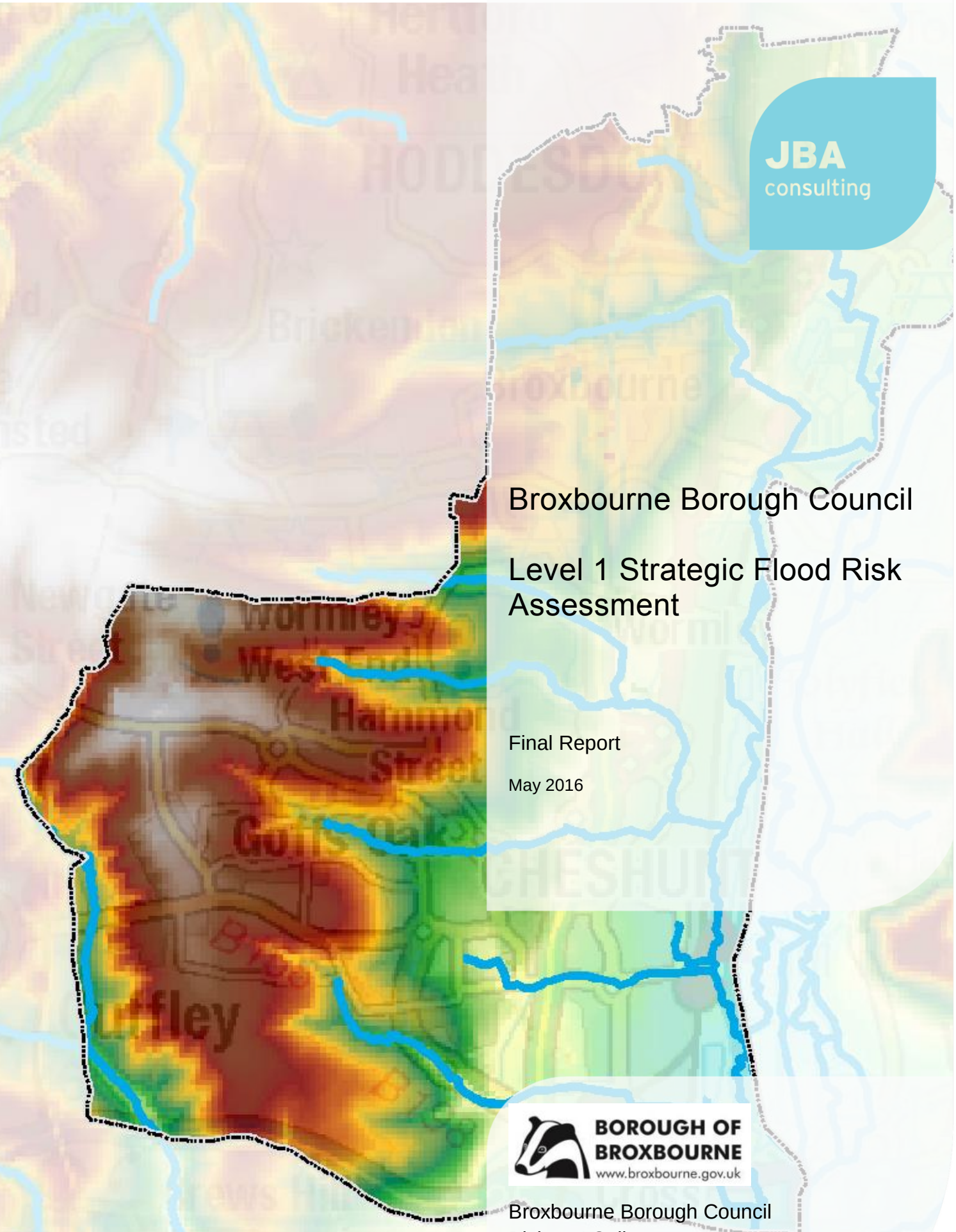

# Broxbourne Borough Council

# Level 1 Strategic Flood Risk Assessment

Final Report

May 2016

Broxbourne Borough Council
Bishops' College
Churchgate
Cheshunt
WALTHAM CROSS
EN8 9XQ

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# JBA Project Manager

Joanne Chillingworth
The Library
St Philip's Courtyard
Church End
COLESHILL
B46 3AD

# Revision History

| Revision Ref / Date Issued | Amendments | Issued to |
|---|---|---|
| Draft v1.0 / May 2016 | | Kim Harding, Broxbourne Borough Council |
| Final v1.0 / May 2016 | | Kim Harding, Broxbourne Borough Council |

# Contract

This report describes work commissioned by Broxbourne Borough Council. The Council's representative for the contract was Kim Harding.

Prepared by ..... Sophie Dusting BSc
Analyst

Joanne Chillingworth BSc MSc MCIWEM C.WEM
Chartered Senior Analyst

Reviewed by ..... Claire Gardner BSc MSc MCIWEM C.WEM
Chartered Senior Analyst

# Purpose

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JBA Consulting has no liability regarding the use of this report except to Broxbourne Borough Council.

# Acknowledgements

We would like to acknowledge the assistance of:

- Broxbourne Borough Council;
- Hertfordshire County Council including Highways;
- Environment Agency;
- Thames Water;
- Lea Valley Regional Park Authority;
- Canal and River Trust; and
- Planners at the neighbouring authorities

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# Executive Summary

## Introduction

This updated Level 1 Strategic Flood Risk Assessment (SFRA) replaces the Level 1 SFRA originally published by Broxbourne Borough Council in December 2007. The report has been prepared to replace the content included in the previous version of the SFRA and to provide appropriate supporting evidence for the emerging Local Plan.

### SFRA objectives

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

- Level One: where flooding is not a major issue in relation to Strategic Housing Land Availability Assessment (SHLAA) sites and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
- Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

The objectives of this SFRA update are to:

1. To update the Council's existing Level 1 SFRA, taking into account most recent policy and legislation in the National Planning Policy Framework.
2. To update the Council's existing Level 1 SFRA, taking into account the latest available flood risk information and data.
3. To investigate and identify the extent and severity of flood risk from all sources presently and in the future within the local planning authority area of Broxbourne Borough Council.
4. To provide a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the local plan.

The following outputs have been prepared to meet the objectives:

- Appraisal of all potential sources of flooding, including Main River, Ordinary Watercourse, surface water and groundwater.
- Review of historical flooding incidents.
- Mapping of location and extent of functional floodplain.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- An assessment of the potential increase in flood risk due to climate change.
- Areas at risk from other sources of flooding, for example surface water, canals or reservoirs.
- An assessment of the impact of future large-scale developments both within and outside Broxbourne.
- An assessment of existing flood warning and emergency planning procedures, including assessment of safe access and egress during an extreme event.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.

## Summary of Level 1 Assessment

The SFRA has considered all sources of flooding including fluvial, surface water, groundwater, sewers, reservoirs and canals within the study area. With regards to assessment methods, fluvial flood risk has been analysed using the results from River Lee 2D Modelling Study (CH2M Hill, 2014), provided by the Environment Agency, as well as Flood Zone 2 and 3 datasets also provided by the Environment Agency. Surface water flood risk has been analysed using the updated Flood Map for Surface Water published online by the Environment Agency and recorded flood incident data supplied by Hertfordshire County Council Highways unit. A number of other data sources have been drawn upon as an evidence base, such as sewer data from Thames Water, canal overtopping data from the Canal and River Trust, National Inundation Reservoir Mapping from the Environment Agency and various geology / groundwater products and datasets from the Environment Agency.

The assessment has concluded the following:

- Flood history shows that the borough of Broxbourne has been subject to flooding from several sources of flood risk.
- Since the 1947 flood, a number of measures have been constructed across the Lower Lee catchment to alleviate the risk of flooding. However, the River Lee Flood Relief Channel almost reached capacity in 1987, 1993 and 2000.
- The primary fluvial flood risk is located along the River Lee corridor, around the eastern boundary of the borough. In addition, the floodplain associated with the tributaries of the River Lee network are generally narrow until reaching the urban areas and / or towards the confluences with the River Lee network.
- The borough of Broxbourne has experienced a number of historic surface water / drainage related flooding caused by a number of mechanisms from insufficient storm and combined drainage capacity to poor surface water management. The uFMfSW further shows a number of prominent overland flow routes in the borough; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. In addition, a number of these follow local road infrastructure.
- The Thames Water DG5 register indicates a total of 36 recorded flood incidents in Broxbourne Borough Council administrative area. The more frequently flooded postcodes are EN8 8, with 15 records, followed by EN10 7 with six records.
- There have been incidents of historic groundwater flooding in the borough of Broxbourne which is thought to primarily be caused by the underlying geology i.e. gravel overlaid on top of London Clay. The study area is known to have a high water table and the bedrock geology of the study area indicates that the borough may be vulnerable to groundwater flooding. This may constrain the suitability of certain types of SuDS techniques such as infiltration.
- In relation to artificial sources of flooding, there are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low.
- There are two records of a canal overtopping along the Lee Navigation Channel (Lower) caused by higher water levels associated with debris from vegetation clearance and by water running from a footpath eroding the bank. The extent of the overtopping is unknown; however, it is thought that no properties were flooded.

Consideration of the residual risk behind flood defences (including assets and structures) has been undertaken as part of this study, using the Environment Agency AIMS database.

A high-level assessment of the potential cumulative impact of development in neighbouring authorities and the Lea Valley Regional Park Authority, to the borough of Broxbourne has also been undertaken.

The Sequential approach to development and flood risk has been defined with guidance provided for the application of the Sequential and Exception Tests for both the Local Plan and for detailed, site-specific Flood Risk Assessments. This SFRA provides details of the FRA requirements and guidance for developers. These recommendations include those of the NPPF, Environment Agency standing advice, as well as reference to regional and local policy. In addition, specific recommendations following the findings of this level 1 SFRA have been put forward for development in Flood Zones 1, 2 and 3. Site-specific FRAs should include assessment of mitigation measures required to safely manage flood risk along with the along with promotion of SuDS to create a conceptual drainage strategy and safe access/ egress at the development in the event of a flood. The LLFA set out a number of conditions which should be implemented within new or re-developments. Broxbourne Borough Council have defined their entire administrative area as the geographical area for which the Sequential Test is to be applied.

Strategic flood risk solutions have been considered for Broxbourne, such as the construction of new upstream storage schemes on a number of watercourses, re-naturalisation, considering SuDS at an early stage in the development of a site, and engaging stakeholders to work together to identify issues and provide suitable solutions.

Emergency planning considerations have been included and the flood warning service coverage assessed; currently there are four Flood Alert Areas and seven Flood Warning Areas (FWAs) covering significant parts of Broxbourne. Requirements for safe access and egress have also been set out.

A map showing the overall WFD status of the main waterbodies in the borough is provided in the main report. All watercourses are classed as 'Moderate'. Future development should ensure there is no adverse impact on the quality of watercourses within the Council administrative area.

## Recommendations

### Assessing Flood Risk and Developments

- The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the borough
- A site-specific FRA is required for all developments over 1ha in Flood Zone 1; for developments less than 1 ha in Flood Zone 1 where there is a change to vulnerability classification or where the development could be affected by sources of flooding; and for all developments located in an area which has been highlighted as having critical drainage problems. The FRA should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development
- It is recommended that the impact of climate change to a proposed site is considered in a FRA and that the percentage increases which relate to the proposed lifetime of the development and the vulnerability classification of the development is accounted for. The Environment Agency and LLFA should be consulted to confirm a suitable approach to climate change in light of the latest guidance
- Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites, through reductions in the amount of surface water runoff generated on a site
- The Local Planning Authority (LPA), Environment Agency and Lead Local Flood Authority (LLFA) should be consulted to confirm the level of assessment required and to provide any information on any known local issues
- When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as provide evidence to show that they have adequately considered other reasonably available sites

### Future Developments

Development must seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of surface water runoff based on Local Plan policy and LLFA Guidance
- Locating development to areas with lower flood risk
- Creating space for flooding.
- Integrating green infrastructure into mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

The Local Planning Authority should consult the National Planning Practice Guidance and Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', published in March 2014, when reviewing planning applications for proposed developments at risk of flooding.

At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances, published by the Environment Agency in February 2016), inform development zoning within the site and prove, if required, whether the Exception Test can be passed.

### Promotion of SuDS

- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration.
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA

SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable and guidance should be sought from the LLFA.

- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints.
- The LPA will need to consider drainage schemes for major applications, but it is advised developers utilise the LLFA's Polices and Guidance to develop their drainage scheme for minor applications.

**Infrastructure and Access**

- Any developments located within an area protected by flood defences, and where the condition of those defences is 'fair' or 'poor', should be identified and the use of developer contributions considered to fund improvements.
- Safe access and egress for residents and emergency and service vehicles will need to be demonstrated at all development sites

**Green Infrastructure and WFD**

Opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought. In addition, opportunities where it may be possible to improve the WFD status of watercourses, for example by opening up culverts, weir removal, and river restoration, should be considered. Green infrastructure should be considered within the mitigation measures for surface water runoff from development.

**Future flood management in Hertfordshire**

Hertfordshire County Council's Local Flood Risk Management Strategy identifies policies and procedures to assist them with achieving and delivering the LFRMS. Hertfordshire County Council will set out to achieve these by adopting a leadership role in FRM in Hertfordshire, working in collaboration with key stakeholders and partners, including Broxbourne Borough Council, to enable capacity building and transparent knowledge-sharing across the County, and to ensure SuDS are effectively accounted for in new developments. Cross-authority working should also include community engagement, to manage expectations about what can be achieved from a funding perspective and to help communities to become more self-resilient.

### Use of SFRA data

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The SFRA should be periodically updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Broxbourne Borough Council, Hertfordshire County Council (in its role as LLFA), the Highways Authority, Thames Water and the Environment Agency. It is recommended that the SFRA is reviewed internally on an annual basis, allowing a cycle of review, followed by checking with the above bodies for any new information to allow a periodic update.

# Contents

# List of Figures



# List of Tables

# Abbreviations and Glossary of Terms

| Term | Definition |
|---|---|
| 1D model | One-dimensional hydraulic model |
| 2D model | Two-dimensional hydraulic model |
| AEP | Annual Exceedance Probability |
| Brownfield | Previously developed parcel of land |
| CC | Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions. |
| CDA | Critical Drainage Area - A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure. |
| CFMP | Catchment Flood Management Plan- A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk. |
| CIRIA | Construction Industry Research and Information Association |
| Cumecs | The cumec is a measure of flow rate. One cumec is shorthand for cubic metre per second; also $m^3/s$. |
| Defra | Department for Environment, Food and Rural Affairs |
| Designated Feature | A form of legal protection or status reserved for certain key structures or features that are privately owned and maintained, but which make a contribution to the flood or coastal erosion risk management of people and property at a particular location. |
| DG5 Register | A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years. |
| DTM | Digital Terrain Model |
| EA | Environment Agency |
| EU | European Union |
| FEH | Flood Estimation Handbook |
| Flood defence | Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard). |
| Flood Risk Area | An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government). |
| Flood Risk Regulations | Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management. |
| Floods and Water Management Act | Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England. |
| Fluvial Flooding | Flooding resulting from water levels exceeding the bank level of a main river |
| FRA | Flood Risk Assessment - A site specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area. |
| FRM | Flood Risk Management |
| FWMA | Flood and Water Management Act |
| FZ | Flood Zones |
| GI | Green Infrastructure – a network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and urban fringe |
| Greenfield | Undeveloped parcel of land |

| Term | Definition |
|---|---|
| Ha | Hectare |
| Indicative Flood Risk Area | Nationally identified flood risk areas, based on the definition of 'significant' flood risk described by Defra and WAG. |
| JBA | Jeremy Benn Associates |
| LFRMS | Local Food Risk Management Strategy |
| LIDAR | Light Detection and Ranging |
| LLFA | Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management |
| LPA | Local Planning Authority |
| mAOD | metres Above Ordnance Datum |
| Main River | A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers |
| NPPF | National Planning Policy Framework |
| NRD | National Receptor Database |
| Ordinary Watercourse | All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance. |
| OS NGR | Ordnance Survey National Grid Reference |
| PFRA | Preliminary Flood Risk Assessment |
| Pitt Review | Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England. |
| Pluvial flooding | Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity. |
| Pound length | Distance of level water impounded between two canal locks. |
| Qbar | The mean annual flow from a catchment. This is approximately the 2.3-year return period event. |
| PPG | National Planning Policy Guidance |
| PPS25 | Planning and Policy Statement 25: Development and Flood Risk – superseded by the NPPF and PPG |
| Resilience Measures | Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances. |
| Resistance Measures | Measures designed to keep flood water out of properties and businesses; could include flood guards for example. |
| Risk | In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood. |
| Return Period | Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time. |
| Sewer flooding | Flooding caused by a blockage or overflowing in a sewer or urban drainage system. |
| SHLAA | Strategic Housing Land Availability Assessment - The Strategic Housing Land Availability Assessment (SHLAA) is a technical piece of evidence to support local plans and Sites & Policies Development Plan Documents (DPDs). Its purpose is to demonstrate that there is a supply of housing land in the borough which is suitable and deliverable. |
| SFRA | Strategic Flood Risk Assessment |
| SoP | Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100 year standard of protection. |
| Stakeholder | A person or organisation affected by the problem or solution, or interested |

| Term | Definition |
|---|---|
| | in the problem or solution. They can be individuals or organisations, includes the public and communities. |
| SuDS | Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques |
| Surface water flooding | Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding. |
| SWMP | Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study. |
| uFMfSW | Updated Flood Map for Surface Water |
| WFD | Water Framework Directive |

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# 1 Introduction

## 1.1 Purpose of the Strategic Flood Risk Assessment

This updated Level 1 Strategic Flood Risk Assessment (SFRA) replaces the Level 1 SFRA originally published by Broxbourne Borough Council in December 2007. This report has been prepared to replace the content included in the previous version of the SFRA and to provide appropriate supporting evidence for the emerging Local Plan.

The 2016 SFRA update will be used in decision-making and to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

The key objectives of the review performed during the preparation of the updated SFRA are:

1. **To update the Council's existing Level 1 SFRA, taking into account most recent policy and legislation in the National Planning Policy Framework.**

   Since the publication of the last SFRA by Broxbourne Borough Council there have been a number of changes to policy and guidance. The following are the key changes to policy and guidance which will be updated within this document:

   - Changes to legislation, both relating to flood risk and planning policy, including the Flood Risk Regulations (2009), Flood and Water Management Act (2010), the National Planning Policy Framework (NPPF) (2012), the Localism Act (2011) and the Climate Change Act (2008); and new powers and responsibilities bestowed on Hertfordshire County Council as the Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (2010) and their dependencies therefore with the Council's local development and forward planning roles.
   - Guidance published in April 2015 regarding the role of LLFAs, Local Planning Authorities and the Environment Agency with regards to SuDS approval.
   - Changes to technical guidance, for example the 2016 climate change allowances, consultation on SuDS Regulations and Standards (2011), Defra's Non-statutory technical standards for sustainable drainage systems (March 2015), and NPPF Planning Practice Guidance replacing PPS25 and PPG25.

2. **To update the Council's existing Level 1 SFRA, taking into account the latest available flood risk information and data.**

   Since the previous SFRA there are a number of new datasets available to more accurately assess flood risk in the study area. These datasets will be used within this document to give a more accurate interpretation of flood risk for the study area and include the following:

   - Hertfordshire Preliminary Flood Risk Assessment (2011)
   - Hertfordshire County Council's SuDS Policy Statement (March 2015), Guidance for developers, and SuDS Design Guidance
   - Hertfordshire Local Flood Risk Management Strategy (Local Strategy) 2011
   - East Hertfordshire & Broxbourne SWMP (ongoing)
   - Availability of the updated Flood Map for Surface Water (uFMfSW)
   - 1D 2D River Lee Modelling and Mapping Study (2010/11)
   - Lower Lee Flood Risk Management Strategy (Revised 2013)
   - Rye Meads Water Cycle Strategy (2009)
   - Scoping Study of Hertfordshire LPA Planning Performance in relation to Climate Change (2009)
   - Strategic Housing Land Availability Assessment (SHLAA, 2016)
   - Broxbourne Sustainability Appraisal Scoping Report (2008)

3. **To investigate and identify the extent and severity of flood risk from all sources presently and in the future within the local planning authority area of Broxbourne Borough Council.**

   Local plans set out the Council's spatial strategy to help guide and manage future development in the in the most sustainable way. There have been changes to sites since the previous SFRA.

4. **To provide a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the local plan.**

   Maps are a good way to present the most recent and available technical data in a clear and user friendly manner. This form of presentation also will help engage with stakeholders. The maps listed below are either shown as a figure within the main report or are contained within the appendices.

   - Main Rivers and ordinary watercourses
   - Drainage area information (geology, soils, topography)
   - Fluvial flood risk, including functional floodplain and climate change
   - Surface water risk
   - Ground water risk
   - Flood warning coverage
   - Water Framework Directive
   - Flood defences
   - Potential local plan allocations

## 1.2 SFRA objectives

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1. **Level One:** where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
2. **Level Two:** where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

The objective of this SFRA update is a Level One Update.

## 1.3 Level 1 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Identification of policy and technical updates, in particular the introduction of the National Planning Policy Framework and accompanying Planning Practice Guidance (any strategic flooding issues which may have cross boundary implications with neighbouring authorities must be considered as part of this review and appropriate consultation with neighbouring Local Authorities undertaken.)
- Review and update of new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc.).
- Clear identification of any critical flood modelling and data gaps and explanation of the impact of these on potential allocations in the emerging Local Plan
- Appraisal of all potential sources of flooding, including fluvial, surface water, groundwater, sewer and reservoir inundation.
- Updated review of historical flooding incidents since 2007.
- Mapping of location and extent of functional floodplain.
- Appraisal of flood risk management infrastructure including reporting on the standard of protection provided.

- An assessment of the potential increase in flood risk due to climate change.
- An assessment of the surface water management issues, how these can be addressed through site allocation and development management policies and the application of Sustainable Drainage Systems (SuDS).
- An assessment of strategic flood risk solutions that can be implemented to reduce risks and avoid exacerbation of flood risk to third parties.
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.

## 1.4 Approach

### 1.4.1 General assessment of flood risk

The flood risk management hierarchy underpins the risk-based approach and is the basis for making all decisions involving development and flood risk. When using the hierarchy, account should be taken of

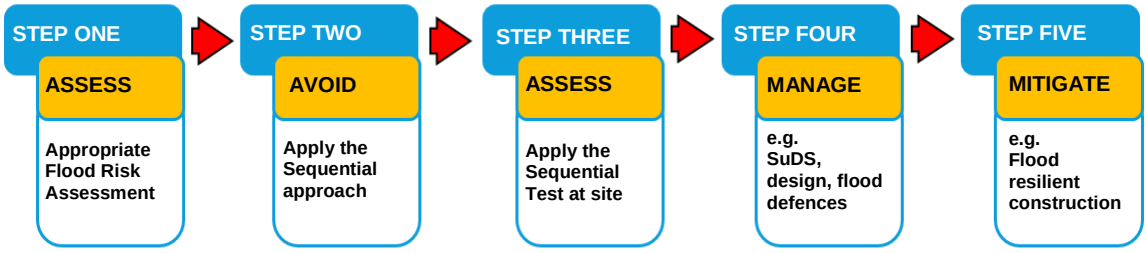
- the nature of the flood risk (the ***source*** of the flooding);
- the spatial distribution of the flood risk (the ***pathways*** and areas affected by flooding);
- climate change impacts; and
- the degree of vulnerability of different types of development (the ***receptors***).

