in a sewerage undertaker pursuant to an agreement under section 104 of the Water Industry Act 1991¹². A developer can therefore request that the SAB adopts drainage systems which serve more than one property and cannot be adopted by the sewerage undertaker. It should also be noted that the draft proposal still requires the Highways Authorities to adopt drainage associated with publically maintained roads.
- 2.1.12 The Flood and Water Management Act 2010 amends Section 106¹³ of the Water Industry Act 1991 by introducing a new Section 106A which removes the automatic right to connect to a surface water sewer. Connection will depend on the drainage system being approved to meet new National Standards for SUDS and only approved SuDS systems will have the right to do so.
- 2.1.13 The principal strategy for the management of surface water runoff is contained within the Draft National Standards for SuDS and follows existing legislation (such as Building Regulations Part H3¹⁴).

ⁱⁱ Defined in the Summary of Consultation Responses to the Draft National Standard for SuDS as: "a drainage system or any part of a drainage system is to be treated as designed only to provide drainage for a single property if it is designed to provide drainage for any buildings or other structures that, following completion of the construction work, will be owned, managed or controlled by a single person or two or more persons together".

National Planning Policy Framework (2012)

- 2.1.14 The NPPF was published on 27th March 2012 together with accompanying Technical Guidance¹⁵. The NPPF revoked most of the previous Planning Policy Statements (PPS) and Planning Policy Guidance, including *PPS25: Development and Flood Risk Practice Guide*¹⁶. However, NPPF did not revoke the PPS25 Practice Guide. This was revoked on the 6th March 2014 along with the NPPF Technical Guidance, when it was replaced by the Planning Practice Guidance *Flood Risk and Coastal Change*.
- 2.1.15 The NPPF consists of a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities.
- 2.1.16 The overall approach to flood risk is broadly summarised in NPPF Paragraph 103:
- 2.1.17 *“When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:*
- *within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and*
 - *development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.”*

2.2 Additional Guidance and Strategy Documents

National Flood and Coastal Erosion Risk Management (FCERM) Strategy

- 2.2.1 In accordance with the FWMA, the Environment Agency has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England¹⁷. This strategy provides a framework for the work of all flood and coastal erosion risk management authorities.
- 2.2.2 The National FCERM Strategy sets out the long-term objectives for managing flood and coastal erosion risks and the measures proposed to achieve them. It sets the context for, and informs the production of, local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage local flood risk. It also aims to achieve effective risk management by LLFAs encouraging information sharing and cooperation between people, communities, business and the public sector to work together to:

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

2.2.3 The Environment Agency's 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities'¹⁸ guidance is a supporting note for the National FCERM Strategy. It provides the UK Climate Projections (UKCP09) climate change factors for river flood flows and extreme rainfall for each river basin district, and provides advice on applying climate change projections in the FCERM. It is essential that investment projects for flood and coastal erosion management measures consider designing for adaptation to a changing climate where appropriate.

Catchment Flood Management Plan (CFMP)

2.2.4 A CFMP is a high-level strategic planning document that provides an overview of the main sources of flood risk and how these can be managed in a sustainable framework for the next 50 to 100 years. The Environment Agency engages stakeholders within the catchment to produce policies in terms of sustainable flood management solutions whilst also considering local land use changes and effects of climate change. CFMPs are due to be replaced by Flood Risk Management Plans (FRMPs) in 2015.

2.2.5 The CFMPs are used to inform and support planning policies, statutory land use plans and implementation of the Water Framework Directive, so that future development in the catchment is sustainable in terms of flood risk. Awareness of the role of CFMPs among land-use planners is in its infancy at the time of this report.

2.2.6 The approach that the Environment Agency would like to see taken to flood risk management within the Study Area is outlined in the Thames CFMP (2009)¹⁹. The CFMP aims to identify flood risk management policies for the catchment and sets out the preferred plan for sustainable flood risk management in the Thames region over the next 50 to 100 years.

2.2.7 The policies listed below are used to identify the appropriate approach to flood risk management across all CFMPs, and will continue to be used in the FRMPs:

- Policy 1 – No active intervention (including Flood Warning and Maintenance). Continue to monitor and advise.
- Policy 2 – Reduce existing flood risk management actions (accepting that flood risk will increase over time).
- Policy 3 – Continue with existing or alternative actions to manage flood risk at current levels.
- Policy 4 – Take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change).
- Policy 5 – Take further action to reduce flood risk.
- Policy 6 – Take action with others to store water or manage runoff in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

2.2.8 The preferred policy for the LBC in the CFMP is Policy 4 - Take further action to sustain the current level of flood risk into the future.

2.3 Regional Policy

The London Plan (2011)

2.3.1 The London Plan (2011)²⁰ is the overall strategic plan for London and delivers an integrated framework for the development of London over the next 20 – 25 years. The plan provides details with regard to the requirement of new development to demonstrate a reduction in surface water runoff.

2.3.2 The Sustainable Design and Construction – Draft Supplementary Planning Guidance (SPG) (2013)²¹ sets out a number of ‘Mayor’s Priorities’ relating to surface water flooding and sustainable drainage, which support the London Plan. These priorities state that developers should aim to achieve greenfield runoff, design schemes following the SuDS hierarchy set out in the London Plan and incorporate surface water attenuation measures.

2.3.3 *“The London Plan Policy 5.13 Sustainable Drainage states that:*

‘Development should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

- *store rainwater for later use;*
- *use infiltration techniques, such as porous surfaces in non-clay areas;*
- *attenuate rainwater in ponds or open water features for gradual release to a watercourse;*
- *attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse;*
- *discharge rainwater direct to a watercourse;*
- *discharge rainwater to a surface water drain;*
- *discharge rainwater to the combined sewer.”*

2.3.4 The use of Sustainable Drainage Systems should be promoted for development unless there are practical reasons for not doing so. Such reasons may include the local ground conditions or density of development. In such cases, the developer should seek to manage as much runoff as possible on site and explore sustainable methods of managing the remainder as close as possible to the site.

2.3.5 *“The Mayor will encourage multi-agency collaboration (GLA Group, Environment Agency, Thames Water) to identify sustainable solutions to strategic surface water and combined sewer drainage flooding/overflows.”*

The Mayor’s Water Strategy (2011)

2.3.6 The Mayor’s Water Strategy²² outlines the Mayor’s aim to *“adopt a more creative approach to managing flood risk from rainfall in London. Taking opportunities to slow the progress of water from ‘rain to drain’ and using rainwater for non-potable uses to reduce demand for treated mains water.”*

2.3.7 The surface water runoff and sustainable drainage requirements of the London Plan are reiterated in Policy 2 respectively of the Mayor’s Water Strategy

2.4 Local Policy

Camden Local Development Scheme (2013)

2.4.1 The Camden Local Development Scheme (LDS)²³ was revised and published in October 2013 and provides information on the documents that (in conjunction with national planning policy and the Mayor’s London Plan²⁴) the Council intends to produce to form its planning policy framework. It sets out the timetable and programme for their production.

Camden Core Strategy (2010)²⁵

2.4.2 The core strategy was adopted in 2010 and defines and presents a plan for the future of the borough. Strategies within the document that are relevant to flood risk are listed below.

CS13 Water and surface water flooding

2.4.3 *We will make Camden a water efficient borough and minimise the potential for surface water flooding by:*

- *g) protecting our existing drinking water and foul water infrastructure;*
- *h) making sure development incorporates efficient water and foul water infrastructure;*
- *i) requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross.*

Camden Development Policies (2010)

2.4.4 The Camden Development Policies present detailed planning criteria that are used to determine planning applications in the borough. Policies relevant to flood risk in the document are listed below.

DP23 Water

2.4.5 *The Council will require developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by:*

- *a) incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;*
- *b) limiting the amount and rate of run-off and waste water entering the combined storm water and sewer network through the methods outlined in part a) and other sustainable urban drainage methods to reduce the risk of flooding;*
- *c) reducing the pressure placed on the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the North London Strategic Flood Risk Assessment and shown on Map 2 as being at risk of surface water flooding are designed to cope with the potential flooding;*

- *d) ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present; and*
- *e) encouraging the provision of attractive and efficient water features.*

DP27 Basements and lightwells

2.4.6 *In determining proposals for basement and other underground development, the Council will require an assessment of the scheme's impact on drainage, flooding, groundwater conditions and structural stability, where appropriate. The Council will only permit basement and other underground development that does not result in flooding or ground instability. We will require developers to demonstrate by methodologies appropriate to the site that schemes:*

- *a) maintain the structural stability of the building and neighbouring properties;*
- *b) avoid adversely affecting drainage and run-off or causing other damage to the water environment;*
- *c) avoid cumulative impacts upon structural stability or the water environment in the local area;*

Camden Planning Guidance

2.4.7 Camden Planning Guidance (CPG) 4: Basements and Lightwells provides additional information on LBC planning policies included in the LDF and covers two key areas relating to basement dwellings;

1. *basement impact assessments, principal impacts of basements, planning and design considerations; and*
2. *how basement dwellings maybe affected in streets at risk from flooding.*

2.4.8 The guidance is relevant to new basement developments and extensions requiring planning permission. It provides further detailed explanation and guidance on the stages required to deliver a Basement Impact Assessment, the aim of which is to ensure no nearby properties, or the water environment are adversely impacted as a result of development, or that adverse impacts can be mitigated. The guidance states that all basement development should undergo the first screening stage of Basement Impact Assessments in order to identify any potential risks from such development.

