London Borough of Redbridge

LONDON BOROUGH OF REDBRIDGE

STRATEGIC FLOOD RISK ASSESSMENT

LEVEL 1

MARCH 2015

Document Information

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Version 1.0 – Final Draft	
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Executive Summary

A Strategic Flood Risk Assessment is a study carried out by a local planning authority to assess the risk to an area from flooding from all sources, now and in the future. This is to take account of the impacts of climate change and to assess the impact that land use changes and development in the area will have on flood risk. The main objective of this study is to assist the Planning Department of the London Borough of Redbridge in the allocation of sites for future development and general decision making.

A Strategic Flood Risk Assessment was first developed for the London Borough of Redbridge in May 2009. Since then the National Planning Policy Framework along with its Guidance document has been introduced and more comprehensive flood modelling has been completed. As the Strategic Flood Risk Assessment is a 'live' document, this has triggered the need for an update.

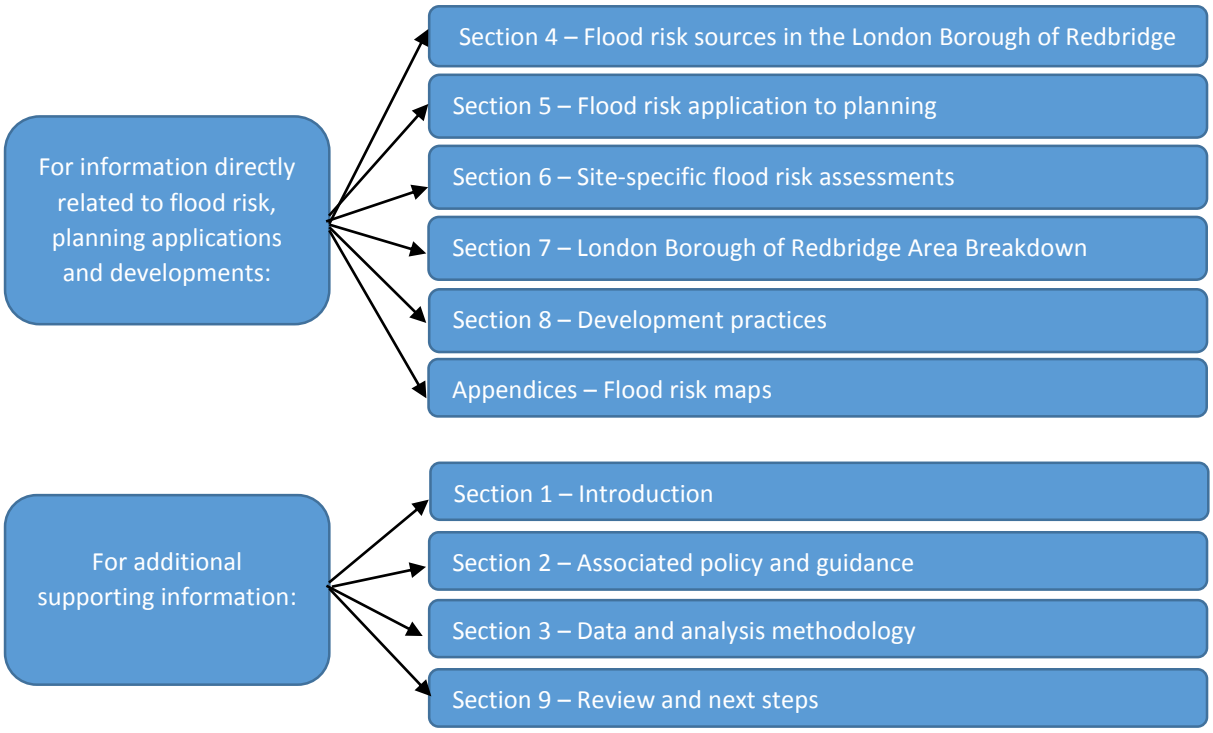
The methodology used for this report is based on guidance set out in the National Planning Practice Guidance document. Local planning authorities are to consult with the Environment Agency, lead local flood authorities, local planning authorities' own functions of emergency response, drainage authorities and internal drainage boards where appropriate to collect and evaluate information on all sources of flood risk. The outcome has led to the production of comprehensive data which clearly outlines which areas of the borough are suitable for different types of development. This document will explain the various sources of flood risk, the vulnerability classification of developments and the sequential, risk-based approach to the location of development.

There are two levels of Strategic Flood Risk Assessment. The Level 1 Assessment should consider the flood risk within the entire administrative area. The Assessment should be sufficiently detailed to allow application of the Sequential Test to the location of development and to identify whether development can be allocated outside high and medium flood risk areas, based on all sources of flooding, without application of the Exception Test. The Exception Test is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactory, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

Where a Level 1 Assessment shows that land outside flood risk areas cannot appropriately accommodate all the necessary development, it may be necessary to increase the scope of the Assessment to a Level 2 to provide the information necessary for application of the Exception Test where appropriate. A Level 2 Assessment should consider the detailed nature of the flood characteristics within a Flood Zone determined by the Level 1 Assessment. This report is the Level 1 Assessment.

This report aims to be as interactive as possible, providing links to appropriate webpages to further assist planners, developers and Redbridge Council. The links are identified by the purple text throughout the report.

User Guide


For information directly related to flood risk, planning applications and developments:
Section 4 – Flood risk sources in the London Borough of Redbridge
Section 5 – Flood risk application to planning
Section 6 – Site-specific flood risk assessments
Section 7 – London Borough of Redbridge Area Breakdown
Section 8 – Development practices
Appendices – Flood risk maps
For additional supporting information:
Section 1 – Introduction
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Section 3 – Data and analysis methodology
Section 9 – Review and next steps

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ABBREVIATIONS

Abbreviation	Definition
AEP	Annual Exceedance Probability.
BGS	British Geological Survey
DCLG	Department of Community and Local Government.
Defra	Department of Environment, Food and Rural Affairs.
DPD	Development Planning Document
EA	Environment Agency
FALP	Further Alterations to the London Plan (January 2014).
FCERM	Flood and Coastal Erosion Risk Management
FCRM	Flood and Coastal Risk Management
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FSA	Flood Storage Area
FZ3b	Flood Zone 3b
GP3	Groundwater Protection: Principle and practice
HRA	Habitats Regulations Assessment
LA	Local Authority
LBR	London Borough of Redbridge
LDF	Local Development Framework
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LTGDC	London Thames Gateway Development Corporation
MHWS	Mean High Water Spring
MHWN	Mean High Water Neap
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
PAR	Project Appraisal Report
REMA	Revised Early Minor Alterations to the London Plan (October 2013)
RMA	Risk Management Authority
SEA	Strategic Environmental assessment
SFRA	Strategic Flood Risk Assessment.
SFRM	Strategic Flood Risk Management
SPG	Supplementary Planning Guidance
SuDS	Sustainable Drainage Systems.
Thames Water	Thames Water Utilities Ltd
uFMfSW	Updated Flood Map for Surface Water
RFRMS	Roding Flood Risk Management Strategy

GLOSSARY

Term	Definition
Annual Exceedance Probability	The estimated probability of a flood of a given magnitude occurring or being exceeded in any year. Expressed as, for example, 1 in 100 year return period or 1 per cent chance of occurring in any one year.
Climate Change	This refers to any change in climate over time. On Earth, the temperatures are rising causing an increase in sea levels and rainfall. This is usually accounted for in models by applying a potential change percentage to the current 1 in 100 year return period rainfall.
Environment Agency	The Environment Agency is a non-departmental public body, established in 1996 and sponsored by the United Kingdom government's Department for Environment, Food and Rural Affairs (DEFRA). Its responsibilities relate to the protection and enhancement of the environment in England.
Exception Test	This is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactory, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.
Flood Map for Planning (Rivers and Sea)	This map shows the assessment of the likelihood of flooding from rivers and the sea at any location. It takes into account the presence and effect of all flood defences, predicted flood levels, and ground levels.
Floodplain	A floodplain is the area that would naturally be affected by flooding if a river rises above its banks.
Flood Resilience	Flood resilience, or wet-proofing, accepts that water will enter the building, but through careful design will minimise damage and allow the re-occupancy of the building quickly.
Flood Resistant	Flood resistance, or dry-proofing. This stops water from entering a building.
Flood Risk	For the purpose of applying the National Planning Policy Framework (NPPF), 'flood risk' is a combination of the probability and the potential consequences of flooding from all sources – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals, lakes and other artificial sources.
Flood Risk Vulnerability Classification	This classification categorises different types of property uses and development according to their vulnerability to flood risk.
Flood Storage Area	These are natural or man-made basins which temporarily fill with water during periods of high river levels.
Flood Zones	These show areas of land that could flood from rivers and/or the sea. They identify the extents over which flooding could occur, if the flooding is not constrained by flood defences.
Flood Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Flood Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Flood Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or land having a 1 in 200 or greater annual probability of sea flooding.
Flood Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.
Fluvial	Of a river. For example, fluvial flooding is caused by river water.
Lead Local Flood Authority	The unitary authorities or county councils responsible for managing local flood risk, including from surface water, ground water and ordinary watercourses, and for preparing the local flood risk management strategy.

Local Flood Risk	Flood risk from surface runoff, groundwater and ordinary watercourses.
Main Rivers	As marked on a main river map, these are larger watercourses which the EA have powers to carry out flood defence work on.
Natura 2000 Site	Part of an EU wide network, Natura 2000 sites are areas established under the 1992 Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most vulnerable and threatened species and habitats.
Ordinary Watercourse	This refers to every watercourse through which water flows and which does not form part of a Main River.
Pluvial	Relating to rainfall. For example, pluvial flooding is caused by rainwater.
Residual Risk	Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigation actions.
Sequential Approach	The sequential, risk-based approach to the location of development is a general approach designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. Application of the sequential approach in the plan-making process, in particular application of the Sequential Test, will help ensure that development can be safely and sustainably delivered.
Sequential Test	This method ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The aim is to steer new development to Flood Zone 1 (areas with the lowest probability of flooding) and only considering sites outside of this zone when there are no reasonably available sites. If this is the case, Flood Zone 2 should be considered ahead of Flood Zone 3. Local Planning Authorities should take account of flood vulnerability of land uses when considering locations outside of Flood Zone 1, applying the Exception Test if required.
Site-Specific Flood Risk Assessment	This is to be carried out by (or on behalf of) a developer to assess the flood risk to and from a development site. Where necessary, the assessment should accompany a planning application submitted to the local planning authority. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users.
SFRA	This is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that land use changes and development in the area will have on a flood risk.
SuDS	Sustainable Drainage Systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. They also provide opportunities to reduce the causes and impacts of flooding, remove pollutants from urban run-off at source and combine water management with green space with benefits for amenity, recreation and wildlife.
Surface Water	This refers to the water which ponds or flows on the surface following rainfall whereby water cannot drain away or soak into the ground fast enough.
Surface Water Flood Extent	The name given to the layer generated using the 1 in 100 year event layer from the uFMfSW to represent the areas at risk of flooding due to surface water.
Tidal	Relating to the tide. For example, tidal flooding refers to a flood caused by unusually high tides.
Unitary Authority	Unitary authorities in England are local authorities who are responsible for an administrative division of local government established in place of, or as an alternative to, a two-tier system of local councils.

1. INTRODUCTION

1.1 OVERVIEW

1.1.1 BRIEF DESCRIPTION OF ADMINISTRATIVE AND GEOGRAPHICAL BOUNDARIES

The London Borough of Redbridge (LBR) is located to the north east of London. It borders Epping Forest District Council and the London Boroughs of Havering, Barking & Dagenham, Newham, and Waltham Forest. The LBR covers an area of around 5,500 hectares and its main metropolitan town centre is Ilford. The borough is predominantly urbanised and residential, with a population of approximately 280,000 (based upon the 2011 Census[1]).

There is one Natura 2000 site within the LBR, Epping Forest, but there are 16 designated conservation areas, 129 statutory listed buildings and about a third of the borough is within the Metropolitan Green Belt. The largest river to flow through the LBR is the River Roding and the other Main Rivers include its tributaries and the largely culverted Cran Brook and Seven Kings Water. The River Roding (Lower) is affected by the tide from Ilford. The locations of these watercourses along with the administrative boundary and key locations within LBR can be seen in **Figure 1.**

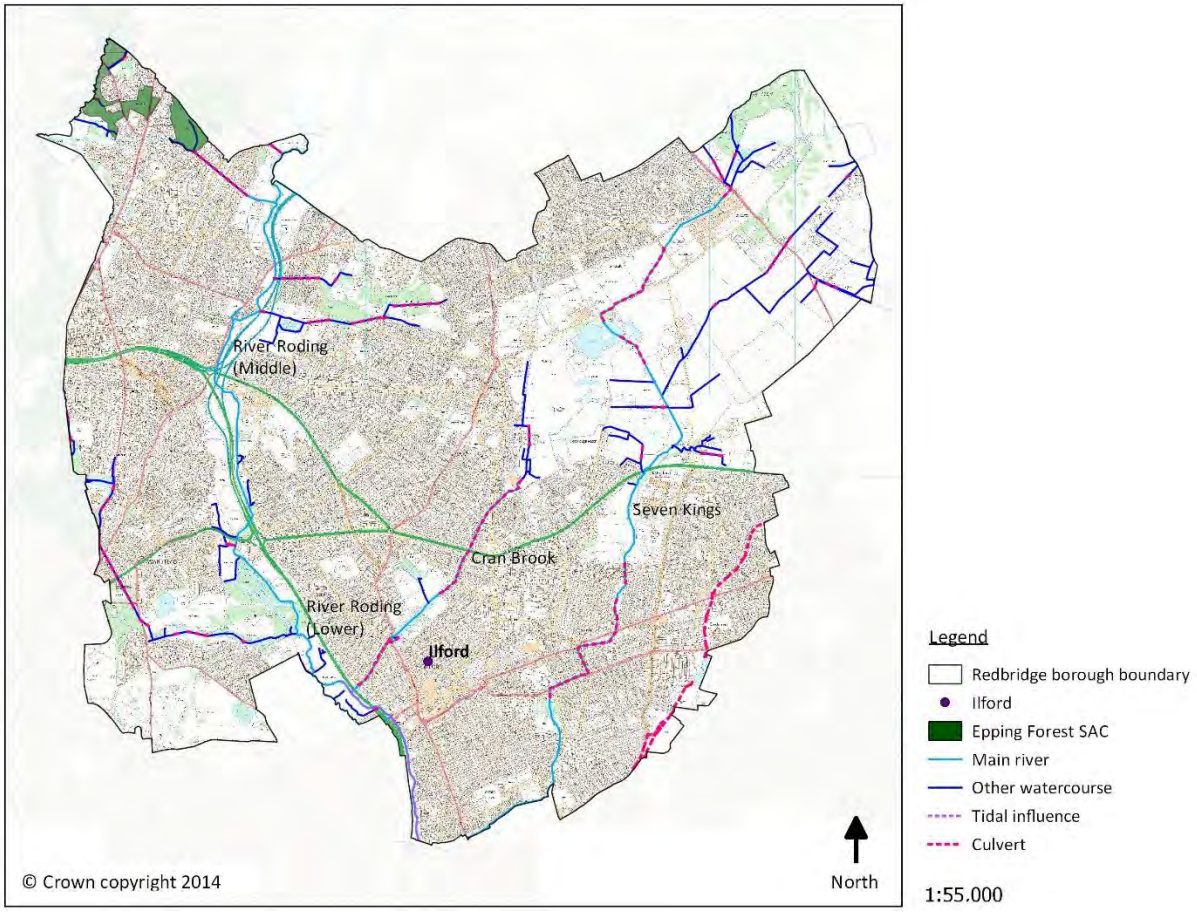

Figure 1. Overview of the administrative boundary, Ilford town centre, main watercourses, Natura 2000 sites and other watercourses[2] within the London Borough of Redbridge.

[1] Data source: Office for National Statistics (www.statistics.gov.uk)

[2] 'Other watercourses' consist of secondary rivers, tertiary rivers and lakes/reservoirs as outlined in the Environment Agency's Detailed River Network GIS layer from GeoStore.

1.1.2 WHAT A STRATEGIC FLOOD RISK ASSESSMENT IS AND WHAT FUNCTIONS IT FULFILS

A Strategic Flood Risk Assessment is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that land use changes and development in the area will have on flood risk.

In order to construct properties that are sustainable, the National Planning Policy Framework (NPPF) requires that a Level 1 SFRA is carried out so that development can be planned in areas that are least at risk from flooding. The document is to be used strategically by the council's planning department.

1.1.3 PURPOSE OF AND REASON BEHIND LEVEL 1 SFRA

- Collate information to determine the variations in risk from all sources of flooding across the area.
- To provide highly vulnerable areas further protection from unsuitable development by delineating the Flood Zone 3b using information from the Environment Agency (EA) and knowledge from LBR staff.
- A tool to be used to inform the sustainability appraisal of the Local Plan and in the preparation of planning policies with regards to fully consider flood risk.
- Provides the information required to apply the Sequential Test and where necessary, the Exception Test when determining land use allocations.
- To provide assistance to planners/developers looking to produce or review a site-specific flood risk assessment.