Developments should reflect the application of the Sequential Test using the maps produced for this SFRA. The information in this SFRA should be used as evidence and, where necessary, reference should also be made to relevant evidence in other documents referenced in this report. The Flood Zone maps and flood risk information on other sources of flooding contained in this SFRA should be used where appropriate to apply the Sequential Test.

Where other sustainability criteria outweigh flood risk issues, the decision making process should be transparent. Information from this SFRA should be used to justify decisions to allocate land in areas at high risk of flooding.

The flood risk management hierarchy is summarised in Figure 1-1.

Figure 1-1: Flood Risk Management Hierarchy




## 1.5 Consultation

The following parties (external to Broxbourne Borough Council) have been consulted during the preparation of this version of the SFRA:

- Environment Agency (Hertfordshire and North London area)
- Hertfordshire County Council
- Thames Water
- Canal & River Trust
- Highways
- Fire and Rescue
- Lea Valley Regional Park Authority

- Neighbouring authorities including:
  - Epping Forest District Council
  - East Hertfordshire District Council
  - Welwyn Hatfield Council
  - Enfield London Borough Council

## 1.6 SFRA user guide

Table 1-1: SFRA report contents

| Section | Contents |
|---|---|
| 1. Introduction | Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed. |
| 2 The Planning Framework and Flood Risk Policy | Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study. |
| **Level One Strategic Flood Risk Assessment** | |
| 3. How flood risk is assessed | Provides an overview of flooding and risk and Flood Zones. |
| 4. The sequential, risk based approach | Summary of the modelling used for the assessment.<br>Description of mapping that should be used for Sequential and Exception testing.<br>Application of the Sequential Approach and Sequential/Exception Test process. |
| 5. Understanding flood risk in the Broxbourne Borough Council | Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting the district. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered. |
| 6. Flood defences | Assessment of residual risk from flood defences, including future protection from climate change. |
| 7. Flood risk from artificial water bodies | Summarises flood risk from artificial water bodies |
| 8. Surface water management and SuDS | Advice on managing surface water run-off and flooding. |
| 9. Flood warning and emergency planning | Outlines the Flood Warning Service, and emergency planning procedures and considerations. |
| 10. Cumulative impact of development and cross boundary issues | Broadscale assessment of areas where the cumulative impact of development may be detrimental to flood risk. An assessment of potential cross boundary flood risk issues as a result of future large scale developments. |
| 11. FRA requirement and guidance for developers | Outlines requirements for FRAs as well as providing guidance for developers |
| 12. Strategic Flood Risk Solutions | Summary of Strategic Flood Risk Solutions. |
| 13. Flood risk management policy considerations | Outlines National, Council Specific and Development Control policy considerations |
| **Summary and recommendations** | |
| 14. Summary | Summary of Level 1 assessment and key findings |

| Section | Contents |
|---|---|
| 15. Recommendations | Outlines key recommendations from the Level 1 study |
| **Appendices** | |
| Appendix A: Watercourses in Broxbourne Borough Council | |
| Appendix B: Flood Zone mapping, including functional floodplain | |
| Appendix C: Climate change mapping | |
| Appendix D: Surface water flood risk mapping | |
| Appendix E: Groundwater flood risk mapping | |
| Appendix F: Flood warning coverage | |
| Appendix G: Artificial sources | |
| Appendix H: Site allocations | |
| Appendix I: Data Register | |

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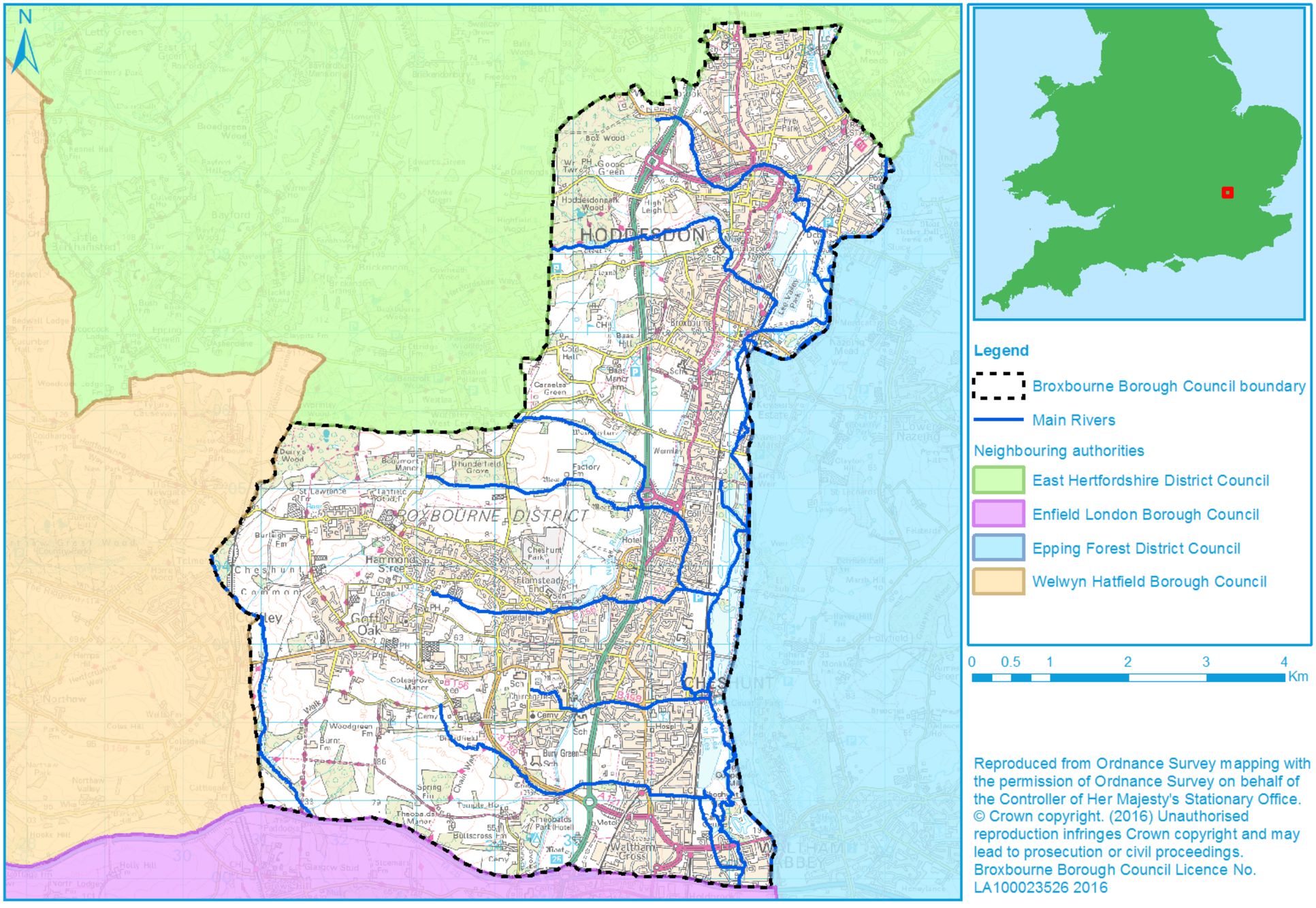
Figure 1-2: Study Area



# 2 The Planning Framework and Flood Risk Policy

## 2.1 Introduction

The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities. In preparing the subsequent sections of this SFRA, appropriate planning and policy amendments have been acknowledged and taken into account.

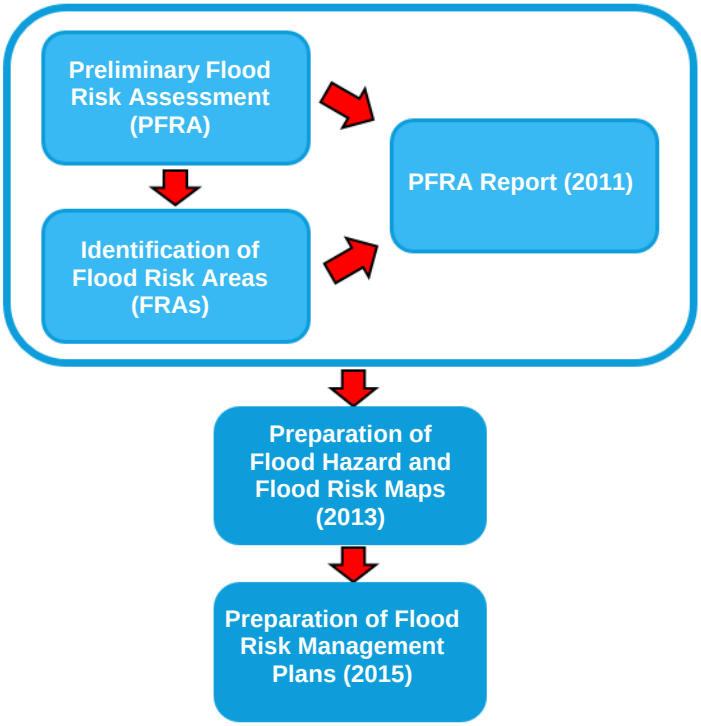
## 2.2 Flood Risk Regulations (2009) and Flood and Water Management Act (2010)

### 2.2.1 Flood Risk Regulations, 2009

The Flood Risk Regulations (2009) are intended to translate the current EU Floods Directive into UK law and place responsibility upon all Lead Local Flood Authorities (LLFAs) to manage localised flood risk. Under the Regulations, the responsibility for flooding from rivers, the sea and reservoirs lies with the Environment Agency; however, responsibility for local and all other sources of flooding rests with LLFAs. In the instance of this SFRA, the LLFA is Hertfordshire County Council.

Figure 2-1 illustrates the steps that have / are being taken to implement the requirements of the EU Directive in the UK via the Flood Risk Regulations.

Figure 2-1: Flood Risk Regulation Requirements




Under this action plan and in accordance with the Regulations, LLFAs have the task of assessing flood risk from local sources over a six-year cycle, beginning with the preparation of a Preliminary Flood Risk Assessment (PFRA) report.

### 2.2.2 Hertfordshire Preliminary Flood Risk Assessment (PFRA), 2011

The PFRA document that covers Broxbourne was published by the LLFA in 2011[1], and gives an overview of local flood risk in Hertfordshire based on a review of records of flooding and data derived from modelling of potential future flooding. It reports on significant past and future flooding from all sources except from Main Rivers and Reservoirs, which are covered by the Environment

1 Hertfordshire County Council PFRA (2011): www.hertsdirect.org/docs/pdf/f/hccpfra.pdf

Agency, and sub-standard performance of the adopted sewer network (covered under the remit of Thames Water).

The PFRA is a high-level screening exercise and considers floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The Regulations require the LLFA to identify significant Flood Risk Areas, and therefore the PFRA identifies such areas and if they are considered to be nationally significant, as defined by Defra.

Based on this analysis no areas were identified in Hertfordshire that meet the national criteria to be designated as Flood Risk Areas (clusters with a total of more than 30,000 people). The three largest clusters are around Watford (11946), Hemel Hempstead (5655) and Stevenage (5110).

No historical evidence was found of extensive surface water flooding (at an equivalent scale to the national thresholds for Flood Risk Areas based on modelled flood risk) that would support the identification of a Flood Risk Area in Hertfordshire.

### 2.2.3 River Basin Flood Risk Management Plans, 2016

Under the Flood Risk Regulations (2009), the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. This then made it a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP). The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans, in accordance with the Water Framework Directive (Section 2.8 contains further information on the Water Framework Directive and the River Basin Management Plans).

The borough of Broxbourne falls within the Thames River Basin District FRMP (March 2016). The FRMP explains the risk from flooding from all sources alongside how risk management authorities will work with communities to manage flood risk from 2015 to 2021. The FRMP draws on previous policies and actions identified in Catchment Flood Management Plans and also incorporates information from Local Flood Risk Management Strategies (it should be noted that FRMPs do not supersede Catchment Flood Risk Management Plans). Each River Basin District is composed of a group of sub-areas or catchments; there are 17 catchments covered by the river Thames Basin and Broxbourne lies at the head of the London Catchment area. The FRMP summarises the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations. The Thames Basin FRMP recommends management actions along the Lower Lee catchment as identified in the 2011 Lower Lee Flood Risk Management Strategy (see Section 2.7).

### 2.2.4 Flood and Water Management Act, 2010

The Flood and Water Management Act (2010)[2] (FWMA) aims to create a simpler and more effective means of managing both flood risk and coastal erosion and implements Sir Michael Pitt's recommendations following his review of the 2007 floods. The FWMA received Royal Assent in April 2010, and designated upper tier local authorities as LLFAs. The LLFA covering the Broxbourne borough is Hertfordshire County Council. Duties for Hertfordshire County Council as LLFA include:

- Develop a Local Flood Risk Management Strategy for Hertfordshire under the Act, in consultation with local partners. This is discussed further in Section 2.2.5. This Strategy acts as the basis and discharge of duty for Flood Risk Management co-ordinated by Hertfordshire County Council
- Develop, maintain, apply and monitor a Local Flood Risk Management Strategy (LFRMS) to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most
- When appropriate and necessary, investigate and report on flooding incidents
- Establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area
- When appropriate, exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it

2 Flood and Water Management Act (2010): http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

- When appropriate, perform consenting of works on ordinary watercourses

The FWMA also makes it clear that the LLFA has powers to manage flood risk from surface water and groundwater and has the lead responsibility for managing/ regulating flood risk from 'ordinary watercourses' (i.e. smaller ditches, brooks), unless there is an IDB. The LLFA are the regulatory body for changes within ordinary watercourses, with responsibility for managing flood risk and actual maintenance for ordinary watercourses (including development of bylaws) sitting with riparian owners, e.g. the district/ borough councils, landowner, farmers etc. If a riparian owner wishes to alter a watercourse then consent from the LLFA is required, otherwise the LLFA has the power to take enforcement action.

The FWMA will also update the Reservoirs Act 1975 by reducing the capacity of reservoir regulation from 25,000m3 to 10,000m3. Phase 1 has been implemented in 2013 requiring large raised reservoirs to be registered to allow the Environment Agency to categorise whether they are 'high risk' or 'not high risk'.

On 18 December 2014 a Written Ministerial Statement laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply for major development from 6 April 2015. When considering planning applications, Local Planning Authorities should consult the LLFA on the management of surface water, in order to satisfy that the proposed minimum standards of operation are appropriate and ensure, through use of planning conditions or obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

In March 2015 the LLFA was made a statutory consultee which came into effect on 15 April 2015. As a result, Hertfordshire County Council, are required to provide technical advice on surface water drainage strategies and designs put forward for new 'major' developments.

Major developments are defined as:

- Residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known
- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of 1 hectare or more

### 2.2.5 Hertfordshire Local Flood Risk Management Strategy (LFRMS)

Hertfordshire County Council as LLFA is responsible for developing, maintaining, applying and monitoring a Local Flood Risk Management Strategy for Hertfordshire[3]. The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management on a day to day basis. The Strategy also sets measures to manage local flood risk. The high-level objectives proposed in the Strategy for managing flood risk include:

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

A 'Vision for Hertfordshire' has also been created under this Strategy to set the strategic direction for the County in terms of making sound decisions about flood risk.

It is also important that the Local Strategy is consistent with the National Strategy which outlines six guiding principles for Flood Risk Management in England. From these six principles, Hertfordshire have set out an overall position which it is striving to achieve, as follows:

- There is a strategic overview of flood risk from all sources
- The potential impacts of climate change are understood
- No new significant flood risk is created due to development

3 HCC LFRMS: http://www.hertsdirect.org/docs/pdf/f/hertslfrmsall.pdf

- Flood risk is managed (and reduced)
- Areas where flood risk is significant have been analysed in more detail
- Potential for measures to reduce flood risk have been assessed
- Where possible proportionate opportunities to reduce flood risk are taken
- Multiple benefits are achieved through the management of flood risk
- Effective partnership arrangements are in place
- Hertfordshire works with other flood risk management partnerships
- Information is made available so flood risk is understood by the community and businesses
- Communities are supported to be resilient and participate in reducing flood risk
- Opportunities to develop funding for risk reduction measures are actively being sought
- Flood risk management work informs the planning of emergency responses

Moving forward, Hertfordshire County Council have put forward and are currently undertaking a work programme for the first three years leading up to the first review of the Strategy (which has already commenced), outlining policies and procedures for actions to be taken to deliver the LFRMS, summarised in the following proposals, and in Section 2.2.2:

- To adopt a leadership role in the management of flood risk in Hertfordshire
- To work in partnership and collaborate with key partners and stakeholders in managing and reducing flood risk in the county
- To build a robust knowledge base that is available to all in order to support flood risk management in Hertfordshire
- To continue to build capacity amongst partners for dealing with and managing flood risk
- To implement fully emerging responsibilities in relation to the management of flood risk structures and features including ordinary watercourses
- To work with partners to secure the effective implementation of Sustainable Drainage Systems (SuDS) in new development
- To support the provision of clear guidance to the development industry about its responsibilities in relation to the management of flooding and flood risk associated with new development

In March 2015, Hertfordshire County Council published an addendum to the LFRMS, regarding SuDS. The SuDS Policy Statement sets out the LLFA recommended approach for the development and delivery of SuDS in the county. The statement contains 18 policies on the context of and requirements for compliance with national policy, guidance or industry practice, pre-application discussions, outline and detailed drainage proposals, other design matters, source control, surface runoff managed on the surface, integrating public space with SuDS, cost-effective operation and maintenance over the development design life, climate change, affordability and design criteria as well as policies on non-statutory SuDS Standards and guidance.

### 2.2.6 Roles and responsibilities

The responsibilities under the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009 are summarised in Table 2-1.

Table 2-1: Roles and responsibilities in Hertfordshire under FWMA 2010

| Risk Management Authority (RMA) | Strategic Level | Operational Level |
|---|---|---|
| Environment Agency | National Statutory Strategy<br><br>Reporting and supervision (overview role) | • Preliminary Flood Risk Assessment (per River Basin District)*<br>• Managing flooding from Main Rivers and reservoirs and communication flood risk warnings to the public, media and partner organisations.<br>• Identifying Significant Flood Risk Area*<br>• Enforcement authority for Reservoirs Act 1975<br>• Managing RFCCs and supporting funding decisions, working with LLFAs and local communities.<br>• Emergency planning and multi-agency flood plans, developed by local resilience forums<br>• Acting consistently with LFRMS in realising FRM activity and have due regard in the discharge of function of the strategy.<br>• Designating authority of infrastructure with a significant impact on flood risk from surface water and groundwater. |
| Lead Local Flood Authority (Hertfordshire County Council) | Input to National Strategy<br><br>Formulate and implement the Hertfordshire Local Flood Risk Management Strategy | • Power for enforcing and consenting works for ordinary watercourses.<br>• Managing local sources of flooding from surface runoff and groundwater and carrying out practical works to manage flood risk from these sources where necessary.<br>• Preparing and publishing a PFRA<br>• Identifying Flood Risk Areas<br>• Investigating certain incidents of flooding in the County in Section 19 Flood Investigations<br>• Keeping asset registers of structures and features which have a significant effect on local flood risk.<br>• Acting consistently with LFRMS in realising FRM activity and have due regard in the discharge of other functions of the strategy<br>• Designating authority for Infrastructure with a significant impact on flood risk from surface runoff and groundwater |

| Risk Management Authority (RMA) | Strategic Level | Operational Level |
|---|---|---|
| Lower Tier Authorities (Broxbourne Borough Council) | Input to National and Local Authority Plans and Strategy (e.g. Broxbourne Local Plan – to develop a spatial strategy for growth within the borough which accounts for flood risk) | • District Councils have the powers to carry out works on ordinary watercourses to reduce flood risk<br>• Preparation of a Local Plan to guide development.<br>• Acting consistently with LFRMS in realising FRM activity and have due regard in discharge of other functions.<br>• The competent determining authority for planning applications and have the ultimate decision on the suitability of a site in relation to flood risk and management of surface water run-off.<br>• Responsibilities for emergency planning as a responder to a flood event.<br>• Own and manage public spaces which can potentially be used for flood risk management. |

* Environment Agency did not prepare a PFRA; instead they exercised an exception permitted under the Regulations

## 2.3 National Planning Policy Framework

The National Planning Policy Framework (NPPF)[4] was issued on 27 March 2012 to replace the previous documentation as part of reforms to the planning system. It replaces most of the Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs), in particular PPS25, which were referred to in the previous version of the SFRA. The NPPF is a source of guidance for local planning authorities to help them prepare Local Plans and in the decision making process. With regards to plan-making and flood risk, the principal provisions of the NPPF are set out in paragraph 100.