2.5 Study Area Overview

2.5.1 This Section provides a description of the study area and the local planning policy context.

2.6 Location

2.6.1 The LBC is located within Greater London, to the north of the River Thames. LBC is bordered by the administrative areas of the City of Westminster, the City of London and the London Boroughs of Brent, Barnet, Haringey and Islington.

2.6.2 LBC encompasses the areas of Holborn, King's Cross, Bloomsbury, Belsize Park, Chalk Farm, Kentish Town, Highgate and Hampstead. Hampstead Heath is a large green space covering over 300 hectares and is located in the north of the borough.

2.7 Topography

2.7.1 Appendix B: Figure 1 shows the topography of the study area. The north of the borough lies at a maximum elevation of approximately 130m AOD. The borough slopes down towards the south and south-east, with elevations in the south-east of the borough as low as approximately 10-15m AOD.

2.8 Waterbodies

Historic rivers

2.8.1 Historically the sources of the Rivers Fleet, Tyburn, Kilburn and Brent were located in the area of Hampstead Heath²⁶. In the present day no main rivers are located in the London Borough of Camden following the incorporation of the reaches located within Camden into the Thames Water Utilities Ltd (TWUL) sewer network and therefore the borough is located entirely in Flood Zone 1. The absence of main rivers has been confirmed by a review of the Detailed River Network provided by the Environment Agency to inform this SFRA. The headwaters of the River Brent, located approximately 2km to the north-west of Camden remains an open watercourse.

2.8.2 The two sources of the River Fleet feed two chains of ponds on Hampstead Heath: the Hampstead Ponds and the Highgate Ponds. The two branches of the River Fleet historically flowed through Gospel Oak and Kentish Town before converging north of Camden Town. The River subsequently flowed past King's Cross, along King's Road, Farringdon Street and then into the River Thames²⁶.

- 2.8.3 The River Fleet became entirely enclosed in the 19th Century and is now fully incorporated into the TWUL sewer network²⁷, eventually out-falling into the River Thames under Blackfriars Bridge. In the 1870s the Fleet Storm Relief Sewer was built to increase the ability of the sewer network to cope during high flow events. TWUL network plans, provided to inform this SFRA, indicate that the Fleet Storm Relief Sewer begins in proximity to Kentish Town railway station before running roughly parallel to the Fleet Trunk Sewer past Camden Town and St Pancras railway stations, southwards along Grays Inn Road, Hatton Garden and subsequently outfalls into the River Thames.
- 2.8.4 The Hampstead Ponds, located along the original path of one branch of the River Fleet, connect to the sewer network downstream of Hampstead Number 1 Pond and the Highgate Ponds connect to the sewer network downstream of Highgate Number 1 Pond. Both discharges into the sewer network are limited, restricted by the capacity of the outfall pipe from the two pond chains. The River Kilburn originated at Whitestone Pond in the north-west of Hampstead Heath. The watercourse flowed through Kilburn and into Hyde Park. Here the river formed the Serpentine, and subsequently flowed through Knightsbridge, Sloane Square and into the River Thames. The River Kilburn was culverted in the 19th Century and incorporated into the TWUL sewer network as the Ranelagh Sewer, which discharges into the River Thames at Battersea Park²⁸.
- 2.8.5 The River Tyburn originally flowed from two sources to the south of Hampstead Heath; Hampstead Heath and Shepherd's Well, before converging at the Woronzow Road. The river subsequently flowed through Regent's Park and under Buckingham Palace, before splitting and entering the River Thames at two points. The River Tyburn has been incorporated into the TWUL sewer network as the King's Scholar's Main Sewer, outfalling into the River Thames at Pimlico near Vauxhall Bridge.
- 2.8.6 The Environment Agency Detailed River Network indicates that a small watercourse originates in West Heath in the north-west of the borough, flowing approximately north-west into the Leg of Mutton Pond, and subsequently westward into the London Borough of Brent. The watercourse is culverted at the west of Golders Hill Park and subsequently open in sections until it connects to the River Brent approximately 2.5km to the west of LBC.
- 2.8.7 Outside of Hampstead Heath, significant water bodies within LBC include three ponds located within Waterlow Park in the north-west of the Borough and the Regent's Canal.

Canals

- 2.8.8 Regent's Canal enters LBC in the east of the borough, to the north of King's Cross railway station, and flows through Camden Town and towards Regents Park to the west of the borough. Regent's Canal is maintained by the Canal and River Trust. A number of lock gates are located along the section of Regent's Canal running through Camden.

2.9 Geology

- 2.9.1 The underlying geology can influence the presence and nature of groundwater in an area, and therefore the potential flood risk from groundwater. The geology can also impact on the potential for infiltration based drainage systems. The geology information has been obtained from British Geological Survey and Environment Agency data. Appendix B Figures 4a and 4b show the underlying geology within LBC.

- 2.9.2 The bedrock geology of LBC comprises primarily of London Clay Formation, with the exception of Claygate Member and Bagshot Formation which underlie the higher ground in the north of the borough on Hampstead Heath.

- 2.9.3 The majority of the borough is shown to be free of superficial deposits. Lynch Hill Gravel Formation, Hackney Gravel Formation and Langley Silt are located in the southern section of the borough, south of Euston Station. Very small isolated sections of Stanmore Gravel are located in the very north of the borough on Hampstead Heath.

2.10 Hydrogeology

Aquifer Type

- 2.10.1 Aquifers are defined as layers of permeable rock or unconsolidated material (sand, gravel, silt etc.) capable of storing and transporting large quantities of water. The understanding of the behaviour and location of aquifers is important as they can provide an indication of the potential for groundwater flooding.
- 2.10.2 In the Environment Agency aquifer type dataset, the River Terrace Deposits, which comprise a number of superficial geological formations in the south of the borough close to the River Thames, are classified as a secondary aquifer. According to Environment Agency definitions, a secondary aquifer is defined as a permeable layer capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.

- 2.10.3 In addition to the secondary aquifer in the south, towards the north of the borough, underlying the Hampstead Heath area, there is a secondary aquifer comprised of the Bagshot Formation geological deposits.
- 2.10.4 The London Clay Formation is a non-aquifer or unproductive strata – these are rocks with low permeability that have negligible significance for water supply or river base flow.
- 2.10.5 The Inner Zone of a Groundwater Source Protection Zone (GSPZ) is located within the south-west of Primrose Hill park. An Outer Protection Zone covers a section of South Hampstead from Prince Albert Road to Swiss Cottage. The aim of GSPZs is to identify particular areas where there are likely to be certain risks posed to quality and/or quantity of groundwater abstracted²⁹, should particular activities occur in the area. The presence of a GSPZ is not primarily of consideration in relation to flood risk, though should be taken into consideration when considering the environmental impact of a development.

Bedrock Permeability

- 2.10.6 Bedrock permeability can provide information relevant to surface water infiltration capacity. Further information on the suitability of infiltration SuDS techniques is provided in Section 7. The Environment Agency bedrock permeability datasets shows that the Bagshot Formation is classified as bedrock deposits that are likely to be free draining. The Claygate Member and London Clay Formation are classified as bedrock whose permeability is spatially variable, but likely to permit moderate infiltration.

3 SFRA METHODOLOGY

3.1 Overview

3.1.1 Under Section 10 of the NPPF, the risk of flooding from all sources must be considered as part of a SFRA, including flooding from rivers, land, groundwater, sewers and artificial sources (flooding from the sea is not relevant to the study area). The methodology for the appraisal of flood risk from all sources is outlined below. A description of the datasets used to assess the risk of flooding from each source is provided, further details of which are included within the data register in Appendix A.