The Level 1 SFRA is to refine information on river and sea flood risk shown on the EA's Flood Map for Planning (Rivers and Sea) (www.maps.environment-agency.gov.uk) and to combine it with surface water, sewer and groundwater flood risk information to determine the variations in risk from all sources of flooding across the area. It should also determine the variations in risks to and from surrounding areas in the same flood catchment. The local planning authority can then use the Level 1 SFRA to inform the sustainability appraisal (www.planningguidance.planningportal.gov.uk) of the Local Plan, so that flood risk is fully taken into account when considering allocation options and in the preparation of plan policies, including policies for flood risk management to ensure that flood risk is not increased.

The Level 1 report is to outline the sequential approach, providing the information required to apply the Sequential Test (www.planningguidance.planningportal.gov.uk) and, where necessary, the Exception Test (www.planningguidance.planningportal.gov.uk) when determining land use allocations. The report should also identify the requirements for site-specific flood risk assessments in particular locations, including those at risk from sources other than river and sea flooding. In terms of emergency planning capability, the Level 1 SFRA is to determine the acceptability of flood risk. Finally, the Level 1 SFRA should be used to consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and of storage for flood water.

1.1.4 FUTURE NEED FOR A LEVEL 2 SFRA

Where a Level 1 Assessment shows that land outside flood risk areas cannot appropriately accommodate all the necessary development, it may be necessary to increase the scope of the Assessment to a Level 2 to provide the information necessary for application of the Exception Test where appropriate. A Level 2 SFRA should consider the detailed nature of the flood characteristics within a Flood Zone including:

- Flood probability;
- Flood depth;
- Flood velocity;
- Duration of flood; and
- Rate of onset of flooding.

A Level 2 SFRA should also reduce burdens on developers, in particular, at windfall sites, in the preparation of site-specific flood risk assessments.

1.2 The 2009 SFRA

1.2.1 Overview of previous SFRA (Level 1 & 2)

In May 2009 the LBR published their current Strategic Flood Risk Assessment (SFRA). This document was a Level 1 and 2 SFRA combined, based upon the Planning Policy Statement 25 (PPS25). Although it considers all sources of flooding, it mainly focuses on fluvial flooding and only considers surface water when there has been evidence of sewer systems surcharging.

1.2.2 Why update the 2009 SFRA

The LBR's Planning Policy Department are in the process of developing the Redbridge Local Plan (2015-2030). To ensure that the SFRA reflects revised legislation and current modelled data, it has been identified that the 2009 SFRA needs to be updated. A brief description of some of the new policies and updates can be found below, followed by a complete list and explanation of all of the relevant policies in Section 2.

Flood and Water Management Act

The Flood and Water Management Act 2010 (FWMA) came into force in 2010 following the recommendations set out in the 2008 Pitt Review. This resulted in the LBR becoming a Lead Local Flood Authority (LLFA) resulting in a significant change in the LBR's roles and responsibilities with respect to flood risk management.

National Planning Policy Framework/Practice Guidance

The National Planning Policy Framework (NPPF) was introduced in March 2012 and superseded all Planning Policy Statements (PPS), including PPS25 which was directly concerned with development and flood risk. The NPPF maintains the same principles as the PPS25, although a few amendments have been made to the flood risk legislation, including the management and definition of flood risk as detailed within this SFRA. The National Planning Practice Guidance (NPPG) supports the NPPF and has been available entirely online since March 2014.

The Mayor's London Plan

This sets out the integrated economic, environmental, transport and social framework for the development of the capital over the next 20-25 years. Since the 2004 Plan, The Mayor of London published a revision in 2011, followed by the Revised Early Minor Alterations to the London Plan (REMA) published on 11 October 2013. From this date, the REMA are operative as formal alterations to the London Plan and form part of the development plan for Greater London. Further alterations have again been made and The Draft Further Alterations to the London Plan (FALP) underwent consultation in January 2014 for 12 weeks and on 15 December 2014, the Mayor published the report of the planning inspector who undertook the examination in public of the Draft FALP. Within the FALP, the Mayor outlines an increase in the 10-year housing target. The LBR will have a new housing target to achieve and the SFRA will play a pivotal role in ensuring any new developments are not constructed within unsuitable, flood risk areas.

LBR Documentation

Following the 2009 SFRA, Redbridge Council has produced new documentation which interact with the SFRA. These include:

- **Local Flood Risk Management Strategy.** This document outlines how the LLFA will manage local flood risk. By improving knowledge, enhancing relationships, explaining responsibilities and working to reduce flood risk, there will be more opportunities for development in sites which may previously have been unsuitable. As the actions and objectives within the LFRMS are achieved, the SFRA can be updated to consider any improvements in understanding and reducing flood risk due to flood alleviation schemes and mitigation measures. The LFRMS for the LBR is currently a draft document.
- **Preliminary Flood Risk Assessment** (2011). The hazard and depth maps produced along with the identification of locations at risk within this document should run alongside the SFRA in providing developers with the information they need to produce flood risk assessments (FRAs) and assist the LPA when dealing with planning applications.
- **Surface Water Management Plan** (2011). The SWMP was delivered as tier 2 of the Drain London Project. It outlines areas within the borough identified as being at risk of flooding from surface water, highlighted as critical drainage areas (CDAs). It is important that areas which experience surface water flooding are considered when allocating sites for development as any change in surface water runoff could have a large effect on the flood risk in the area and in downstream locations. Additionally, as detailed modelling and flood alleviation schemes are completed (tier 3), the results should be fed into the SFRA so that new areas suitable for development can be identified.
- **SuDS Design and Adoption Guide.** Once fully developed and published, this document will exist alongside National Guidance to help inform developers and planners of the options available for ensuring that new developments do not increase flood risk and even potentially decrease flood risk. This information would be used in FRAs and is referenced within Section 8 of this SFRA.

Flood Risk Modelling and Understanding

Since the introduction of the Flood Risk Regulations in 2009 there has been a significant improvement in the understanding of flood risk across London. The flood risk maps produced by the EA are more accurate and consequently improvements to the local flood risk policies, based upon SFRAs have been possible. The EA have published an updated Flood Map for Surface Water (2013) and the Flood Maps (2014) for flooding from rivers and sea.

In producing this updated SFRA, the LBR have worked alongside the EA to redefine Flood Zone 3b. This is due to a better understanding of the geology, groundwater and risk of flooding from the rivers and sea, combined with an increased knowledge of known flood issue locations within the borough. Also since the publication of the SFRA in 2009, there has been a greater understanding of the flood risks within the surface water critical drainage areas and updated flood risk modelling data is available.

This updated SFRA is able to better consider the risk of flooding from surface water whereas the previous SFRA focused mainly on fluvial flooding.

1.3 LEVEL 1 SFRA REPORT STRUCTURE

Following this introduction section, the rest of this SFRA is structured in the following way:

Section 2 Associated Policy and Guidance	This section identifies and provides a brief explanation of the national, regional and local policies and guidance documents which link to the SFRA.
Section 3 Data and Analysis Methodology	Within this section, all of the data and sources used for the collation of flood risk data have been listed. The methodology behind the analysis and presentation has also been explained.
Section 4 Flood Risk Sources in Redbridge	This section clarifies why each of the sources of flood risk are analysed separately and then shows the results from each source. This has been displayed in the form of text and maps.
Section 5 Flood Risk Mapping and Application to Planning	This section sets out how the LBR should apply the flood risk maps along with the NPPF and NPPG to planning. This relates to the sustainability appraisal within the Local Plan as well as when dealing with pre-application advice and development consent.
Section 6 Site-Specific Flood Risk Assessments	Following the specification of when a site-specific flood risk assessment is required, this sections outlines the LBR's specific requirements.
Section 7 Area Discussion	The borough has been split up into 9 areas allowing for planners/developers to have a clearer picture when focusing on single locations. The full size maps are in Appendix C.
Section 8 Development Practice	This section provides information on SuDS and flood mitigation to enhance development best practice. It outlines and encourages these measures which produce more sustainable developments.
Section 9 Review and Next Step	This section highlights the triggers which result in an update to the SFRA being required. It clarifies the document owner and responsibility to review it. It outlines the benefits of completing a Level 2 SFRA.
Section 10 Appendices	All of the maps and supporting documents mentioned throughout the main body of this SFRA report can be found within this section.

1.4 CONSULTATION

The NPPG states that the SFRA should be prepared by LPAs in consultation with the EA, LLFAs, LPAs own functions of emergency response, the drainage authority (under the Land Drainage Act 1991) and where appropriate, internal drainage boards.

An initial start-up meeting was attended by Redbridge Council officers and an EA Flood and Coastal Risk Management (FCRM) officer in June 2014.

During the production of the document, Thames Water were consulted with to obtain sewer flood information whilst those organisations already mentioned helped to compile data on river and sea, surface water, groundwater and additional flood sources. This included discussions with various LBR council departments, including the highways and planning departments.

2. ASSOCIATED POLICY AND GUIDANCE

2.1 NATIONAL POLICY

2.1.1 NATIONAL POLICY PLANNING FRAMEWORK

The National Planning Policy Framework (NPPF) (www.planningguidance.planningportal.gov.uk) was published on the 27th March 2012 by the Department for Communities and Local Government. It sets out the Government's planning policies for England and how these are expected to be applied. It provides a framework within which local people and their accountable councils can produce their own distinctive local plans and neighbourhoods plans, which reflect their needs and priorities of their communities. The NPPF replaces most of the Planning Policy Statements (PPS), including PPS25: Development and Flood Risk. The new flood risk policy can be found in the NPPF Section 10: Meeting the challenge of climate change, flooding and coastal change. A full list of documents replaced by this framework can be found in the NPPF, Annex 3.

The NPPF sets out the Government's requirements for the planning system only to the extent that is relevant, proportionate and necessary to do so. The purpose of the planning system is to contribute to the achievement of sustainable development. The NPPF retains the principles of PPS25 in seeking to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. To guide local planning policy, LPAs continue to be required to produce a SFRA which will inform the sustainability appraisal of the Local Plan and identify the requirements for site-specific flood risk assessments in particular locations. This is done firstly by determining the variations in risk from all sources of flooding across the area and then using the sequential approach which comprises of the Sequential Test and the Exception Test to locate future developments.

2.1.2 NATIONAL PLANNING PRACTICE GUIDANCE

The National Planning Practice Guidance (NPPG) (www.planningguidance.planningportal.gov.uk) was produced in March 2014 and accompanies the NPPF. The section entitled Flood Risk and Coastal Change advises on how planning can take account of the risk associated with flooding and coastal change in plan-making and the application process. It defines flood risk and details how flood risk should be taken into account when preparing local plans. The NPPG explains how a SFRA should be prepared and address various sources of flood risk. Within the NPPG, the sequential, risk-based approach to the location of development is outlined along with details on how the Sequential and Exception Tests should be applied. Amongst other things, the NPPG contains tables detailing the Flood Zones, Flood Risk Vulnerability Classification and Flood Zone 'compatibility'.

2.1.3 FLOOD RISK REGULATIONS 2009

The Flood Risk Regulations (FRR) (www.legislation.gov.uk) came into force on the 10th December 2009. As explained in the Defra prepared explanatory memorandum, the purpose of the FRR is to transpose the EC Floods Directive (Directive 2007/60/EC on the assessment and management of flood risks) into domestic law and to implement its provisions. In particular, it places duties on the EA and local authorities (LAs) to prepare flood risk assessments, flood risk maps and flood risk management plans. As a LLFA, the LBR have the following responsibilities under the FRR 2009:

- Duty to prepare preliminary assessment reports
- Duty to prepare flood hazard maps and flood risk maps
- Duty to prepare flood risk management plans

2.1.4 FLOOD AND WATER MANAGEMENT ACT 2010

Following the floods across the UK in the summer of 2007, Sir Michael Pitt was asked to undertake a comprehensive review of the lessons to be learnt. This review was published in 2008 titled *Learning*

Lessons from the 2007 Floods (www.webarchive.nationalarchives.gov.uk), more commonly called 'The Pitt Review'. Within the review, Sir Michael Pitt made a number of recommendations from which the Flood and Water Management Act (FWMA) (www.legislation.gov.uk) was produced. The FWMA came into effect in April 2010 and in summary, places new responsibilities on the EA, LAs and property developers (among others) to manage the risk of flooding. The EA have been given an overview role of Flood and Coastal Erosion Risk Management (FCERM) and unitary authorities and county councils have been made the lead in managing local flood risk, designating them as Lead Local Flood Authority (LLFA). Local flood risk includes flooding from ordinary watercourse, surface water and groundwater. The FWMA also labels the EA, a LLFA, a district council for an area for which there is no unitary authority, an internal drainage board, a water company and a highway authority as 'risk management authorities' (RMAs).

As a LLFA and RMA, the LBR have a number of key responsibilities under the FWMA which include:

- Local Strategy for Flood Risk Management
- Investigating flood incidents
- Duty to maintain a register of assets
- Leadership and partnership
- Designation powers
- SuDS Approving Body. This is pending an application decision and an implementation date.

2.2 REGIONAL POLICY

2.2.1 LONDON PLAN

The Greater London Authority (GLA) produced the London Plan (www.london.gov.uk) in 2011 which is a strategic overview of development across London for the next 20 years, including frameworks relating to economic, environmental, social and transport factors. Alterations were made to this document and the Revised Early Minor Alterations to the London Plan (REMA) was published in October 2011. It states that the Mayor has carefully considered the extent to which the policies in this Plan are consistent with those in the NPPF. He is satisfied that the Plan reflects the intent of the NPPF and in particular the presumption in favour of sustainable drainage.

Chapter 5, *London's Response to Climate Change* contains Policy 5.12 *Flood Risk Management* which outlines the need for development proposals to comply with the requirements set out in the NPPF and the associated technical guidance (now the NPPG). The London Plan also sets out housing targets of which the LBR has an allocation to achieve. The SFRA will be used to identify appropriate locations and determine those sites unsuitable for development due to flood risk.

On the 15th January, the Mayor published Draft Further Alterations to the London Plan (FALP) for a twelve week period of public consultation and on 15 December 2014, the Mayor published the report of the planning inspector who undertook the examination in public of the Draft FALP. This Plan outlines new housing targets amongst other changes. Should these come into effect, there may be an increased pressure on the LBR to find land suitable for development which will rely upon the findings in this SFRA.

2.2.2 SUPPLEMENTARY PLANNING GUIDANCE (SPG) – SUSTAINABLE DESIGN AND CONSTRUCTION

The Supplementary Planning Guidance - Sustainable Design and Construction (www.london.gov.uk) was produced by the GLA in April 2014 to provide guidance on the implementation of London Plan Policy 5.3 – Sustainable Design and Construction, as well as a range of policies, primarily in chapters 5 and 7 that deal with matters relating to environmental sustainability.

Chapter 3 of the SPG, Adapting to Climate Change and Greening the City contains a section on flooding and provides guidance on the following key areas:

- Surface water flooding;
- Flooding and the resilience and resistance of buildings;
- Flooding a basement developments;
- Flood risk management from tidal and fluvial flooding; and
- Sustainable drainage;
- Safety;
- Flood defences;
- Other sources of flooding.

The Mayor's priorities outline that developers should maximise all opportunities to achieve greenfield runoff rates in the developments and that developers should design SuDS into their schemes that incorporate attenuation for surface water runoff as well as habitat, water quality and amenity benefits. This is all reflected in the SFRA through the sequential approach of allocating sites not only in areas free from flood risk, but in areas suitable for SuDS and flood mitigation measures. The SPG also reinforces the fact that the risk of flooding from all sources should be defined by the LPA in their SFRA.

2.2.3 THAMES CATCHMENT FLOOD MANAGEMENT PLAN

Catchment Flood Management Plans (CFMPs) provide an overview of the flood risk across a catchment and set out the preferred plan for sustainable flood risk management over the next 50 to 100 years. To consider the impacts of climate change, the CFMPs assumes that mild, wetter winters will result in increases in peak river flows of 20% and more frequent, short duration intense storms in the summer will cause more regular, widespread 'flash flooding' from overwhelmed drainage systems and some rivers.

The LBR falls within the Thames catchment and the EA issued the Thames CFMP (www.gov.uk) in 2009. It suggests that LBR has 2,000-5,000 properties at risk from a 1% annual probability river flood. The LBR has been categorised as being in sub-area 8 (heavily populated floodplain) and sub-area 9 (London catchments). There are six policy options for the management of flood risk and one has been applied to each sub-area. These describe how the level of flood risk actions should be changed in the future and range from implementing a big step reduction in the level of risk to accepting that the risk will get worse as climate change increases the likelihood of flooding. Sub-area 8 has the preference of policy option 5 and sub-area 9 has the preference of policy option 4.

Policy 4 - Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.

Policy 5 - Areas of moderate to high flood risk where we can generally take further action to reduce flood risk**.**

The Thames CFMP states that regional planning bodies and LAs should use the document as an additional resource for the management of spatial planning and emergency planning. Therefore it should be used alongside the SFRA.

2.2.4 RIVER RODING FLOOD RISK MANAGEMENT STRATEGY

The floodplain surrounding the River Roding within the LBR is an area of moderate to high fluvial flood risk. The EA have identified the need for further action which has been explored and will be implemented via the Roding Flood Risk Management Strategy (RFRMS) (www.gov.uk). This strategy, produced by the EA and adopted in 2012, gives options for improving the management of flood risk on the River Roding, from its source near Stansted to where it becomes tidal in Ilford, for the next 100 years.