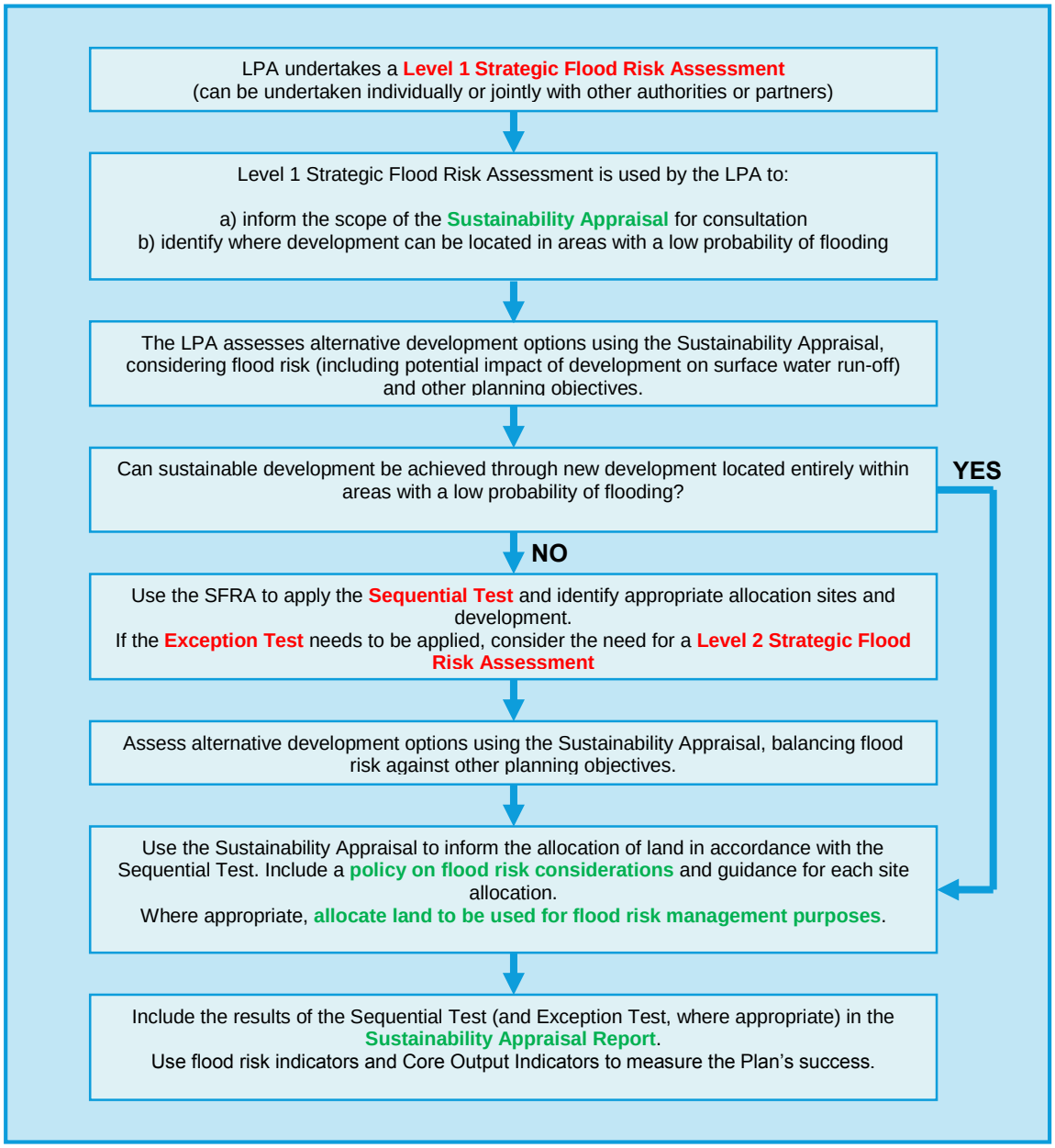
**Paragraph 100 of the NPPF:**

> "Local Plans should be supported by a strategic flood risk assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities and Internal Drainage Boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change".

Planning Practice Guidance on flood risk was published alongside the NPPF in March 2014 and sets out how national policy should be implemented. This was subsequently updated on April 6 2015 to take into account the new statutory role of the LLFA and the requirement for surface water drainage assessments for all 'major' developments. A description of how flood risk should be taken into account in the preparation of Local Plans is outlined in Diagram 1 contained within the Planning Practice Guidance (Figure 2-2).

4 National Planning Policy Framework (Department for Communities and Local Government, March 2012)

Figure 2-2: Flood risk and the preparation of Local Plans†




† Based on Diagram 1 of NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-005-20140306) March 2014

## 2.4 Water Cycle Studies

Water Cycle Studies assist local authorities to select and develop growth proposals that minimise impacts on the environment, water quality, water resources, infrastructure and flood risk and help to identify ways of mitigating such impacts. This can be achieved in areas where there may be conflict between any proposed development and the requirements of the environment through the recommendation of potential sustainable solutions.

A Water Cycle Study – Scoping Study covering Broxbourne was completed in April 2010. A new Water Project for Hertfordshire is currently being commissioned by Hertfordshire County Council with the aim of identifying the critical factors which affect robust water supply and wastewater treatment to 2051 in Hertfordshire. The scope of the study will only extend to flood risk, water quality and surface water management as far as necessary to take a holistic and integrated approach.

## 2.5 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken, when required, by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

The SWMP for Broxbourne is currently under development. The Local Flood Risk Management Strategy[5] set out by the LLFA states that preparation of a SWMP for Broxbourne / East Hertfordshire started in the financial year of April 2014/2015 and is proposed to take approximately 18 months to complete.

## 2.6 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

There are six pre-defined national policies provided in the CFMP guidance and these are applied to specific locations through the identification of 'Policy Units'. These policies are intended to cover the full range of long-term flood risk management options that can be applied to different locations in the catchment.

The study area is covered by the River Thames CFMP[6]. Broxbourne falls within the Policy Unit 8 - heavily populated floodplain. The CFMP notes that although this policy unit covers 10% of the floodplain within the Thames CFMP, it has 40% of properties at risk of flooding (1%) in the Thames CFMP; this figure is estimated to increase by between 5% and 25% in the future due to the impacts of climate change. It is important to acknowledge that large-scale flood risk interventions will be difficult to develop and maintain; the CFMP notes that there are major technical obstacles in large-scale interventions and consequently, *"any solutions will be expensive, provide differing levels of protection and not benefit everyone in the affected communities".* The area is covered by Policy Option 5. The proposed actions to implement this policy are the following:

- Deliver actions recommended in the Flood Risk Management Strategies for Oxford, the Lower Lee, the Wey and Lower Thames.
- In the short-term, encourage partners to develop policies, strategies and initiatives to increase the resistance and resilience of all new development at risk of flooding. Protect land that may be needed to manage flood risk in the future, and work with partners to identify opportunities for this and to recreate river corridors in urban areas.
- In the long-term, land and property owners need to adapt the urban environment to be more flood resilient. This includes the refurbishment of existing buildings to increase resilience and resistance to flooding.
- Promote the management of flood consequences, by working with our partners to improve public awareness and local emergency planning.

## 2.7 Lower Lee Flood Risk Management Strategy (2013)

The Environment Agency's Lower Lee Flood Risk Management Strategy is used to review how fluvial flood risk associated with rivers in the Lower Lee catchment is managed now and long term (100 years). The Strategy draws on previous policies and actions identified in Catchment Flood Management Plans. Recommended measures as part of this Strategy would protect a further 1,000 properties in the catchment and include:

- Maintain, refurbish and replace existing flood defences.

5 Hertfordshire County Council – Local Flood Risk Management Strategy for Hertfordshire 2013-2016 (2011)

6 Environment Agency (2010): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293903/Thames_Catchment_Flood_Management_Plan.pdf

- If flood risk increases in the future with climate change, as predicted, promote additional flood alleviation schemes at Turnford (Turnford Brook) and Hoddesdon (Wollens Brook).
- Manage flood risk through influencing development planning, expanded flood monitoring and warning services, and promoting individual property-level flood protection measures.

Measures relating to watercourses through Broxbourne borough include:

- Lynch and Spital Brook: Continue operation and maintenance of channel and continue to operate and maintain the flood warning service to the area. No specific measures were identified; however, partnership working with local communities and organisations to find opportunities to reduce flood risk will continue. Suggestions that individual property-level protection measures could be investigated.
- Cuffley Brook: No proposed structural measures on the Cuffley Brook. No river maintenance is required in this rural catchment to maintain the current standard of protection.
- Turnford Brook, Rags Brook, College Brook and Trinity Marsh Ditch: Continue operation and maintenance of channel and existing flood storage areas at Theobalds and Cheshunt North and continue to operate and maintain the flood warning service to the area. No specific measures were identified; however, partnership working with local communities and organisations to find opportunities to reduce flood risk will continue. Suggestions that individual property-level protection measures could be investigated.
- Small Lee (including Highbridge Stream): Continue operation and maintenance of channel and other flood risk management assets and continue to operate and maintain the flood warning service to the area. No specific measures were identified, however, partnership working with local communities and organisations to find opportunities to reduce flood risk will continue. Suggestions that individual property-level protection measures could be investigated.
- Lee Flood Relief Channel: Continue maintenance, refurbishment and replacement of the channel and its component control structures, in order to sustain the current standard of protection. Continue to operate and maintain the flood warning service to the area.

## 2.8 Water Framework Directive

The EU Water Framework Directive (WFD) seeks to integrate and enhance the way in which water bodies are managed throughout Europe by the preservation, restoration and improvement of the water environment. On 23 October 2000 the European Commission established the WFD requiring each Member State of the European Union to satisfy the environmental objectives set by the Directive and implement the legislation. This was transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. In England, the Environment Agency is responsible for the delivery of the WFD objectives.

The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Ecological Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies) by a defined date. Note the Lee Navigation Channel is classified as 'Heavily Modified'.

The WFD requires the production of Management Plans for each River Basin District. Each District is composed of a group of catchments termed river basins to which all water bodies are assigned.

### 2.8.1 Thames River Basin Management Plan (RBMP), 2015

The Thames River Basin Management Plan (2015)[7] is prepared under the WFD and assesses the pressures facing the water environment in the Thames River Basin District. The 2009 version has been updated and the update was published in December 2015. The WFD aims to achieve at least 'good' status for all water bodies; the default deadline for achieving this objective is by 2021 although, in some cases, where it is deemed more appropriate, less stringent objectives have been set with extended deadline of 2027 or beyond.

7 Thames River Basin Management Plan, December 2015: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/500548/Thames_RBD_Part_1_river_basin_management_plan.pdf

As the Thames River Basin District is one of the most populated parts of Britain, there are several challenges which can impact progress towards cleaning and protecting natural asset including:

- Physical modifications
- Pollution from waste water
- Pollution from towns, cities, transport and rural areas
- Changes to the natural flow and level of water; and,
- Negative effectives of invasive non-native species.

As of 2015, 11% of all water bodies (surface water and ground water) in the Thames River Basin District are at good or better overall status; this is predicted to increase to 13% by 2021. Over 99% of the measures summarised in the 2009 plans have now been completed. The RBMP summarises ongoing measures which seek to prevent the deterioration in status and improve the quality of the water environment. At a local level, the report has also identified partnership measures in the Lower Lea North catchment, covering the study area which include the promotion of sustainable drainage systems in new developments and retrofitting existing sites within the catchment to reduce the impacts of urban diffuse pollution on flood risk and water quality.

## 2.9 Insurance

### 2.9.1 Association of British Insurers Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England

The Association of British Insurers (ABI) and the National Flood Forum have published guidance for Local Authorities with regards to planning in flood risk areas[8]. The guidance aims to assist Local Authorities in England in producing local plans and dealing with planning applications in flood risk areas. The guidance complements the NPPF. The key recommendations from the guidance are:

- Ensure strong relationships with technical experts on flood risk
- Consider flooding from all sources, taking account of climate change
- Take potential impacts on drainage infrastructure seriously
- Ensure that flood risk is mitigated to acceptable levels for proposed developments
- Make sure Local Plans take account of all relevant costs and are regularly reviewed

### 2.9.2 FloodRe

FloodRe went live in April 2016 and will extend insurance cover to high-risk private (non-commercial) properties built after 2009. The scope of FloodRe is to operate for 25 years, by which time the strategy is that the Government, local authorities and the insurance industry will have become better prepared to deal with severe flood events within the UK and provide sufficient time to gain a wider understanding of the influence climate change is having on the UK's weather. More information on the FloodRe scheme can be found here: http://www.floodre.co.uk/.

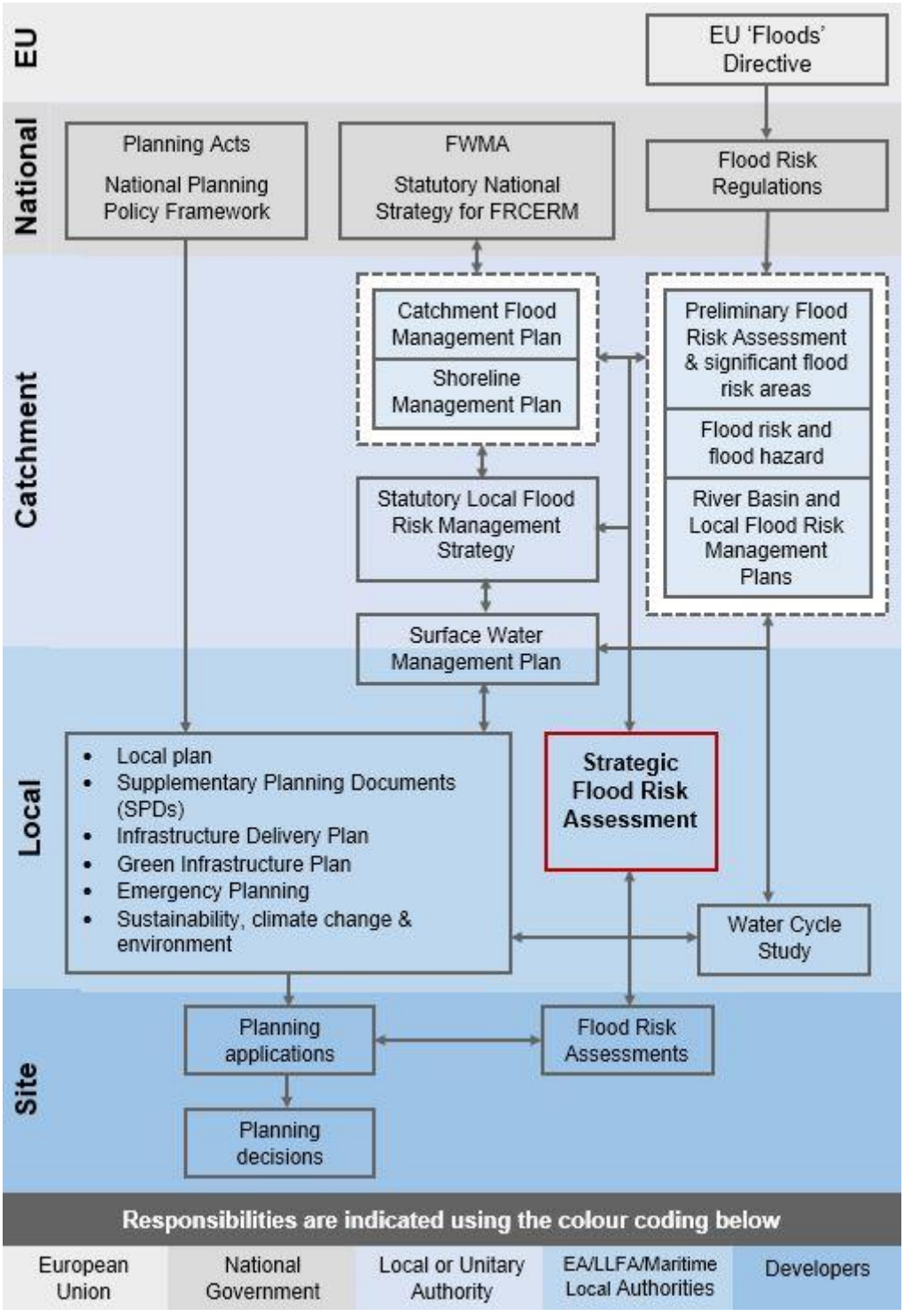
## 2.10 Implications for Broxbourne

Figure 2-3 outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and Flood and Water Management Act, in conjunction with the Localism Act's "duty to cooperate", introduce a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and plans. SFRAs are also linked to the preparation of CFMPs, SWMPs and WCSs.

8 Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England (Association of British Insurers and National Flood Forum, April 2012)

Figure 2-3: Strategic planning links and key documents for flood risk




† See Table 2-1 for roles and responsibilities for preparation of information

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# 3 How flood risk is assessed

## 3.1 Definitions

### 3.1.1 Flood

Section[1] (subsection 1) of the Flood and Water Management Act (FWMA) (2010)[9] defines a flood as:

**'any case where land not normally covered by water becomes covered by water'**

Section 1 (subsection 2) states that 'it does not matter for the purposes of subsection (1)' whether a flood is caused by:

- Heavy rainfall
- A river overflowing or its banks being breached
- A dam overflowing or being breached
- Tidal waters
- Groundwater, or
- Anything else (including any combination of factors).

Note: Sources of flooding under this definition do not include excess surface water from any part of a sewerage system, unless caused by an increase in the volume of rainwater entering or affecting the system, or a flood caused by a burst water main.

### 3.1.2 Flood Risk

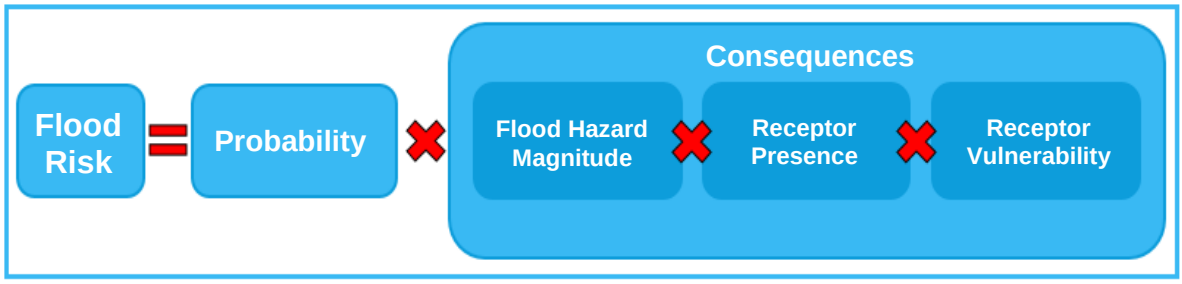
Section 3 (subsection 1) of the FWMA defines the risk of a potentially harmful event (such as flooding) as:

**'a risk in respect of an occurrence is assessed and expressed (as for insurance and scientific purposes) as a combination of the probability of the occurrence with its potential consequences.'**

Thus it is possible to summarise flood risk as:

**Flood Risk = (Probability of a flood) x (Scale of the Consequences)**

On that basis it is useful to express the definition as follows:




Using this definition it can be seen that:

- **Increasing the probability or chance of a flood being experienced increases the flood risk.** In situations where the probability of a flood being experienced increases gradually over time, for example due to the effects of climate change, then the severity of the flood risk will increase (flooding becomes more frequent or has increased effect).

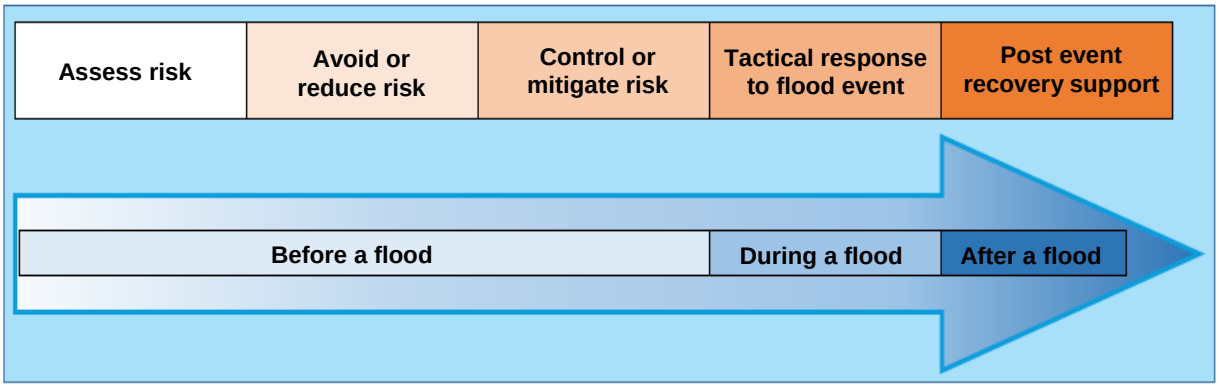
9 Flood and Water Management Act (2010): http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

- **The potential scale of the consequences in a given location can increase the flood risk**.
    - Flood Hazard Magnitude: If the direct hazard posed by the depth of flooding, velocity of flow, the speed of onset, rate of risk in flood water or duration of inundation is increased, then the consequences of flooding, and therefore risk, is increased.
    - Receptor Presence: The consequences of a flood will be increased if there are more receptors affected; for example, with an increase in extent or frequency of flooding. Additionally, if there is new development that increases the probability of flooding (for example, increase in volume of runoff due to increased impermeable surfaces) or increased density of infrastructure, then consequences will also be increased.
    - Receptor Vulnerability: If the vulnerability of the people, property or infrastructure is increased then the consequences are increased. For example, old or young people are more vulnerable in the event of a flood.

## 3.2 Using SFRA risk information

This SFRA contains information that can be used at strategic, operational and tactical levels as shown by Figure 3-1.

Figure 3-1: Use of SFRA information




The SFRA will complement the Hertfordshire Local Flood Risk Management Strategy[10] and Lower Lee Flood Risk Management Strategy and will assist the LLFA with the stated objectives.

The assessment of flood risk in the SFRA is primarily based on the following three types of information:

Flood Zones

Actual Flood Risk

Residual Risk

### 3.2.1 Flood Zones

The SFRA includes maps that show the fluvial Flood Zones. These zones describe the land that would flood if there were no defences present. The NPPF Guidance identifies the following Flood Zones (see Table 3-1):

10 Hertfordshire County Council (2015): http://www.hertsdirect.org/services/envplan/water/floods/floodrisk/lfrmsherts/

Table 3-1: Flood Zone descriptions

| Zone | Probability | Description |
|---|---|---|
| Zone 1 | Low | This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%). |
| | | All land uses are appropriate in this zone. |
| | | For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment. |
| | | Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems. |
| Zone 2 | Medium | This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.1% – 0.5%) in any year. |
| | | Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) as appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test. |
| | | All developments in this zone require an FRA. |
| | | Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems. |
| Zone 3a | High | This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year Developers and the local authorities should seek to reduce the overall level flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage. |
| | | Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test. |
| | | All developments in this zone require an FRA. |
| | | Developers and local authorities should seek opportunities to:<br>reduce the overall level of flood risk in the area and beyond through the layout and form of the development.<br>relocate existing development to land in lower risk zones<br>create space for flooding by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open spaces for flood storage. |
| Zone 3b | Functional Floodplain | This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain should take account of local circumstances. |
| | | Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. Infrastructure must also not increase flood risk elsewhere. |
| | | All developments in this zone require an FRA. |
| | | Developers and local authorities should seek opportunities to:<br>reduce the overall level of flood risk in the area and beyond through the layout and form of the development<br>relocate existing development to land in lower risk zones |

The preference when allocating land is, whenever possible, to place all new development on land in Zone 1. Since the Flood Zones identify locations that are not reliant on flood defences, placing

development on Zone 1 land means there is no future commitment to spending money on flood banks or flood alleviation measures. It also does not commit future generations to costly long term expenditure that would become increasingly unsustainable as the effects of climate change increase.

**Important note on Flood Zone information in this SFRA**

**Appendix B:**

The Flood Zones presented in Appendix B are the same as those shown on the Environment Agency's 'Flood Map for Planning'.

The Environment Agency Flood Zones do not cover all catchments or ordinary watercourses. As a result, whilst the Environment Agency Flood Zones may show an area is in Flood Zone 1, it may be that there is actually a degree of flood risk from smaller watercourses not shown in the Flood Zones.

**Appendix C:**

Additional modelling using the existing River Lee hydraulic models (see Section 5.9.4) was undertaken to refine the extent of the Climate Change scenario due to the revised 2016 Climate Change guidance and allowances published by the government. In addition, generalised modelling was undertaken for the flood zones not covered by detailed hydraulic models. Full details are provided in Section 5.9.4. The Climate Change flood extent shown in Appendix C therefore reflects the recently published 2016 Climate Change guidance and allowances.