3.2 Data Collection and Methodology

3.2.1 Table 3.1 outlines the stakeholders contacted during the development of this SFRA.

Table 3.1: SFRA Stakeholder Organisations and Roles

Stakeholder Organisation	Role with respect to the LBC SFRA
LBC	<p>As a LPA LBC has a responsibility to consider flood risk in their strategic land use planning and the development of their Local Plan. The NPPF requires LPAs to undertake a SFRA and to use their findings, and those of other studies, to inform strategic land use planning including the application of the Sequential Test which seeks to steer development towards areas of lowest flood risk prior to consideration of areas of greater risk. LBC is also required to consider flood risk when assessing applications for development.</p> <p>During the preparation of the SFRA, records held by the Council of flood incidents across the borough were used to help inform the flood risk within Camden.</p> <p>The SFRA should be used by the LBC Emergency Planning team so that the findings where appropriate are incorporated into their understanding of flood risk and the preparation of their Multi-Agency Flood Plans (MAFP).</p>
Environment Agency	<p>The Environment Agency has a role to provide technical advice to LPAs and developers on how best to avoid, manage and reduce the adverse impacts of flooding. Part of this role involves advising on the preparation of spatial plans and sustainability appraisals as well as the evidence base documents underlying such documents, including SFRAs.</p> <p>The Environment Agency undertakes systematic modelling and mapping of fluvial flood risk associated with all Main Rivers in the study area, as well as mapping of surface water flood risk, and will supply available datasets for use within the SFRA.</p> <p>The Environment Agency will perform a technical review role of the draft project deliverables.</p>
The City of London Corporation	<p>The City of London Corporation (CoLC) maintains Hampstead Heath, including the Hampstead Heath ponds, ensuring that they are safe. CoLC was consulted in order to confirm the maintenance and management of the Hampstead Heath Ponds, to obtain information of the Hampstead Heath Ponds Project currently being developed with the aim to ensure the safety of the pond dams and to confirm the rate of discharge from the ponds to the local TWUL sewer network.</p>

Stakeholder Organisation	Role with respect to the LBC SFRA
Thames Water Utilities Ltd	Thames Water is responsible for surface water drainage from development via adopted sewers and for maintaining public sewers into which much of the highway drainage connects. In relation to the SFRA, the main role that Thames Water plays is providing data regarding past sewer flooding.
Network Rail	Network Rail was consulted to provide details of any known historic and recent flood risks across their infrastructure routes in the borough, areas that are susceptible to flooding, flood mitigation measures that have already been put in place and maintenance regimes. At the time of writing this SFRA, no data had been provided by Network Rail.
British Geological Survey	The British Geological Survey holds a number of datasets that will inform the SFRA, including superficial and bedrock geology and suitability of infiltration SuDS.
Transport for London (TfL)	Transport for London (TfL) is responsible for the running and management of the London Overground, London Underground and sections of the London road network. TfL was consulted to provide details of any known historic and recent flood risks across their infrastructure routes in the borough, areas that are susceptible to flooding, flood mitigation measures that have already been put in place and maintenance regimes. At the time of writing this SFRA, no data had been provided by TfL.
Canal and River Trust	The Canal and River Trust (C&RT) maintains over 2,000 miles of canals and rivers in the UK, including Regent's Canal which runs through LBC. The C&RT provided details of the assets within LBC which they control and confirmed the absence of any overtopping events in the borough.

Flooding from Rivers

- 3.2.2 All main rivers historically located within LBC are now culverted and incorporated into the TWUL sewer network. The flood risk from these 'lost rivers' is discussed within Section 4.4. The original sources of the River Fleet feed the Hampstead Heath Ponds. The flood risk from the Hampstead Heath Ponds is discussed in Section 4.5.

Historic Flooding

- 3.2.3 The Environment Agency's Historic Flood Map shows that no flooding has occurred within LBC from fluvial or tidal sources.

Flooding from Surface Water

- 3.2.4 Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding.

Updated Flood Map for Surface Water

- 3.2.5 The Environment Agency has undertaken modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three annual exceedance probability events: 1 in 30 year (3.33% AEP), 1 in 100 year (1% AEP and 1 in 1,000 year (0.1% AEP). The latest version of the mapping is referred to as the updated Flood Map for Surface Water (uFMfSW) and the extents have been made available to LBC as GIS layers.
- 3.2.6 The uFMfSW provides all relevant stakeholders, such as the Environment Agency, LBC (as the LLFA) and the public access to information on surface water flood risk which is consistent across England and Wales³⁰. The modelling will help the Environment Agency take a strategic overview of flooding, and assist LBC (as the LLFA) in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping allows an improved understanding of areas within the LBC administrative area which may have a surface water flood risk.
- 3.2.7 The modelling represents a significant improvement on previous mapping, namely the Flood Map for Surface Water (FMfSW) (2010) and the Areas Susceptible to Surface Water Flooding (AStSWF) (2009), for example:
- Increased model resolution to 2m grid;
 - Representation of buildings and flow routes along roads and manual editing of the model for structural features such as flyovers;
 - Use of a range of storm scenarios; and
 - Incorporation of appropriate local mapping, knowledge and flood incident records.
- 3.2.8 However, it should be noted that this national mapping has the following limitations:
- Use of a single drainage rate for all urban areas;
 - It does not show the susceptibility of individual properties to surface water flooding;
 - The mapping has significant limitations for use in flat catchments;
 - No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses;
 - In a number of areas, modelling has not been validated due to a lack of surface water flood records;

- As with all models, the uFMfSW is affected by a lack of, or inaccuracies, in available data.

3.2.9 Local surface water modelling carried out for the Highgate and West Camden areas on behalf LBC has been incorporated into the uFMfSW data.

Climate Change

3.2.10 The uFMfSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual exceedance probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide an indication of the implications of climate change.

Historic Flooding

3.2.11 Appendix B Figure 3i – 3v presents this mapping for the LBC study area in combination with historical surface water flooding data recorded by LBC. It should be noted that where streets are shown to have experienced flooding during the 1975 and 2002 flood events, this mapping is relatively coarse in scale and does not allow a distinction between, for example, an entire street flooding, or an isolated section of road flooding as a result of a blocked gully.

Flooding from Groundwater

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

3.2.13 Table 3.2 details the datasets that were supplied to the project team by the Environment Agency and the British Geological Survey (BGS) regarding the underlying geology, the presence of groundwater and the risk of groundwater flooding.

Table 3.2: Geology and Groundwater Flood Risk Datasets

Source	Dataset Title	Figure No.
1	Superficial geology (British Geological Survey)	Appendix B Figure 4a
2	Bedrock geology (British Geological Survey)	Appendix B Figure 4b
3	Aquifer Type (Environment Agency)	-
4	Bedrock Permeability	-
5	Groundwater Vulnerability Classification (Environment Agency)	-
6	SuDS drainage potential – depths to water table (BGS)	-
7	SuDS drainage potential – infiltration constraints summary (BGS)	Appendix B Figure 4c
8	SuDS drainage potential – drainage summary (BGS)	Appendix B Figure 4d
9	Increased Potential for Elevated Groundwater (LBC SWMP)	Appendix B Figure 4e

3.2.14 In order to provide a strategic assessment of the risk of groundwater flooding in LBC, the following two stage assessment was undertaken using the data sources in Table 3.2.

3.2.15 The initial stage included a review of the GIS layers of the BGS superficial geology (Source 1) and bedrock geology (Source 2), the EA aquifer type (Source 3), bedrock permeability (Source 4) and groundwater vulnerability (Source 5).

3.2.16 The next stage was to use the GIS layer produced by the BGS showing a data set of infiltration SuDS mapping, the GIS layers used were the depth to water table (Source 6), the infiltration constraints summary (Source 7) (identifying areas with very significant potential for one or more geohazards) and the drainage summary (Source 8) (identifying areas with very significant constraints, areas probably suitable for infiltration SuDS and areas potentially suitable for infiltration SuDS).

3.2.17 The risk of flooding from groundwater is detailed in Section 4.3.

Flooding from Sewers

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

1. *The rainfall event exceeds the capacity of the sewer system/drainage system:*

3.2.19 Sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP (1 in 30 years) or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While TWUL are concerned about the frequency of extreme rainfall events, it is not economically viable to build sewers that could cope with every extreme rainfall event.

2. *The system becomes blocked by debris or sediment:*

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

3. *The system surcharges due to high water levels in receiving watercourses:*

3.2.21 Where the local area is served by 'combined' sewers i.e. containing both foul and storm water, if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

Historic Flooding

3.2.22 TWUL has provided an extract from their DG5 Flood Register for the study area. Due to data protection requirements this data has not been provided at individual property level; rather the register comprises the number of properties within 4 digit postcode areas that have experienced flooding either internally or externally within the last 10 years.

3.2.23 Appendix B: Figure 5a shows that 8 properties have been affected by internal sewer flooding in the past 10 years in two separate areas in South Hampstead and north-west of Primrose Hill. In Hampstead, including an area in Hampstead Heath, 4 properties have been affected by internal sewer flooding. A small number of properties (1-2 properties) have experienced internal flooding in three separate areas in Camden Town, West Hampstead and Kilburn.

3.2.24 Appendix B: Figure 5b shows that external flooding is concentrated in the west of the borough in the South Hampstead and Kilburn areas. An area of South Hampstead has 18 recorded incidents of external sewer flooding, with adjacent areas experiencing between 1 and 4 recorded external flooding incidents in the past 10 years. One external flooding incident has also been recorded in the Hampstead area.

Flooding from Reservoirs, Canals and Other Artificial Sources

- 3.2.25 The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The Planning Practice Guidance encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.
- 3.2.26 Table 3.3 provides a summary of the artificial sources of flooding in the study area that have been identified from a review of the Ordnance Survey (OS) 1:10,000 scale mapping. Water bodies over 1500m² in area have been identified in Table 3.3. A number of smaller ponds, pools and other water bodies are present within the borough, though have not been included due to their limited potential to impact on local flood risk.
- 3.2.27 The Environment Agency's Risk of Flooding from Reservoirs Mapping³¹ identifies areas that could be flooded if a large³² reservoir were to fail and release the water it holds. There are three water bodies designated as 'large' within LBC; Hampstead Pond Number 1 and Highgate Ponds Number 2 and 3.
- 3.2.28 Reservoirs in the UK have an extremely good safety record. The Environment Agency is the regulatory authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers on an annual basis.
- 3.2.29 The Maiden Lane Reservoir in Islington is a covered service water reservoir owned by TWUL which could also pose a risk to Camden residents if there was a breach. The LBC Local Flood Risk Management Strategy³³ states that TWUL declared that there is a low risk of the Maiden Lane Reservoir failing. TWUL is able to rapidly empty the reservoir should there be a requirement to do so.
- 3.2.30 During consultation with the CoLC it was confirmed that there are three designated reservoirs on Hampstead Heath, which are routinely inspected as required by the Reservoirs Act 1975. Previous inspection identified that there was a substantial risk of failure of the ponds and there was therefore a need for works to be carried out on the Hampstead Heath Ponds. This has led to the City of London Corporation Hampstead Heath Ponds Project. The risk from reservoir flooding is discussed in Section 4.5.