As the RFRMPS plans are implemented, flood risk management along the River Roding will improve and the flood risk should be reduced. Therefore, the Flood Zones delineated in this SFRA may be altered, potentially freeing up more land for development opportunities.

2.2.5 THAMES ESTUARY 2100 FLOOD RISK MANAGEMENT PLAN

The Thames Estuary 2100 Plan (TE2100) (www.gov.uk) is an adaptive plan developed by the EA with recommendations for flood risk management for London and the Thames estuary through to the end of the 21st century and beyond. In developing the TE2100, the EA have investigated and understood flood risk in the Estuary today, how it might change in the future and the many ways that those changes can be managed and adapted to. The flood risk management recommendations are split into short term (the first 25 years), medium term (the following 15 years) and long term (the end of the century) and could be implemented by different parties. The latest 2012 report splits the tidal Thames up into nine zones, each with action plans associated with local issues. Major changes to the existing defences is not expected to be required until 2070 although upgrade investment will be needed from 2035. In some cases raising could be carried out ahead of 2070.

The River Roding flowing through the LBR, is identified as being in Action Zone 4 – east London and downstream of Thames Barrier. There are 12 recommendations, ranging from short to long term. Development along the riverside should demonstrate that it will not preclude the future raising of the defences in line with the TE2100. As and when actions are carried out to reduce the flood risk to areas within LBR, the SFRA should be updated to include new modelling and knowledge.

2.2.6 THAMES RIVER BASIN MANAGEMENT PLAN

The Thames River Basin Management Plan (TRBMP) (www.gov.uk) was produced by the EA in 2009 and is about the pressures facing the water environment in the Thames river basin district and the actions that will address them. It was prepared under the Water Framework Directive (WFD) Regulations, which was passed into UK law in 2003, and is the first of a series of six-year planning cycles. The WFD aims to:

- Prevent deterioration in water quality
- Improve and protect inland waters and groundwater
- Encourage more sustainable use of water as a natural resource
- Create better habitats for wildlife that live in and around water
- Help reduce the effects of floods and droughts

The TRBMP is a statutory plan which summarises a 'programme of measures' required in order to meet the objectives of the WFD. Although an update on the TRBMP is currently being consulted on, the existing document outlines that river morphology, water quantity and water quality are all significant issues in the LBR. It is essential that future development does not cause a negative effect on these issues or the work being done to improve them. Developers and planners should consult the TRBMP along with the SFRA when designing developments.

2.2.7 REGIONAL FLOOD RISK APPRAISAL

The Regional Flood Risk Appraisal (RFRA) (www.london.gov.uk) is a strategic overview of flood risk across London produced by the GLA in 2009. It contains 19 recommendations which are either region wide, applicable to boroughs in undertaking their SFRAs or apply to utility/service providers. Progress against these recommendations will be reported annually in the London Plan Annual Monitoring Report. The RFRA is a live document with regular updates to reflect the changing position in relation to both climate change and development pressure and policy responses. The first review produced a draft for consultation in January 2014.

Chapter 3, Spatial Implications of Flood Risk, outlines the importance of a SFRA to identify areas where there are particular flood risks. It also states that when SFRAs are updated, they should consider taking forward key recommendations into flood risk management policies within the Local

Development Framework (LDF) and identify areas where redevelopment could be an opportunity to reduce flood risk, as explained in recommendations 1 and 6.

2.2.8 THE MAYOR'S CLIMATE CHANGE ADAPTATION STRATEGY

Managing risks and increasing resilience: the Mayor's climate change adaptation strategy (www.london.gov.uk) is part of a series of strategies that together set out actions and policies to make London the best big city in the world. It was published in 2011 by the GLA and focuses on the issues climate change may have in the form of floods, droughts, heatwaves and very cold weather, in the future. The aim of the Strategy is to assess the consequences of climate change on London and to prepare for the impacts of climate change and extreme weather to protect and enhance the quality of life of Londoners. The Mayor proposes that this will be met through achieving a number of objectives.

Chapter 3 of the Strategy focuses on flooding and highlights the Drain London Forum progress and the importance of not increasing the risk of surface water flooding through greater urbanisation. This is to be reinforced in the SFRA with sections on SuDS and flood mitigation.

2.2.9 THE MAYOR'S WATER STRATEGY

The Mayors Water Strategy (www.london.gov.uk) was developed by the GLA in 2011 to present a London-specific view of water management. It draws on the other plans and strategies but also seeks to influence their future development. Its goal is to improve water management, both in terms of the water we want (such as drinking water) and the water we do not want (such as sewage and floodwater in the wrong place). The Strategy lists 18 actions which cover managing water use, paying for water services, managing rainwater and disposal of wastewater. Action 18 is relevant to the SFRA as it focuses on surface water flood risk.

2.3 LOCAL POLICY

2.3.1 LOCAL DEVELOPMENT FRAMEWORK

The Local Development Framework (LDF) (www.redbridge.gov.uk) is a portfolio of planning documents, individually known as Local Development Documents. The LDF delivers the spatial development strategy for the LBR and builds upon existing local and regional strategies and initiatives, in particular the Mayor's London Plan and Sustainable Community Strategy. The LDF is made up of a number of documents, including adopted Development Plan Documents (DPDs) and Supplementary Planning Documents (SPDs) (www.redbridge.gov.uk). One of the key adopted DPDs relevant to the SFRA is the **Core Strategy DPD**. This was adopted in March 2008 and sets out an overall spatial strategy for the LBR and provides general guidelines on the types of development the LBR would like to see and where they should be built. Other DPDs include policies for determining development proposals and show where new housing is to be built of the next ten-year period.

Since the LDF was adopted in 2008, a number of issues have emerged which need to be addressed. Therefore, the LBR is currently progressing a Local Plan 2015-2030 which will set out where, when and how growth may take place across the borough, reviewing the emerging issues which need to be addressed.

SPDs elaborate on how policies in the council's LDF DPDs will be applied. The **Sustainable Design and Construction SPD**, published in January 2012, includes a chapter on water use which outlines the fact that all developments are required to manage flood risk. It focuses on SuDS, the use of water and flood risk resilience techniques for new developments.

2.3.2 LOCAL FLOOD RISK MANAGEMENT STRATEGY

Under the FWMA, the LBR, as a LLFA, has the duty to develop, maintain, apply and monitor a Local Flood Risk Management Strategy (LFRMS). This is a live document which sets out the methods of how the LBR, along with other stakeholders, will provide support and manage flood risk within the borough. The LFRMS introduces these stakeholders and their responsibilities in addition to highlighting areas at risk of flooding. The LFRMS has been created to be a framework which local residents, businesses and organisations are able to use to gain a greater understanding of the flood risks and what the LBR are doing to manage them. The LFRMS contains five objectives which the LBR aim to achieve, with an action plan outlining 14 actions proposed to deliver the objectives.

The LFRMS is currently in a draft format and due to go to public consultation following Cabinet approval with the aim of being published in the summer of 2015. It is proposed that the LFRMS will be reviewed every 5 years, although the objectives and actions will be reviewed internally on an annual basis and amended where necessary.

2.3.3 SURFACE WATER MANAGEMENT PLAN

In July 2011, the LBR published their **Surface Water Management Plan** (SWMP). This was undertaken as part of the Drain London Project, with the objectives of developing a robust understanding of surface water flood risk in and around the borough and identifying, defining and prioritising Critical Drainage Areas (CDAs). From here, holistic and multifunctional recommendations for surface water management were made.

The LBR was split into 14 CDAs and those at significant risk have been investigated further. Detailed hydraulic modelling has been carried out for areas located adjacent to existing watercourses which flow through the borough. Hazard maps were also included in the SWMP to fulfil the FRR 2009 requirement of identifying areas at higher risk, and these and improved modelling have fed into the updated Flood Map for Surface Water (uFMfSW) produced by the EA in December 2013, which in turn has feed into this SFRA update.

2.3.4 PRELIMINARY FLOOD RISK ASSESSMENT

The Preliminary Flood Risk Assessment (PFRA) (www.redbridge.gov.uk) was published by the LBR in March 2011 following the requirements set out by the FRR 2009. It is a high level screening exercise that identifies areas of significant flood risk from surface water, rivers and groundwater and summarises the probability and harmful consequences of past (historic) and future (potential) flooding. The PFRA reviews existing data to summarise past flood risk and predict how and where flooding may occur in the future taking into account the effects of climate change and long term developments. The PFRA has been compiled using readily available information from a number of sources which include the EA's national datasets and existing local products (e.g. SFRAs and SWMPs).

2.3.5 FLOOD HAZARD MAPS AND FLOOD RISK MAPS

The EA has identified London as one of ten indicative Flood Risk Areas in England (www.gov.uk). This area incorporates the majority of the LBR, although a small section to the north east of the borough is outside of this area. The FRR 2009 specifies that once Flood Risk Areas have been identified, the EA and LLFAs are to produce Hazard and Risk maps for the sea, Main River and reservoir flooding as well as 'other' relevant sources. These Flood Hazard and Flood Risk Maps are obtainable from the Environment Agency and should be used within the Level 2 SFRA when carrying out site-specific flood risk assessments (FRAs).

2.3.6 SUDS DESIGN AND ADOPTION GUIDE

In February 2014 the LBR produced a **SuDS Design and Adoption Guide** to assist developers and other applicants through the SuDS approval process introduced by the FWMA. The document provides an overview of what will be looked for in SUDS proposals, identification of SUDS requirements for amenity and biodiversity and signposts to related guidance, policies and legislation. It highlights the importance for developers to engage early with the LBR to reduce the likelihood of an application being refused further along the process due to sustainable drainage issues. The Guide refers to both the National Standards for SuDS and The SuDS Manual (C697) (www.ciria.org) by CIRIA.

2.4 ASSOCIATED POLICY AND GUIDANCE SUMMARY

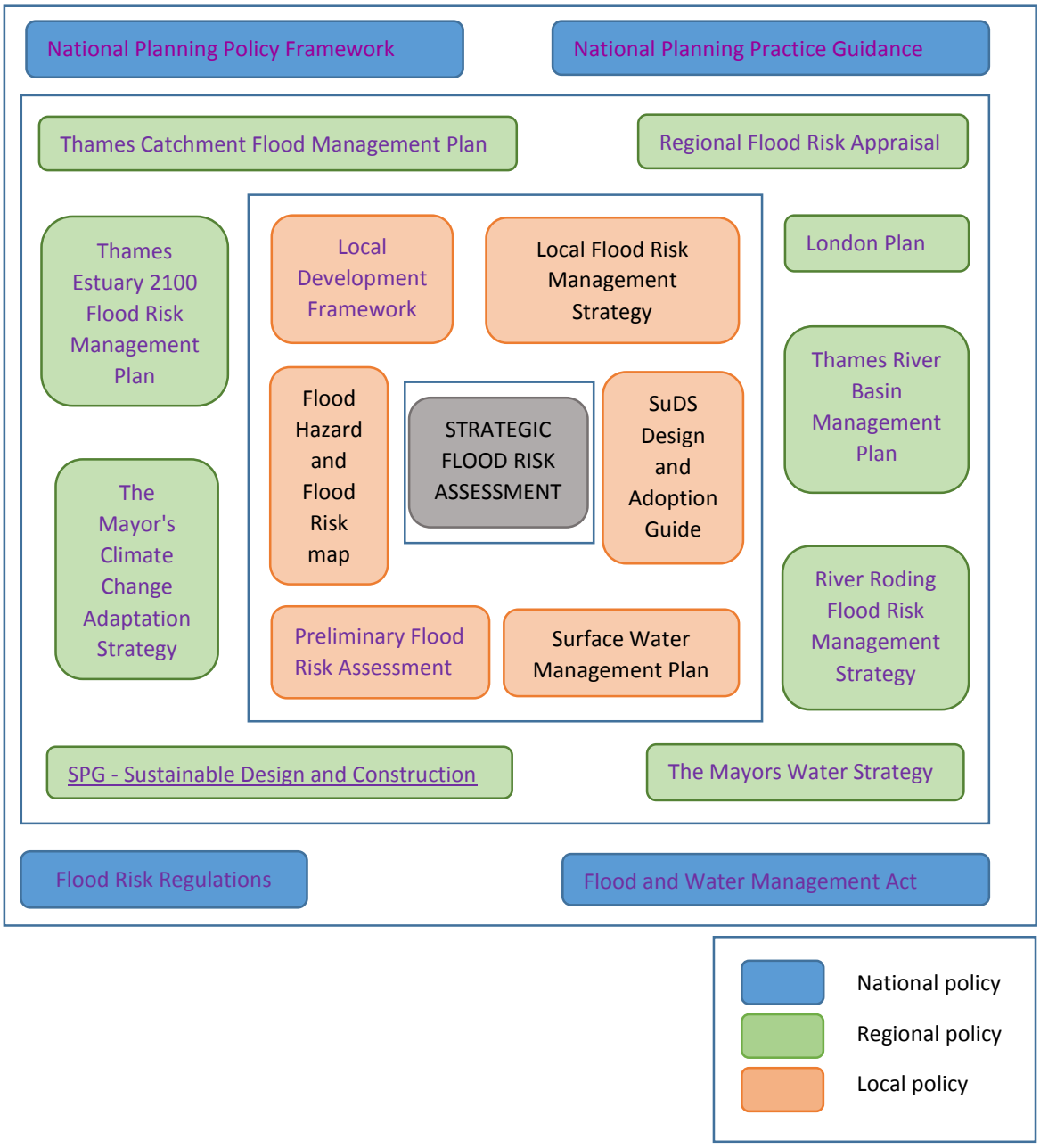

Figure 2. Flood Management Legislation and Policy Overview (with hyperlinks)

3. DATA AND ANALYSIS METHODOLOGY

3.1 DATA UTILISED AND SOURCES

In order to investigate the flood risk within the LBR, data was collected from various sources through consultation with the relevant RMAs. The data was mostly provided in the form of shapefiles (electronic map files) which were loaded into and analysed by a geographic information system (GIS). The table below outlines what data has been used, where it has been sourced from and any limitations that have been identified.

Table 3. Overview of the GIS data used within this SFRA along with details of where it was sourced from and any limitations that have been identified and should be noted.

Data	Supplied by	Limitations
OS 1:10000	OS	No known limitations
Redbridge borough boundary	LBR	No known limitations
Detailed river network	EA	The DRN is captured from the water features theme of the OS MasterMap topographic layer and built into a network using automated rules. Other input datasets and extensive local Environment Agency staff knowledge has been used to augment the core geometry to incorporate critical spatial detail and attribution, such as flow direction and path, not available from the OS mapping and to verify the accuracy of the centreline itself.
Epping Forest SAC	LBR	No known limitations
Ilford – OS Vector Map District	OS	No known limitations
LBR postcode data	LBR/Royal Mail	No known limitations
DG5 register	TW	No caveat required.
Complex Updated Flood Map for Surface Water	EA	See section 8.2 (page 30) of the What is the uFMfSW document (report version 1.0, November 2013).
Aquifer Designation Map (Bedrock Geology)	EA	The aquifer designation data is based on geological mapping provided by the British Geological Survey. It will be updated regularly to reflect their ongoing programme of improvements to these maps. For EA data and policy, see their website or click here.
Aquifer Designation Map (Superficial Deposits)	EA	
Flood map – Flood Zones 2 and 3	EA	Flood mapping is a complex, detailed and extensive process which can never be completely accurate, but the EA will always provide the best currently available information using national consistent data. The Flood Map gives a good indication of the areas at risk of flooding in England and Wales. However it cannot provide detail on individual properties. For further information, see Flood Map - your questions answered
Middle Roding 1:20 defended	EA	The data in this map has been extracted from the Middle Roding Modelling Study (JBA, 2012). This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide flood defences. See Model Information section below for more details on limitations.

Lower Roding 1:20 defended	EA	The data in this map has been extracted from the Lower Roding Flood Risk Modelling (CAPITA SYMONDS, 2009). This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. See Model Information section below for more details on limitations.
Flood Storage Areas	EA	This data has been taken from the same Flood Map source as the Flood Zones 2 and 3 data therefore the same text applies.
Cran Brook 1:20 integrated	WSP UK	WSP UK was commissioned by the LBR to develop a hydraulic model to improve the base scenario outlining the flood risk. It was not developed to produce flood levels for specific development sites within the borough. See Model Information section below for more details on limitations.
Seven Kings 1:20 integrated	WSP UK	
Localised historic flood locations	LBR	This information is based on LBR officer knowledge.

3.2 MODEL INFORMATION

3.2.1 CRAN BROOK

WSP UK was commissioned by the LBR to deliver a Project Appraisal Report (PAR) to alleviate surface water flood risk to residential properties, main roads, industrial and commercial properties in the Cran Brook Catchment. WSP UK carried out a hydraulic modelling study with the aim to improve the base scenario (existing hydraulic model) and the effect that proposed mitigation options have in support to the PAR. The model's results that were used within this SFRA as part of the flood risk investigation.

The modelling information used for the study was a combination of data and models provided by Imperial College and from the pre-feasibility study (carried out by Jacobs in May 2012). Both models were InfoWorks models and in turn, based on an original Thames Water 1D model. InfoWorks ICM by Innovyze 4.0.0.8004 Unicode July 2013 was used for the WSP UK model as at the time, it was the most capable software on the market for modelling drainage networks, sewer networks and river channels in 2D. LiDAR data was obtained from the LBR and other topographic data included the Thames Water GIS network data, a collection of drainage drawings, culvert plans, CCTV surveys and a topographic survey.