### 3.2.2 Actual Flood Risk

If it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- Residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) taking into account climate change in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated;
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth then it will be a priority for the Flood Risk Management Strategy to be reviewed;
- The standard of safety must be maintained for the intended lifetime of the development (assumed to be 100 years for residential development). Over time the effects of climate change will erode the present day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures; and
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater, it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

For information on defences reference should be made to the Environment Agency's Asset Information Management System (AIMS) which contains details on the standard of protection of defences.

### 3.2.3 Residual Risk

The residual risk refers to the risks that remain in circumstances after measures have been taken to alleviate flooding. It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be:

- The effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges; or
- Failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner or failure of pumping stations.

The assessment of residual risk demands that attention be given to the vulnerability of the receptors and the response to managing the resultant flood emergency. In this instance attention should be paid to the characteristics of flood emergencies and the roles and responsibilities during such events. Additionally, in the cases of breach or overtopping events, consideration should be given to the structural safety of the dwellings or structures that could be adversely affected by significant high flows or flood depths.

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# 4 The Sequential, risk based approach

## 4.1 The Sequential, risk-based approach

This approach is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible.

It is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic. A greater understanding of the scale and nature of the flood risks is required.

When deciding on the ability to manage flood risk for new development located in Zones 2 and 3, consideration must be given to a wide range of issues. The issues to be addressed include how any evacuation of the occupants would be handled, how the new development fits in with the existing flood management provision and, in circumstances where flooding is experienced, how quickly the wider area would recover and return to normal. At some locations it could be found that Flood Risk Management (FRM) measures are more easily integrated alongside proposed new development to address the flood risk issues, usually as a consequence of the prevailing natural or artificial topography. In these circumstances the FRM proposals could be deployed without causing a significant alteration to the design and its place setting. However, even in these circumstances it should be recognised that FRM measures at one location can have the potential to cause an alteration to the flood risk to adjacent property or in flood cells on the opposite bank.

## 4.2 Applying the Sequential Test and Exception Test in the preparation of a Local Plan

When preparing a Local Plan, the Local Planning Authority should demonstrate it has considered a range of site allocations, using Strategic Flood Risk Assessments to apply the Sequential and Exception Tests where necessary.

The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan (Figure 4-1).

The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPF Planning Practice Guidance: Flood Risk and Coastal Change. NPPF Planning Practice Guidance: Flood Risk and Coastal Change describes how the Exception Test should be applied in the preparation of a Local Plan (Figure 4-2).

Figure 4-1: Applying the Sequential Test in the preparation of a Local Plan

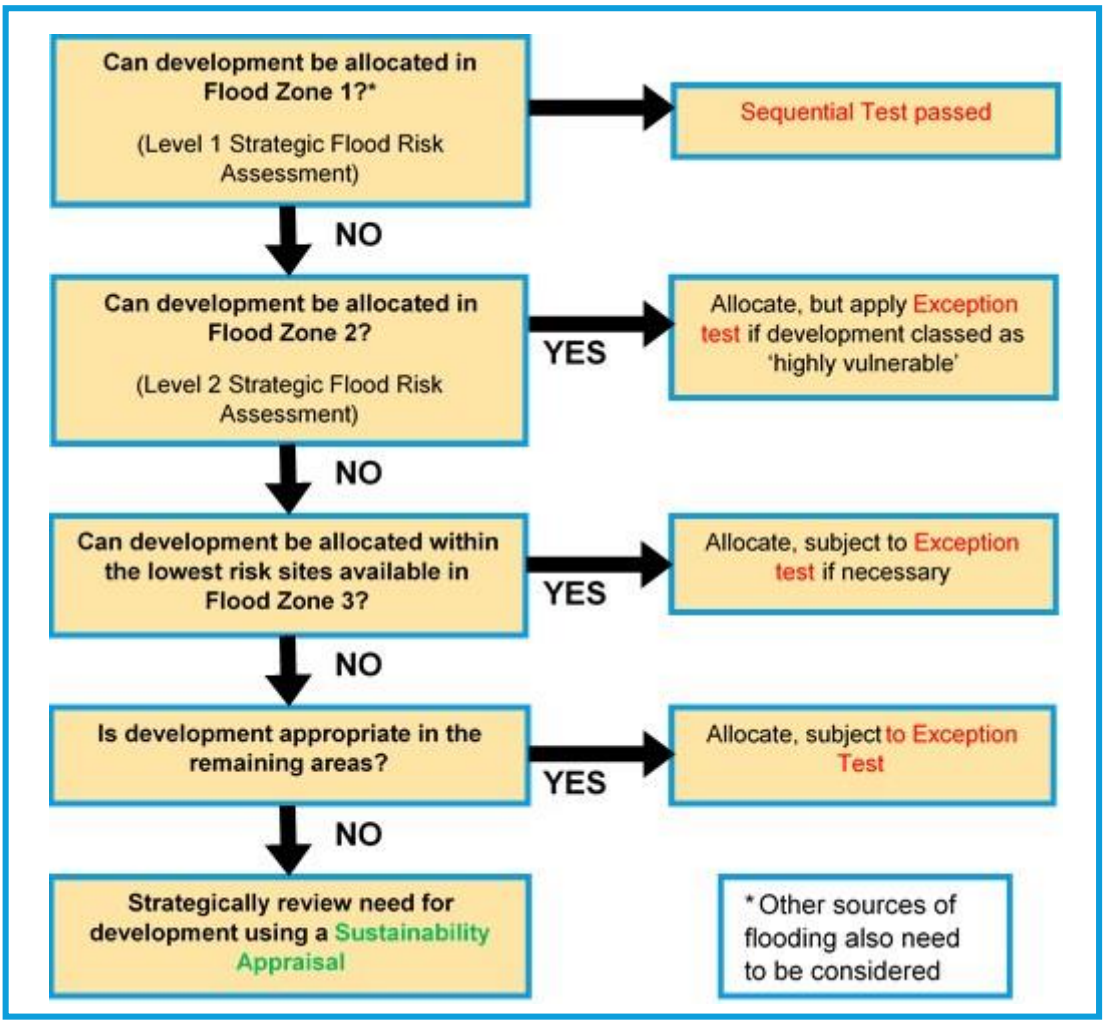
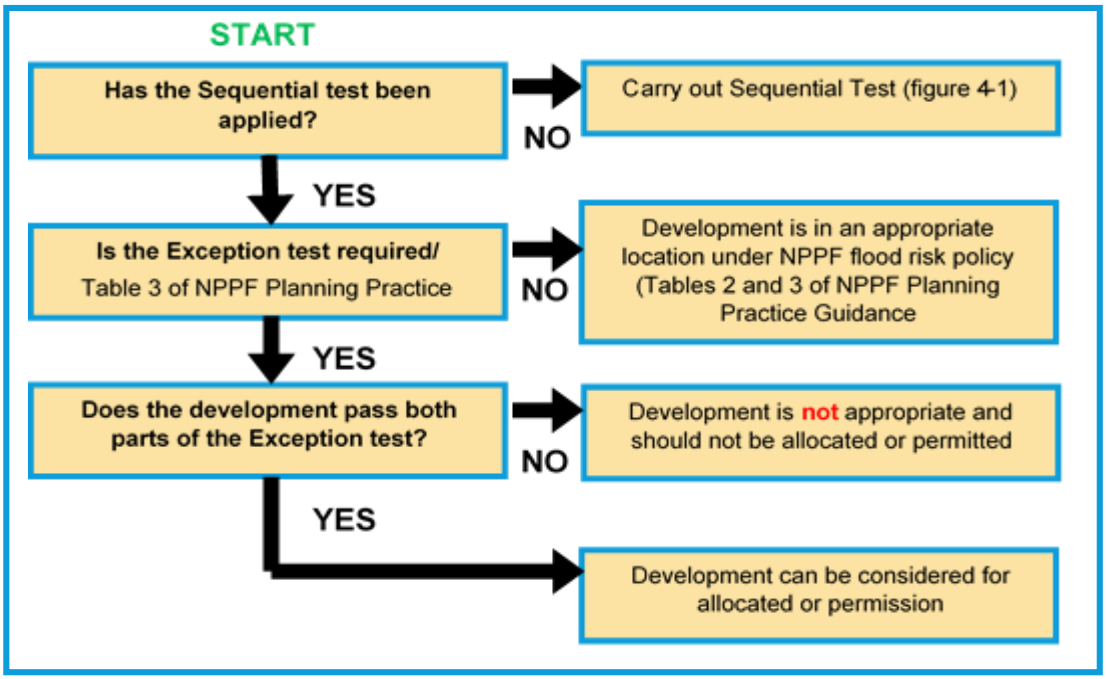



Figure 4-2: Applying the Exception Test in the preparation of a Local Plan



## 4.3 Applying the Sequential Test and Exception Test to individual planning applications

The NPPF Planning Practice Guidance[11] sets out how developers and planners need to consider flood risk to, and from, the development site, following the broad approach of assessing, avoiding, managing and mitigating flood risk. A checklist for site-specific Flood Risk Assessments is provided in Paragraph 68 of the Guidance.

A site-specific Flood Risk Assessment should be carried out to assess flood risk to, and from, a development. The assessment should demonstrate how flood risk will be managed over a development's lifetime, taking climate change and the user vulnerability into account.

The NPPF Planning Practice Guidance sets out the following objectives for a site-specific Flood Risk Assessment (FRA) and states it should 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 required) the Sequential Test; and
- whether the development will be safe and pass the Exception Test (where applicable).

### 4.3.1 Sequential Test

The Sequential Test must be performed when considering the placement of future development and for planning application proposals. The sequential approach to locating development should be followed for all sources of flooding. The Flooding and Coastal Change Planning Practice Guidance to the NPPF gives detailed instructions on how to perform the test.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the Sequential Test.
- Applications for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site).

It is normally reasonable to presume and state that individual sites that lie in Zone 1 satisfy the requirements of the Sequential Test; however, consideration should be given to risks from all sources, areas with critical drainage problems and critical drainage areas (as defined in SWMPs).

For developments that do not fall under the above categories, local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other Local Plan policies[11]. A pragmatic approach should be taken when applying the Sequential Test.

**Broxbourne Borough Council have defined their entire administrative area as the geographical area for which the Sequential Test is to be applied.**

Broxbourne Borough Council, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied, and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

The information provided in this SFRA can be used to:

- Identify the area to be assessed (including alternatives) on the Flood Zone Maps that are provided with this assessment.
- Establish the risk of flooding from other sources.
- Follow the instructions given in the Planning Practice Guidance.

11 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 033, Reference ID: 7-056-20140306) March 2014

### 4.3.2 Exception Text

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding the Exception Test must then be applied if deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable property types, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the Test to be satisfied, both of the following elements have to be accepted for development to be allocated or permitted:

1. **It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.**

   Local Planning Authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied, and give advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused[12].

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

   The site-specific Flood Risk Assessment should demonstrate that the site will be safe and the people will not be exposed to hazardous flooding from any source. The following should be considered[13]:

   - The design of any flood defence infrastructure.
   - Access and egress.
   - Operation and maintenance.
   - Design of the development to manage and reduce flood risk wherever possible
   - Resident awareness.
   - Flood warning and evacuation procedures.
   - Any funding arrangements required for implementing measures.

The NPPF provides detailed information on how the Test can be applied.

12 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014
13 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306) March 2014

# 5 Understanding flood risk in the borough of Broxbourne

## 5.1 Summary of SFRA mapping for all sources of flood risk and methodology

Table 5-1 provides an overview of the supplied data, used to inform the assessment of flood risk for the borough of Broxbourne.

Table 5-1: Overview of supplied data for Broxbourne SFRA

| Source of flood risk | Data used to inform the assessment | Data Supplied By |
|---|---|---|
| Historic (all sources) | Historic Flood Map and Recorded Flood Outlines<br>River Lee 2D Modelling Study (CH2MHill, 2014) - final report | Environment Agency |
| | 2007 SFRA | Broxbourne Borough Council |
| | 2011 PFRA<br>Section 19. Flood Investigation Reports | Hertfordshire County Council |
| | Historic flood incidents / records | Broxbourne Borough Council - Highways, Canal and River Trust |
| | DG5 Register | Thames Water |
| Fluvial (including climate change) | River Lee 2D Modelling Study (CH2MHill, 2014)<br>Flood Zone mapping | Environment Agency |
| Surface water | updated Flood Map for Surface Water | Environment Agency |
| | Reported flood incident data | Hertfordshire County Council - Highways |
| Groundwater | Areas Susceptible to Groundwater flooding<br>Bedrock geology / superficial deposits maps | Environment Agency |
| Sewer | DG5 Register | Thames Water |
| Reservoir | National Inundation Reservoir Mapping | Environment Agency |
| Canal | GIS Data showing the River Lee Navigation Channel, locks and incidents of over-topping. | Canal and River Trust |

### 5.1.1 Hydraulic modelling used in the SFRA

***Environment Agency detailed modelling***

Fluvial flood risk within Broxbourne borough has been assessed using results from hydraulic models supplied by the Environment Agency and existing Environment Agency Flood Zone mapping.

The data used to prepare the fluvial mapping for this study is based on the results from River Lee 2D Modelling Study (CH2MHill, 2014), provided by the Environment Agency. The River Lee modelling study developed 14 new 1D-2D linked models, comprising four models covering the River Lee from Water Hall to the River Thames and 10 models of selected tributaries. The following three models, developed in the River Lee 2D Modelling Study, are located within the borough of Broxbourne and were used in this SFRA:

- M02: River Lee to M25, including Small River Lee and lower part of the River Stort
- M05_M06: Woollens Brook/Lynch and Spital Brook (M05) and Nazeing Brook (M06)
- M07_M08: Rags Brook and Turnford Brook (M07) and College Brook and Theobalds Brook (M08)

Figure 5-1 shows the 2D domain for these detailed hydraulic models. As shown, the M02 model 2D domain over-laps that of the M05_M06 and M07_M08 domains. In the River Lee 2D Modelling Study the models representing the tributaries were run first i.e. M05_M06 and M07_M08. The M02 model, representing the River Lee, was then run with associated lumped catchment hydrological inflows, informed by the models of the tributaries.

The benefit of using these 1D-2D detailed hydraulic models to represent Flood Zone 3a, Flood Zone 3b and Flood Zone 2 for a number of main watercourses is that flood risk can be more accurately mapped. These models are available from the Environment Agency if developers are required to simulate different scenarios as part of a detailed Flood Risk Assessment (FRA).

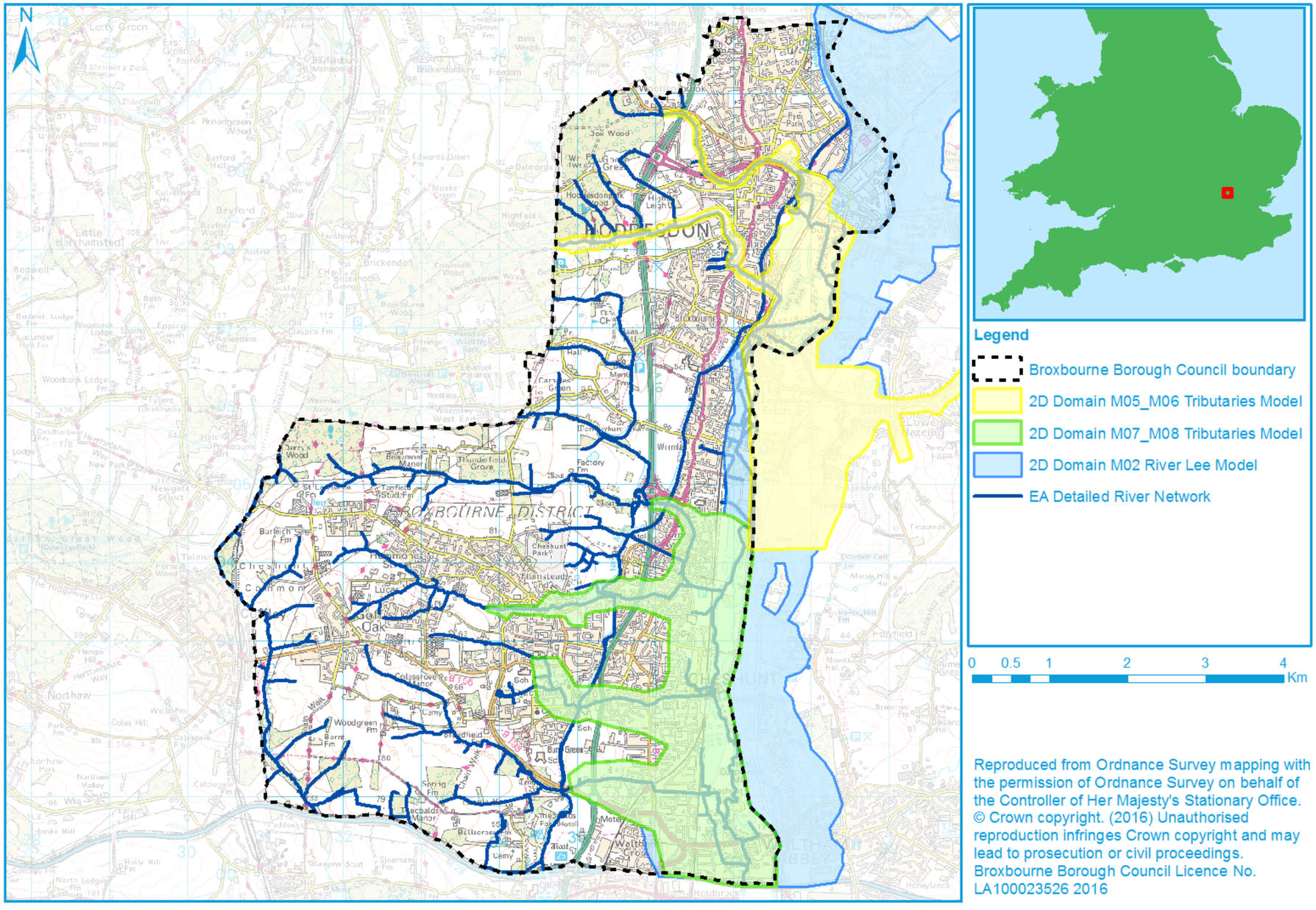
## 5.2 Data Gaps

A review of the supplied data has indicated critical flood modelling and data gaps which may impact on potential allocations in the emerging Local Plan, as discussed below.

1. Canal breach modelling:
    - The New River: The New River is not a river but a water supply aqueduct, bringing drinking water from Hertfordshire to North London[14]. This New River is operated by Thames Water and regulated by sluice gates and boreholes which enable surplus treated water to be stored in chalk aquifers and pumped into the New River when extra water is required. As the New River is regulated, the risk is considered to be low. However, in a number of places the New River is perched and / or raised above properties and infrastructure and therefore, there is a residual risk of a breach and failure. For potential allocations in the emerging Local Plan and / or development applications located around the vicinity of the New River, it is recommended that detailed breach modelling is considered as part of a site-specific FRA to establish the residual risk to the development.
    - The River Lee Navigation Channel (Lower): The Canal and River Trust is the navigation authority for the River Lee Navigation Channel (Lower) and supplied overtopping data for use in this SFRA. Although there are a number of locks and other control assets along this channel, there is a residual risk of a breach and failure. For potential allocations in the emerging Local Plan and / or development applications located around the vicinity of the River Lee Navigation Channel (Lower), it is recommended that detailed breach modelling is considered as part of a site-specific FRA to establish the residual risk to the development.
    - It is recommended that flood risk management authorities / stakeholders in the borough of Broxbourne investigate the feasibility of conducting a borough-wide breach modelling analysis of the New River and the River Lee Navigation Channel (Lower), as well as identification and modelling of any other watercourses that are perched above housing for parts of their course e.g. Woodlands Drive along Spital Brook.
    - Section 7 discuss flood risk from artificial water bodies further.
2. Detailed hydraulic model of the Wormleybury Brook, the Turnford Brook, the College Brook and Theobalds Brook:
    - The River Lee 2D Modelling Study covers a significant proportion of the watercourses in the study area and covers reaches of the Turnford Brook, the College Brook and Theobalds Brook. The M07_M08 detailed hydraulic model could be extended and re-run to cover the entire length of the Turnford Brook, the College Brook and Theobalds Brook and include the Wormleybury Brook and to establish the risk to any existing and potential development near these watercourses.

14 Thames Water, The New River Path: https://www.thameswater.co.uk/tw/common/downloads/aboutus/new-river-path-booklet.pdf

Figure 5-1: Source of data for fluvial flood risk analysis



### 5.2.1 Suite of Maps

All of the mapping can be found in the appendices to this SFRA and is presented in the following structure:

- Appendix A: Watercourses in Broxbourne borough
- Appendix B: Environment Agency Flood Zone Mapping, including functional floodplain
- Appendix C: Climate Change Mapping
- Appendix D: Surface Water Mapping
- Appendix E: Groundwater flood risk mapping
- Appendix F: Flood warning coverage
- Appendix G: Artificial sources

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. This information includes:

- River Thames Catchment Flood Management Plan (2009) – Environment Agency[15].
- Hertfordshire Local Flood Risk Management Strategy – Hertfordshire County Council[16]
- Hertfordshire Preliminary Flood Risk Assessment (2011) – Hertfordshire County Council[17]
- Flood Risk Management Plan in accordance with the Flood Risk Regulations (available in 2015) – Environment Agency and Lead Local Flood Authority
- Environment Agency's Asset Information Management System (AIMS) – users should note that recently completed schemes may not yet be included in this dataset.

## 5.3 Historical flooding

Historical records of flooding in the study area have been informed from Environment Agency Historic Flood Map and Recorded Flood Outline datasets, previous studies including the 2011 PFRA, the River Lee 2D Modelling Study (CH2MHill, 2014) and information supplied through consultation with stakeholders. It is noted that at the time of preparing this SFRA, none of the Hertfordshire Council Council's Section 19 Flood Investigation Reports covered communities within the study area.

### 5.3.1 Fluvial flooding

Table 5-2 displays the recorded / observed historic fluvial flood events known to have affected the borough of Broxbourne. The most notable incident of widespread flooding is the 1947 event which caused significant flooding throughout Hertfordshire and the Lower Lee catchment; Broxbourne is noted to have been one of the worst affected areas[18]. The 1947 event led to the construction of the River Lee Flood Relief Channel (RLFRC) which has subsequently contained flooding along the Lower Lee catchment. Section 6 discusses the RLFRC further, as well as other defences in the study area.