- 3.2.31 The CoLC were consulted during the writing of this SFRA in order to confirm its current maintenance and management practices for the Hampstead Heath Ponds. The existing risk of flooding from the Hampstead Heath Ponds was assessed as part of the Hampstead Heath Ponds Quantitative Risk Assessment³⁴ and Hampstead Heath Ponds Project Assessment of Design Flood³⁵ reports. A summary is provided in Section 4.5.
- 3.2.32 LBC is responsible for working with members of the Local Resilience Forum (LRF) to develop emergency plans for reservoir flooding.

Table 3.3: Artificial Sources / Water bodies

Area	Water body	Approximate Area (m ²)
Hampstead Heath	Wood Pond	6,920
Hampstead Heath	Thousand Pound Pond	4,085
Hampstead Heath (Highgate Pond Chain)	Stock Pond	4,383
Hampstead Heath (Highgate Pond Chain)	Kenwood Ladies' Bathing Pond	6,810
Hampstead Heath (Highgate Pond Chain)	Bird Sanctuary Pond	6,504
Hampstead Heath (Highgate Pond Chain)	Model Boating Pond	16,134
Hampstead Heath (Highgate Pond Chain)	Highgate Men's Bathing Pond	18,229
Hampstead Heath (Highgate Pond Chain)	Highgate No. 1 Pond	13,613
Hampstead Heath	Leg of Mutton Pond	2,470
Hampstead Heath	Whitestone Pond	1,852
Hampstead Heath (Hampstead Pond Chain)	Vale of Health Pond	8,548
Hampstead Heath (Hampstead Pond Chain)	Viaduct Pond	2,452
Hampstead Heath (Hampstead Pond Chain)	Mixed Bathing Pond (No. 3)	6,864
Hampstead Heath (Hampstead Pond Chain)	Hampstead No. 2 Pond	10,845
Hampstead Heath (Hampstead Pond Chain)	Hampstead No. 1 Pond	15,074
Waterlow Park	Waterlow Park Lakes	2,638 and 2,459

Area	Water body	Approximate Area (m ²)
King's Cross / Camden Town	Regent's Canal	N/A

Historic Flooding

3.2.33 The C&RT have confirmed that no flooding incidents associated with the Regent's Canal have been recorded within LBC.

3.2.34 The dams on the Hampstead Heath Ponds experienced damage following the 1975 extreme rainfall event. In addition, in 2010 Stock Pond was overtopped during a rainfall event³⁶. Further detail is provided in Section 4.5.

3.3 Summary

3.3.1 This Section has provided a description of the datasets that have been supplied for use as part of the SFRA. The following Section uses these datasets to provide an assessment of the flood risk within the borough.

4 STRATEGIC ASSESSMENT OF FLOOD RISK WITHIN LONDON BOROUGH OF CAMDEN

4.1 Flooding from Rivers

4.1.1 As stated in Section 3.2.2 all main rivers historically located within LBC are now culverted and incorporated into the TWUL sewer network and therefore there is no fluvial flood risk within LBC.

4.1.2 The flood risk from these 'lost rivers' is discussed within Section 4.4. The original sources of the River Fleet feed the Hampstead Heath Ponds. The flood risk from the Hampstead Heath Ponds is discussed in Section 4.5.

4.2 Flooding from Surface Water

4.2.1 The LBC Surface Water Management Plan (SWMP) identified a number of Critical Drainage Areas (CDAs) within LBC (Appendix B: Figure 6), which are defined in the SWMP as:

“A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.”

4.2.2 Therefore a specific area within a CDA is not necessarily at higher risk from surface water than an area outside of a CDA. However the location of an area within a CDA indicates that it is within a catchment area which contributes to a flooding hotspot. Within CDAs, surface water management should be a particular focus of new developments.

4.2.3 The majority of the borough is located within a CDA identified in the SWMP (See Appendix B Figure 6), with the exception of a narrow strip of land along the northern boundary of the borough, the western section of Hampstead Heath including the Hampstead Pond chain and an area around Royal Free Hospital. Any development in areas of previously undeveloped land in LBC is likely to have a negative impact on surface water flood risk in LBC by reducing the potential for infiltration of runoff, unless appropriate surface water management is incorporated into the development to reduce the runoff from the site post-development.

4.2.4 The SWMP also identifies a number of Local Flood Risk Zones (LFRZ), which are included in Appendix B Figure 6, and are defined in the SWMP as:

4.2.5 *“discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location.”*

- 4.2.6 The uFMfSW is the most recent and up-to-date surface water modelling available for LBC and is presented in Appendix B Figure 3. The mapping shows that for the model scenarios (3.33% AEP, 1% AEP and 0.1% AEP) the surface water flood extent broadly follows the natural topography of the borough, as expected. Potential flooding also follows man-made features such as roads and rail lines. Such flow routing is most prominent during the 3.33% AEP event, which represents the least extreme rainfall event of those modelled. For the more extreme modelling scenarios, increased ponding in areas of properties can be identified. Whilst potential flooding is identified throughout the borough, concentrations of ponding occur in the Camden Town and Dartmouth Park areas, as well as in West and South Hampstead.
- 4.2.7 Historic flood records indicate that LBC, particularly to the north of Euston Road, is prone to surface water flooding. Two large surface water flooding events have occurred in LBC in 1975 and 2002 causing widespread damage, as described below.
- 4.2.8 A large storm event occurred in north London on 14th August 1975, and has been identified as the most extreme rainfall event ever recorded in London³⁷, with approximately 170.8mm of precipitation recorded by the Hampstead Scientific Society in a 2 to 3 hour period.
- 4.2.9 Numerous roads and houses in the area were severely flooded, with the local sewer network overloaded leading to surcharging. One member of the public lost their life as a result of flood waters and over 250 people were re-housed either temporarily or permanently³⁷. The following areas were identified as being affected by flooding during the August 1975 rainfall event:
- Gospel Oak
 - West Hampstead
 - Kilburn
 - Primrose Hill
 - Oak Village
 - Hampstead Garden Suburb
 - Hornsey
 - Golders Green
 - Willesden
 - Cricklewood
 - Kentish Town.

- 4.2.10 In 1994 a Flood Relief Sewer was constructed by TWUL; the North West Storm Relief Sewer. The sewer runs from the western end of Fawley Road in West Hampstead south-eastward roughly parallel to Fairhazel Road, before turning approximately south-west along Belsize Road and Oxford Road. The Storm Relief Sewer was designed to accommodate a 1 in 10 year storm event³⁸ (10% AEP).
- 4.2.11 Severe surface water flooding was also experienced in Camden on 7th August 2002. Appendix B: Figure 3 shows the location of roads affected by surface water flooding during this event. As with the 1975 flooding records, this mapping is relatively coarse and should be used to indicate roads where flooding was experienced and not to identify the exact extent of flood waters during the rainfall event. The Report of the Floods Scrutiny Panel for the 2002 floods³⁸ found that Hampstead Heath experienced 60mm of rain in under an hour resulting in flooding primarily in West and South Hampstead and Kentish Town, with flooding on a number of other roads.
- 4.2.12 As with the 1975 rainfall event, the sewer system capacity was exceeded resulting in surcharging of the sewer system in a number of locations³⁸. The flooding caused damage to housing, public services and private businesses. Following the flood event, TWUL provided evidence confirming that the sewer system had reached maximum capacity reducing the ability of the sewer network to drain surface water. Evidence suggests that during extreme rainfall events, the TWUL sewer network reaches capacity very quickly resulting in surcharging of sewers. Due to the magnitude of the rainfall event, the North West Storm Relief Sewer also reached capacity and therefore flooding was experienced along roads in proximity to the sewer.
- 4.2.13 TWUL, upon consultation, provided details of a flood alleviation scheme at Sumatra Road, West Hampstead, delivered after the 2002 flood event. A sewer was constructed at Sumatra Road, designed to intercept and divert flow towards a storage tank which provides approximately 1700m³ of storage during extreme rainfall events. Whilst the scheme will help to reduce the local flood risk, there is still potentially still a flood risk during an extreme rainfall event.

4.3 Flooding from Groundwater

Geology

4.3.1 In Source 1 (see Table 3.2), there are superficial deposits in the southern part of the Camden BC area comprising River Terrace Deposits (see Appendix B: Figure 4a). The named formations are the Lynch Hill Gravel Formation (Sand & Gravel (S&G)), Hackney Gravel Formation (S&G) and Langley Silt (Silt). In Source 2, the bedrock geology in the borough is underlain by Bagshot Formation (Sand), Claygate Member (Sand, Silt and Clay) and London Clay Formation (Silt and Clay) in different parts of the area (see Appendix B: Figure 4b). The majority of the area is underlain by London Clay Formation, although there is Bagshot Formation and Claygate Member underlying the higher ground in the north of the borough on Hampstead Heath.