In producing the Mastermap Building Layer, buildings were represented as porous polygons with no porosity and kerbs and railways were modelled as break lines. As previously mentioned, the sewer network originates from the Thame Water 1D model, with additional information incorporated from the Imperial College model.

The Design rainfalls used in the modelling were generated within InfoWorks ICM using the FEH DDF rainfall model, with the catchment parameters extracted from the FEH CDROM v3. Sensitivity testing was carried out on the surface water network to determine the 'worse case' storm and summer rainfall profiles were used for all of the rainfall profiles owing to the highly urbanised nature of the catchment. The model used a variety of runoff surfaces which represents the different types of terrain and infiltration zones were used to ensure that only the surface runoff of the rainfall is applied to the cell as opposed to the entire rainfall.

The updated model for this study was calibrated for three events and the outcome is that the same level of good calibration was achieved as it was in the original Imperial College model.

3.2.2 SEVEN KINGS

To be added following data being supplied by WSP.

3.2.3 MIDDLE RODING

The EA commissioned JBA Consulting to undertake a Flood Risk Mapping Study of the Middle Roding and a number of tributaries, including the Loughton Brook, Chigwell Brook and Loughon Farm Hall Ditch, in Essex. The study was commissioned under the Strategic Flood Risk Management Framework (SFRMF2), and was completed under commission SE011. The following methodology has been taken from the accompanying JBA report.

A detailed hydrological assessment along the study reaches has been carried out to derive inflows to the hydraulic model. A linked 1D-2D ISIS-TUFLOW model has been developed and simulated for a full suite of return period events. These include the 1 in 2, 5, 10, 20, 30, 50, 100, 200 and 1000 AEP events. In addition, the effects of climate change on the 100-year return period event were considered, represented by increasing the 1 in 100 AEP event peak flows by 20%. Sensitivity analysis was also undertaken on the models. This included tests on the effects of structure coefficients, hydraulic roughness and downstream boundary conditions on maximum water levels along the study reach. In addition, six blockage scenarios were completed at structures across the study area for the following AEP events: 1 in 2, 1 in 5, 1 in 20, and 1 in 100.

The hydrodynamic, linked 1D-2D ISIS-TUFLOW models developed along the study reaches were most appropriate for the purposes of the study. They provide accurate information on flood water depths, levels, velocities, timings and hazard ratings, which needed to be quantified to provide the EA with sufficient information to manage the areas effectively. The approach outlined is suitable to fulfil the EA's study objectives as the linked ISIS-TUFLOW models can provide the necessary outputs easily. All calculations and methodologies used in the hydrology and hydraulic modelling stages of this study have been documented and added as appendices to the JBA report.

The largest source of uncertainty in modelled water levels quoted for a given AEP event is often the inherent uncertainty surrounding design flow estimation. Flood frequency estimates tend to be the largest source of uncertainty, especially for rarer events such as the 1 in 100 AEP, as they are derived from growth curves fitted to flood peak series that rarely exceeds the 1 in 40 AEP. This is particularly the case for the tributary flow estimations due to the lack of gauging data on these watercourses to calibrate flows to. A formal assessment of the uncertainty of a flood frequency curve is a major undertaking, requiring techniques such as re-sampling of pooled growth curves to investigate natural uncertainty. However, typical confidence limits for design flows are often quoted at 30-40%.

The equations generally used to model hydraulic systems are approximations of the physical processes involved, but after decades of use and of continuous improvement the limitations and implications of the approximations are well understood. Uncertainty can be introduced by the modeller who decides on the best way to represent the study reach. It is important that all decisions that may introduce model uncertainty are well documented.

Structure types and coefficients can have a significant impact on model results. Best practice guidance has been adopted when modelling structures throughout this study and has been based on the original survey data, where available.

Sensitivity analysis has been carried out to provide a semi-quantitative measure of parameter uncertainty with the water level being the dependent variable and hydraulic resistance and peak flow being the independent variables.

3.2.4 LOWER RODING

The 'Lower Roding Flood Risk Mapping' (reference TH766) has been undertaken as part of the Strategic Flood Risk Management (SFRM) Framework Agreement for the North East Thames Area of the EA. The commission encompasses a hydraulic assessment and specification floodplain mapping for the Lower reaches of the River Roding. The following methodology has been taken from the accompanying CAPITA SYMONDS report.

The model was simulated using the latest version of the TUFLOW software available at the time of commission. The hydraulic model has been based on the EA owned 1D/2D TUFLOW model of the River Roding. This is known as the Lower Roding TUFLOW Model and was originally developed to inform the flood risk assessment for the Barking Town Centre Development Framework by London Thames Gateway Development Corporation (LTGDC). The model was constructed in November 2007 and is based upon the EA's ISIS model of the Lower Roding. The surveyed cross-sectional data, undertaken in 1987 and the hydrology have been retained in the TUFLOW model of the River Roding. This model was subsequently passed to the EA. The use of ESTRY-TUFLOW was retained for the development of this hydraulic model.

The model extents of the Newham SFRA model have been retained. The upstream extent is located at the Redbridge Gauging Station just downstream of Eastern Avenue (A12) in Wanstead. The downstream extent of the model is located at the confluence of the River Roding with the River Thames at the Barking Barrier.

The 1D network is used to define in channel flows. Out of bank flow is modelled in a single 2D domain. This 2D domain extends along the length of the 1D network and a link is established between the 1D model network and the 2D model domain to allow water to pass between the different elements of the model.

The inflow hydrographs have been retained from the Newham SFRA model and are specified as flow-time boundaries. A head time boundary representing water levels in the River Thames was applied at the downstream model extent. Three tidal curves were provided by the EA in October 2008 for use in the model. These were the Mean High Water Spring tide (MHWS), the Mean High Water Neap tide (MHWN) and a Near Miss tide. The EA suggested that the MHWS tide be used for all runs with the remaining two tides used for sensitivity testing. Previous studies of the River Roding have used a 1 in 20 year tidal curve as the downstream boundary and not the MHWS boundary used for this study. The EA has stated that for this commission they do not wish to consider a joint probability approach and that they only wish to assess fluvial flood risk from the River Roding.

Manning's n coefficients have been used to represent the roughness of the open channel and floodplain. Roughness values are a means of representing the effect on the conveyance capacity of vegetative growth, channel and floodplain composition and channel sinuosity. Since the vegetative growth changes seasonally, it is usual for channel and floodplain roughness to follow such changes. The roughness values have been retained from the Newham SFRA model. The values assigned have been verified by referring to a number of established reference works 5,6,7,8. The values used to define the roughness of the 2D domain have been based on Mastermap data. The mapping defines different areas based on ground surface appearance. Mastermap groups similar features and assigns them a feature code, and each of these has been given an appropriate Manning's n coefficient.

Buildings within the floodplain have not been modelled as raised land, but instead as areas with high roughness values. This assumption was made on the basis that whilst buildings impede flow, they are generally permeable and water would gradually permeate through and be stored in the structure. Therefore by reducing flow rates through these areas by increasing the Manning's n roughness value, the general flood behaviour has been modelled appropriately. A total of seven structures are included in the River Roding model river network, comprised of five bridges, one culvert and one weir.

The grid size was reduced from the 15m used in the Newham SFRA model down to a 10m grid size. This was discussed and agreed with the EA. A 15m grid size was deemed appropriate for the Newham SFRA, allowing for a sufficient level of detail in model results whilst keeping simulation times within the project time frames. The advances in computer hardware since the construction of the Newham SFRA model have allowed for a reduction in grid size for this commission whilst still maintaining reasonable simulation times.

Sensitivity testing was undertaken to assess the impact on model results of assumptions made during the model development. The sensitivity testing does not assess whether a particular location is sensitive to a particular model parameter, i.e. would the change in a parameter cause a defence to

overtop. The following parameters were varied to assess the model sensitivity and therefore their potential impact on maximum flood levels for the 100 year fluvial and MHWS tidal events:

- Design flows (+/- 20%);
- Manning's 'n' (+/- 20% in 1D model domain and +/- 50% in 2D model domain) and;
- Tidal boundary (Increase in tidal level (Near Miss Tide) and decrease in tidal level (MHWN)

The model is sensitive to change in tidal boundary to a neap tide or a near miss tide. In both cases, the water level was observed to change by more than +/-20% immediately downstream of the Barking Barrage. The River Roding is known to be tidally dominated in its lower reaches when the Barking Barrier is not closed; therefore sensitivity to the downstream tidal boundary in the model is expected.

All flood extents were sensibility checked. In particular checks were undertaken to ensure that flood extent increased with increases in the return period flows modelled. For greater return period flood events, the extent of flooding was observed to either coincide with, or exceed, the extent observed for lower return period events.

To assess the impact that flood defences along the Lower River Roding have upon the extent of flooding, an undefended model was developed. Raised flood walls are present along the length of the modelled stretch of the Lower River Roding, on both the right and left banks to prevent out of bank flooding. These walls are apparent along the entire modelled stretch of the River Roding on left bank and the majority of the right bank. There are no defences along the right bank in Little Ilford and in Wanstead. To remove these walls, Z lines were used to overwrite the existing walls to lower the elevation to match the level of the ground surface behind the defence.

TUFLOW automatically generates a list of errors warnings and notes for each model run which inform the modeller of assumptions the model is making. A review of these messages was undertaken to assess any potential problems with the model. A summary of the 1000 year event is chosen as it generally incorporates errors and warnings from the small flood events.

The model mass balance (Cum ME) was checked and this was found to vary between -0.3% and 0.1% for all events. For a model to be considered healthy, the cumulative mass error should fall in the range of +/- 1%. The River Roding TUFLOW model is well within these limits.

An internal model review was undertaken by a Senior Hydraulic Modeller at Capita Symonds to check that the model is an accurate representation of the study area and to ensure that good practice and the EA Specification for hydraulic modelling is followed.

The model was run for 120 hours which was found to be a sufficient amount of time to ensure that the flood passed through the study area and that the peak flood level was reached in all locations in the model. A computational timestep of one second was used in the 1D model network and five seconds in the 2D model domain.

In this commission there are various assumptions that have been made. It is important that these assumptions are understood when interpreting the model results and some general points are now highlighted.

The maps produced as part of this commission do not show localised flooding resulting from intense rainfall and where surface flow might exceed the capacity of the drainage system. Likewise, the flood maps produced for this study do not show areas where overland sheet flow or runoff might cause flooding.

The latest National guidance provided by the EA has been followed when identifying and including flood defences in the hydraulic model. This guidance states that flood defences should be assumed to be in perfect condition. This may not reflect reality and thus the condition of flood defences should be considered when undertaking site specific flood risk assessment.

In this commission the focus has been on flooding from fluvial sources rather than tidal inundation. It is important that consideration is given to tidal flooding for any further development, in addition to combinations of fluvial and tidal events. Further consideration should also be given to the

operating rules of the Barking Barrage, and in particular, the Barking Barrier. In the current model, the Barking Barrage has been modelled as closed for all events. The effects and use of the Barking Barrier have not been assessed as it has been assumed to be open for all events considered for this commission.

The maps and digital data supplied should be considered only a summary of the conclusions of the study. Additional information pertinent to modelling is contained within the reports and appendices. It will be necessary to collect more detailed topographic information for particular sites where development is proposed and undertake a more detailed site-specific hydrological and hydraulic analysis for the location under study.

3.3 DATA PRESENTATION

As mentioned above, the data listed in **Table 3** has mostly been displayed through maps. These maps have been included alongside the relevant text within the report, but also in the appendix in A3 sizing when they are to be used by planners and developers as a higher level of detail and clarity is required. As and when data files are updated, these maps should also be updated.

3.4 INCORPORATING CLIMATE CHANGE

Climate change has been considered wherever possible. As much of the data used within the SFRA has been supplied via other organisations, we are dependent on the parameters they used. At times, we have selected rarer probability occurrences and water depths in an attempt to over compensate and account for climate change. For example, the surface water flood extent was initially going to be displayed using the 1 in 30 year event, but due to a lack of climate change information, a 1 in 100 year event was used instead.

4. FLOOD RISK SOURCES IN THE LONDON BOROUGH OF REDBRIDGE

For the purposes of applying the NPPF, "flood risk" is a combination of the probability and the potential consequences of flooding from all sources – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

The LBR have commissioned flood modelling which combines flood sources within the borough. However for reasons of split responsibility, historically flood risk modelling has focused on individual sources. Despite the drive in the NPPF to consider all sources of flood there remains a split between the EA, who are responsible for establishing river and sea flood risk zones and the LLFA who are responsible for local flood sources. Therefore the flood sources within the LBR have been analysed and displayed separately.

4.1 RIVER AND SEA FLOOD RISK

During heavy or prolonged rainfall events, rivers can encounter large flows which can result in them exceeding their capacity (fluvial flooding). Additionally, when a river has a tidal influence, high tides and storm surges can result in river capacity exceedance. In the natural environment, open spaces near a river act as storage areas or 'flood plains', providing space for the out-of-channel flow, alleviating downstream flood risk. This can be severely affected by urbanisation as the impermeable surfaces cause faster run-off rates from upstream urban areas which result in an increase in flow in the rivers downstream. Additionally, building on the flood plain can significantly increase the risk of flooding both directly to the development concerned and on a wider basis by removing capacity from the flood plain. The negative impacts caused by rivers exceeding their capacity and bursting their banks within an urbanised area can be significantly more devastating compared to that in the natural environment.

The EA have produced the Flood Map for Planning (Rivers and Sea) (www.maps.environment-agency.gov.uk) which is a multi-layered map providing information on flooding from rivers and the sea in England and Wales. In line with the NPPG's Table 1: Flood Zones, the Flood Map for Planning (Rivers and Sea) delineates the Flood Zones but does not take account of the possible impacts of climate change and consequent changes in the future probability of flooding. The Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. Flood Zone 3 outlines the areas where there is a high probability of flooding, Flood Zone 2 outlines the areas with a medium probability of flooding and everywhere else is defined as Flood Zone 1, low probability. This is explained further in Section 5.Although the EA defines Flood Zones 1, 2 and 3, the NPPF also refers to Flood Zone 3b (FZ3b). This is termed the functional floodplain and the NPPG explains that LPAs should identify areas of functional floodplain in their SFRAs in discussion with the EA and the LLFA.

4.1.1 FLOOD ZONE 3B DELINEATION METHODOLOGY

The identification of the functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. However, land which would naturally flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood (such as a flood storage area) in an extreme flood (0.1% annual probability) flood, should provide a starting point for consideration and discussions to identify the functional floodplain. Flood Zone 3b (FZ3b) should consider flood defences. The LBR have combined the following model layers to delineate FZ3b:

- Middle Roding 1:20 defended (see section 3.2.3 for details)
- Lower Roding 1 :20 defended (see section 3.2.4 for details)
- Cran Brook 1:20 integrated (see section 3.2.1 for details)
- Seven Kings 1:20 integrated (see section 3.2.2 for details)
- Flood Storage Areas

The Cran Brook and Seven Kings integrated modelling combined surface water and fluvial sources which resulted in a flood extent covering a large section of the borough. In places where the flood extent was not near a watercourse, it was clear that this was due to surface water and therefore

unsuitable for FZ3b. To resolve this, the integrated model layers were confined to within the EA's Flood Zone 3, as the functional floodplain would be within the areas of high probability of flooding. The depths below 150mm were removed as this is the minimum height of a buildings damp proof course (see Section 5 of The Building Regulations 2010 (www.planningportal.gov.uk) and therefore not deemed a significant flood risk.

Following a review of the new FZ3b extent, it was apparent that there were 'patches' of flood risk areas which were disconnected from the open watercourses. Where the joining land was marginal, the FZ3b was extended to protect those areas. Where the patches were disconnected and not next to an open or culverted watercourse, they were assumed to be surface water and removed. There are areas along the culverted channels whereby river water could cause flooding by surcharging from gullies connected to the channel. Due to the lack of drainage asset data it could not be proven where this was the case, therefore these areas were removed from the FZ3b extent, knowing that they were still protected by Flood Zone 3 and the surface water flood extent in places. Due to the nature of the modelling, there were also some online water bodies which were not considered at risk of flooding due to them already being watercourses. These were added manually to the FZ3b layer during the data cleaning process as they do form part of the floodplain and should be protected from future inappropriate development. Due to the fact that the flood extent does combine fluvial and surface water flooding, it was decided that this is an overcompensation which, in effect, is a way to account for climate change.

Once FZ3b is defined, the EA's Flood Zone 3 is renamed Flood Zone 3a for ease of clarification. All of the Flood Zones can be seen below in **Figure 4.1** (and **Figure A4.1** in Appendix A).

4.1.2 Fluvial flood extent description

Figure 4.1 below shows the fluvial flood risk extent along with the Main Rivers and Ordinary Watercourses. The Main Rivers include the Seven Kings, the River Roding and the Cran Brook, whereas Ordinary Watercourses include the Mayes Brook, Main River tributaries and land drains. The Flood Map for Planning (Rivers and Sea) shows that the River Roding, the Cran Brook and the Seven Kings water are the main sources of fluvial flood risk in the LBR. The River Roding is also affected by the tidal influence from the River Thames downstream from Ilford. Other large bodies of water which have been delineated as Flood Zone 3b include the waterbodies in and around Wanstead Park, the waterbody in Goodmayes Park and the three flood storage areas (FSA). FSA's are natural or man-made basins which temporarily fill with water during periods of high river levels. There are 3 FSA's in the LBR; Fairlop Waters, Valentine Park and Winn Brook.