15 River Thames CFMP (2009): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293903/Thames_Catchment_Flood_Management_Plan.pdf

16 Hertfordshire County Council LFRMS - http://www.hertsdirect.org/docs/pdf/f/hertslfrmsall.pdf

17 Hertfordshire PFRA (2011): http://www.hertsdirect.org/docs/pdf/f/hccpfra.pdf

18 EA Thames 1947 River Lee Floods 50 Years On: http://www.environmentdata.org/archive/ealit:199/OBJ/19000552.pdf

Table 5-2: Historic fluvial flood events in the borough of Broxbourne

| Watercourse | Event Date |
|---|---|
| River Lee | 1947, 1968, 1987, 1993, 2000 |
| Small Lee | 1968, 1878, 2000 |
| Cuffley Brook | 1947 |
| Rags Brook | 1974, 1978, 1979, 1982, 1988, 1990, 1993 |
| Spital Brook | 1978, 1979, 1983, 1987, 1990 |
| Theobalds Brook | 1979, 1987 |
| Theobalds Lane / Trinity Marsh Ditch | 1947, 1968, 1974, 1979, 1982, 1983, 2000 |
| Trinity Marsh Ditch | 1974, 1878, 1982, 2000 |
| Turkey Brook | 1974, 1978, 1987, 1990, 1993, 2000, 2001 |
| Turnford Brook | 1947, 1974, 1979, 1993 |
| Woollens Brook | 1993 |

### 5.3.2 Historic flood mechanisms

There are a number of historical flood mechanisms in the borough of Broxbourne including:

- Heavy storm events which cause high runoff (exacerbated by the urban nature of the catchment) and result in flashier flooding from small streams that drain west of the catchment into the River Lee.
- Poor antecedent conditions combined with heavy, prolonged rainfall associated causing the main River Lee network to flood.
- Straightening of watercourses in the borough. A number have been divided, straightened and realigned as well as perched above housing.
- Culverting of watercourses causing localised flooding problems through the limited capacity of the culverts, surcharging and damage or blocked culverts.
- Historic urban extensions that rely on outlets into watercourses for surface water drainage and poor surface water management e.g. not considering the use of SUDS.
- Reliance on soakaways which are not suitable for catchments with high water tables, causing saturation / seepage from watercourses into roads and properties.
- Insufficient storm and combined drainage capacity.
- Insufficient road ditches / gully capacity and lack of maintenance.
- Collapse of water mains / insufficient capacity of water mains.
- Land drainage surface water runoff from fields.
- Groundwater flooding; in certain cases this is thought to have been caused by the underlying geology i.e. gravel overlaid on top of London Clay.

## 5.4 Topography, geology, soils and hydrology

The topography, geology and soil are all important in influencing the way the catchment responds to a rainfall event. The degree to which a material allows water to percolate through it, the permeability, affects the extent of overland flow and therefore the amount of run-off reaching the watercourse. Steep slopes or clay rich (low permeability) soils will promote rapid surface runoff, whereas more permeable rock such as limestone and sandstone may result in a more subdued response.

### 5.4.1 Characteristics of the borough

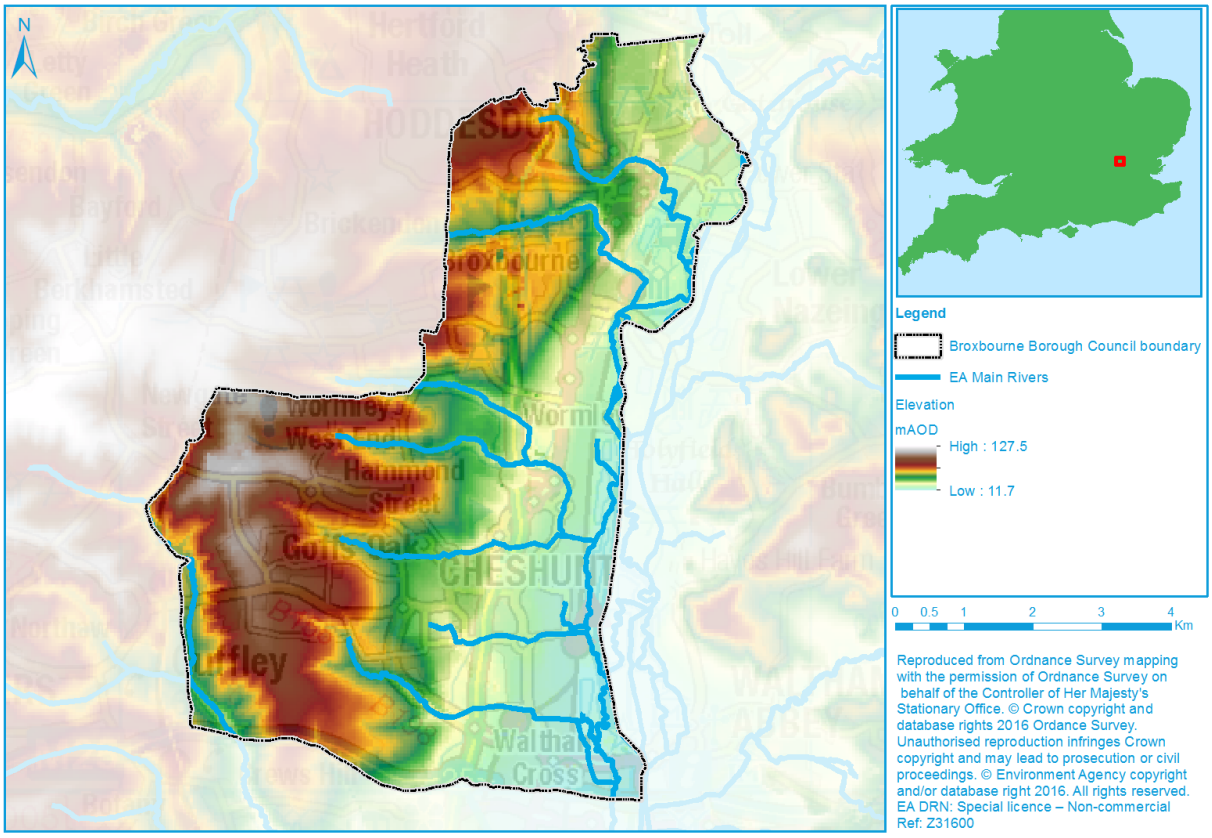
Broxbourne covers an area of approximately 51.4km$^2$ and has a population of approximately 93,600[19]. The largest urban areas in the borough are Cheshunt, Waltham Cross and Hoddesdon, alongside a number of large and small villages and isolated farm buildings throughout the borough. The borough is characterised by a typical north-south ribbon-development, running parallel and adjacent to the River Lee network. Comparatively, the western part of the borough is predominantly rural.

The 2008 Landscape Character Assessment for Broxbourne[20] identified five generic Landscape Character Types within the borough. Type D: River Valley Floodplain, Flooded Gravel Pits and Marshes comprises D1: Mid Lea Valley and D2: Turnford and Thistly Marshes. Type D is generally found along the eastern boundary of the borough and encompasses the low-lying, flat River Lee corridor, canalised course of the River Lee navigation channel and large waterbodies, the result of former mineral extraction.

The topography of the study area can be seen in Figure 5-2. The figure shows that Broxbourne is distinctly split into two characteristics; flat land along the River Lee corridor and principal urban areas in the borough and moderate slopes in the west of the borough, over higher ground and where a number of the tributaries of the River Lee rise. Higher elevations reach approximately 110m AOD in the west, decreasing in an easterly direction towards the lowest elevations in the vicinity of the River Lee corridor, around Cheshunt, Waltham Cross and Hoddesdon. Elevations in this region are approximately 25m AOD. The main watercourse, the River Lee, meanders eastwards around Hertford (outside of the borough) before turning southwards and flowing along the eastern boundary of the borough. The smaller watercourses including Lynch Brook, Spital Brook, Turnford Brook, Rags Brook, College Brook and Trinity Marsh Ditch, originate from these areas of higher ground.

19 Broxbourne Borough Council Annual Report and Summary of Accounts 2012/13:
https://www.broxbourne.gov.uk/sites/default/files/documents/Broxbourne_Services/CP-2014-01-01-AnnualReport2012-13.pdf
20 2008 Broxbourne Landscape Character Assessment (Chris Blandford Associates):
https://www.broxbourne.gov.uk/sites/default/files/Documents/Planning_Policy/pp_ChrisBlandford_Landscape_Character_Assessment_0.pdf

Figure 5-2: The topography of Broxbourne and the surrounding area




### 5.4.2 Geology and soils

The geology of the catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

The study area consists of the sedimentary rocks deposited over distinct geological periods; the Palaeogene, Eocene and Cretaceous. The oldest rock sequence, formed in the Cretaceous period, consists of chalk. The majority of the study area is represented by the younger rock sequences, formed in the Palaeogene and Eocene periods, comprising clay, gravel, sand and silt. Sandstone formations are typically associated with well-draining soils. Figure 5-3 shows the arrangement of the various bedrock formations throughout the study area.

Figure 5-3: Bedrock deposits in Broxbourne and the surrounding area

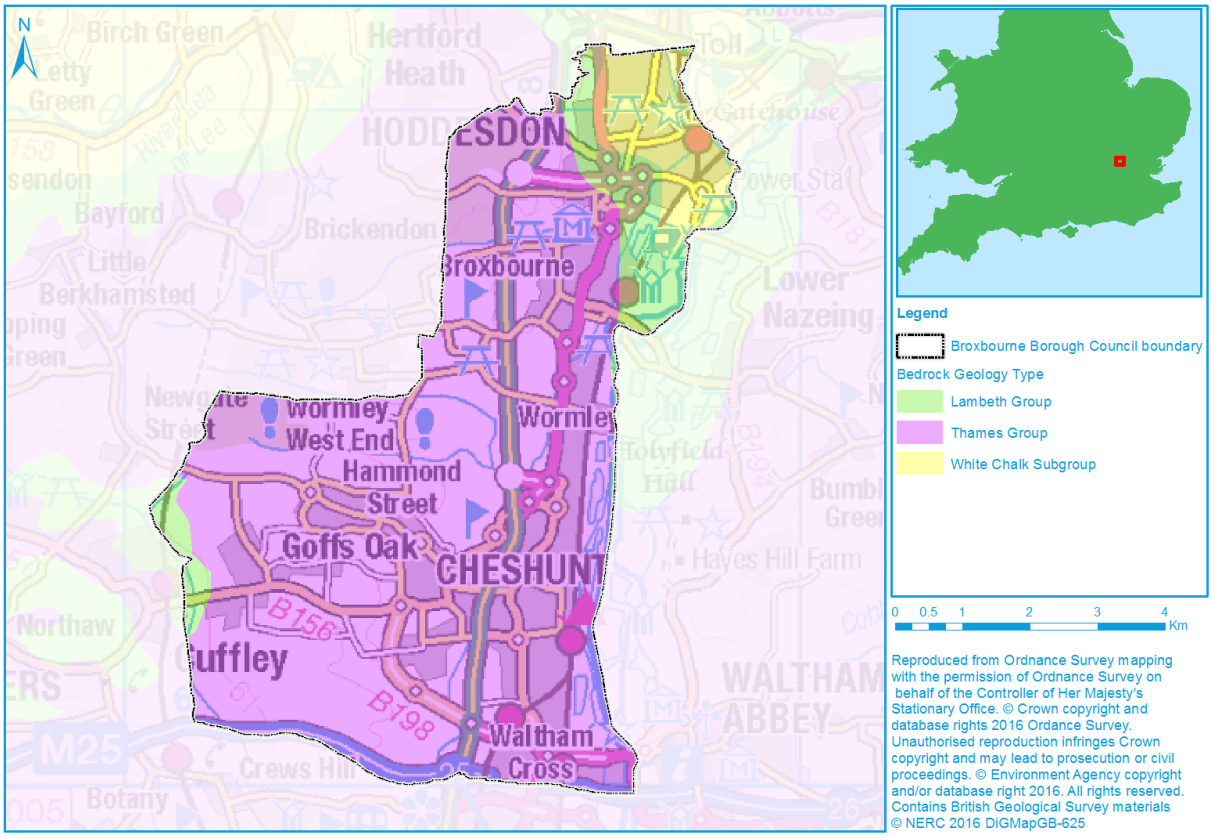


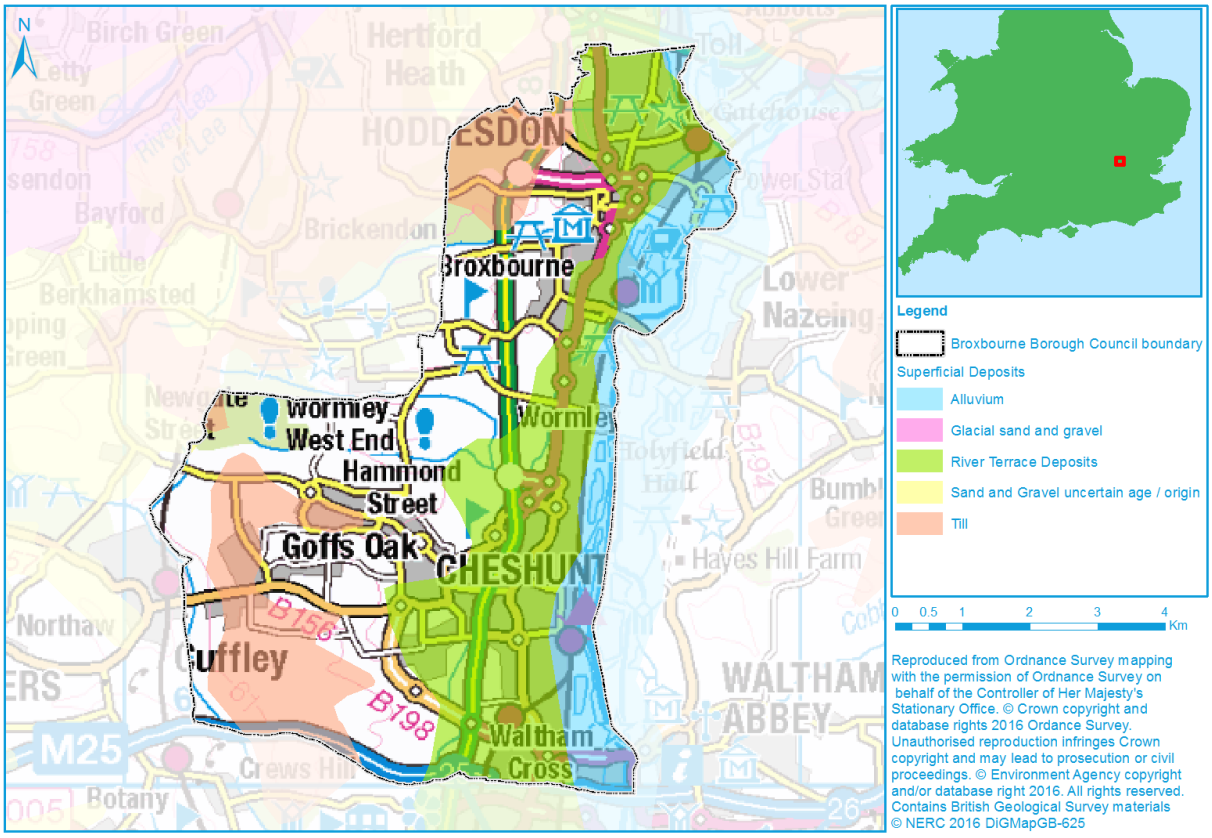

Table 5-3: Bedrock deposits found in the borough of Broxbourne

| LEX_D | EPOCH | LEX_RCS_D |
|---|---|---|
| Lambeth Group | Palaeocene | Clay, silt, sand and gravel |
| Thames Group | Eocene | Clay, silt, sand and gravel |
| White Chalk Subgroup | Late Cretaceous | Chalk |

*Source: Contains British Geological Survey materials. NERC 2016. DiGMap-GB625*

Superficial (at the surface) deposits in the borough consist of mainly River Terrace Deposits, Alluvium and Till. Alluvium (Clay, Silt and Sand) underlies the more mature river beds including the River Lee. The tributaries of the River Lee in the east are generally underlain by River Terrace Deposits (Sand and Gravel) which flank the alluvium deposits of the main River Lee. Till deposits which formed beneath glaciers and ice-sheets, occurs mainly in the west of the borough, on higher ground. These have been deposited by ice sheets and meltwater over the past 500,000 years. Figure 5-4 shows the arrangement of the various superficial deposit formations throughout the study area.

Figure 5-4: Superficial deposits in Broxbourne and the surrounding area




The geology of the study area indicates that the borough may be vulnerable to groundwater flooding. The British Geological Survey states that two of the most vulnerable settings for groundwater flooding are areas of outcrop of Chalk and river valleys underlain by permeable superficial deposits[21]. Chalk and the majority of superficial deposits in the study area are permeable. Permeability is a measure of if water can flow through a rock and how this is achieved. A high permeability means that water infiltrates the rock, at a high rate of infiltration. As a result, this causes more water to soak into the ground contributing to the baseflow rather than contributing to surface water runoff. Further, local knowledge of Broxbourne Borough Council staff indicates that the study area is known to have a high water table.

### 5.4.3 Hydrology

The principal watercourse flowing through the SFRA area is the River Lee; the entire study area falls within the Lower Lee catchment. The River Lee network is complex in the borough, formed of the River Lee, the River Lee Navigation Channel (Lower) and the Small Lee. Tributaries to this network of channels include smaller Main Rivers and a couple of Ordinary Watercourses (which are named) and numerous unnamed drains. A summary of the principal watercourses in the SFRA area is provided in Table 5-4. Appendix A shows the location of the main watercourses within the study area.

21 British Geological Survey Groundwater Flooding: http://www.bgs.ac.uk/research/groundwater/flooding/home.html

Table 5-4: Watercourses in the study area

| Watercourse name | Classification | Description |
|---|---|---|
| River Lee | Main River | A tributary of the River Thames, which enters the borough from the north and flows in a southerly direction. For 25km of its length, the River Lee is divided into the main channel and the River Lee Flood Relief Channel (RLFRC). |
| River Lee Navigation Channels | Main River | There are a number of navigation channels on the River Lee. The primary navigation channel, the Lee Navigation (Lower), starts around TL 38582 08221, in Hoddesdon and continues in a southerly direction. The Lee Navigation (Lower) Channel forms the majority of the eastern boundary of the borough. The Canal and River Trust is the navigation authority for the River Lee Navigation Channel. |
| Small River Lee | Main River | The Small River Lee is a branch of the main River Lee, which starts around TL 37310 04495, at the northern extent of the River Lea Country Park. The Small River Lee then flows in a southerly direction, through the Park and the Holdbrook estate in Waltham Cross. |
| Woollens Brook | Main River | Woollens Brook is a tributary of the River Lynch and enters the borough, west of Wollensbrook, flowing in a south-easterly direction. |
| River Lynch | Main River | The River Lynch rises in a pool, located at an area called "The Lynch", in east Hoddesdon. This then flows in a south-easterly direction, before joining the Lee Navigation Channel. |
| Spital Brook | Main River | The Spital Brook enters the borough and flows in an easterly direction, along the southern edge of Hoddesdon Park. Around Barclay Park, the Brook turns and starts flowing in a south-easterly direction, through Hoddesdon, joining the Lee Navigation (Lower) Channel in Broxbourne. |
| Broxbourne Ditch | Main River / Ordinary Watercourse | A tributary of the Small River Lee, the Broxbourne Ditch rises near Mill Lane in Broxbourne, flowing in a predominantly southerly direction, before joining the Small Lee around the aqueduct lock at TL 37241 04458.<br>A second branch / watercourse called the Broxbourne Ditch is shown to rise around the Fairfield Drive / Elgin Road area of Broxbourne, flowing in a predominantly south-easterly, before joining the River Lee Navigation Channel, immediately upstream of the aqueduct lock. The most upstream reach of this ditch is an Ordinary Watercourse, changing to Main River around Slipe Lane, at TL 36906 05107. |
| Wormleybury Brook | Main River | The Wormleybury Brook enters the borough around Holy Cross Hill Road and flows in a predominantly south-easterly direction, south of Wormleybury and joins the Turnford Brook at upstream of the A10 highway, at Turnford. |
| Turnford Brook | Main River / Ordinary Watercourse | The Turnford Brook, raises around the Hazel Grove / Derry's Wood area and flows in an easterly direction towards Turnford. At Turnford, the Brook follows the B176 High Road Turnford / Cheshunt Wash Road, before turning east around Saint Clement's Church and joining the Small River Lee. The Brook changes from Ordinary Watercourse to Main River around Bread and Cheese Lane, at TL 33107 05148. |
| Rags Brook | Main River | The Rags Brook is a tributary of the Turnford Brook and rises as a series of un-named drains within the Hammond Street / Goff's Oak area. The Brook flows in a south-easterly direction, through Rosedale and Flamstead End. At Flamstead End the watercourse runs parallel, between the Cheshunt Reservoir (North) and the B158 Brookfield Lane. An un-named drain is shown to lead from the reservoir to the Brook. The Brook then continues to flow in an easterly direction, before joining the Turnford Brook, downstream of the Saint Clement's Church. |
| Windmill Lane Ditch | Main River | The Windmill Lane Ditch rises around TL 36434 02762, flowing in a south-easterly direction. Downstream of Delamare Road, the watercourse splits into an easterly and southerly branch. The easterly branch is culverted and joins the Small River Lee and the southerly branch is open and joins the College Brook. |

| Watercourse name | Classification | Description |
|---|---|---|
| College Brook | Main River | The College Brook starts at Dark Lane, flowing in a south-easterly direction through the Cheshunt Area. The watercourse is fed by a number of un-named drains, the largest of which joins the watercourse around TL 34690 02365. The Brook flows beneath and parallel to the B198 College Road and Windmill Lane, before joining the Small River Lee downstream of Cheshunt Train Station. The College Brook is culverted in a number of sections through Cheshunt. |
| Theobalds Brook / Trinity Marsh Ditch | Main River / Ordinary Watercourse | The Theobalds Brook rises around the Isabelle Close / Doverfield area of Goff's Oak, flowing in a south-easterly direction. At Silver Street, the Theobald's Brook changes from Ordinary Watercourse to Main River. The watercourse continues and starts to flow in an easterly direction, parallel to Thoebald's Lane and then Trinity Lane, in Waltham's Cross. Downstream of the railway bridge / Trinity Lane, the watercourses name changes from Theobald's Brook to Trinity Marsh Ditch and flows in a predominantly south-easterly direction and joins the Small River Lee at Holdbrook. The Trinity Marsh Ditch is culverted from approximately TL 36789 00431, upstream of the A121 road, to its confluence with the Small River Lee. |
| New River | Ordinary Watercourse | The New River enters the borough, around Chestnut Grove in Hoddesdon and flows in a southerly direction through the borough, before exiting at the M25 motorway, west of Junction 25. The New River is not a river but a water supply aqueduct which, in places, is perched and crosses a number of the tributaries of the River Lee network. |
| Cuffley Brook | Main River | The Cuffley Brook follows the far south-western boundary of the borough, flowing in a predominantly southerly direction, before exiting around the M25, east of Burnt Farm Ride road at TL 31659 00794. |
| Northaw Brook | Main River | The Northaw Brook is a tributary of the Cuffley Brook; their confluence is near the south-eastern boundary of the borough at TL 31007 01599. |
| NOTE: This table is based on information found within the Environment Agency's Detailed River Network (DRN) database therefore there may be a number of Ordinary Watercourses within the study area which are not included within this table. | | |

## 5.5 Fluvial flood risk

Flood Zones show the areas potentially at risk of flooding from rivers, ignoring the presence of defences (although areas benefiting from formal defences are identified). This information has been used, in conjunction with historical flooding records, to give an account of flood risk in the study area. Appendix B presents the Flood Zone maps for the borough.