Flooding from Groundwater

4.3.2 In Source 6 (see Table 3.2), the areas underlain by bedrock within the borough are expected to have depths to the water table of either >5m throughout the year or <3m for part of the year. The deepest water tables are expected to occur on Bagshot Formation, such as on Hampstead Heath. In the areas with superficial deposits, the expected depths to the water table is either between 3 and 5m for part of year or <3m for part of the year. In Source 7, the infiltration constraints map shows very significant potential for one or more geohazards in the area lying along the northern edge of the River Terrace Deposits (in the south of the borough) (see Figure 2 – elevated groundwater levels map). In this area, a factor which may be influencing this risk is that the River Terrace Deposits may be quite thin (i.e. limited storage) and the underlying bedrock is a relatively impermeable London Clay Formation (i.e. the water cannot drain away).

4.3.3 Appendix A Figure 4e shows a dataset from the LBC SWMP described as 'Increased Potential for Elevated Groundwater'. This dataset was derived from four individual data sources (BGS Groundwater Flood Susceptibility maps; Environment Agency Thames Estuary 2100 groundwater hazard maps; Defra Groundwater emergence maps; and JBA Consulting Groundwater flood maps) and identifies areas where there is increased potential for groundwater levels to rise within 2m of the ground surface following periods of higher than average recharge. Permeable superficial deposits with increased potential for elevated groundwater only cover a small area towards the south of the borough.

4.3.4 It can be noted that a number of groundwater flooding incidents have been recorded outside the areas of Increased Potential for Elevated Groundwater. Groundwater flooding is often relatively small scale and site-specific, whereas the mapping shown in Appendix A Figure 4e (and also the SuDS suitability mapping in Appendix A Figure 4d) are produced from regional mapping and therefore should be used as a guide only. Therefore there is a potential for groundwater flooding outside the areas identified as having an Increased Potential for Elevated Groundwater.

4.3.5 As detailed in the Camden Geological, Hydrogeological and Hydrological Study³⁹ within Camden groundwater can be encountered within River Terrace Deposits, isolated perched water bodies within sandy layers of the London Clay and a more significant water table within the Bagshot Beds. Perched groundwater is typically isolated above the primary aquifer, where the two are separated by an impermeable layer, such as the London Clay present underneath Camden. The perched water tables are identified to be a slope stability, rather than flood risk, issue within Camden and should be assessed as such in any Basement Impact Assessment. The Study details that: *“Low permeability clay layers within the Bagshot Formation may lead to perched water tables which can affect slope stability.”*

4.4 Flooding from Sewers

4.4.1 The majority of LBC is served by a combined surface and foul water sewer system. The TWUL sewer systems are now typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. However the North London SFRA²⁷ identified the sewer network within Camden as being particularly old, with some sections of sewer potentially designed to only convey storms up to the 10% AEP event.

4.4.2 Historic ‘lost rivers’ within LBC, such as the River Fleet, were culverted and incorporated into the local sewer network in the 19th Century. The River Fleet was incorporated into the sewer network as the Fleet Trunk Sewer, with the Fleet Storm Relief Sewer built in the 1870s to increase the ability of the sewer network to cope during extreme rainfall events. The Fleet Storm Relief Sewer runs through Kentish Town railway station before running roughly parallel to the Fleet Trunk Sewer past Camden Town and St Pancras railway stations, southwards along Grays Inn Road, Hatton Garden and subsequently outfalls into the River Thames. The River Kilburn has been incorporated into the TWUL sewer network as the Ranelagh Sewer and the River Tyburn as the King’s Scholar’s Trunk Sewer. Further detail on the lost rivers of Camden is provided in Section 2.8.

- 4.4.3 The River Fleet would historically have drained a large proportion of LBC and the Fleet Trunk Sewer broadly still follows the natural topography of the borough, running approximately south-east from Hampstead Heath towards the River Thames. Therefore rain falling within the former River Fleet's broad catchment area is likely to flow into the combined sewer network.
- 4.4.4 The combined sewer network is designed to outfall into the River Thames during intense rainfall events when the sewer network reaches capacity. However there is evidence that during the 1975 and 2002 extreme rainfall events surcharging of the local sewer network occurred as its capacity was exceeded^{38 39}. This is potentially due to the inability of the combined sewer network to discharge to the River Thames at a high enough rate to convey surface water present during particularly extreme rainfall events.
- 4.4.5 TWUL DG5 flood records (Appendix B: Figure 5a) show that internal sewer flooding of properties is concentrated in the north of the borough. One or more flood incidents have occurred in the areas of Camden Town, West Hampstead and Kilburn, with 8 flooding incidents in the past 10 years in both South Hampstead and north-west of Primrose Hill.
- 4.4.6 Appendix B: Figure 5b shows that external flooding is further concentrated in the west of the borough in the South Hampstead and Kilburn areas. One or more properties have experience external sewer flooding in the past 10 years in Hampstead and South and West Hampstead with 18 flooding incidents recorded in one area of South Hampstead.

4.5 Flooding from Reservoirs, Canals and other Artificial Sources

Reservoirs and other ponds

4.5.1 There are about 30 ponds located within Hampstead Heath⁴⁰, three of which are classified as 'large raised reservoirs' under the Reservoirs Act 1975. Following routine inspection by a Supervising Panel Engineer, CoCL was advised that works were required to ensure that the flood risk from the ponds is minimised. As a result of this the Hampstead Heath Ponds Project was initiated in 2012 by CoCL, who have managed Hampstead Heath for 25 years. It is important to note that the Project is currently in progress and a number of reports are in draft form. A planning application for the Project is currently programmed for July 2014⁴¹. If approved, and once completed, the potential flood risk from failure of one or more of the Hampstead Heath ponds is expected to be reduced significantly as a result of the completion of the Hampstead Heath Ponds Project. Should this occur it is recommended that this SFRA be revised to reflect the change in flood risk from this source.

4.5.2 As discussed in Section 2.8 the Hampstead Ponds connect to the sewer network downstream of Hampstead Number 1 Pond and the Highgate Ponds connect to the sewer network downstream of Highgate Number 1 Pond.

4.5.3 Table 4.1 shows the flow rates from the ponds into the local sewer network, provided by CoLC. The discharge rates are based on a peak water level within the Highgate and Hampstead No. 1 Ponds, as indicated within Table 2.1. The rates are provided for the Probable Maximum Flood event which is an industry standard design flood event for reservoir safety studies⁴² and is estimated to be a 1 in 400,000 year event, Appendix B: Figure 2 shows the location of the Hampstead Heath Ponds.

Table 4.1: Hampstead Heath Ponds outfall pipe flow rates

Pond	Overflow pipe diameter, mm	Probable Maximum Flood peak discharge (existing scenario), m ³ /s
Highgate No. 1 Pond	457	0.60 (at peak level of 64.12m)
Hampstead No. 1 Pond	300	0.25 (at peak level of 71.1m)

4.5.4 The Hampstead Heath Ponds Project: Assessment of Design Flood report³⁵ developed an estimate of the Probable Maximum Flood (PMF) (estimated as a 1 in 400,000 year event), as well as 1 in 100 year, 1000 year and 10,000 year storm events and provides an indication of the likelihood of overtopping of each pond within the study area. Ponds within the Highgate and Hampstead chains were included within the study, with the exception of Wood Pond and Thousand Pounds Pond within the Highgate chain in Kenwood Park which are owned by English Heritage. Ponds within the Golders Hill Park and Heath Extension chain were excluded from the study.

4.5.5 The report provides a summary of the current standard of protection of each pond assessed in the study. The summary is replicated below in Table 4.2.

Table 4.2: Current Standard of Protection of Highgate and Hampstead Chain Ponds.
Source: Atkins (2013), Hampstead Heath Ponds Project: Assessment of Design Flood

Pond	Current Standard of Protection (Rainfall event where overtopping occurs)
Highgate Chain	
Stock	1 in 5 year
Ladies Bathing	1 in 20 year
Bird Sanctuary	1 in 20 year
Model Boating	1 in 20 year for auxiliary spillway 1 in 50 year for main embankment
Men's Bathing	1 in 50 year
Highgate No. 1	1 in 100 year
Hampstead Chain	
Vale of Heath	1 in 1,000 year
Viaduct	1 in 1,000 year
Mixed Bathing	1 in 100 year
Hampstead No. 2	1 in 100 year
Hampstead No. 1	1 in 10,000 year

- 4.5.6 Maximum dam overtopping depths, representing the depths of water flowing over the embankments of the ponds, were calculated for a range of design flood events. Maximum water depths over the embankments ranged from 0.12m to 0.62m during the PMF, with velocities ranging from 2.34m³/s to 5.42m³/s. Maximum dam overtopping depths ranged from 0m to 0.43m and 0.06m to 0.46m for the 1 in 1,000 year and 1 in 10,000 year events respectively. Predicted flood extents during the PMF are shown in Figure 5-2 in the Hampstead Heath Ponds Project: Assessment of Design Flood report. The flood extent mapping has informed both the Design Flood Report and Quantitative Risk Assessment Report; however the full mapping is currently not available in the public domain and therefore is not presented in this SFRA. The Environment Agency Risk of Flooding from Reservoirs mapping³¹ (discussed below) should be consulted for a consideration of risk in the event of a reservoir failure. The Assessment of Design Flood report indicated that the pond embankments require reinforcement to prevent erosion during overtopping events which could lead to a breach of one or more of the ponds.
- 4.5.7 The Hampstead Heath Ponds Quantitative Risk Assessment Interim Report³⁴ should be consulted for a more detailed assessment of the probability of failure of the Hampstead Heath Ponds.
- 4.5.8 Consultation with CoLC confirmed that inspection of the ponds is carried out as required under the Reservoirs Act 1975 for the three ponds designated as 'large' reservoirs, as well as for the smaller ponds owned by CoLC. Routine inspection and maintenance is carried out as and when required, and during large rainfall events. CoLC has developed its own on-site Emergency Response Plan to be implemented in the event of flooding on Hampstead Heath.
- 4.5.9 It is important to note that a routine inspection by a Supervising Panel Engineer has identified a significant risk associated with overtopping and potential failure of one or more of the ponds on Hampstead Heath. In response, the City of London Corporation has initiated the Hampstead Heath Ponds Project, with the aim of reducing this risk.