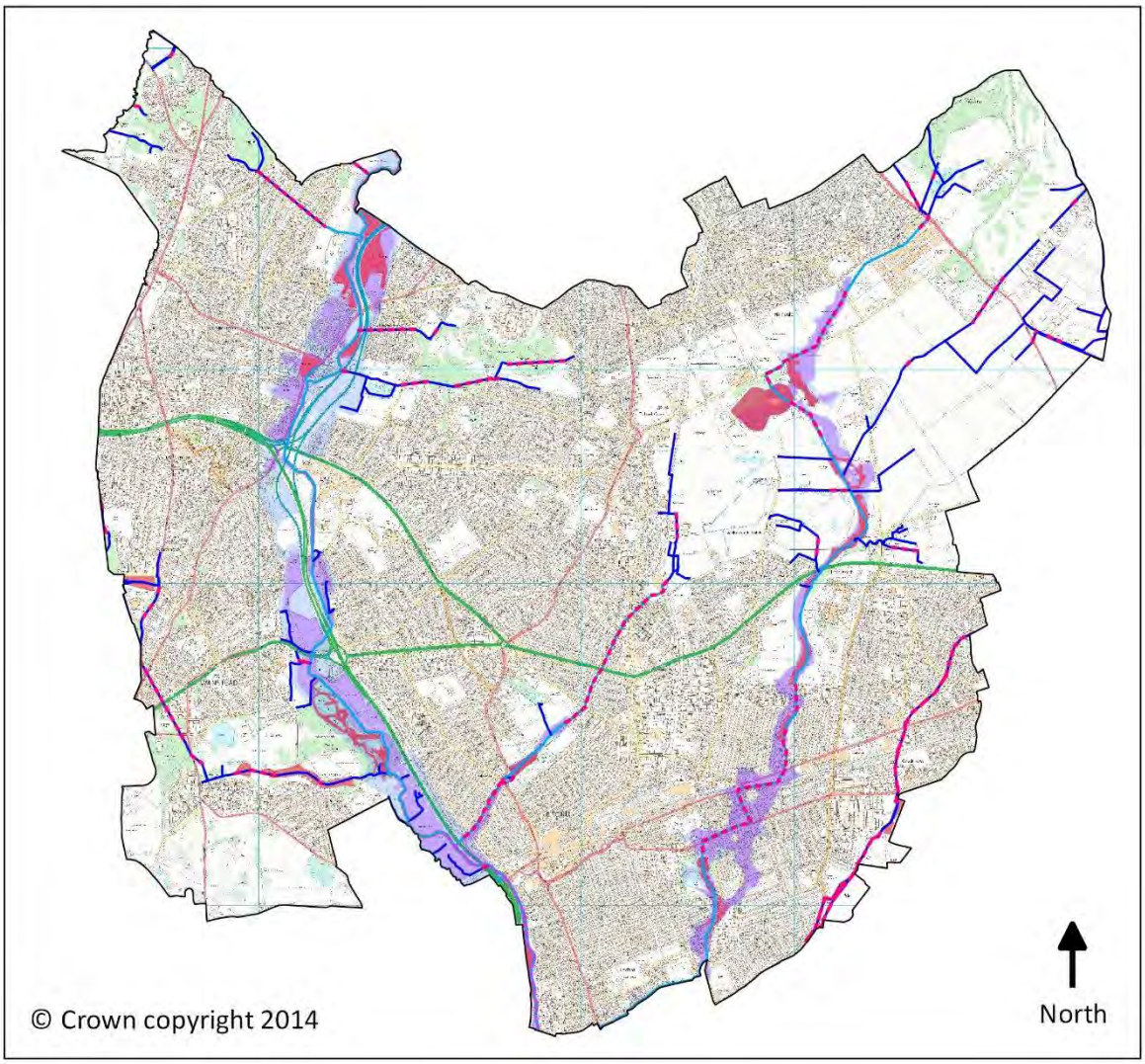

Figure 4.1. Overview of the Flood Zones produced by the Environment Agency and Redbridge Council with respect to the London Borough of Redbridge.

4.2 SEWER FLOOD RISK

A sewer is an underground pipe used to carry drainage water or wastewater. Thames Water Utilities Ltd (Thames Water) are responsible for the public water supply and waste water treatment in large parts of Greater London. All waste water drainage in the LBR is dealt with by Thames Water and water is supplied by Thames Water and Essex and Suffolk Water. Part of Thames Water's responsibilities include the operation of public sewers which drain more than one property. They are also responsible for the sewers which drain water collected from highway gullies (as long as more than one property drains into these sewers as well), although the gully pot and connections are the responsibility of the highways

authority (in this case, the LBR). Flooding can occur when there are blockages in the sewers and water is either unable to enter the system or surcharges from the sewers back onto the surface. Thames Water work to resolve these problems and reduce the number of properties susceptible to flooding. Thames Water do have long-term plans which include measures to adapt to the effects of climate change. Information on this can be found on their website, or by clicking here.

Water companies are required to report their performance each year against performance indicators called levels of service indicators. One of these is DG5: Flooding from sewers. Each company reports its assessment of the number of properties at risk of internal flooding because of overloaded sewers under two categories: once in every ten years; and twice or more in every ten years. Through consultation, Thames Water provided the LBR with information taken from their DG5 register (see **Table B4** in Appendix B). This shows the number of properties at risk of internal and external sewer flooding over a range of occurance, represented in terms of postcode areas, dating back to 1991 at least. The total figures for each postcode area have been displayed on **Figure 4.2** below**.**

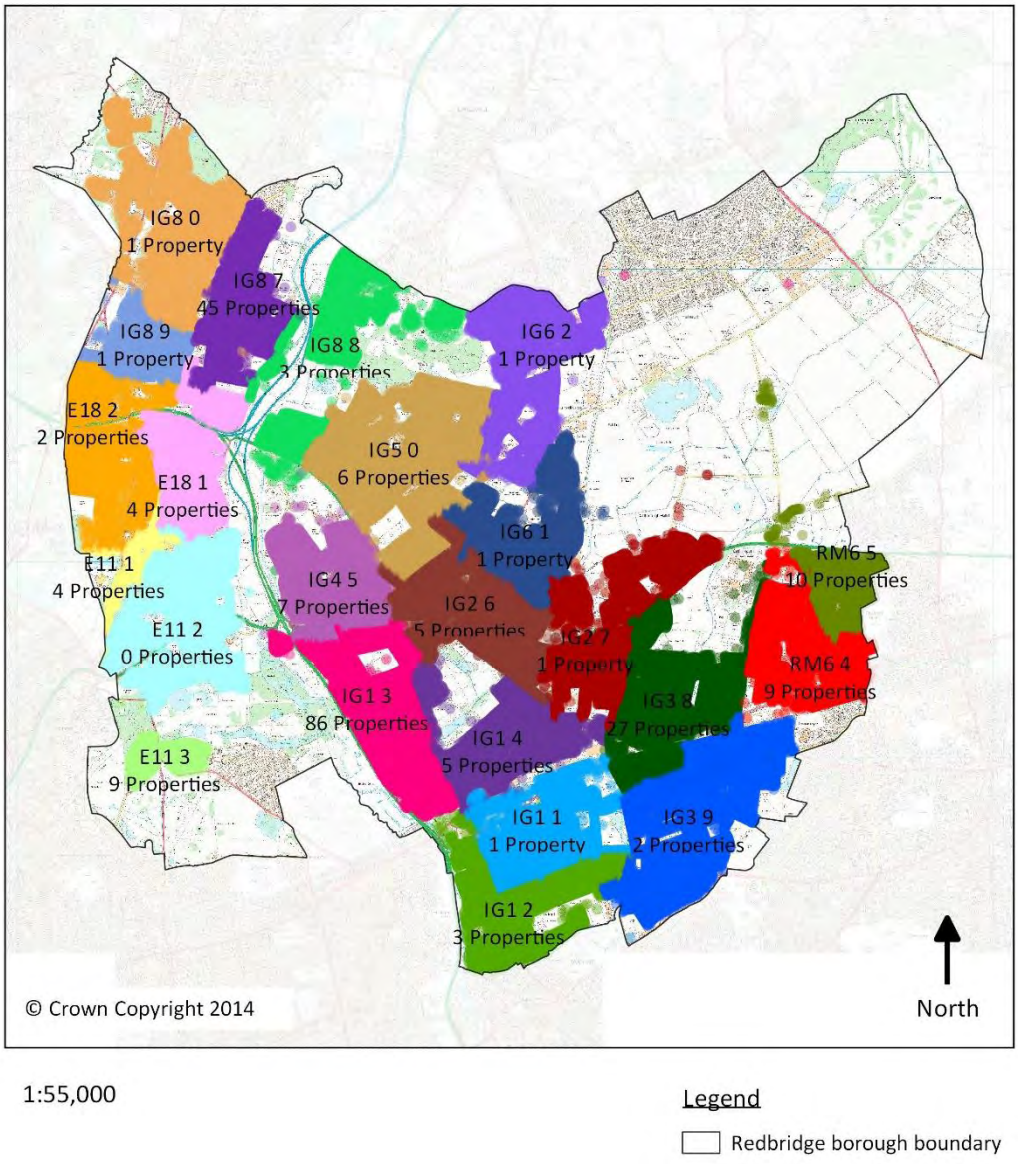

Figure 4.2. An overview of the Thames Water DG5 register data with respect to the London Borough of Redbridge.

4.3 SURFACE WATER FLOOD RISK

Surface water flooding occurs when rainwater does not drain away through drainage systems or soak into the ground, but lies on or flows over the ground instead. This happens following prolonged rainfall

resulting in saturated ground and sewers/drainage being at full capacity, or, following a 'flash flood', rainwater may not have time to flow into sewers or soak into the ground due to the intensity of the rainfall. Water can re-emerge from surface water flow routes when connected pipes or watercourses experience high levels causing water to flow in the other direction and back onto the surface.

In 2013, the EA, under their Strategic Overview role, worked with LLFAs to produce the updated Flood Map for Surface Water (uFMfSW). The *'What is the updated Flood Map for Surface Water?'* document explains why and how this was done. The uFMfSW assess flooding scenarios as a result of rainfall with the following annual probabilities: 1 in 30, 1 in 100 and 1 in 1000. LAs were given the mapping for their borough which provides data on the extent, depth, velocity and hazard for each of the flood scenarios.

The LBR have decided to map surface water flood risk when water is deeper than 150mm and caused by a rain event with an annual probability of 1% (1 in 100). Initially the 1 in 30 year even was chosen but as this did not account for climate change, the 1 in 100 year event was chosen instead. The depth of 150mm was selected as this is the minimum height of a buildings damp proof course. The surface water flood extent has been split into classes so that developers and planners have an idea of the actual water depth predicted. The outcome of these decisions can be seen in **Figure 4.3** (and **Figure A4.3** in Appendix A).

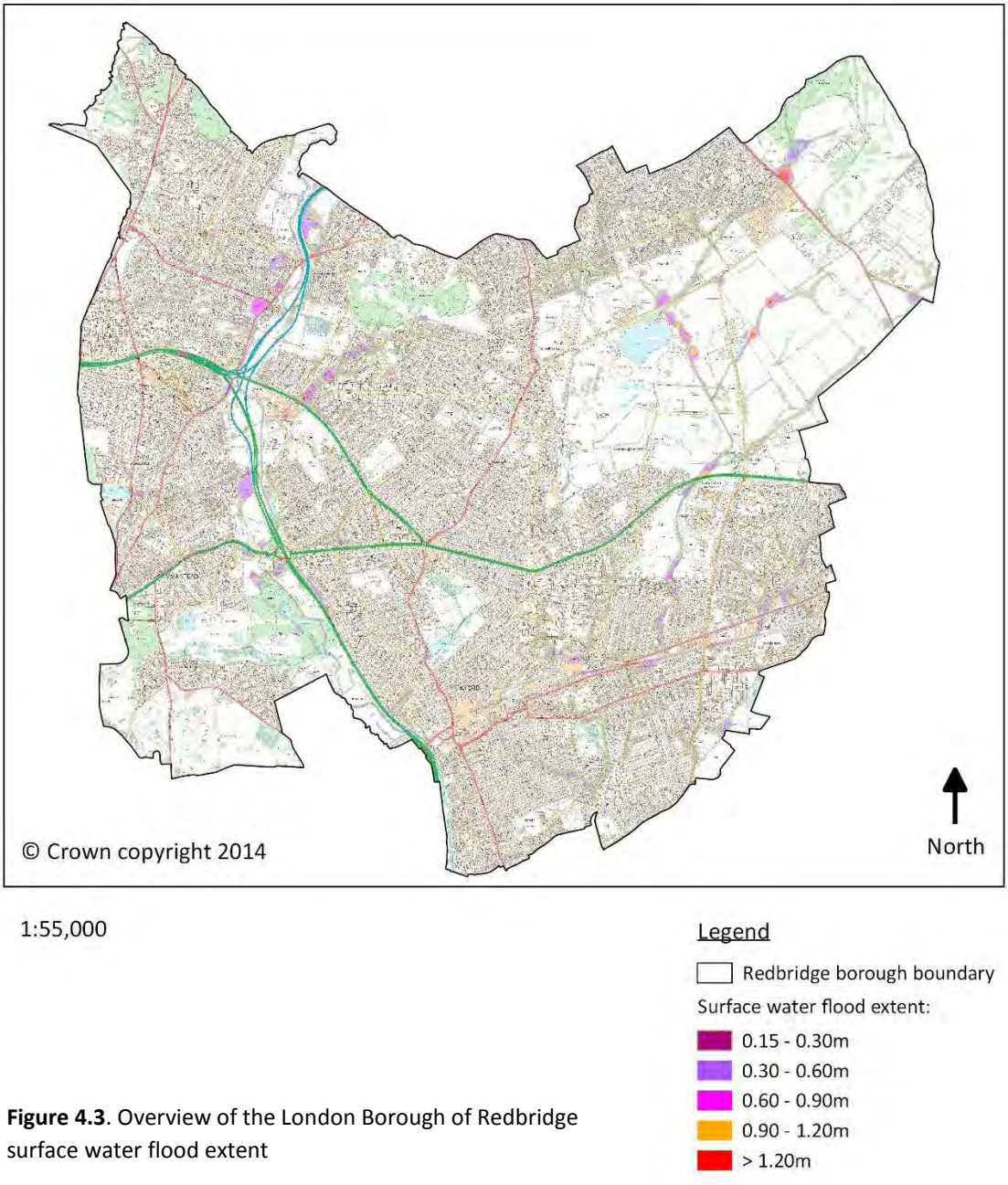

Figure 4.3. Overview of the London Borough of Redbridge surface water flood extent

4.4 GROUNDWATER FLOOD RISK

Groundwater is water which is found underground, held in the soil or in pores and crevices in rock. Groundwater flooding occurs when water levels in the ground rise above surface levels or into subterranean property such as basements. Rises in groundwater level close to or above ground level can result in interference to property and infrastructure. Although groundwater flooding accounts for a small proportion of the number of properties at risk of flooding across England and Wales, when it does occur it usually lasts longer than flooding from rivers, the sea or surface water. It is most likely to occur in areas underlain by permeable rocks, areas known as aquifers. These can be extensive regional aquifers, such as chalk or sandstone, or more local sand or river gravels in valley bottoms underlain by less permeable rocks. The Environment Agency's 2013 Groundwater Protection: Principle and Practice (GP3) (www.gov.uk) document explains how flooding from groundwater arises from:

- natural, exceptional rises in groundwater level, re-activating springs and intermittent watercourses (such as bournes) This is often referred to as 'clearwater' flooding);
- rising groundwater (rebound) following reductions in historic, usually industrial abstraction;
- minewater recovery;
- local shallow drainage/flooding problems unrelated to deep groundwater responses.

It is predicted that the effects of climate change may increase groundwater flood risk. An increase in rainfall can result in aquifers becoming fully recharged more frequently resulting in excess water rising back to the surface in the form of springs. Additionally, intermittent watercourses can be found to contain a flow. These effects can also be caused by higher sea levels which can cause an increase in the water table resulting in groundwater being found closer to the surface.

There has been little groundwater flood risk modelling due to the complexities surrounding it, but as groundwater is a source of drinking water, the EA has done some mapping work. They have produced the Aquifer Maps (www.apps.environment-agency.gov.uk) which show the locations of any aquifers, based on geological mapping provided by the British Geological Survey (BGS). The maps are split into two different types of aquifer designation:

- **Superficial (drift)** - permeable unconsolidated deposits. For example, sands and gravels.
- **Bedrock** - solid permeable formations e.g. sandstone, chalk and limestone.

Within these two designations, aquifer designations are split further into principle and secondary aquifers. These are explained below in **Table 4.**

Table 4. Explanation of the Aquifer Designations.