The primary fluvial flood risk is along the River Lee corridor, including the Navigation Channels and Small River Lee along the eastern boundary of the study area. Generally, Flood Zone 3 is contained east of the railway line. The principal urban centres at risk are Hoddesdon, Cheshunt and Waltham Abbey.

The tributaries of the River Lee present fluvial flood risk to rural communities as well as to the main urban centres in the borough. In general, these tributaries and Ordinary Watercourses have narrow Flood Zones, constrained by the local moderate gradients.

The locations with associated flood risk from the River Lee and tributaries are detailed below:

- Areas west of the railway line to the eastern boundary of the study area: The Flood Zones indicate that this area is almost entirely within the floodplain of the River Lee network comprising the Lea Navigation Channel (Lower), Lee (Upper) and Small Lee, as well as the confluence of numerous tributaries with this network of channels. The vast majority of this area is within Flood Zone 2 and 3. In particular the communities at risk include the industrial and commercial estate east of Hoddesdon, a caravan park south of Dobb's Weir, the River Lea Country Park and the Sail Training and Canoeing Centre, as well as significant amount of properties located in the Holdbrook area. This area is also contained within the Environment Agency's historic flood map.
- Hoddesdon: The Lynch brook, a tributary of the River Lee Navigation Channel, flows through Hoddesdon. Through Hoddesdon, the Flood Zones show a relatively narrow floodplain until the Brook reaches Burford Street, in the Rye Park area. Downstream of Burford Street, the Flood Zones show a relative wide floodplain, particularly on the right bank of the Lynch Brook. The Lee (Upper) and Lee Navigation Channel (Lower) have an extensive floodplain, particularly through the commercial and industrial estates, located in the eastern part of Hoddesdon. These areas are also within the historic flood map. In places, the railway line is shown to contain the flood extent.
- Spitalbrook: The Spital Brook flows through. The Flood Zones show a relatively narrow floodplain. Properties are shown to be at risk and are within Flood Zone 2, either side of the three culverts, until the Brook meets the railway line. Properties towards the east of Spital Brook, near Admirals Walk Lake, are also contained within Flood Zone 2 of the Lynch Brook.
- Broxbourne: The Lee Navigation Channel (Lower) Flood Zones are fairly compact around Broxbourne with few properties at risk. Downstream of Winford Drive, the Flood Zones are contained east of the railway line, until Turnford, around the Hertford Regional College.
- Turnford: The Turnford Brook also has a narrow floodplain across much of its length, until reaching the B176 High Road Turnford where its floodplain merges with that of the Small Lee and Lee Navigation Channel. From this location, on the right bank of the Turnford Brook to the railway line, the floodplain is extensive with a significant number of properties at risk, located in Flood Zone 2 and within the Environment Agency's Historic Flood Map. Downstream of the railway line, where the Turnford Brook meets with the Small Lee, the floodplain is vast. The River Lea Country Park is almost entirely within Flood Zone 3.
- Flamstead End and the Rags Brook: The Rags Brook is a tributary of the Turnford Brook and flows through the Turnford area. The Flood Zones indicate that the floodplain is relatively narrow. Due to the Rags Brook and Turnford Brook improvements schemes, properties are only shown to be within Flood Zone 2 across the majority of its length, including properties on the right bank, from Rosedale Way to Brookfield Gardens and properties on the left bank from Southbrook Drive to Cheshunt Wash. Around the confluence of the Turnford Brook, the floodplain is extensive with numerous properties at risk.

- Cheshunt: In Cheshunt, a significant number of properties are shown to be located within Flood Zone 2, between Turnford Brook and Windmill Lane Ditch; the Flood Zone 2 extent reaches as far west as properties around Penton Drive. This area is also within the Environment Agency's Historic Flood Map. The College Brook, a tributary of the Small Lee, has a narrow floodplain across much of its length. The extent of Flood Zone 3, in general, tends to be greater around the vicinity of the culverts along the College Brook and Windmill Lane Ditch which suggests that these culverts may not have sufficient capacity or are vulnerable to surcharge during lower return period events.
- Trinity Marsh Ditch: The Trinity Marsh Ditch is a tributary of the Small River Lee and flows through Cheshunt, before entering the Holdbrook area. In Cheshunt, the Flood Zone 2 extent is wide and is contained by the railway lines. The Flood Zone 2 extent falls towards the southern boundary of the study area, around Waltham Cross. Downstream of the railway line, towards the Holdbrook area, the floodplains of Trinity Marsh Ditch, the Small River Lee and the Lee Navigation Channel (Lower) appear to merge. A significant amount of properties located in the Holdbrook area are within Flood Zones 2 and 3.
- Cuffley Brook: The Cuffley Brook flows in the vicinity of the western boundary of the study area, in a southerly direction. The Cuffley Brook has narrow floodplains and flows through a predominantly rural area, with few properties at risk.

## 5.6 Surface water flooding

Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours and usually occurs in lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding.

### 5.6.1 Highways Data

Hertfordshire County Council Highways, Operations and Strategy Unit supplied historic flood records since 2011; this data records the frequency, the nature, the date and the location of reported flood incidents to the Unit. A summary of the nature of the flooding and the year of the flooding can be found in Table 5-5. The data shows that 2014 and 2015 have the greatest incidents of reported property and road flooding across the borough. 2014 in particular was warmer and wetter than average for the south-east of England[22] which may account for the notable rise in reported property damage by flooding. 20 records of property damage due to flooding were recorded during 21/07/2014 to 25/07/2014 and 30 records of property damage due to flooding were recorded during 24/08/2015 to 27/08/2015.

Table 5-5: Hertfordshire County Council Highways - summary of reported flood incidents

| **Count of Flooding Faults** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Flooding Subject Codes | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | **Grand Total** |
| Footway flood | 4 | 28 | 20 | 71 | 25 | 16 | **164** |
| Carriageway flood | 30 | 56 | 84 | | | | **170** |
| Subway flood | 4 | 19 | 8 | 25 | 8 | 3 | **67** |
| Property damaged by flooding | 5 | 3 | 3 | 79 | 62 | 6 | **158** |
| Road flood | | | 8 | 306 | 210 | 56 | **580** |
| Blocked gully/drain | 76 | 151 | 157 | | | | **384** |
| Ditch problem | 6 | 16 | 6 | | | | **28** |
| **Grand Total** | **125** | **273** | **286** | **481** | **305** | **81** | **1551** |

In general, there is a greater number of recorded incidents of property damage due to flooding through the Hoddesdon area of the borough and adjacent to the Spitalbrook in Spital Brook; this

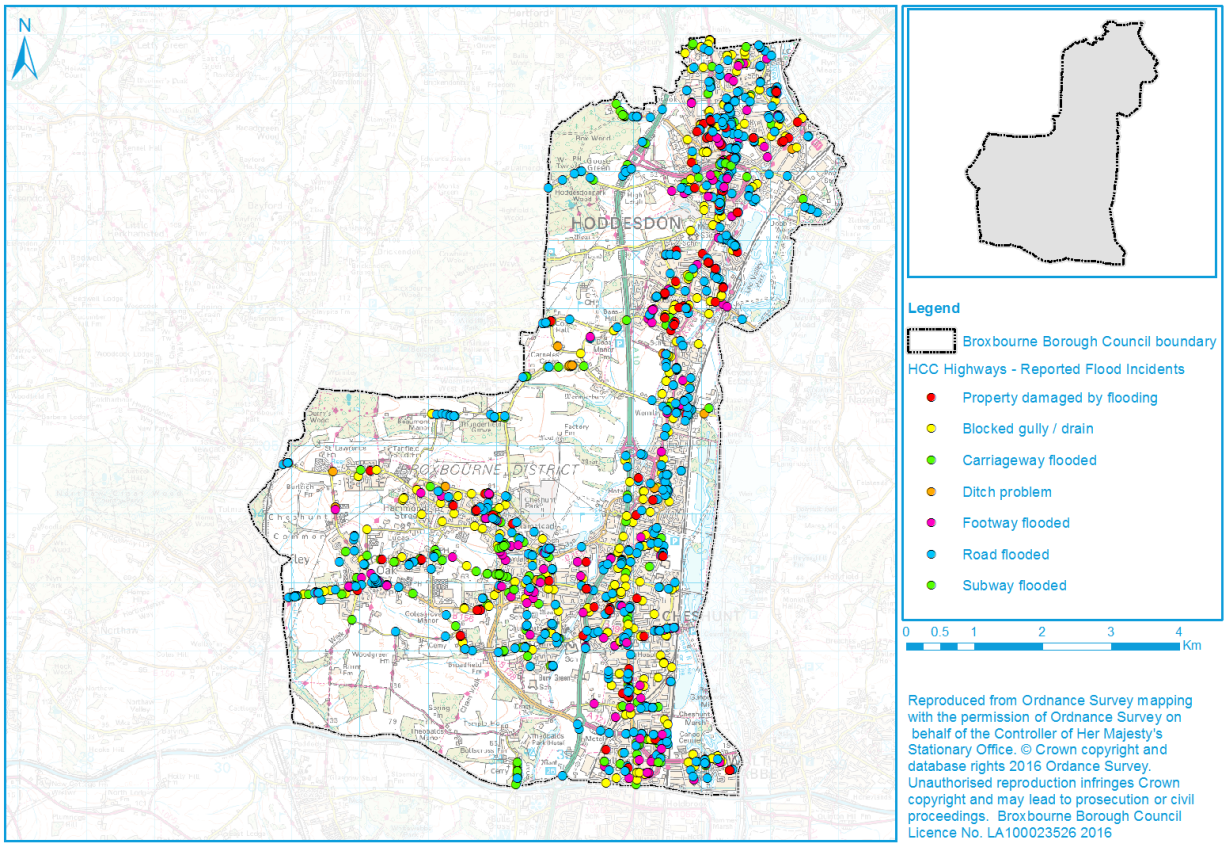
22 Met Office UK Climate Summarise: 2014 Annual

is consistent with the prominent overland flow routes identified in the uFMfSW. In addition, cases of four or more properties reported as damaged due to flooding since 2011, were noted at:

- Castle Road, Hoddesdon
- A1170 Road and service roads, Hoddesdon
- Thurgood Road to The Drive, Hoddesdon
- Essex Road to Stortford Road, Hoddesdon
- Westhill Road, Hoddesdon
- Upper Marsh Lane to Admiral's Walk, Spitalbrook
- St Catharine's Road to opposite Ivy Bridge, Spitalbrook
- Bell Lane / Baas Lane to Park Lane, Broxbourne
- Westlea Close, Wormley, Broxbourne

The locations of the reported flood incidents can be found in Figure 5-5.

Figure 5-5: Hertfordshire County Council Highways - location of reported flood incidents




### 5.6.2 Updated Flood Map for Surface Water

Mapping of surface water flood risk in Broxbourne has been taken from the updated Flood Map for Surface Water (uFMfSW) provided by the Environment Agency (and also found online on the Environment Agency's website). Surface water flood risk is subdivided into the four categories shown in

Table 5-6.

Table 5-6: uFMfSW risk categories

| Category | Definition |
|---|---|
| High | Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year (annual probability of flooding 3.3%) |
| Medium | Flooding occurring as a result of rainfall of between 1 in 100 (1%) and 1 in 30 (3.3%) chance in any given year. |
| Low | Flooding occurring as a result of rainfall of between 1 in 1,000 (0.1%) and 1 in 100 (1%) chance in any given year. |
| Very Low | Flooding occurring as a result of rainfall with less than 1 in 1,000 (0.1%) chance in any given year. |

The updated uFMfSW shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. The uFMfSW maps can be used to determine surface water hotspots. Detailed uFMfSW maps are shown in Appendix D.

Locations with associated surface flood risk, using the uFMfSW 30-year and 100-year extents, are detailed below:

- There is a prominent overland flow route through the Hoddesdon area of the borough. An overland flow route follows Springle Lane and another flows through Hailey Hall School to the A41170 Ware Road. This then propagates to the Bridle Way (South) and through residential areas towards Rye Park. This flow route then joins the Lynch / Woollens Brook, south of Rye Park.
- Urban areas adjacent to the Spital Brook in Hoddesdon and Broxbourne are vulnerable to surface water flooding, particularly through the community of Spitalbrook itself and around the vicinity of the railway line.
- There are numerous overland flow routes following major and minor roads through Broxbourne. In particular, the A1170 High Road Broxbourne and minor roads around Wormley Primary School (e.g. Cozens Lane East, Lammasmead and Wharf Road) are shown to convey overland flows.
- Urban areas adjacent to the Rags Brook, particularly at Flamstead End, are vulnerable to surface water flooding. In addition, there are two overland flow routes along Park Lane and Longfield Lane which converge at the junction of these roads; the Rags Brook also flows through Flamstead End at the junction of these roads.
- There is an overland flow route, starting west of Andrew's Lane Primary School area in Rosedale, Cheshunt, through the urban area to the south and continuing to the playing fields and to College Brook. This is also joined by an overland flow route to the east, which follows the B156 road from Tudor Villas and the nurseries located west of the B108 road.
- The surface water flood extent tends to be greater around the vicinity of the Churchfields Road Bridge and New River Viaduct culverts at Spitalbrook and the culvert which runs under the New River at the rear of Lordship Road in Cheshunt. This suggests that the culverts may surcharge during heavy rainfall events. Alternatively, for the case of the two culvers noted at Spitalbrook this may suggest that the uFMfSW is not accurately representative of the flood risk in these areas, as these culverts have a 1,000-year design Standard of Protection.

Locations with associated surface flood risk, using the uFMfSW 1,000-year extent, are detailed below:

- The overland flows routes noted during the 30-year and 100-year extents are more significant and cause more extensive flooding during the 1,000-year event.
- The majority of the urban areas around the River Lee Corridor are shown to be at risk during the 1,000-year event.
- In addition to those overland flow routes noted during the 30-year and 100-year extents, the following areas are shown to be particularly vulnerable during the 1,000-year event:

  - The area from the Turnford Haileybury School, through to the industrial area around Delmare Road in Cheshunt.
  - The urban area between Windmill Lane, the B176 Crossbrook Street and the railway line.
  - The Waltham Cross industrial estate.
- The surface water flood extent during the 1,000-year event around the Hammond Street, Flamstead End, Rosedale and Cheshunt areas is significant.
- Those areas at risk of surface water tend to correlate with the topography of the borough; the land classified as flat land is vulnerable to surface water flooding whereas the land with moderate slopes is not as vulnerable.

It is clear that the borough of Broxbourne is sensitive to surface water flooding and this should be taken into consideration as part of future development. Chapter 8 discusses surface water management and sustainable drainage systems (SuDS).

## 5.7 Groundwater flooding

In comparison to fluvial flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Under the Flood and Water Management Act (2010), LLFAs have powers to undertake risk management functions in relation to groundwater flood risk. Groundwater level monitoring records are available for areas on Major Aquifers. However, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a high water table in mudstones, clays and superficial alluvial deposits, very few records are available. Additionally, there is increased risk of groundwater flooding where long reaches of watercourse are culverted as a result of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

As part of the SFRA deliverables, mapping of the whole borough has been provided showing the Areas Susceptible to Groundwater Flooding (AStGWF). The AStGWF is a strategic-scale map showing groundwater flood areas on a 1km square grid. The data was produced to annotate indicative Flood Risk Areas for PFRA studies and allow the LLFAs to determine whether there may be a risk of flooding from groundwater. This data shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring. It does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

The AStGWF mapping for Broxbourne borough can be found in Appendix E. The AStGWF shows that the areas around the vicinity of the main River Lee and the confluence of the tributaries with the River Lee, have a >75% susceptibility to groundwater flooding. Generally, areas of high ground west of the borough have a <25% susceptibility to groundwater flooding.

There have been incidents of historic groundwater flooding in the borough of Broxbourne which is thought to primarily be caused by the underlying geology, i.e. gravel overlaid on top of London Clay. Local knowledge from Broxbourne Borough Council indicates that the study area is known to have a high water table and the bedrock geology of the study area, indicates that the borough may be vulnerable to groundwater flooding. Additionally, there is increased risk of groundwater flooding where long reaches of watercourse are culverted with elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

There may be an implication on the suitability of certain types of SuDS due to the groundwater vulnerability in Broxbourne; this is discussed in further detail in Section 8.7.

## 5.8 Sewer flooding

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration or entry of soil or groundwater into the sewer system via faults within the fabric of the sewerage system, is another cause of sewer flooding. Infiltration is often related to shallow groundwater, and may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that most new surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year, although until recently this did not apply to smaller private systems. This means that, even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in a given year). Existing sewers can also become overloaded as new development adds to the discharge to their catchment, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

Historical incidents of flooding are detailed by Thames Water through their DG5 register. This database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons this data has been supplied on a postcode basis. Data covers all reported incidences as of 16th March 2016. The DG5 register is shown in Table 5-7.

Table 5-7: DG5 Register recorded flood incidents

| Post Code | Recorded Flood Incidents |
|---|---|
| EN106 | 3 |
| EN107 | 6 |
| EN110 | 3 |
| EN118 | 1 |
| EN3 4 | 0 |
| EN7 5 | 3 |
| EN7 6 | 0 |
| EN8 7 | 3 |
| EN8 8 | 15 |
| EN8 9 | 1 |
| HA4 6 | 1 |
| Total | 36 |
| Note: Based on information exported on 16/03/16 | |

The DG5 register indicates a total of 36 recorded flood incidents in the Broxbourne Borough Council administrative area. The more frequently flooded postcodes are EN8 8, with 15 records, followed by EN107 with six records. The EN8 8 post code is within the Cheshunt area of the borough.

It is important to recognise the DG5 register does not contain information about properties and areas at risk of sewer flooding caused by operational issues such as blockages. Also the register represents a snap shot in time and will get outdated with properties being added to the register following rainfall events, whilst risk will be reduced in some locations by capital investment in increase the capacity of the network. As such the sewer flooding flood risk register is not a comprehensive ‘at risk register’.

## 5.9 The impact of climate change

### 5.9.1 General impacts

The December 2012 Sustainability Appraisal of the Broxbourne Local Plan (Scoping Report)[23] details the general risks relevant to the borough of Broxbourne as a results of climate change (using the UKCIP 2009 data). Those risks relating to flood risk and drainage are as follows:

- Effects on water resources from climate change;
- Reduction in availability of surface water in reservoirs and rivers for abstraction in summer;
- Adverse effect on water quality from watercourse levels and turbulent flow after heavy rain and a reduction of water flow;
- Increased risk of flooding, including increased vulnerability to 1 in 100-year floods;
- Changes in insurance provisions for flood damage;
- A need to increase the capacity of wastewater treatment plants and sewers;
- A need to upgrade flood defences;
- Soil erosion due to flash flooding;
- An increased move by the insurance industry towards a more risk-based approach to insurance underwriting, leading to higher cost premiums for local business;
- Increased drought and flood related problems such as soil shrinkages and subsidence;
- Flooding of roads and railways.

The 2010 Broxbourne Climate Change Strategy outlines the approach the Council is taking and regarding flood risk impacts; the Council is aiming to *"work with key partners, such as the Environment Agency and Thames Water, to secure effective local water resources management (including through Council activities) and avoid or reduce climate change induced flood risk."*[23]

### 5.9.2 Fluvial and pluvial flooding

It is important to remember that even where flood extent may not significantly increase, flooding is likely to become more frequent under a climate change scenario. For example, what is currently an event with a 2% probability of occurring in any one year, may increase to say a 5% probability under climate change.

The impact of an event with a given probability is also likely to become more severe. For example, as water depths, velocities and flood hazard increase, so will the risk to people and property. Although qualitative statements can be made as to whether extreme events are likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of the localised impact of these changes.

### 5.9.3 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months.

### 5.9.4 New Guidance (2016) and the implication for the SFRA

The Environment Agency published new climate change guidance on 19 February 2016[24], which must now be considered in all new developments and planning applications.

The peak river flow allowances show the anticipated changes to peak flow by river basin district, for three future epochs and percentiles, as shown in Table 5-8.

23 December 2012 Sustainability Appraisal of the Broxbourne Local Plan (Scoping Report): https://www.broxbourne.gov.uk/sites/default/files/Documents/Planning_Policy/pp_Scoping-Report_%20Final_Version_Lepus.pdf

24 https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Table 5-8: Peak river flow allowances by river basin district

| River basin district | Allowance category | Total potential change anticipated for '2020s' (2015 to 2039) | Total potential change anticipated for '2050s' (2040 to 2069) | Total potential change anticipated for '2080s' (2070 to 2115) |
|---|---|---|---|---|
| Thames | Upper end | 25% | 35% | 70% |
| | Higher central | 15% | 25% | 35% |
| | Central | 10% | 15% | 25% |

The Flood Zone and appropriate flood risk vulnerability classification should be considered to decide which allowances applies to the development or plan. This is detailed in Section 11.

Increased rainfall affects river levels and land and urban drainage systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments.

Table 5-9: Peak rainfall intensity allowance in small and urban catchments

| Applies across all of England | Total potential change anticipated for 2010 to 2039 | Total potential change anticipated for 2040 to 2059 | Total potential change anticipated for 2060 to 2115 |
|---|---|---|---|
| Upper end | 10% | 20% | 40% |
| Central | 5% | 10% | 20% |

Climate change mapping has been provided in Appendix C as part of the SFRA.

**Important note on Climate Change mapping in this SFRA (Appendix C)**

For this Level 1 SFRA update, the existing M02, M05_M06 and M07_M08 climate change scenarios were re-modelled to account for the new climate change guidance. Three scenarios were modelled to reflect the three climate change allowances for the '2080s' timeframe in the Thames River Basin District and i.e. 25%, 35% and 70% allowances. The climate change mapping reflects the results for these three allowances and does not account for the influence of defences i.e. the climate change mapping is for the undefended scenario.

The existing models were run for a number of scenarios, reflecting variables such as gate openings and critical storm durations, as agreed with the Environment Agency.

2D (JFlow) modelling was undertaken in order to simulate the new climate change allowances, along those watercourses covered by a Flood Zone map, but not covered by a detailed Environment Agency hydraulic model.

These watercourses where JFlow modelling was undertaken are:

- The Turnford Brook north and south branches until their confluence
- The Theobalds Brook
- The Cuffley Brook

This additional modelling is considered less detailed than 1D-2D hydraulic modelling, but does take into account the floodplain topography, using LIDAR data, and follows the same methodology used to derive the Environment Agency's Flood Zones. The modelling was based upon flow points along the Environment Agency's Detailed River Network (checked against 10K OS mapping). In the absence of detailed channel / culvert survey, model inflows took into account an allowance for channel / culvert capacity; for the purposes of the SFRA a channel capacity / culvert capacity of QMED (the 2-year flow) was assumed. This approach is consistent with that used for the creation of the Environment Agency's Flood Zone datasets. This modelling was undertaken to assist the Council with the preparation of their Local Plan. Developers will need to undertake a more detailed assessment of climate change as part of the planning application process when preparing FRAs.