Environment Agency Risk of Flooding from Reservoirs Mapping

- 4.5.10 The Environment Agency's Risk of Flooding from Reservoirs Mapping³¹ identifies areas that could be flooded if a largeⁱⁱⁱ reservoir were to fail and release the water it holds. The mapping shows that in the unlikely event of Hampstead Pond No. 1 failing, water would initially flow southwards towards Hampstead Heath Rail and Overground Station and then eastwards as far as Gospel Oak Rail and Overground Station. Flood depths could potentially reach between 0.3m and 2m, with isolated areas where depths could potentially reach over 2m, with flood velocities exceeding 2m/s.
- 4.5.11 In the event that Highgate Ponds No. 2 or 3 failed, flood waters would flow south-east from Hampstead Heath and reach as far east as York Rise in Dartmouth Park. Flood water would also flow southwards towards the rail line west of Kentish Town and then along the rail line as far as just north of St Pancras rail station. Flood depths would be predominantly between 0.3m and 2m and flood velocities between 0.5m/s and 2m/s, with isolated areas of velocities above 2m/s. In the event that Highgate Pond No. 3 failed, flood waters would flow further south nearly as far south as Pentonville Road.
- 4.5.12 The Maiden Lane Reservoir in Islington is a covered service water reservoir owned by TWUL which could pose a risk to Camden residents if there was a breach. Environment Agency mapping indicates that flood waters resulting from the unlikely failure of the Maiden Lane reservoir would be similar to those as a result of failure of the Highgate Ponds No.2 and 3, though flood waters would not extend southwards beyond Kentish Town Rail and Overground Station. Flood waters would also flow across an area along and around Burghley Road.

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

Hampstead Heath Ponds Project

- 4.5.13 As outlined in Section 4.5.1 works are required to the Hampstead Heath Ponds in order to ensure that they are safe. The primary aim of the Hampstead Heath Ponds Project, developed by CoLC, is to reduce the likelihood of overtopping of the ponds during extreme rainfall events, thereby reducing the risk of downstream bank erosion and subsequent breaching of one or more ponds.
- 4.5.14 The Hampstead Heath Ponds Project Preferred Solution Report⁴³ provides details of the preferred solutions and should be consulted for further detail on the proposed works. A single option each has been selected for the Highgate and Hampstead Pond Chains, from two preferred options for each pond chain presented in the Hampstead Heath Ponds Project Preferred Options Report⁴⁴. Restoration of the dam crests is proposed for Stock Pond, Kenwood Ladies Bathing Pond and Bird Sanctuary Pond. Raising of the existing dams is proposed for the Model Boating Pond (raising by 2.5), Men's Bathing Pond (raising by 1.0m) and Highgate Pond No. 1 (raising by 1.25m). New open grass spillways are proposed for all ponds with the exception of the Bird Sanctuary Pond, where relocation of the overflow pipe will occur.
- 4.5.15 The preferred solution for the Hampstead Pond Chain is for restoration of the dam crests at the Vale of Heath Pond, Viaduct Pond and Hampstead No. 2 Pond. New open grass spillways are proposed for the Vale of Heath Pond, Viaduct Pond and Catchpit area, the latter of which will also include the building of a new flood storage dam up to 5.6m high. A new box culvert overflow will be constructed for the Hampstead No. 1 and 2 Ponds.

Regent's Canal

- 4.5.16 The Canal and River Trust (C&RT) was consulted during the writing of this SFRA and confirmed that there are no recorded incidents of overtopping or breaches of the Regent's Canal in or within 500m of LBC. The C&RT has documented standards for asset inspection and management, outlining requirements and responsibilities for asset inspection. Such procedures ensure the appropriate management of all C&RT assets.
- 4.5.17 The water level within Regent's Canal is controlled by a series of lock gates, and the risk of flooding as a result of overtopping or breaching of the canal is low.

4.6 Consideration of Climate Change

4.6.1 The Environment Agency was consulted during the writing of this SFRA in order to confirm the approach towards the assessment of future climate change impacts on flood risk within LBC. The Environment Agency has released guidance on how to allow for climate change in the future⁴⁵, with the relevant information outlined below:

Table 4.3: Climate change allowance for calculation of future peak rainfall intensity. (Extract from Table 2 of Environment Agency guidance note: ‘Climate change allowance for planners’.)

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%

4.6.2 The Environment Agency confirmed that the impacts of climate change have not currently been taken into account within the uFMfSW.

5 GUIDANCE ON THE APPLICATION OF THE SEQUENTIAL AND EXCEPTION TESTS

5.1 Overview

5.1.1 As described in Section 2, the NPPF and Planning Practice Guidance for Flood Risk and Coastal Change set strict tests to protect people and property from flooding which LBC, as a Local Planning Authority (LPA), must adhere to during the preparation of their Local Plan.

5.1.2 The emphasis of the NPPF is to steer new development away from areas at risk of flooding using the Sequential Test. Where development cannot be avoided in areas identified to be at risk of flooding, guidance is provided regarding the types of development that are appropriate, based on the vulnerability classification and criteria are set for when the Exception Test may be required before development can be permitted.

5.1.3 Guidance on the application of the Sequential and Exception Test is largely focused on flood risk from fluvial sources, as outlined in Figure 5.1 below, an extract from the Planning Practice Guidance for Flood Risk and Coastal Change.

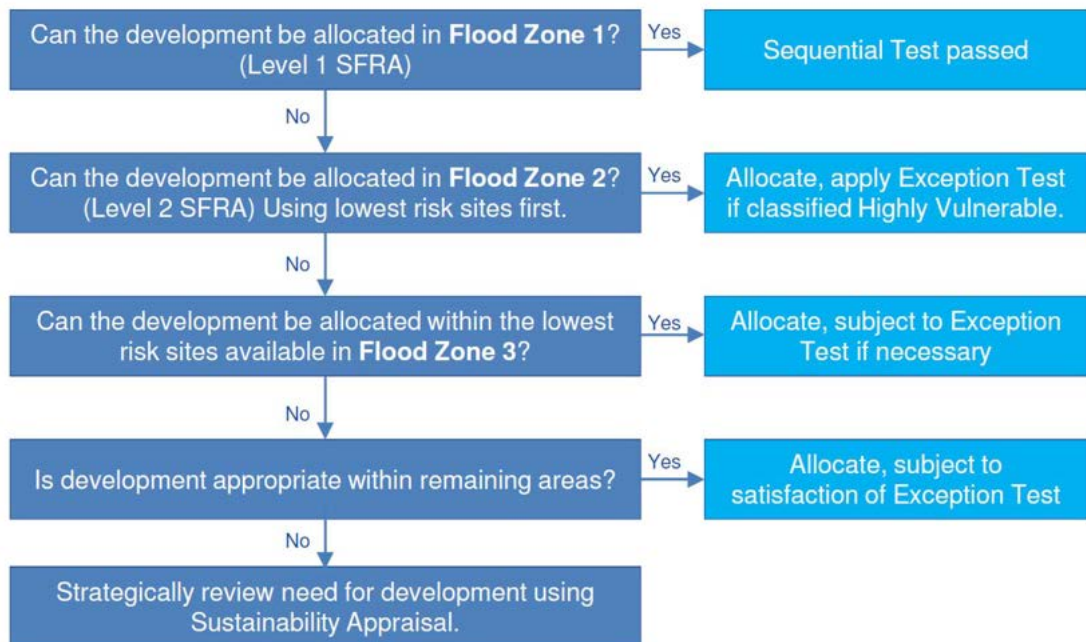


Figure 5.1: Application of Sequential Test for Local Plan preparation (Diagram 2 from Planning Practice Guidance – Flood Risk and Coastal Change)

5.1.4 Despite the focus on fluvial flood risk the Planning Practice Guidance for Flood Risk and Coastal Change makes it clear that developments in Flood Zone 1 should consider and where appropriate be steered away from other sources of flooding such as surface and ground water.