Aquifer Designation		Description
Primary Aquifer (Formally major aquifers)		These are layers of rock or drift deposits that have a high intergranular and/or fracture permeability. They usually provide a high level of water storage and may support water supply and/or base flow on a strategic scale.
Secondary Aquifer	Secondary A (Formally minor aquifers)	These have permeable layers capable of supporting water supplies at a local level and in some cases they form an important source of base flow to rivers.
	Secondary B (Formally the water-bearing parts of non-aquifers)	These predominantly have lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
	Secondary Undifferentiated Aquifers	These refer to cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

The Aquifer Map can be used to help assess flood risk as properties located above an aquifer are at a higher risk of experiencing groundwater flooding. It is also beneficial to know whether an aquifer is a principle or a secondary aquifer as this relates to how much water there could be and how quickly it could move through the ground to reach the surface. The Aquifers Map shows that the LBR does not contain any principle aquifers, as seen in **Figure 4.4** and (**Figure A4.4** in Appendix A).

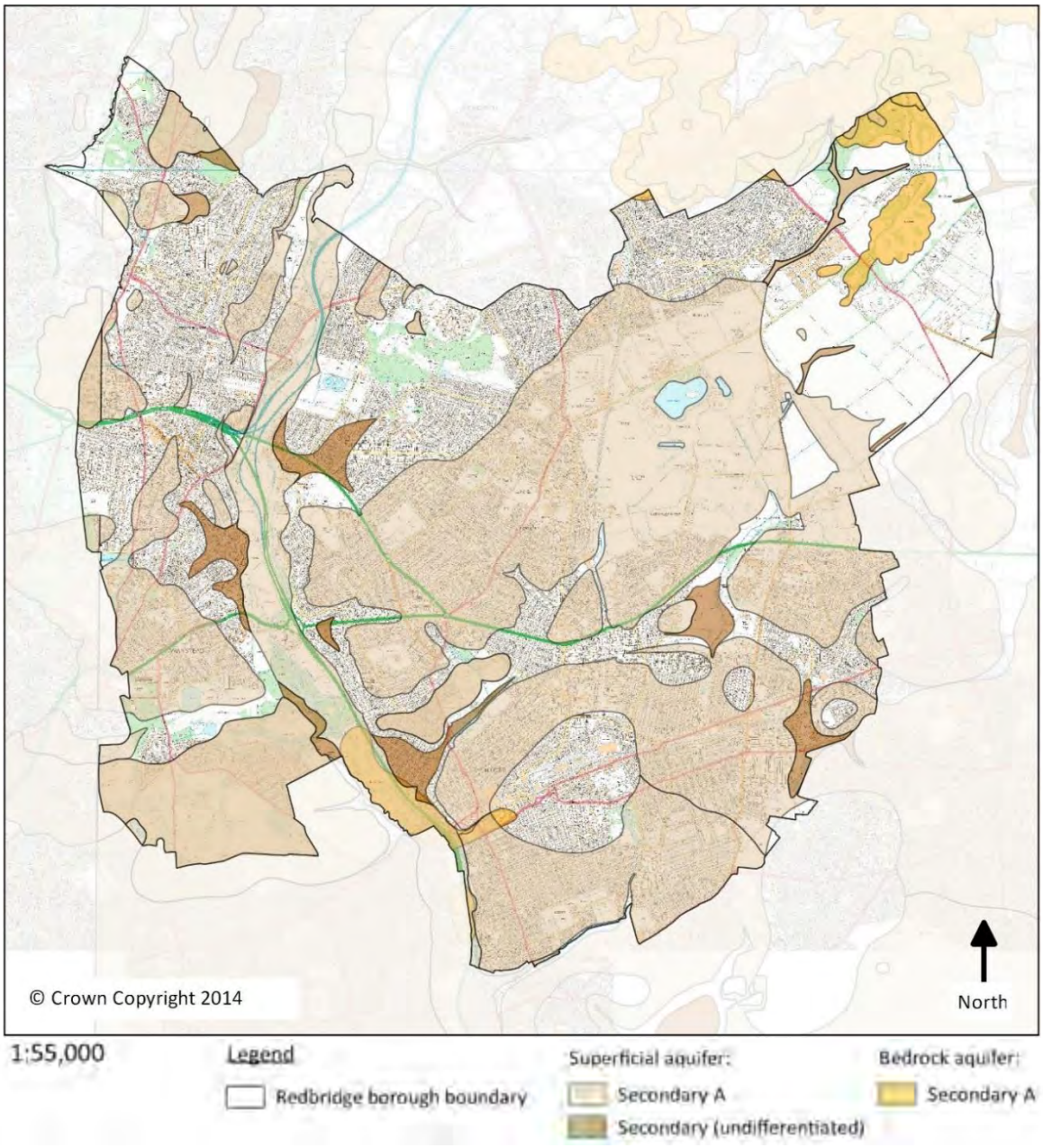

Figure 4.4. Overview of the Aquifer Maps produced by the Environment Agency with respect to the London Borough of Redbridge.

4.5 RESERVOIR FLOOD RISK

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPG outlines that when reviewing their SFRA, the LPA will need to evaluate the potential damage to buildings or loss of life in the event of dam failure, compared to other risks, when considering development downstream of a reservoir. LPAs will need to evaluate how an impounding reservoir will modify 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. To do this, planners and developers should refer to the EA's Risk of Flooding from Reservoirs map which shows

the maximum extent of flooding should a large reservoir fail. A large reservoir refers to one that holds over 25,000 cubic meters of water, equivalent to approximately 10 Olympic sized swimming pools.

4.6 Additional Information

The LBR are aware of localised historic flood locations within the borough. These are caused by an assortment of flood sources and there is a high probability that they are already covered by the associated flood maps. The known historic flood locations can be seen below in **Figure 4.5**.

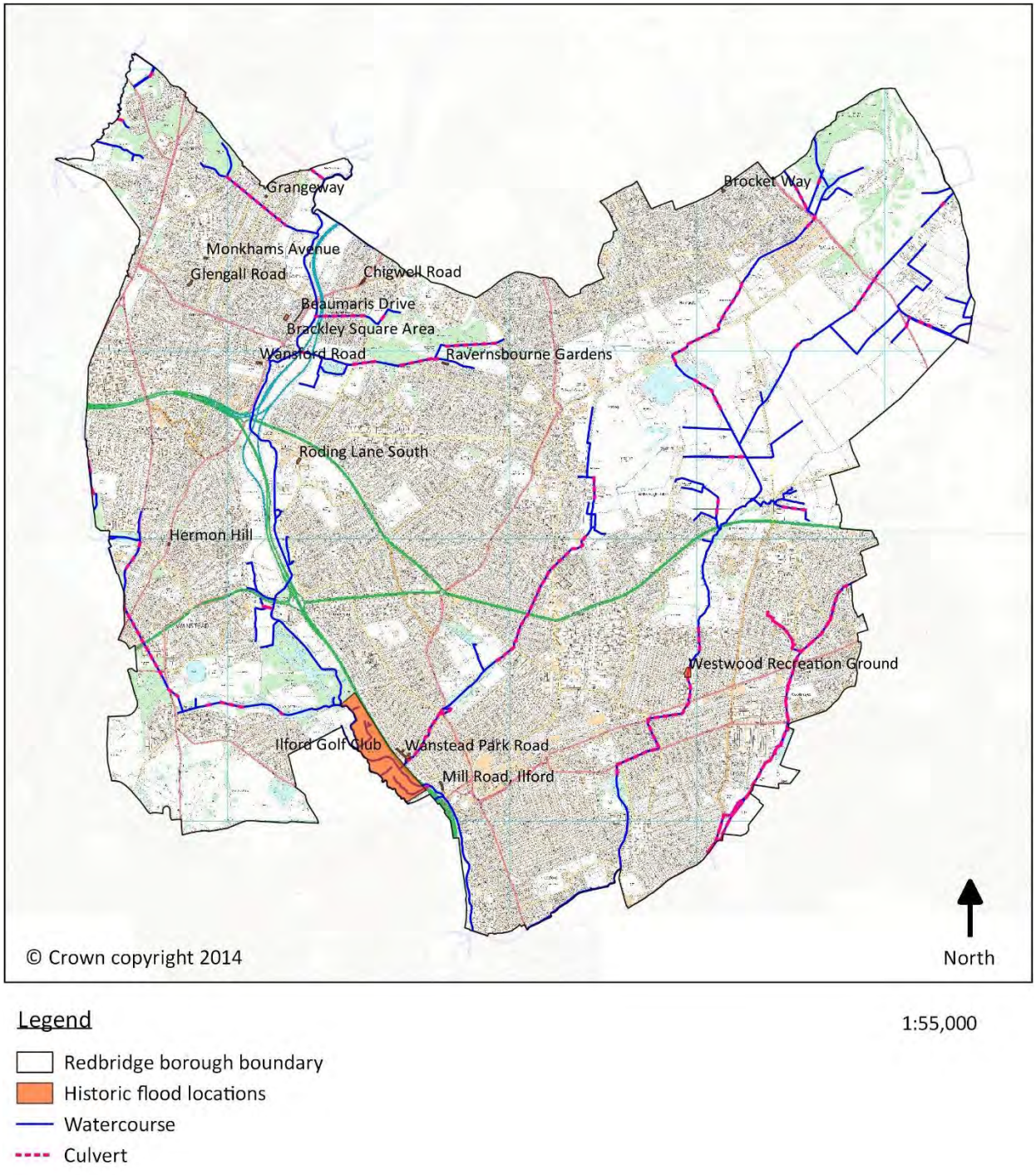

Figure 4.5. Known historic flood locations within the London Borough of Redbridge.

5 FLOOD RISK APPLICATION TO PLANNING

5.1 INTRODUCTION

To ensure that future developments will be sustainable and safe, it is important that the flood risk is considered at the earliest planning stage. That way, inappropriate developments can be ruled out or mitigation measures can be incorporated into the designs. For every location identified as being a potential development site, the maps within this SFRA should be used to carry out an initial desktop assessment of the flood risk which may be encountered. The findings of the initial desktop assessment will indicate the implications to planning and whether a detailed site-specific flood risk assessment (FRA) is required.

This remainder of this section outlines how each source of flood risk identified should be dealt with in terms of planning applications.

5.2 RIVER AND SEA FLOOD RISK

The Floods Zones represent the probability of river and sea flooding, ignoring the presence of defences. They include the Flood Zones 1, 2 and 3a delineated in the EA's Flood Map for Planning (Rivers and Sea) and Flood Zone 3b outlined by the LBR. The Flood Zone definitions are explained in Table 1 of the NPPG, outlined below in **Table 5.1**.

Table 5.1. Definition of the Flood Zones set out by the NPPG (Table 1).

Flood Zone	Definition
Zone 1: Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Zone 2: Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Zone 3a: High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.
Zone 3b: The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood.

The Flood Zones form the baseline information used when carrying out the sequential, risk-based approach to the location of development. This general approach is designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. The aim should be to keep development out of medium and high flood risk areas (Flood Zones 2 and 3). Application of the sequential approach in the plan-making process will help ensure that development can be safely and sustainably delivered and developers do not waste their time promoting proposals which are inappropriate on flood risk grounds. There are two stages of the sequential approach, the Sequential Test and when required, the Exception Test.

5.2.1 SEQUENTIAL TESTING

The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding with the Flood Zones providing the basis for applying the Test. The aim is to steer new development to Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, LPAs in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required. Table 2 in the NPPG categorises different types of uses & development according to their vulnerability to flood risk. Table 3 maps these vulnerability classes against the Flood Zones set out in Table 1 to indicate where development is 'appropriate' and where it should not be permitted. Tables 2 and 3 from the NPPG can be seen below in **Table 5.2** and **Table 5.3** respectively.

Table 5.2. Flood Risk Vulnerability Classification from the NPPG (Table 2).

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

* Landfill is as defined in Schedule 10 to the Environmental Permitting (England and Wales) Regulations 2010.

Table 5.3. Flood risk vulnerability and Flood Zone 'compatibility' from the NPPG (Table 3).

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**	**Water-Compatible**
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a +	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:

✓ Development is appropriate.

✗ Development should not be permitted.

Notes to table 3:

- This table does not show the application of the Sequential Test which should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and Exception Tests do not need to be applied to minor developments and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site;
- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

5.2.2 Applying the Sequential Test in the preparation of a Local Plan

Applying the Sequential Test in the preparation of the Local Plan is illustrated in Diagram 2 of the NPPG and below in **Figure 5.1.** As some areas at lower flood risk may not be suitable for development for various reasons and therefore out of consideration, the Sequential Test should be applied to the whole LPA area to increase the possibilities of accommodating development which is not exposed to flood risk. More than one LPA may jointly review development options over a wider area where this could potentially broaden the scope for opportunities to reduce flood risk and put the most vulnerable development in lower flood risk areas. The NPPG does contain advice on how to apply the Sequential Test to individual planning applications which can be found here (www,planningguidance.planningportal.gov.uk).

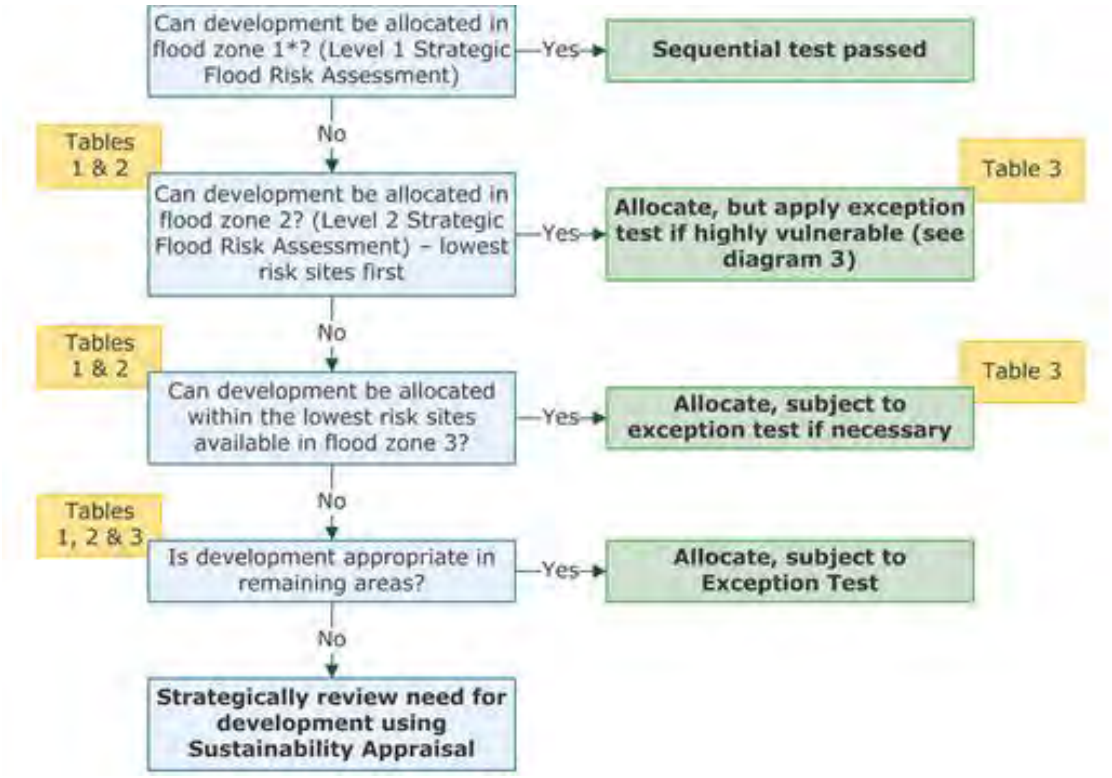

Figure 5.1. Sequential Test for Local Plan preparation taken from the NPPG (Diagram 2).

5.2.3 What is the role of sustainability appraisal in the sequential test?

A LPA should demonstrate through evidence that it has considered a range of options in the site allocation process, using the SFRA to apply the Sequential Test and the Exception Test where necessary. This can be undertaken directly or, ideally, as part of the sustainability appraisal. Where other sustainability criteria outweigh flood risk issues, the decision making process should be transparent with reasoned justifications for any decision to allocate land in areas at high flood risk in the sustainability appraisal report. The Sequential Test can be demonstrated in a free-standing document, or as part of strategic housing land or employment land availability assessments.

5.2.4 Exception testing

The Exception Test, as set out in paragraph 102 of the NPPF (www.planningguidance.planningportal.gov.uk), is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. It follows the Sequential Test and essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

Evidence of wider sustainability benefits to the community should be provided, for instance, through the sustainability appraisal. If a potential site allocation fails to score positively against the aims and objectives of the sustainability appraisal, or is not otherwise capable of demonstrating sustainability benefits, the LPA should consider whether the use of planning conditions and/or planning obligations could make it do so. Where this is not possible the Exception Test has not been satisfied and the allocation should not be made.

Wider safety issues need to be considered as part of the plan preparation. If infrastructure fails then people may not be able to stay in their homes. Flood warnings and evacuation issues therefore need

to be considered in design and layout of planned developments. In considering an allocation in a Local Plan a Level 2 SFRA should inform consideration of the second part of the Exception Test. See further information on making development safe from flood risk here and on what is considered to be the lifetime of development here.