It is recommended that the impact of climate change on a proposed site is considered as part of a detailed Flood Risk Assessment, using the percentage increases which relate to the proposed lifetime and the vulnerability classification of the development. The Environment Agency should be consulted to provide further advice for developers on how best to apply the new climate change guidance.

Section 11 provides further details on climate change for developers, as part of the FRA Guidance.

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# 6 Flood Defences

## 6.1 Defence standard of protection and residual risk

Consideration of the residual risk behind flood defences has been undertaken as part of this study. The residual risk of flooding in an extreme flood event or from failure of defences should be carefully considered.

The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is a factor that needs to be considered as part of the risk-based sequential approach and, in light of this, whether proposed land allocations are appropriate and sustainable.

In addition, site-specific FRAs will need to thoroughly explore the condition of defences, especially where these defences are informal. Informal flood defences are measures or infrastructure or obstructions that are not likely to have been designed, constructed or maintained to the same standards as formal flood defences / schemes and impede the flow of flood waters. Examples of informal defences can include motorway, canal and railway embankments, raised landfill sites, garden walls and buildings.

It is important that all of these assets are maintained to a good condition and their function remains unimpaired. Developers should also consider the Standard of Protection (SoP) provided by defences and residual risk as part of a site-specific FRA.

**Standard of Protection**

Flood defences are designed to give a specific standard of protection, reducing the risk of flooding to people and property in flood prone areas. For example, a flood defence with a 1% AEP standard of protection means that the flood risk in the defended area is reduced to a 1% chance of flooding in any given year.

Although flood defences are designed to a standard or protection it should be noted that, over time, the actual standard of protection provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to climate change.

## 6.2 Defence condition

Flood Alleviation Schemes identified within the SFRA area may involve formal defences, initiatives to improve drainage, and/or land management to reduce the risk of high velocity overland surface run-off. Formal structural defences are given a rating based on a grading system for their condition. A summary of the grading system used by the Environment Agency for condition is provided in Table 6-1.

Table 6-1: Defence asset condition rating

| Grade | Rating | Description |
|---|---|---|
| 1 | Very Good | Cosmetic defects that will have no effect on performance. |
| 2 | Good | Minor defects that will not reduce the overall performance of the asset. |
| 3 | Fair | Defects that could reduce the performance of the asset. |
| 4 | Poor | Defects that would significantly reduce the performance of the asset. Further investigation required. |
| 5 | Very Poor | Severe defects resulting in complete performance failure. |

Source: Condition Assessment Manual – Environment Agency 2006

## 6.3 Flood defences in Broxbourne borough

A high level review of formal flood defences has been carried out using AIMS data from the Environment Agency, provided in Table 6-2, followed by a more detailed view of:

- the Turnford and Rags Brook Improvements Scheme;

- the Trinity Marsh Ditch flood defence assets including the Trinity Lane Flood Alleviation Scheme;
- the Kings Weir embankments; and
- the River Lee Flood Relief Channel.

The defended outlines shown in Figure 6-1, Figure 6-3 and Figure 6-5 are taken from the River Lee 2D Modelling Study (CH2MHill, 2014).

Table 6-2: Formal Flood Defence Assets in the Broxbourne borough

| Watercourse | Location | NGR | Type | Asset Maintained By | Design SoP | Approximate Length (m) | Comments |
|---|---|---|---|---|---|---|---|
| River Lee (Upper) | Rye Park / Feildes Lock Defence | TL 38551, 09769 | High ground with steel and timber lined channel. | Private | 1 in 50-year for majority, reduces to 1 in 10-year in sections | 1600 | Right bank only |
| Lee Navigation Channel (Lower) | Nr Broxbourne railway station | TL 37307, 06895 | Concrete caping between road and railway bridge | Private | 1 in 50-year | 215 | Left bank only |
| Lee Navigation Channel (Lower) | From around Slipe Lane in Broxbourne to Waltham Town Lock | TL 37435, 00609 | Embankment | Local Authority | 1 in 2-year, 1 in 25-year and 1 in 200-year | 4700 | Kings Weir Embankment, right bank only |
| New River | Essex Road | TL 37828, 08993 | Concrete retaining wall | Private | 1 in 50-year | 31 | Right bank only |
| Woollens Brook | Geddings Road | TL 37891, 08888 | Concrete wall | Private | 1 in 50-year | 53 | Left bank only |
| Spital Brook | Nr Sheredes School / Civic Hall, downstream of Barclay Pond | TL 36957, 08121 | Raised earth defence | Private | 1 in 25-year | 560 | Left bank only |
| | Osbourne Road | TL 37137, 07700 | Concrete retaining wall | Private | 1 in 200-year | 250 | Left bank only |
| Turnford Brook | Turnford | TL 36427, 04482 | Concrete walls | Environment Agency | 1 in 25-year for majority, reduces to 1 in 10-year in sections | 1400 | Turnford Brook Improvements Scheme. |
| Rags Brook | Flamstead End to Turnford Brook confluence | TL 35200, 03521 | Cheshunt North Reservoir Embankment, walls | Environment Agency | Within 1 in 10-year to 1 in 200-year | 4300 | Rags Brook Improvements Scheme and Rag and Turnford Brook Improvement Scheme |
| | | TL 34689, 03390 | Bypass Culvert | Local Authority | 1 in 70-year | 93 | Left bank only - classified as high ground |

| Watercourse | Location | NGR | Type | Asset Maintained By | Design SoP | Approximate Length (m) | Comments |
|---|---|---|---|---|---|---|---|
| College Brook | Windmill Lane | TL 36549, 02290 | Flood Defence Wall | Private | 1 in 50-year | 31 | Left bank only, Red Cow Pub defence |
| Windmill Lane Ditch | In front of industrial estate along Delamare Road, Chestunt | TL 36404, 02500 | Embankment | Private | 1 in 70-year | 46 | Left bank only |
| | In front of industrial estate along Delamare Road, Chestunt | TL 36515, 02397 | High Ground | Environment Agency | 1 in 70-year | 205 | Windmill Lane Improvements |
| Trinity Marsh Ditch | Theobald's Lane, Chestunt | TL 34625, 01047 | Embankment | Environment Agency | 1 in 5-year | 178 | Right bank only |
| | Trinity Lane, by St. Joseph's School, Waltham Cross | TL 36353, 01043 | Flood Wall | Environment Agency | 1 in 25-year and 1 in 50-year | 168 | Trinity Lane Flood Alleviation Scheme |
| | Trinity Lane, from railway station, Marsh Close and over railway bridge, Waltham Cross | TL 36100, 01061 | High Ground | Local Authority and Private | 1 in 25-year | 1350 | Concrete and masonry lined defence. |
| Burnt Farm Lake | Burnt Farm Lake | TL 31045, 01919 | Embankment | Private | 1 in 1000-year | 127 | - |

### 6.3.1 Turnford Brook and Rags Brook

Along the Turnford Brook and Rags Brook, in the Cheshunt area of the borough, the Environment Agency AIMS data lists approximately 20 flood defence 'assets' which are shown in Figure 6-1. The overall condition of these flood defence 'assets' are shown in Figure 6-2. The main large defences are discussed below:

- The Cheshunt North Reservoir Embankment is a large earth embankment located at the eastern end of the reservoir, on the left hand bank of the Rags Brook. The embankment is approximately 357m in length and is protected by timber cladding / capping and sheet piles. The embankment is classified as a fluvial flood defence, with a 1 in 70-year standard of protection. This embankment is considered to be in a 'fair' overall condition.
- The Turnford and Rags Brook Improvements Scheme provides a design standard of 1 in 70-years and improved 2.45km of channel side along the two brooks, where they flow through urban areas. The defences are flood walls, located on the right and left hand banks of the brooks, which protect north Cheshunt and smaller urban areas in Broxbourne. The flood walls comprise either masonry brick, dye cast blocks and in situ concrete and are all maintained by the Environment Agency. The flood walls are considered to have a 'fair to good' overall condition.
- There are three culverts which convey flows beneath road infrastructure; two are located on the Rags Brook and one is located on the Turnford Brook. The culverts are considered to have a 'good' overall condition.

Figure 6-1: Turnford Brook and Rags Brook Flood Defences

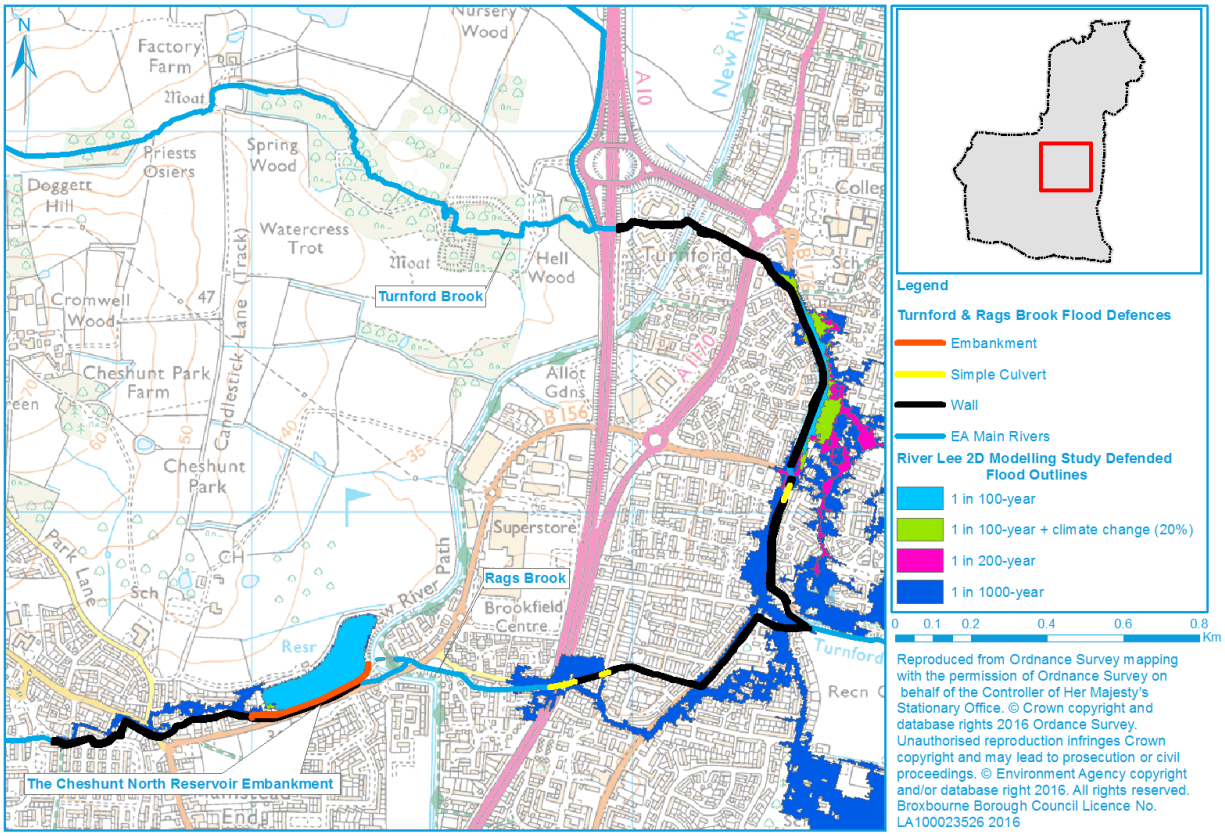
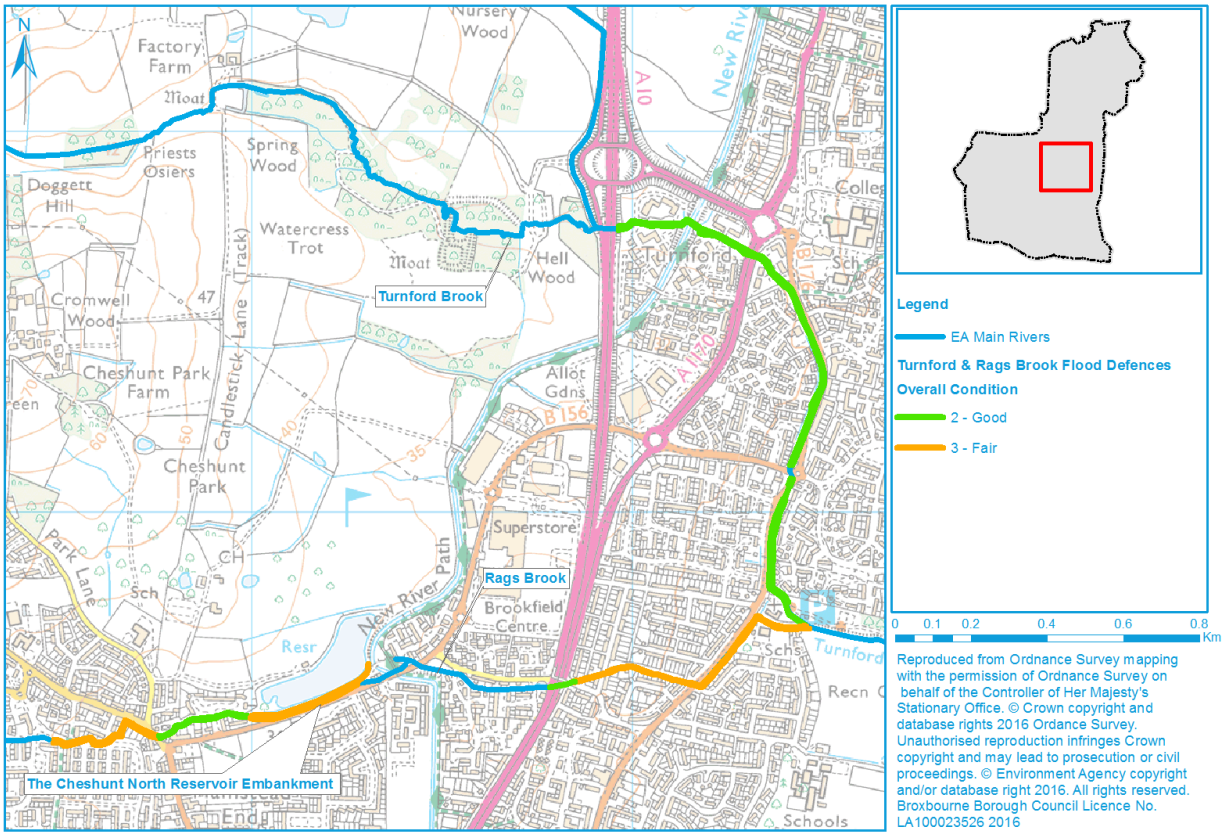


Figure 6-2: Turnford Brook and Rags Brook Flood Defences - Overall Condition




### 6.3.2 Trinity Marsh Ditch and Trinity Lane Flood Alleviation Scheme

Along the Trinity Marsh Ditch, in the Waltham Cross and Holdbrook area of the borough, the Environment Agency AIMS data lists approximately five flood defence 'assets' which are shown in Figure 6-3. The overall condition of these flood defence 'assets' are shown in Figure 6-4. The main large defences are discussed below:

- The Trinity Lane Flood Alleviation Scheme protects Trinity Lane and the surrounding area in Waltham Cross. The Scheme provides between a 1 in 25-year and 1 in 50-year standard of protection and consists of two flood walls, made with engineering bricks and standing 0.5m high, with a combined length of 266m. The flood walls are considered to have a 'good' overall condition.
- The Trinity Marsh Ditch is culverted through the Holdbrook area of the borough, to its confluence with the Small Lee. The culvert provides a 1 in 10-year standard of protection and is considered to have a 'fair' overall condition.

Figure 6-3: Trinity Marsh Ditch Flood Defences

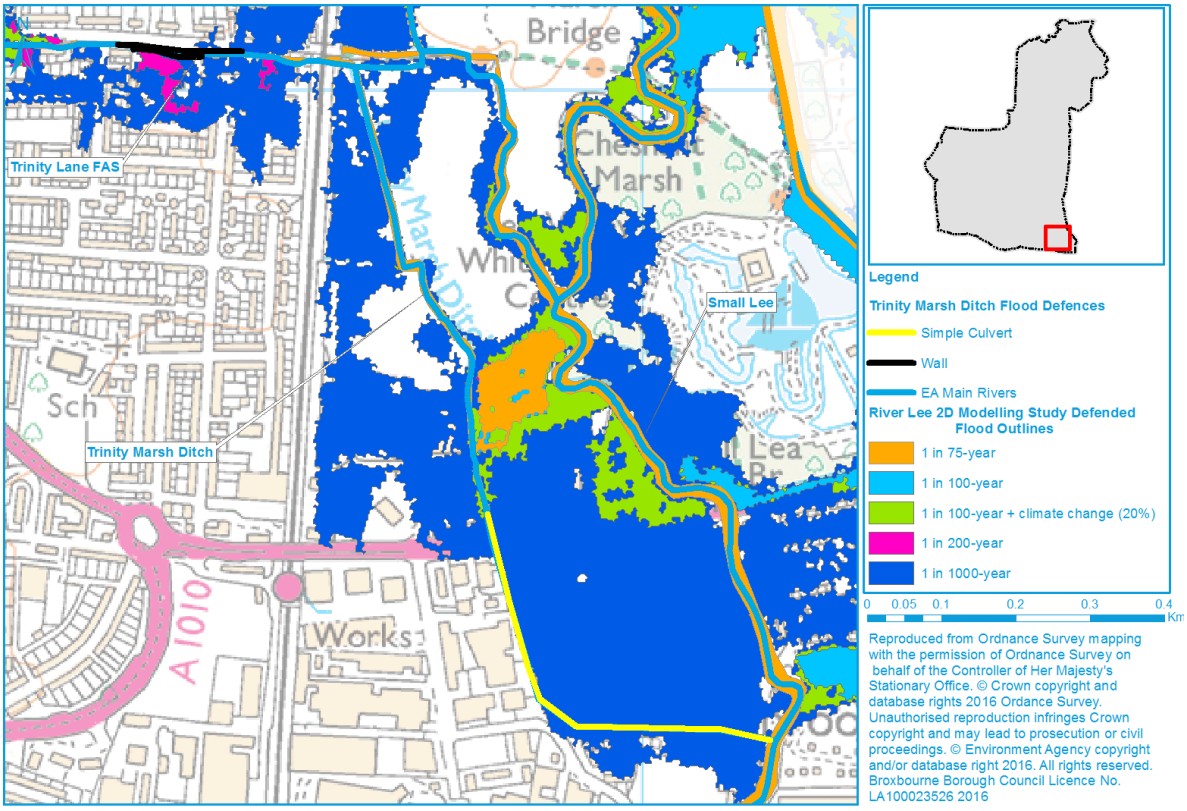
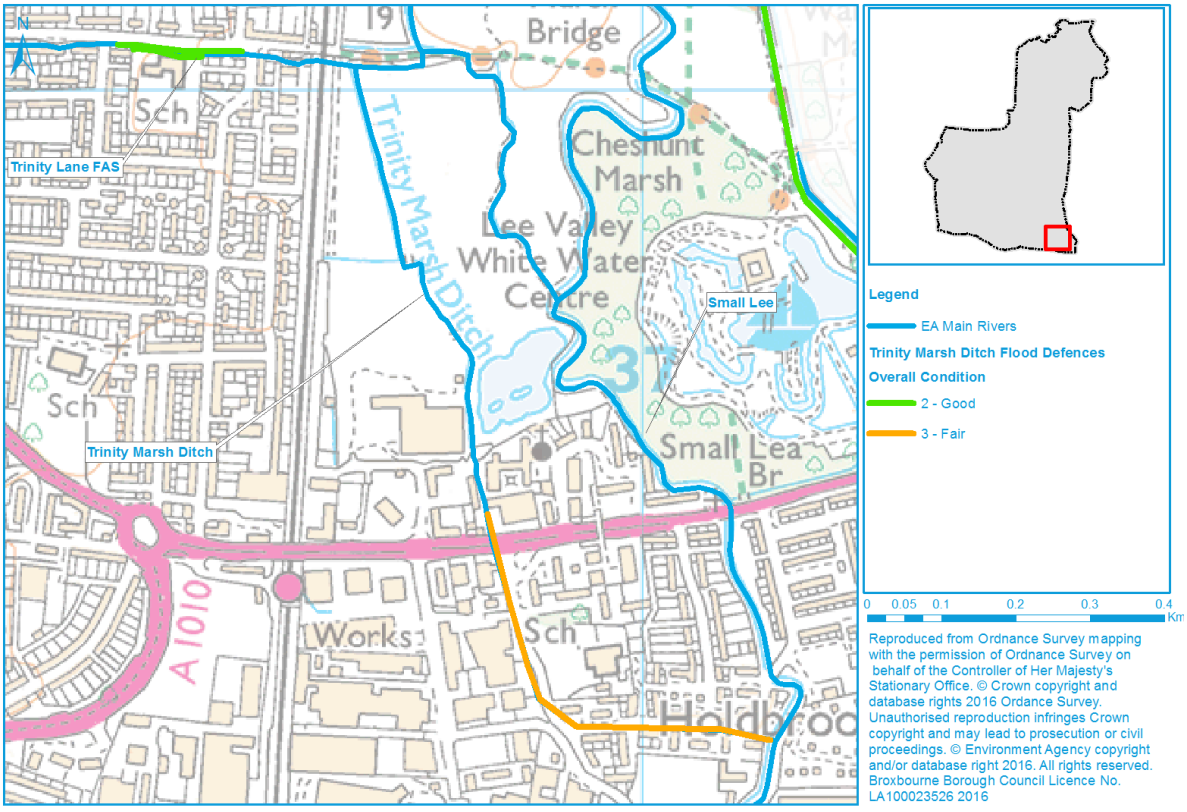



Figure 6-4: Trinity Marsh Ditch Flood Defences - Overall Condition



### 6.3.3 Kings Weir Embankments

The Kings Weir Embankments are a series of earth embankments, 4.82km in length, located on the right bank, on the eastern boundary of the borough. Two embankments provide a 1 in 200-year standard of protection and one embankment provide a 1 in 25-year standard of protection. These flood defence assets are shown in Figure 6-5 and the overall condition of the embankments are shown in Figure 6-6. The embankments separate the Lee Navigation, River Lee and RLFRC at this location and are considered to be in a 'fair to good' overall condition.