5.1.5 The application of the sequential approach aims to manage the risk from flooding by avoidance. This will help avoid the promotion of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test will ensure that new developments in flood risk areas will only occur where flood risk is clearly outweighed by other sustainability drivers.

5.2 Fluvial Flood Zones

5.2.1 As no main rivers are located within LBC the entire borough is located within Flood Zone 1. The Sequential Test must therefore consider flood risk from other sources.

Development Vulnerability

5.2.2 The NPPF provides guidance on the suitability of a development based on its vulnerability and location within a flood risk area. Flood risk vulnerability classifications, as defined in the Planning Policy Guidance, are presented in Table 5.1.

Table 5.1: Flood Risk Vulnerability Classification (Planning Practice Guidance, 2014)

Vulnerability Classification	Development Uses
Essential Infrastructure	<p>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.</p> <p>Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood.</p> <p>Wind turbines.</p>
Highly Vulnerable	<p>Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding.</p> <p>Emergency dispersal points.</p> <p>Basement dwellings.</p> <p>Caravans, mobile homes and park homes intended for permanent residential use.</p> <p>Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).</p>

Vulnerability Classification	Development Uses
More Vulnerable	<p>Hospitals.</p> <p>Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels.</p> <p>Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.</p> <p>Non–residential uses for health services, nurseries and educational establishments.</p> <p>Landfill and sites used for waste management facilities for hazardous waste.</p> <p>Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.</p>
Less Vulnerable	<p>Police, ambulance and fire stations which are not required to be operational during flooding.</p> <p>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.</p> <p>Land and buildings used for agriculture and forestry.</p> <p>Waste treatment (except landfill and hazardous waste facilities).</p> <p>Minerals working and processing (except for sand and gravel working).</p> <p>Water treatment works which do not need to remain operational during times of flood.</p> <p>Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).</p>
Water-Compatible Development	<p>Flood control infrastructure.</p> <p>Water transmission infrastructure and pumping stations.</p> <p>Sewage transmission infrastructure and pumping stations.</p> <p>Sand and gravel working.</p> <p>Docks, marinas and wharves.</p> <p>Navigation facilities.</p> <p>MOD defence installations.</p> <p>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.</p> <p>Water-based recreation (excluding sleeping accommodation).</p> <p>Lifeguard and coastguard stations.</p> <p>Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.</p> <p>Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.</p>

5.2.3 The NPPF indicates suitability of a development based on its vulnerability and location within a fluvial flood zone (see Table 5.2).

Table 5.2. Planning Practice Guidance, Table 3 Flood Risk Vulnerability and Flood Zone ‘Compatibility’

FLOOD RISK VULNERABILITY CLASSIFICATION		ESSENTIAL INFRASTRUCTURE	WATER COMPATIBLE	HIGHLY VULNERABLE	MORE VULNERABLE	LESS VULNERABLE
FLOOD ZONE	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3A	Exception Test Required	✓	✗	Exception Test Required	✓
	3B	Exception Test Required	✓	✗	✗	✗

✓ – Development is appropriate ✗ – Development should not be permitted

5.2.4 However the vulnerability classification of types of development is still relevant when considering flood risk from other sources. For example a basement dwelling will still be more vulnerable to surface water flooding than an office development.

5.2.5 Indeed, the NPPF acknowledges that some areas will be at risk of flooding from flood sources other than fluvial or tidal systems. All sources of flooding must be considered when looking to locate new development. The other sources of flooding requiring consideration when siting new development allocations include:

- Surface Water;
- Groundwater;
- Sewers; and
- Artificial Sources.

5.2.6 LBC should consider utilising the Environment Agency’s uFMfSW which provides banding of Low, Medium and High surface water flood risk within Camden. The Low, Medium and High bands of surface water flood risk may be substituted in place of Flood Zones 1, 2 and 3, in Table 5.2, above.

5.2.7 Where a ‘More Vulnerable’ development is proposed in an area with a potential flood risk, suitable mitigation measures, such as raising of finished floor levels and access levels and introducing thresholds to buildings, should be utilised in order to mitigate risks to property and people.

5.2.8 LB Camden should consider restricting development of 'Highly Vulnerable' development in 'High' surface water flood risk areas where a specific flood risk has been identified. For example new basement dwellings should be discouraged in such areas. Essential infrastructure associated with proposed developments may be discouraged from being placed on the ground flood in high risk areas.

5.2.9 LB Camden should consider requiring a FRA for More Vulnerable development in High surface water flood risk areas, and for Highly Vulnerable development in Medium surface water flood risk areas.

5.3 Recommended stages for LPA application of the Sequential Test

5.3.1 The flood risk within Camden has been identified on a strategic basis in Section 4, with a number of areas identified as being within broad areas of higher risk of flooding. The deliverables from the LB Camden SWMP provide Local Flood Risk Zones (LFRZ) where discrete flooding is possible, affecting houses, business or infrastructure. In addition to the LFRZs, the uFMfSW also identified areas of potential surface water ponding in South Hampstead, Dartmouth Park and Camden Town. The uFMfSW extent mapping should be utilised to identify areas of Low (within the flood extent during a 1 in 1000 year rainfall event), Medium (within the flood extent during a 1 in 100 year rainfall event and High (within the flood extent during a 1 in 30 year rainfall event) surface water flood risk, as defined by the Environment Agency. The flood risk banding developed by the Environment Agency should be utilised to initially allocate development in Camden towards areas of lower flood risk i.e. following a sequential approach to location of development.

5.3.2 Hazard Mapping created by the Environment Agency as part of the uFMfSW (Appendix B, Figure 3vi-x) indicates the hazard to people following a methodology presented by Defra in its R&D report on Flood Risks to People⁴⁶. Hazard is defined as a factor of depth and velocity of flow. Hazard categories are as Low, Moderate, Significant and Extreme. Even for the 1 in 1000 year rainfall event, areas of Extreme Hazard within Camden are limited.

5.4 Exception Test

5.4.1 The purpose of the Exception Test is to ensure that development is only permitted in medium and high flood risk areas, dependant on their vulnerability to flooding and where flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

- 5.4.2 In the absence of fluvial flood zones in Camden, available information on flood risk from all sources should be consulted to determine the risk to a site or area. Information discussed in this SFRA includes the uFMfSW, Environment Agency Risk of Flooding from Reservoirs Mapping and historic flood records. If available information indicates that the flood risk to a site is not low i.e., there is a potential flood risk to the site dependent on the vulnerability, then the Exception Test should be applied.
- 5.4.3 For the Exception Test to be passed:
- *It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared; and*
 - *A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*
- 5.4.4 Both elements of the test will have to be passed for development to be allocated or permitted.
- 5.4.5 In order to satisfy part (a) of the Exception Test, the objectives of the Sustainability Appraisal (SA) can be used to assess each potential development site. The LBC SA⁴⁷ includes a series of Sustainability Objectives which allow quantification of the sustainable performance of a potential development sites. The criteria could provide a consistency in the sustainability analysis of sites. When determining planning applications, LBC should ensure flood risk is not increased elsewhere and should only consider development in areas at risk of flooding to be appropriate where, informed by a site-specific FRA, following the Sequential Test, and if required the Exception Test, it can be demonstrated that:
- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
 - development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning carried out by the resident and/ or owner; and it gives priority to the use of sustainable drainage systems.
- 5.4.6 There are a number of ways a new development can be made safe:
- Avoiding flood risk by not developing in areas at risk from floods;

- Substituting higher vulnerability land uses for lower vulnerability uses in higher flood risk locations and locating higher vulnerability uses in areas of lower risk on a strategic scale, or on a site basis;
- Providing adequate flood risk management infrastructure which will be maintained for the lifetime of the development; and
- Mitigating the potential impacts of flooding through design and resilient construction..

Applying the Sequential Test to proposed developments not included in London Borough of Camden’s Allocated Sites

5.4.7 As illustrated in Figure 5.2, the flood risk Sequential Test can be considered adequately demonstrated if (1) the Sequential Test has already been carried out for the site for the same development type at the Local Plan level for allocated sites AND (2) the development vulnerability is appropriate to the flood risk, as determined by LBC.