Residential development should be considered for a minimum of 100 years, unless there is specific justification for considering a shorter period. For example; the time in which flood risk or coastal change is anticipated to impact on it, where a development is controlled by a time-limited planning condition. The lifetime of a non-residential development depends on the characteristics of that development. Planners should use their experience within their locality to assess how long they anticipate the development being present for. Developers would be expected to justify why they have adopted a given lifetime for the development, for example, when they are preparing a site-specific FRA. The impact of climate change needs to be taken into account in a realistic way and developers, the LPA and EA should discuss and agree what allowances are acceptable.

5.2.5 Applying the Exception Test in the preparation of a Local Plan

Applying the Exception Test in the preparation of the Local Plan is summarised in Diagram 3 of the NPPG and **Figure 5.2** below. The Exception Test should *only* be applied as set out in Table 3 of the NPPG and following application of the Sequential Test. Further information on applying the Exception Test to planning applications can be found here.

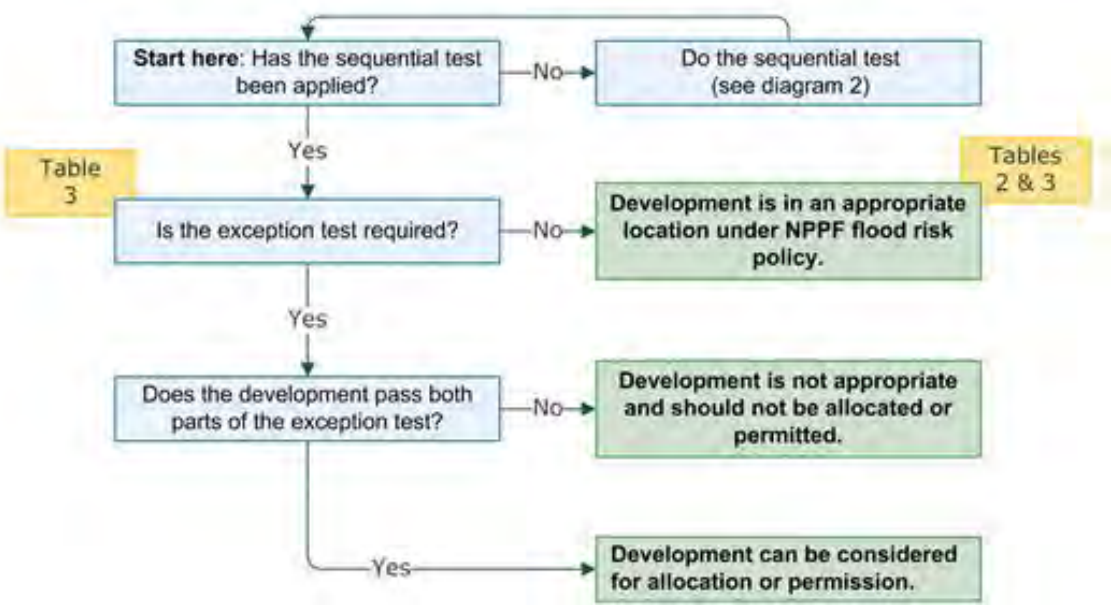

Figure 5.2. Application of the Exception Test to Local Plan preparations taken from the NPPG (Diagram 3).

5.2.6 Tidal limit

The southern section of the River Roding in the LBR is influenced by the tide. This means that on those tidal sections of the watercourse, river defences should maintain a minimum height of 5.6mOD.

The Thames Estuary 2100 Plan (TE2100) sets out the recommendations for flood risk management for London and the Thames estuary through to the end of the century and beyond. The generic estuary-wide options consist of improving existing defences, storing tidal waters, constructing new barriers and converting barriers to barriers with locks. These should be considered when looking to develop sites alongside the tidal watercourse as it could be that plans need to consider the defence heights and the need to raise or replace them.

5.2.7 Development within 8m of a Main River

Developments within 8m of a Main River must obtain consent from the EA. This also applies to culverted channels. Although not a Main River, development within 8m of the culverted Mayes Brook will also require additional consideration but this will be handled by Redbridge Council rather than the EA.

5.2.8 River and sea flood risk planning application requirements

- Use the Sequential Test to try and place proposed developments within Flood Zone 1. If this is not possible, take account of the flood risk vulnerability of the land use and consider reasonable available sites in Flood Zone 2, applying the exception test when required. Only when there are no reasonable available sites in Flood Zones 1 and 2 should the suitability of sites within Flood Zone 3 be considered, taking account of the flood risk vulnerability of the land use and applying the Exception Test when required.
- Use Table 1 of the NPPG (Table 5.1 in this SFRA) and the Flood Maps available (EA website, Figure 4.1 or Figure A4.1) for delineation of the Flood Zones.
- Use Table 2 of the NPPG (Table 5.2 in this SFRA) for classification of flood risk vulnerability.
- Use Table 3 of the NPPG (Table 5.3 in this SFRA) for clarification on flood risk vulnerability and Flood Zone 'compatibility' and to see when an Exception Test is required.
- All developments within 8m of a Main River must obtain consent from the EA. This also applies to culverted channels. Although not a Main River, development within 8m of the culverted Mayes Brook will also require additional consideration but this will be handled by Redbridge Council rather than the EA.
- Development located alongside the tidal section of the Lower Roding should ensure that flood defences maintain a minimum height of 5.6mOD. The TE2100 should also be considered.
- Footnote 20 in the NPPF outlies that a site-specific FRA is required for the following proposals:
  - 1 hectare or greater in Flood Zone 1;
  - All proposals for new development (including minor development and change of use) in Flood Zones 2 and 3;
  - In an area within Flood Zone 1 which has critical drainage* problems (as notified to the LPA by the EA); and
  - Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

5.3 Sewer flood risk

Sewer flooding is not considered in the same way as fluvial, surface water and groundwater flooding due to the fact that it is caused by blockages or burst pipes and could occur anywhere at any time. It cannot be predicted and Thames Water work to resolve any issues and stop them from reoccurring. The locations highlighted at being at risk on Thames Water's historic record (DG5 register) are those that have encountered flooding. Thames Water would have resolved a number of those issues and will be working to resolve others. Although it is not a valid enough reason to base future development decisions on past sewer flood events, it should be considered in case the problem has not been resolved or if it is a reoccurring problem.

5.3.1 SEWER FLOOD RISK PLANNING APPLICATION REQUIREMENTS

A site-specific flood risk investigation should consider sewer flood risk but a FRA is not required solely due to sewer flood risk.

5.4 SURFACE WATER FLOOD RISK

The EA's uFMfSW 1 in 100 year event output has been modified to create the surface water flood extent for the LBR. No additional modelling was carried out. This flood extent uses the 1 in 100 year storm event whereby areas are affected by a water depth of 150mm or greater. The flood extent has been split into classes allowing developers and planners to obtain a clearer idea of the predicted flood depth.

The LBR have decided to treat the surface water flood extent in the same was as Flood Zone 3a. This means that should a development be located within the surface water flood extent, the NPPG Tables 2 and 3 (Tables 5.2 and 5.3 above) should be used. This will ensure that the sequential approach to development location is carried out and where this in not possible, the Exception Test will need to be passed. It should be noted that although this method uses the NPPG tables and process, any advice and data required relating to surface water flood risk should be obtained from Redbridge Council and NOT the EA.

If a development is to occur in the surface water flood extent area, Sustainable Drainage Systems (SuDS) would be required to ensure that the proposed development does not increase the surface water runoff. The use of SuDS are encouraged to reduce the surface water runoff back to the Greenfield rate where possible. Developers should refer to National and Local SuDS documents for clarification on the standards required. SuDS designs should be contained in the planning application and all of this information should accompany a site-specific FRA which is required for all developments located within the surface water flood extent.

The FRA, as outlined in Section 6 of this document, should include details on the potential flood depth which can be obtained using the maps within this SFRA. The flood depth value should be the maximum depth from the class in which the site is located within.

5.4.1 SURFACE WATER FLOOD RISK PLANNING APPLICATION REQUIREMENTS

- The surface water flood extent should be treated in the same way as Flood Zone 3a. Therefore the NPPG Table 2 and 3 apply. Any advice and additional data required relating to surface water flood risk should be obtained from Redbridge Council and NOT the EA.
- Where a development is to be located within the surface water flood extent, SuDS should be used to ensure that surface water runoff is not increased. Developers should refer to National and Local SuDS documents for clarification on the standards required.

5.5 GROUNDWATER FLOOD RISK

There is no set guidance for dealing with groundwater flood risk, only that it should be considered. The LBR have decided that due to the absence of detailed groundwater data such as the depth of the water table below ground and soil permeability and porosity, developers should consider its local impacts by assessing the Groundwater Flood Risk Map within this document and reviewing the historic flooding records. Should a site-specific FRA be carried out, then the groundwater flood risk should also be considered.

5.5.1 GROUNDWATER FLOOD RISK PLANNING APPLICATION REQUIREMENTS

Should a site-specific FRA be carried out, then the groundwater flood risk should be considered.

5.6 RESERVOIR FLOOD RISK

Although the failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water, the likelihood of it occurring is extremely low. The EA's Risk of Flooding from Reservoirs map (www.watermaps.environment-agency.gov.uk) shows the maximum extent of flooding should a large reservoir fail. Since this is a worst case scenario, it is unlikely that any actual flood would be this large and therefore if planning applications were to depend on the outcome of this mapping, a large number of sites could be deemed unsuitable for development due to a source of flooding highly unlikely to occur. The risk of flooding due to a reservoir failure should be considered, but only when appropriate to the type of development proposed, for example, if the application is to construct a new reservoir or a power plant. This decision falls to the LPA.

5.6.1 RESERVOIR FLOOD RISK PLANNING APPLICATION REQUIREMENTS

Reservoir flood risk should be considered depending on the type of development proposed. Where this is the case, a site-specific FRA will be required.

5.7 COMBINATION OF FLOOD RISK SOURCES

Should a development site be subjected to a number of flood risks, all of the relevant planning application requirements should be followed and the worse-case scenario FRA findings should be used when developers design the buildings and SuDS, as well as when the LPA considers the application.

5.8 FLOOD RISK APPLICATION TO PLANNING RECOMMENDATIONS SUMMARY

5.8.1 PREPARATION OF THE LOCAL PLAN

When preparing the Local Plan, the LBR should assess flood risk using the flow chart in **Figure 5.3**.

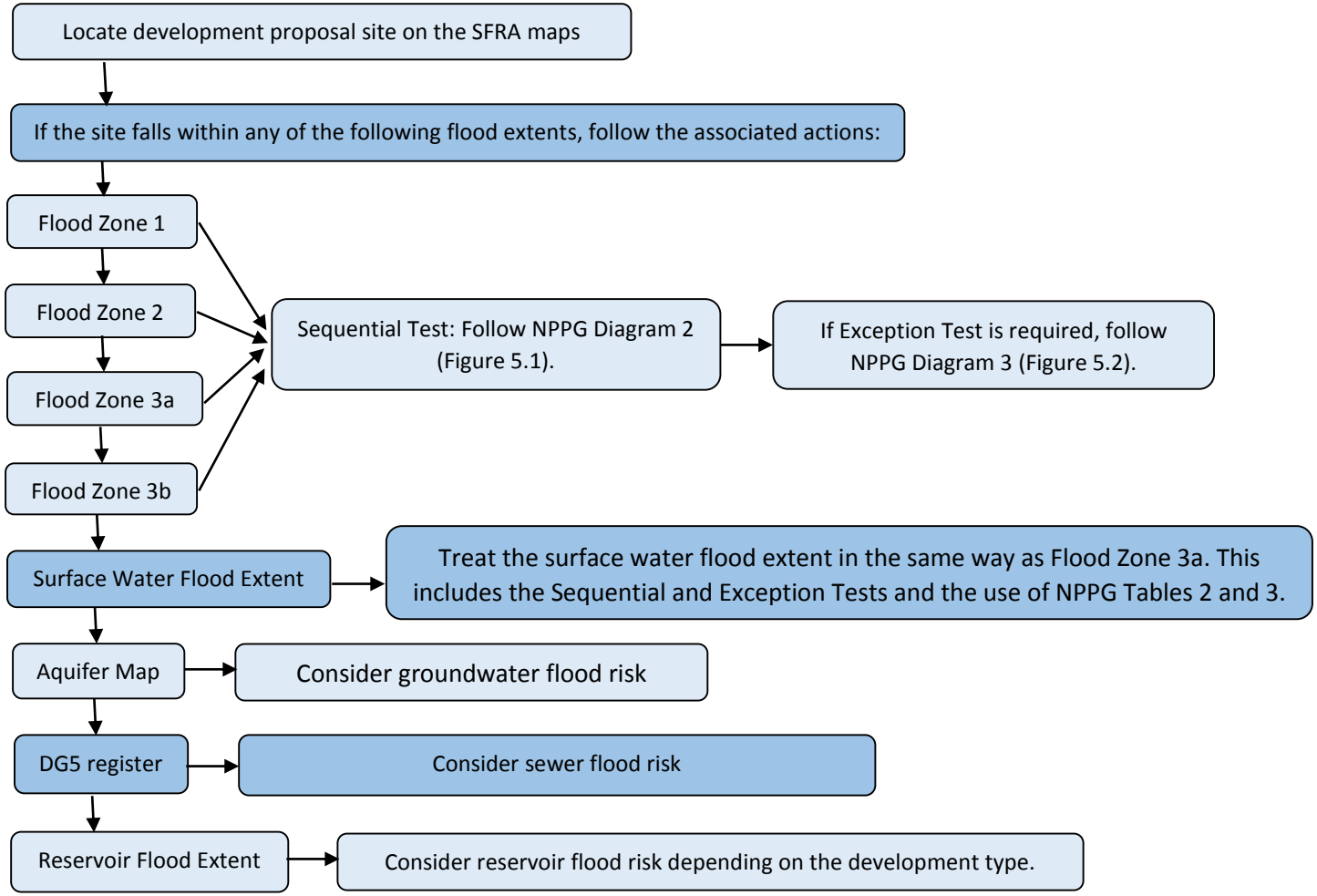

Figure 5.3. Applying Flood Risk to the preparation of the Local Plan.

5.8.2. INDIVIDUAL PLANNING APPLICATIONS.

When processing a planning application, the LBR should assess the flood risk using the actions set out in the flow chart below in **Figure 5.4**.

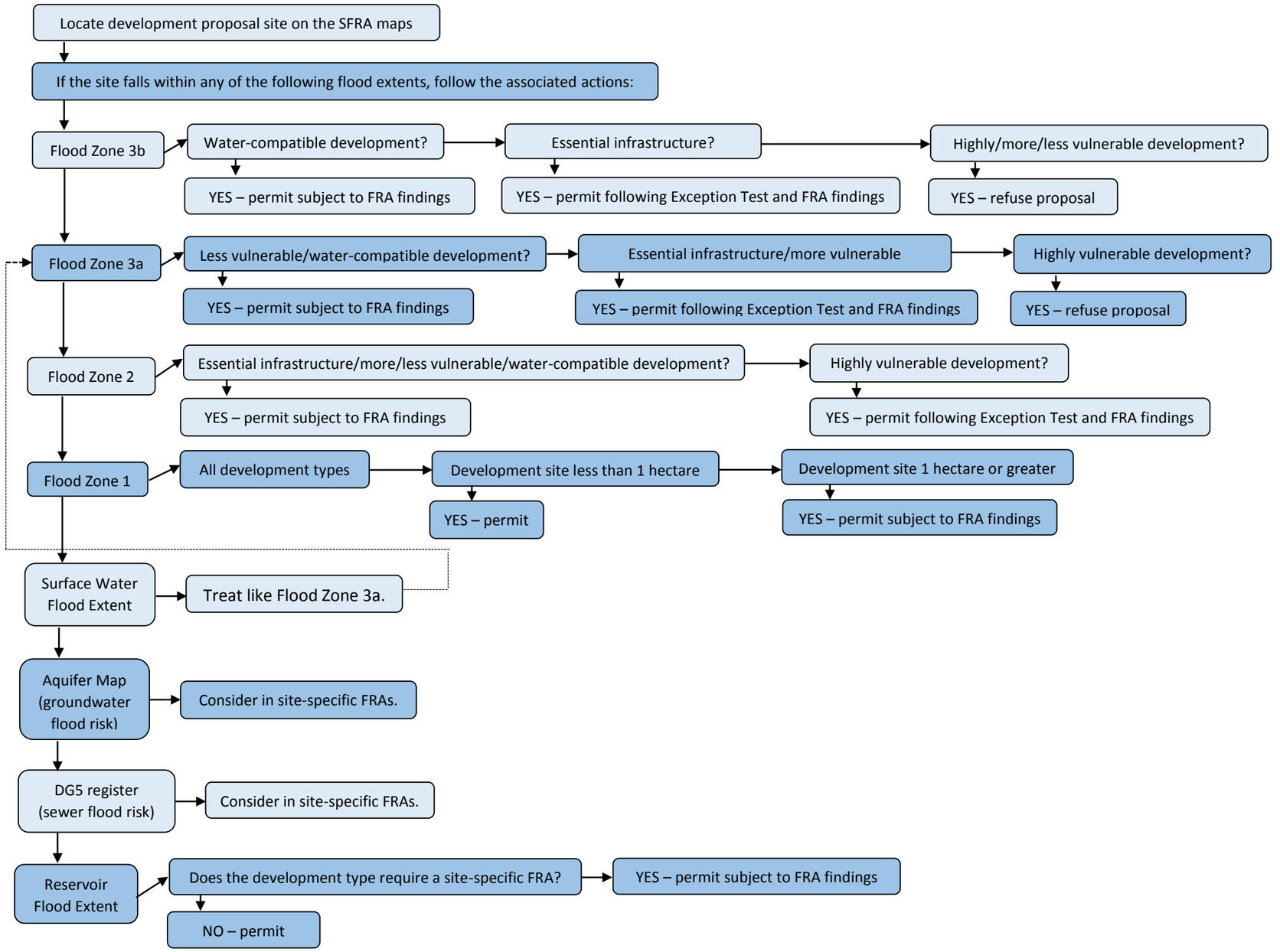

Figure 5.4. Applying Flood Risk to Individual Planning Applications

6 SITE-SPECIFIC FLOOD RISK ASSESSMENTS

6.1 NATIONAL PLANNING PRACTICE GUIDANCE

A site-specific Flood Risk Assessment (FRA) is carried out by, or on behalf of, a developer to assess the flood risk to and from a development site. Footnote 20 in the NPPF outlies that a site-specific FRA is required for the following proposals:

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

*Note: whereby the NPPF uses the term 'critical drainage problems', this SFRA refers to the surface water flood extent. The LBR do not have any 'critical drainage problems' as per the NPPF but, it has been decided that the LBR will adopt a policy whereby sites which fall within the surface water flood extent are required to produce a FRA. This will be adopted by the Local Plan.