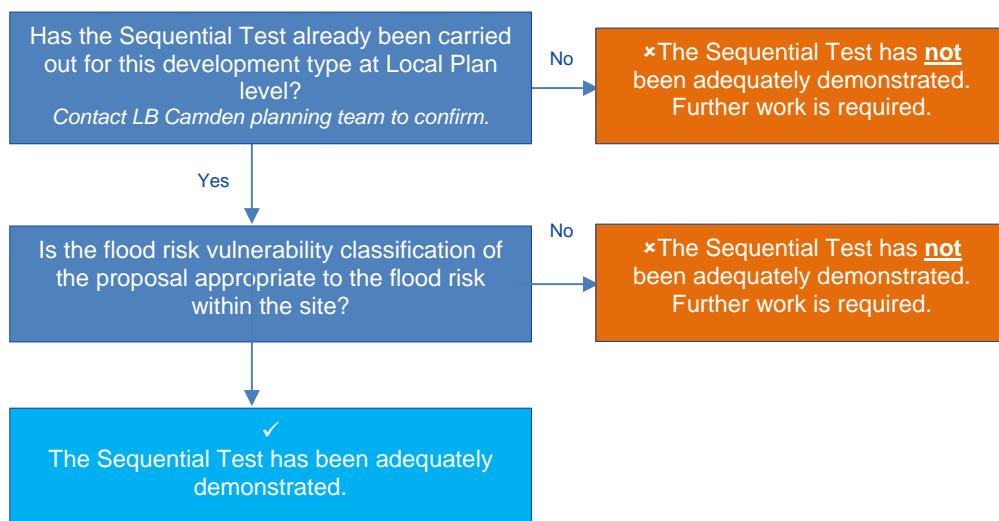


Figure 5.2: Determining when the Sequential Test is required

5.4.8 If the answer to either of these two criteria is ‘no’, then it is necessary to undertake a Sequential Test for the site. The Environment Agency publication ‘Demonstrating the flood risk Sequential Test for Planning Applications ’ sets out the procedure as follows:

- Identify the geographical area of search over which the test is to be applied; for example the borough area, or a specific catchment if this is appropriate and justification is provided;

- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan;
- State the method used for comparing flood risk between sites; for example the Environment Agency updated Flood Map for Surface Water, the SFRA mapping, site specific FRAs if appropriate, other mapping of flood sources;
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, apply the Exception Test.
- Apply the Sequential approach (See Section 5.3) to locating development within the site.

5.4.9

Windfall sites are defined in the NPPF as: '*Sites which have not been specifically identified as available in the Local Plan process*' and therefore will not have undergone the Sequential Test at Local Plan level, as detailed in Section 5.4.7. The procedure set out above (See Section 5.3) would therefore be required.

6 GUIDANCE FOR PREPARING SITE SPECIFIC FRAS

6.1 When is a Flood Risk Assessment required?

6.1.1 The Environment Agency provides flood risk standing advice for applicants and agents on their website: <https://www.gov.uk/planning-applications-assessing-flood-risk>. This includes information on when a FRA is required and advice on the contents of FRAs for various development types in Flood Zone 1, Flood Zone 2 and Flood Zone 3. As LBC is located entirely within Flood Zone 1, advice relating to Flood Zone 2 and 3 is not relevant.

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

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

6.1.3 It should be noted that LBC is located entirely within Flood Zone 1 and therefore no proposals located within Flood Zone 2 and 3 will be brought forward for development.

6.1.4 The Environment Agency Guidance Note for FRAs in Flood Zone 1⁴⁸ (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/311502/LIT_91_93.pdf) should be consulted for advice on the approach and content of a FRA.

6.2 Scope of a site-specific FRA

6.2.1 The Planning Practice Guidance states that site-specific FRAs should always be proportionate to the degree of flood risk and make optimum use of readily available information, for example the mapping presented within this SFRA.

6.2.2 Table 6.1 is based on the checklist for site specific FRAs provided in the Planning Practice Guidance. Where appropriate, references have been added to determine where the information can be found to support each required item.

Table 6.1: Site-Specific Flood Risk Assessment Checklist (Planning Practice Guidance)

1. Development description and location	
1a. What type of development is proposed (e.g., new development, an extension to existing development, a change of use etc.) and where will it be located?	<input type="checkbox"/>
1b. What is its flood risk vulnerability classification? Refer to Section 5.2 Table 5.1.	<input type="checkbox"/>
1c. Is the proposed development consistent with the Local Plan for the area? LBC is currently carrying out a review of the LBC Core Strategy and Development Policies and are due to publish its Draft Local Plan in late 2014. The existing Core Strategy and Development Policies should be referred to on the LBC website: http://www.camden.gov.uk/ccm/navigation/environment/planning-and-built-environment/planning-policy/ and seek advice from LBC if necessary	<input type="checkbox"/>
1d. What evidence can be provided that the Sequential Test and where necessary the Exception Test has/have been applied in the selection of this site for this development type? Consult LBC to determine if the site has been included in the Sequential Test. If not, refer to Section 5.3 for guidance on undertaking the Sequential Test for individual development sites and to determine whether the Exception Test is required.	<input type="checkbox"/>
1e. Will your proposal increase overall the number of occupants and/or users of the building/land, or the nature or times of occupation or use, such that it may affect the degree of flood risk to these people? This is particularly relevant to minor developments (alterations & extensions) & changes of use.	<input type="checkbox"/>
2. Definition of the flood hazard	
2a. What sources of flooding could affect the site? Refer to Section 4	<input type="checkbox"/>
2b. For each identified source under 2a above, can you describe how flooding would occur, with reference to any historic records where these are available? Refer to Section 4	<input type="checkbox"/>
2c. What are the existing surface water drainage arrangements for the site? Undertake a site survey to determine specific details. Where appropriate an asset location survey can be provided by Thames Water http://www.thameswater-propertysearches.co.uk/ .	<input type="checkbox"/>
3. Probability	
3a. Which flood zone is the site within? In the case of LBC, the borough is entirely within Flood Zone 1 as defined by the Flood Map for Planning (Rivers and Sea) on the Environment Agency's website http://maps.environment-agency.gov.uk/wiyby . Therefore Section 3a of this checklist does not apply.	<input type="checkbox"/>
3b. Does the SFRA show the same or a different flood zone compared with the Environment Agency's flood map? Both this SFRA and the Flood Map for Planning (Rivers and Sea) on the Environment Agency's website http://maps.environment-agency.gov.uk/wiyby indicate that the borough is entirely within Flood Zone 1. If different you should seek advice from the local planning authority and, if necessary, the Environment Agency enquiries@environment-agency.gov.uk .	<input type="checkbox"/>

<p>3c. What is the probability of the site flooding, taking account of the maps of flood risk from rivers and the sea and from surface water, on the Environment Agency's website, and the SFRA, and of any further flood risk information for the site?</p> <p>Refer to mapping in Section 4.2 and Appendices B, as well as the Flood Map for Planning (Rivers and Sea) and the Flood Risk from Surface Water mapping on the Environment Agency's website http://maps.environment-agency.gov.uk/wiyby. In the case of LBC the Flood Map for Planning (Rivers and the Sea) is not applicable due to LBC's location entirely within Flood Zone 1.</p>	<input type="checkbox"/>
<p>3d. If known, what (approximately) are the existing rates and volumes of surface water run-off generated by the site?</p>	<input type="checkbox"/>
4. Climate change	
<p>How is flood risk at the site likely to be affected by climate change?</p> <p>No main rivers are located within LBC and therefore there is no flood risk from fluvial sources. Refer to Section 4.6 for a description of how climate change will impact other sources of flooding.</p>	<input type="checkbox"/>
5. Detailed development proposals	
<p>Where appropriate, are you able to demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding (including providing details of the development layout)?</p> <p>Refer to Section 6.3 regarding the use of the sequential approach within development sites.</p>	<input type="checkbox"/>
6. Flood risk management measures	
<p>How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime?</p> <p>Refer to Section 6.4 for details regarding finished floor levels, basement dwellings, flood resilient design, car parking considerations, and provision of safe access / egress.</p>	<input type="checkbox"/>
7. Off-site impacts	
<p>7a. How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere?</p> <p>Refer to Section 6.11 regarding off-site impacts including flood routing and Section 7.</p>	<input type="checkbox"/>
<p>7b. How will you prevent run-off from the completed development causing an impact elsewhere?</p> <p>Refer to Section 7 regarding surface water management. Refer to Section 7.3 regarding the use of specific types of SuDS throughout the borough.</p>	<input type="checkbox"/>
<p>7c. Are there any opportunities offered by the development to reduce flood risk elsewhere?</p> <p>Refer to Section 7 regarding surface water management. Refer to Section 7.3 regarding the use of specific types of SuDS throughout the borough.</p>	<input type="checkbox"/>
8. Residual risks	
<p>8a. What flood-related risks will remain after you have implemented the measures to protect the site from flooding?</p>	<input type="checkbox"/>
<p>8b. How, and by whom, will these risks be managed over the lifetime of the development? (E.g., flood warning and evacuation procedures).</p> <p>Refer to Section 6.9 for details regarding flood warning and flood evacuation plans.</p>	<input type="checkbox"/>

6.3 Sequential Approach within Development Sites

- 6.3.1 Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas e.g. residential developments should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground with a higher probability of flooding.
- 6.3.2 Should development pressure create a need to develop more vulnerable land uses within the site in higher flood risk areas appropriate mitigation measures should be incorporated that are proportionate to the flood risk and would not increase the risk of flooding to surrounding areas.
- 6.3.3 Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground.

6.4 Flood Risk Management Measures

Finished Floor Levels

- 6.4.1 There is no set guidance for the setting of finished floor levels of development in relation to flood risk other than from fluvial sources, where the Environment Agency requires a minimum freeboard of 300mm above the 1% AEP plus climate change peak fluvial flood level for More Vulnerable development such as housing.

In the absence of national guidance on finished floor levels, LBC should consider requiring a freeboard for proposed developments in areas of surface water flood risk. Appendix B Figure 6 shows the majority of Camden has been identified as being within a Critical Drainage Area (CDA) “A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.”

- 6.4.2 The Environment Agency’s updated Flood Map for Surface Water details flood extents and depths during three rainfall events, and is available online at <http://watermaps.environment-agency.gov.uk/wiyby>.