The FRA should accompany a planning application submitted to the LPA, which will therefore be reviewed by the LBR Planning department. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users.

The objectives of a site-specific flood risk assessment are to establish:

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

The NPPG outlines the need for a LPA to assist developers by setting out and agreeing the scope of a site-specific FRA. The checklist (www.planningguidance.planningportal.gov.uk) in the NPPG has provided the basis of the LBR site-specific FRA content requirement set out in the following section.

6.2 LONDON BOROUGH OF REDBRIDGE REQUIREMENTS

The information provided in a site-specific FRA should be credible and fit for purpose. Site-specific FRAs should always be proportionate to the degree of flood risk and they should make optimum use of information already available, including information in a SFRA for the area, historic information on previous events and the interactive flood risk maps available on the EA's web site (www.maps.environment-agency.gov.uk).

A site-specific FRA should also be appropriate to the scale, nature and location of the development. For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, the LPA would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater, the LPA would need a more detailed assessment.

For major developments, a FRA should also consider the potential cumulative impact of the loss of floodplain storage at the development site, and elsewhere within the catchment, needs to be considered and, if required, mitigation should be provided.

A site-specific FRA should be undertaken by competent people as early as possible in the planning process to avoid misplaced effort and raising landowner expectation where land is unsuitable for development. There is standing advice from the EA on how to complete a FRA as part of a planning application and advice for LPAs (www.gov.uk).

The checklist from the NPPG has been added to in **Table 6** to outline the extent of information required in a site-specific FRA for the associated flood risk**. Should a development site be subjected to a number of flood risks, each source should be investigated separately and the worse-case scenario findings should be used when developers design the buildings and SuDS and when the LPA considers the application.

**Note: should a development consist of building an extension, the developer should consult with the Local Planning Authority to determine the level of detail that the site-specific flood risk assessment is required to incorporate. .

Table 6. The National Planning Practice Guidance modified site-specific flood risk assessment checklist. Please note that the 'surface water flood extent' column was not included in the NPPG table and has been added.

FRA Requirements			Flood Zone 3a or 3b	Flood Zone 2	Flood Zone 1 (>1ha)	Surface Water Flood Extent	Reservoir Flood Risk
1.	**Development description and location**						
	a.	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?	✓	✓	✓	✓	✓
	b.	What is its flood risk vulnerability classification?	✓	✓	✓	✓	✓
	c.	Is the proposed development consistent with the Local Plan for the area? (Seek advice from the local planning authority if you are unsure about this).	✓	✓	✓	✓	✓
	d.	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?	✓	✓		✓	✓
	e.	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? (Particularly relevant to minor developments (alterations & extensions) & changes of use).	✓	✓	✓	✓	✓
2.	**Definition of the flood hazard**						
	a.	What sources of flooding could affect the site?	✓	✓	✓	✓	✓
	b.	For each identified source in box 2a above, can you describe how flooding would occur, with reference to any historic records where these are available?	✓	✓		✓	✓
	c.	What are the existing surface water drainage arrangements for the site?	✓	✓	✓	✓	✓

3.	**Probability**						
	a.	Which Flood Zone is the site within? (As a first step, check the Flood Map for Planning (Rivers and Sea) on the Environment Agency's web site)	✓	✓	✓		
	b.	If there is a Strategic Flood Risk Assessment covering this site (check with the LPA), does this show the same or a different Flood Zone compared with the EA's flood map? (If different you should seek advice from the local planning authority and, if necessary, the EA).	✓	✓	✓	✓	✓
	c.	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 Strategic Flood Risk Assessment, and of any further flood risk information for the site?	✓	✓	✓	✓	✓
	d.	If known, what (approximately) are the existing rates and volumes of surface water run-off generated by the site?	✓	✓		✓	✓
4.	**Climate change**						
	How is flood risk at the site likely to be affected by climate change? (The LPA's SFRA should have taken this into account. Further information on climate change and development and flood risk is available on the EAs website.		✓	✓		✓	✓
5.	**Detailed development proposals**						
	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)?		✓	✓		✓	✓
6.	**Flood risk management measures**						
	How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime?		✓	✓		✓	✓
7.	**Off-site impacts**						
	a.	How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere?	✓	✓		✓	✓
	b.	How will you prevent run-off from the completed development causing an impact elsewhere?	✓	✓		✓	✓
	c.	Are there any opportunities offered by the development to reduce flood risk elsewhere?	✓	✓	✓	✓	✓
8.	**Residual risks**						
	a.	What flood-related risks will remain after you have implemented the measures to protect the site from flooding?	✓	✓		✓	✓
	b.	How, and by whom, will these risks be managed over the lifetime of the development? (E.g., flood warning and evacuation procedures).	✓	✓		✓	✓

7 LONDON BOROUGH OF REDBRIDGE AREA BREAKDOWN

In order to look at the flood risk within the LBR in more detail, the borough has been split into nine geographic areas and mapped with a 1:10,000 scale. An overview of the geographic area splits can be seen below in **Figure 7**. For each of the geographic areas, there are two maps, one to show the river and sea Flood Zones and one to show the surface water flood extent. These maps will assist in producing the FRAs required to accompany a planning application. The 18 individual maps can be found in Appendix C.

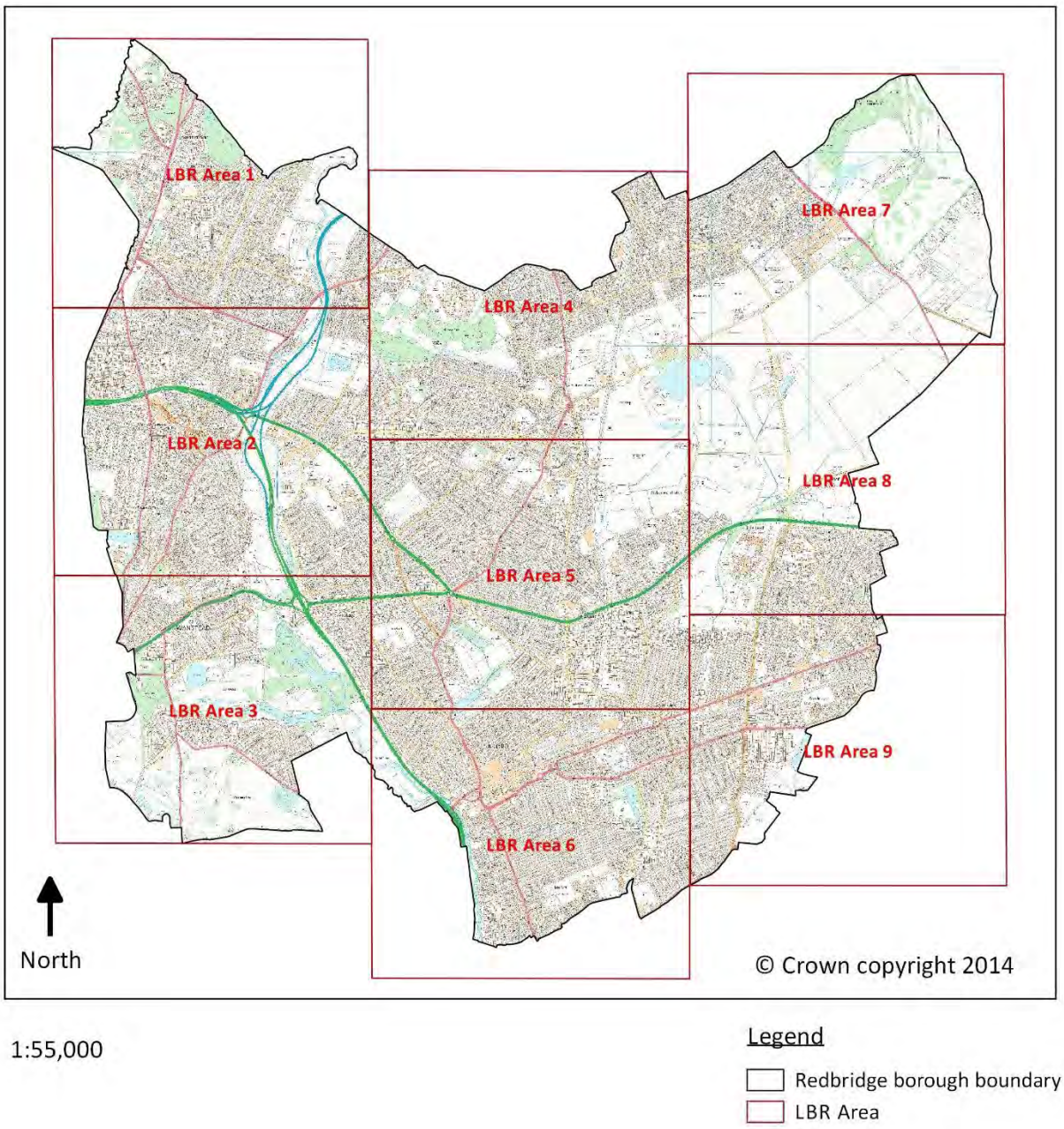

Figure 7. The 9 geographically split areas within the London Borough of Redbridge.

8 DEVELOPMENT PRACTICE

Paragraph 103 of the NPPF states that *'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 flood risk assessment 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.'*

8.1 SUSTAINABLE DRAINAGE SYSTEMS

There are a number of methods which can be put into practice to prevent the increase of flood risk following a development. Sustainable Drainage Systems (SuDS) are used on development sites to minimise runoff from the site, with the aim of achieving pre-development, greenfield runoff rates. This is often required as a condition of the planning permission. It is essential that development upstream does not increase the risk of flooding at a downstream location. SuDS can also be retro-fitted to existing properties and highways to reduce surface water and therefore reduce flood risk.

Schedule 3 of the Flood and Water Management Act 2010 (FWMA), outlines the requirement for a unitary authority to adopt the role of the SuDS Approving Body. It was initially intended that this body would approve planning applications based upon the proposed drainage system, ensure that the drainage system complies with the national standards and then adopt the drainage system where it becomes responsible for maintain the system. Since this was enacted in 2010, a number of consultations have run whereby the structure and roles of this body has changed from how it was initially described.

At the time of writing this report, the revised method for ensuring that SuDS are considered during the planning stage will be built into the current planning process. This will mean that surface water flood risk will be considered with more weight by the planning department rather than a secondary planning application being submitted to a second consenting body as initially proposed in the FWMA. To bolster this new process, the LLFA is to become a statutory consultee on major planning applications (made up of 10 or more units). Information on local and national standards will be made available as the role is established.

8.1.1 NATIONAL GUIDANCE

In December 2011, Defra presented the National Standards for Sustainable Drainage Systems (www.gov.uk) for consultation. These Standards are proposed to be used in England in order to manage surface water runoff in accordance with Schedule 3 to the FWMA. The National Standards set out what to design and construct in order to obtain approval from the SuDS Approving Body and for operating and maintaining SuDS which the approving body adopts. Drainage for approval from the SuDS Approving Body must be designed to comply with National Standards.

Following the 2011 Standards, Defra published the Draft National Standards and Specified Criteria for Sustainable Drainage in June 2014. These Standards are issued to set out the requirements for the design, construction, maintenance and operation of SuDS in accordance with paragraph 5 of Schedule 3 to the FWMA.

The Construction Industry Research and Information Association (CIRIA) are a neutral, independent, not-for-profit body who link with organisations with common interests and facilitate a range of collaborative activities that help improve the industry. They have produced The SuDS Manual (C697)

(www.ciria.org) which provides best practice guidance on the planning, design, construction, operation and maintenance of SuDS to facilitate their effective implementation within developments. The publication supersedes previous general guidance on SuDS and addresses landscaping, biodiversity issues, public perception and community integration as well as water quality treatment and sustainable flood risk management.

8.1.2 LONDON BOROUGH OF REDBRIDGE POLICY FOR SUSTAINABLE DRAINAGE SYSTEMS

Although Schedule 3 of the FWMA is yet to be enacted, the government has expressed its intention to do so following a detailed consultation and finalisation of the legislation. Therefore the LBR have started preparing the **Redbridge SUDS Design and Adoption Guide** which has been composed to assist developers and other applicants through the application process by providing:

- An overview of what the SAB will be looking for in SuDS proposals.
- Signposts to related guidance, policies and legislation.
- The SAB's interpretation of new SuDS approval and adoption processes.
- Identification of SuDS requirements for amenity and biodiversity.
- Guidance on the SAB's position on health and safety in relation to open water features.

This guide references the National Standards for Sustainable Drainage Systems (2011), although these are currently being revised and so the Guide will be amended to reflect any changes once the new standards are published.

8.2 ADDITIONAL BUILDING GUIDANCE

Building Regulations are in place to ensure that developments are safe and accessible and limit waste and environmental damage. These are statutory instruments which must be complied with. On top of the Building Regulations, there are additional guidance documents which aim to provide developers and designers with useful information. In terms of flood risk, the Improving the Flood Performance of New Buildings (www.gov.uk) document aims to provide guidance on how to improve the resilience of new properties in low or residual flood risk areas by the use of suitable materials and construction details. A particularly relevant section is where it outlines that the Environment Agency requires that floor levels are set 300mm above the predicted 100 year flood level plus climate change allowance, for river flooding.

8.3 FLOOD WARNING SYSTEMS

The Environment Agency provides a number of services to help people prepare for flooding. These include a Live Flood Warning Map, a Three Day Flood Risk Forecast, current River and Sea Levels and the Floodline Warnings Direct service (www.apps.environment-agency.gov.uk).

The Floodline Warnings Direct service is particularly effective as it allows you to register for flood warnings if your home or business is at risk of flooding. By supplying a telephone number or email address, the EA will contact you at any time of the day or night when they detect a flood risk in your area.

9 REVIEW AND NEXT STEPS

9.1 REVIEW AND UPDATES

A SFRA is a live document which is to be used by a local planning authority to assist in allocating sites for future development and general decision making. Therefore it is essential that the data contained within the SFRA is as up to date as possible to ensure that decisions are made on the best information available.

The NPPF forms the basis of the SFRA so should this undergo a significant change, the SFRA should be reviewed and updated to incorporate the changes made. Additionally, should any of the overarching regulations and Acts be updated which may alter the responsibilities of the Council, the SFRA should be reviewed and an update considered. Another review trigger is based around the data which is used to make the maps within the SFRA. Our knowledge of flood risk is constantly changing and improving and the SFRA should reflect this. Not only could this enhanced knowledge highlight risk areas which were not previously at risk, it could also free up areas which may have been at risk but are not longer considered to be so. This could open up land for potential future development.

9.2 POLICY TO MAINTAIN AN UPDATED SFRA

In order to provide developers and the LPA with the most accurate flood risk information, it is essential that the SFRA is kept up to date. Due to the continuous work that goes into increasing our flood risk knowledge and reducing flood risk, it is important that site-specific flood risk assessments include the most up-to-date information and planning decisions are made on the most accurate data. As the document is owned by the LBR Planning department, they are responsible for organising an internal review every 5 years or when any of the triggers mentioned above are instigated.

9.3 NEED FOR A LEVEL 2 SFRA

The aim of a Level 1 SFRA is to ensure that development is not inappropriately constructed in areas whereby there is a significant flood risk. It encourages the use of sustainable drainage systems and flood mitigation measures to help reduce the risk of flooding. Where a Level 1 Assessment shows that land outside flood risk areas cannot appropriately accommodate all the necessary development, it may be necessary to carry out a Level 2 Assessment. This focuses on areas whereby development initially seems inappropriate and therefore collects information necessary for the application of the Exception Test. The scope of the Level 2 Assessment includes a more detailed investigation which should consider the detailed nature of the flood characteristics within a Flood Zone, including:

- Flood probability;
- Flood depth;
- Flood velocity;
- Rate of onset of flooding; and
- Duration of flood.

Through detailed, location-specific investigation, sites which may initially appear to be unsuitable for development, could in fact have potential uses. Additionally, a Level 2 SFRA should also reduce burdens on developers, in particular, at windfall sites, in the preparation of site-specific FRAs.