Figure 6-5: Kings Weir Embankments

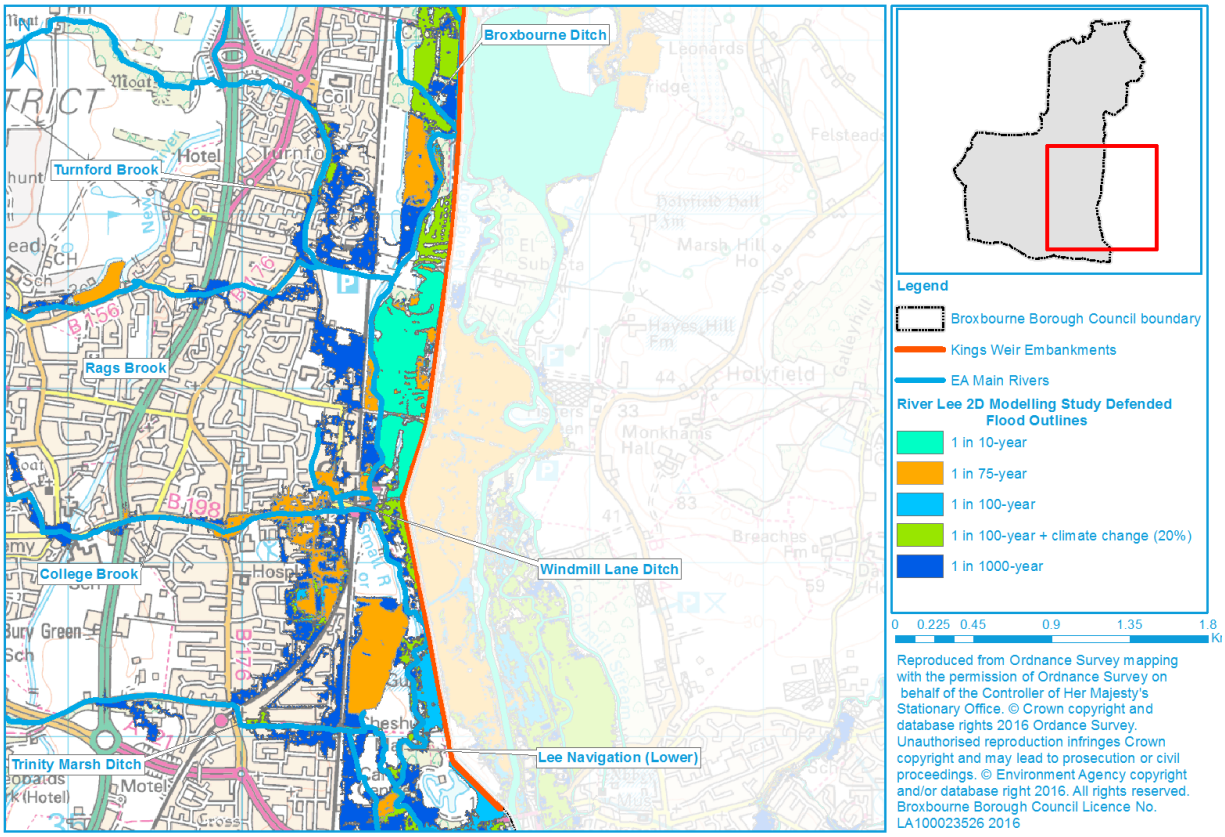
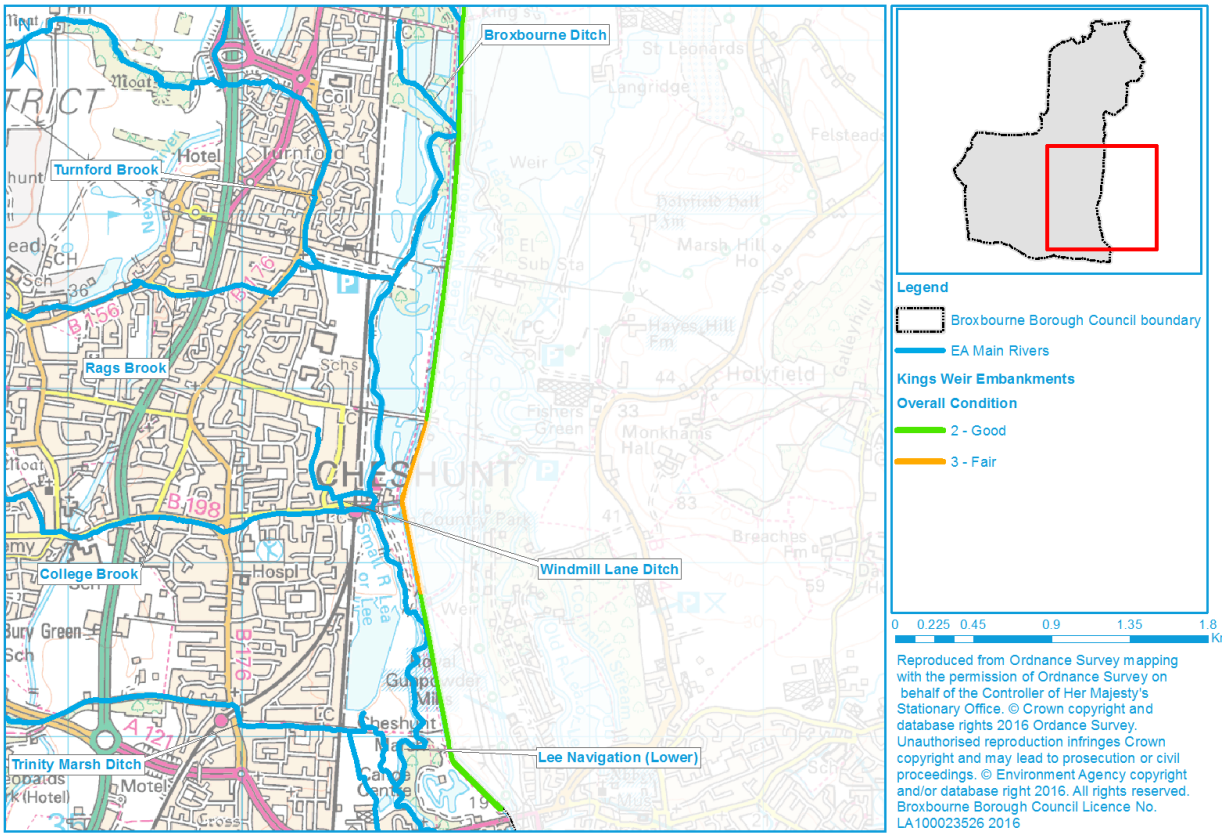


Figure 6-6: Kings Weir Embankments - overall condition




### 6.3.4 River Lee Flood Relief Channel

Since the 1947 flood, a number of measures have been constructed across the Lower Lee catchment, to alleviate the risk of flooding. One such measure is the River Lee Flood Relief Channel (RLFRC); designed to a 1 in 70-year standard of protection, this has provided flood relief in the area by increasing conveyance capacity through the catchment. However, the North London Level 1 SFRA (Mouchel 2007) states that the level of protection is known to have been reduced further by the extensive development in the upper catchment; the standard of protection now offered is thought to be 1 in 50-year[25]. Further, the flood relief channel almost reached capacity in 1987, 1993 and 2000.

There are numerous structures along the RLFRC including:

- Fields Weir and Vertical Lift Gates
- Richard White Radial Gates
- Mead Gate Sluices
- Anteing Weir
- Kiore Radial Gates
- Holy field Weir
- Fishers Green Sluice
- David Stoker Radial Gates
- Ramey Sluices
- Newman's Sluices

25 North London Level 1 SFRA: https://www.islington.gov.uk/publicrecords/library/Transport-and-infrastructure/Information/Advice-and-information/2015-2016/(2015-08-14)-North-London-Strategic-Flood-Risk-Assessment.pdf

### 6.3.5 Future flood defences

The future of flood defences in the borough of Broxbourne is discussed in the following documents:

- 2016 Thames River Basin Flood Risk Management Plan (see Section 2.8.1)
- 2013 Lower Lee Flood Risk Management Strategy (see Section 2.7)
- 2011 Hertfordshire County Council Local Flood Risk Management Strategy (see Section 2.2.5)
- 2009 River Thames Catchment Flood Management Plan (see Section 2.6)

All of the above documents refer to the recommendations in the 2013 Lower Lee Flood Risk Management Strategy regarding the future of flood risk management activities in the Lower Lee catchment (the recommendations are detailed in Section 2.7). The vast majority of the recommended measures for watercourses in the borough of Broxbourne revolve around a commitment to maintain, refurbish and replace existing flood defences, flood storage areas and other flood risk management assets. There are no new structural measures proposed under the 2013 Lower Lee Flood Risk Management Strategy which affect watercourses in the borough of Broxbourne. However, there is a commitment to continue partnership working with local communities and organisations to find opportunities to reduce flood risk.

### 6.3.6 LLFA Asset Register

Hertfordshire County Council has compiled a Flood Risk Asset Register for the County under Section 21 of the FWMA (2010). This list is compiled from flood investigations and local FRAs enabling data to be collected on structures and features which are likely to have a significant effect on flood risk within Hertfordshire. Examples of structures include culverts, drainage ditches and embankments and can be both natural and man-made.

Before structures are added to the Asset Register, the relevant information about each asset such as ownership and condition are recorded. The list is updated periodically as Hertfordshire County Council becomes aware of significant assets.

Table 6-3: LLFA Asset Register within the Study Area

| Asset No. | Location | X | Y | Asset Type | Asset Description | Water source |
|---|---|---|---|---|---|---|
| 01BBC | East of Sorbus Road and west of Turnford Marsh | 536818 | 204775 | Culvert | Turnford Marsh 1 - Network Rail | Unnamed watercourse |
| 02BBC | East of Asset No. 02BBC and west of Turnford Marsh | 536839 | 204775 | Culvert | Turnford Marsh 2 - Lee Valley Regional Park | Unnamed watercourse |
| **The data shown above was extracted from the LLFA asset register. This list of structures which have a significant impact on local flood risk was last updated in 24 March 2015.** | | | | | | |

# 7 Flood risk from artificial water bodies

## 7.1 Flood risk from canals

Canals do not generally pose a direct flood risk as they are a regulated waterbody. The residual risk from canals tends to be associated with lower probability events such as overtopping and embankment failure (breach and sudden escape of the water retained in the canal channel).

The residual risk associated with canals is more difficult to determine as it depends on a number of factors including, for example, the source and magnitude of surface water runoff into the canal, the size of the canal, construction materials and level of maintenance. The probability of the risk of a breach is managed by continued maintenance.

### 7.1.1 Overtopping

The level of water in canals is normally controlled by the level and size of weirs. When surface water enters a canal, the level of water rises. The water level may then reach a point in which it discharges from the canal through control structures such as weirs. Should the capacity of these control structures be exceeded, or should they become blocked, overtopping may occur.

### 7.1.2 Breach

Breaches or embankment failure may be caused by a number of factors including:

- Culvert collapse.
- Overtopping.
- Animal burrowing.

Flooding from a breach of a canal embankment is largely dictated by canal and ground levels, canal embankment construction, breach characteristics and the volume of water within the canal that can discharge into the lower lying areas behind the embankment. The volume of water released during a breach is dependent on the upstream pound length (i.e. the distance between locks) and how quickly the operating authorities can react to prevent further water loss, for example by the fitting of stop boards to restrict the length of the canal that can empty through the breach, or repair of the breach.

### 7.1.3 Recorded flood incidents from the River Lee Navigation Channel

There is one canal within the borough of Broxbourne; the River Lee Navigation channel follows the majority of eastern boundary of the study area. There are a number of structures along the River Lee Navigation channel from the A414 to the M25 including six locks as well as a number of sluices and waste weirs.

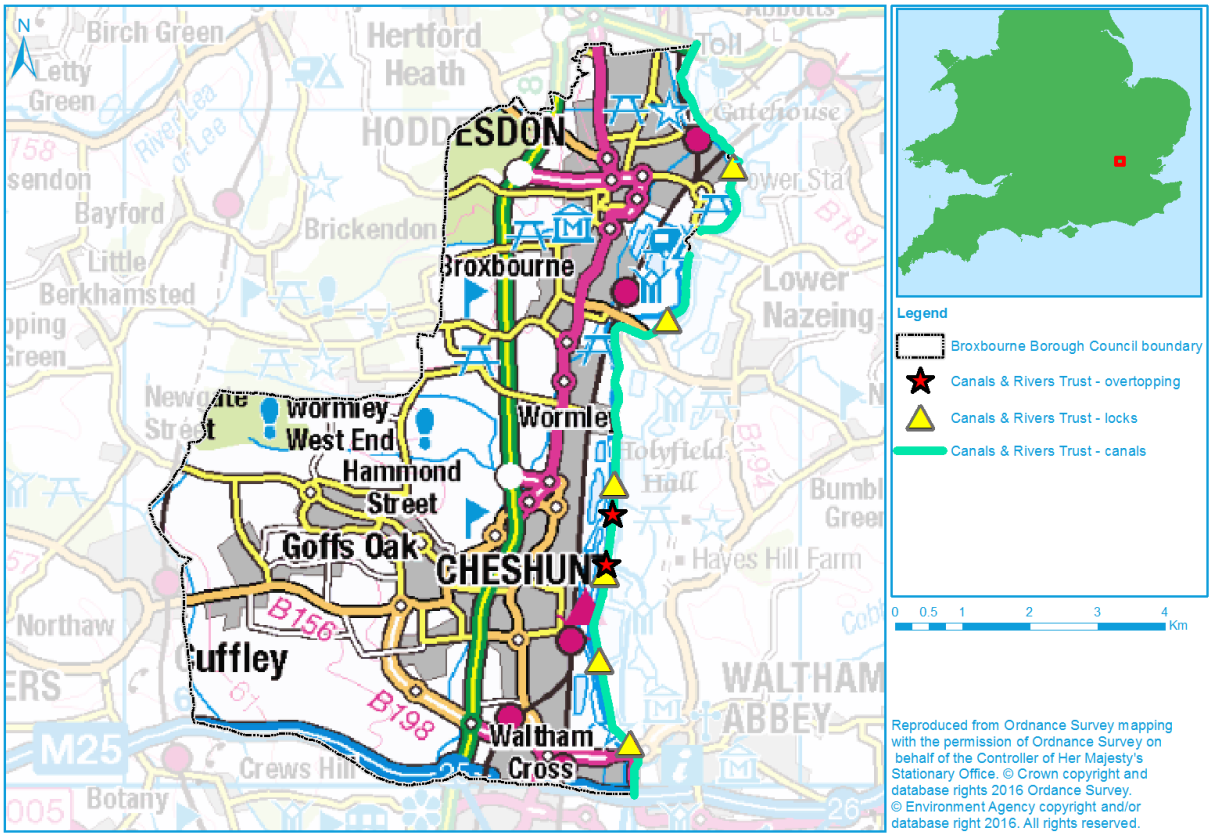
Within the study area, the canal is shown to be connected to the River Lee and as such would interact and has a potential to become a flow path, if the canal were overtopped or breached.

There are two records of overtopping incidents; one was caused by higher water levels associated with debris from vegetation clearance and another caused by water running from a footpath eroding the bank. The records indicate that no property flooding occurred as a result of these incidents.

There are no recorded incidents of breaches associated with this canal. However, any development proposed adjacent to a canal, should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific Flood Risk Assessment.

Figure 7-1 shows the River Lee Navigation Channel including the locations of locks and incidents of overtopping within the study area.

Figure 7-1: River Lee Navigation Channel and locations of overtopping incidents




## 7.2 Flood risk from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low. Recent changes to legislation under the Flood and Water Management Act require the Environment agency to designate the risk of flooding from reservoirs over 25,000 cubic metres and at some time in the future to consider the risk from reservoirs with a volume greater than 10,000 cubic metres. The Environment agency is currently progressing a 'Risk Designation' process so that the risk is formally determined.

Flooding from reservoirs occurs following partial or complete failure of the control structure designed to retain water in the artificial storage area.

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult to estimate, but it is less likely than flooding from rivers of surface water. It may not be possible to seek refuge upstairs from floodwater as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure.

The risk of inundation to the borough of Broxbourne as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Mapping (NIRIM) study.

There are reservoirs located within the borough of Broxbourne, including Cheshunt North FAS. There are also a number of reservoirs outside of the area whose inundation mapping is shown to affect the borough of Broxbourne, as detailed in Table 7-1 and shown in Appendix G.

The Environment Agency maps represent a credible worst case scenario. In these circumstances it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

Table 7-1: Reservoirs that may potentially affect the borough of Broxbourne in the event of a breach

| Reservoir | Location (grid reference) | Reservoir owner | Environment Agency area | Local authority |
|---|---|---|---|---|
| Rye Hill No. 2 | 544972, 206451 | Affinity Water | Hertfordshire and North London | Essex County Council |
| Cheshunt North FAS | 535305, 203635 | Environment Agency | Hertfordshire and North London | Hertfordshire County Council |
| Rye Meads Lagoons 10, 12, 14 & 16 | 539232, 209756 | Thames Water Ltd | Hertfordshire and North London | Hertfordshire County Council |
| Rye Meads Lagoons 11, 13, 15 & 17 | 538634, 209944 | Thames Water Ltd | Hertfordshire and North London | Hertfordshire County Council re |
| King George V | 537055, 197188 | Thames Water Ltd | Hertfordshire and North London | Enfield London Borough Council |
| Cobbins Brook FAS | 541006, 202028 | Environment Agency | Hertfordshire and North London | Essex County Council |

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage.

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# 8 Surface water management and SuDS

## 8.1 What is meant by Surface Water Flooding?

For the purpose of this SFRA, the definition of surface water flooding is that set out in the Defra SWMP guidance. Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall in urban areas.

Surface water flooding includes:

- Pluvial flooding: flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity.
- Sewer flooding: flooding that occurs when the capacity of underground water conveyance systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters which may cause water to back up and flood on the urban surface. Sewer flooding can also arise from operational issues such as blockages or collapses of parts of the sewer network.
- Overland flows entering the built up area from the rural / urban fringe: includes overland flows originating from groundwater springs.

## 8.2 Assessment of Surface Water Flood Risk

In assessing the surface water flood risk across the Broxbourne Borough Council administrative area, the Environment Agency's updated Flood Map for Surface Water (uFMfSW) has been used (Appendix D). These maps are intended to provide a consistent standard of assessment for surface water flood risk across England and Wales in order to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk.

The uFMfSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water (as shown in

Table 5-6).

Although the uFMfSW offers improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be considered to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the uFMfSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

## 8.3 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are water management practices which aim to enable surface water to be drained in a way that mimics (as closely as possible) the run-off and drainage prior to site development.

There are a number of ways in which SuDS can be designed to meet surface water run-off, water quality, and biodiversity and amenity goals. Given this flexibility, SuDS are generally capable of overcoming or working alongside various constraints affecting a site, such as restrictions on infiltration, without detriment to achieving these goals.

The inclusion of SuDS within developments should also be seen as an opportunity to enhance ecological and amenity value as well as promote Green Infrastructure by incorporating above ground facilities into the landscape development strategy. SuDS must be considered at the outset and during preparation of the initial conceptual site layout to ensure that enough land is given to design spaces that will be an asset to the development as opposed to an ineffective afterthought. SuDS should be designed in management trains (logical sequence of SuDS facilities) to optimise the performance as a whole. Management trains use SuDS in series to reduce flows and improve the quality of surface runoff. For SuDS trains to work effectively it needs to be ensured that appropriate techniques are selected based on the objectives for drainage and the site specific constraints. It is recommended that on all developments source control is implemented as the first stage of a management train allowing for improvements in water quality and reducing or eliminating runoff from smaller, more frequent, rainfall events.

All new major development proposals should ensure that sustainable drainage systems for management of run-off are put in place. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

## 8.4 Types of SuDS Systems

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (Table 8-1). The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

Table 8-1: Examples of SuDS techniques and potential benefits

| SuDS Technique | Flood Reduction | Water Quality Treatment & Enhancement | Landscape and Wildlife Benefit |
|---|---|---|---|
| Living roofs | ✓ | ✓ | ✓ |
| Basins and ponds | ✓ | ✓ | ✓ |
| Constructed wetlands | ✓ | ✓ | ✓ |
| Balancing ponds | ✓ | ✓ | ✓ |
| Detention basins | ✓ | ✓ | ✓ |
| Retention ponds | ✓ | ✓ | ✓ |
| Filter strips and swales | ✓ | ✓ | ✓ |
| Infiltration devices | ✓ | ✓ | ✓ |

| | | | |
|---|---|---|---|
| Soakaways<br>Infiltration trenches and basins | ✓<br>✓ | ✓<br>✓ | ✓<br>✓ |
| Permeable surfaces and filter drains<br>Gravelled areas<br>Solid paving blocks<br>Porous pavements | ✓<br>✓<br>✓<br>✓ | ✓<br>✓<br>✓<br>✓ | |
| Tanked systems<br>Over-sized pipes/tanks<br>Storm cells | ✓<br>✓<br>✓ | | |

When installing SuDS consideration should be given to water recycling technologies which can be incorporated into the design. The use of such technologies offers a means to not only reduce the amount of water which is dealt with by the drainage system but also help ease water available issues for the region as a whole. Example of water recycling could be the collection of water from roofs which could be stored and used for internal infrastructure (e.g. flushing toilets) or for watering local planting.

### 8.4.1 SuDS constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints. These should be taken into account and reflected upon during the conceptual, outline and detailed stages of SuDS design. Such physical and policy factors include

- Topography
- Geology and soil permeability
- Available land area
- Former site use
- Proposed site use
- Groundwater conditions
- Future adoption and maintenance possibilities

Table 8-2 details how some of these constraints may be overcome.

Table 8-2: Overcoming SuDS constraints

| Constraint | Recommendation |
|---|---|
| **Topography:** steep slopes making it difficult to implement components of shallow SuDS and increasing the velocity of runoff into features. | In areas of steep slopes, check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows along the SuDS train. |
| **Land availability:** insufficient open space for some SuDS features. | With limited space, SuDS can be built into urban areas with features such as permeable paving and green roofs which can offset the need open space dedicated to SuDS. |
| **Land remediation:** contaminated land is present and there is significant risk of mobilising pollutants. | In areas that are shown to be contaminated infiltration SuDS should be restricted. Shallow surface SuDS should be used to minimise disturbance to the underlying soil. Infiltration should also not be allowed to reduce treatment requirements. Linings can be used to prevent infiltration. |
| **Groundwater:** Groundwater is high in the location of proposed SuDS. | In areas where the groundwater table is high, non-infiltrating features can be used. Features can be lined with an impermeable liner or clay to prevent the egress of water into the feature. |

| | |
|---|---|
| **Ground permeability:** poor permeability limiting infiltration under greenfield conditions. | Shallow surface SuDS features which do not rely on infiltration can be used. Additionally, the concept of infiltrating to a great depth can be explored if there is a small band of impermeable geology. This should be confirmed with detailed site investigations. |
| Note: Based on Hertfordshire County Council SuDS Design Guidance for Hertfordshire (March 2015) | |

## 8.5 Groundwater Vulnerability Zones

The Environment Agency have published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise the underlying bedrock. The maps show the vulnerability of groundwater at a location based on the hydrological, hydrogeological and soil properties within a one kilometre grid square.

Two maps are available:

- **Basic groundwater vulnerability map:** this shows the likelihood of a pollutant discharged at ground level (above the soil zone) reaching groundwater for superficial and bedrock aquifers and is expressed as high, medium and low vulnerability
- **Combined groundwater vulnerability map:** this map displays both the vulnerability and aquifer designation status (principal or secondary). The aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

The groundwater vulnerability maps should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the types of SuDS appropriate to certain areas; this is discussed further in Section 8.7.

## 8.6 Groundwater Source Protection Zones (GSPZ)

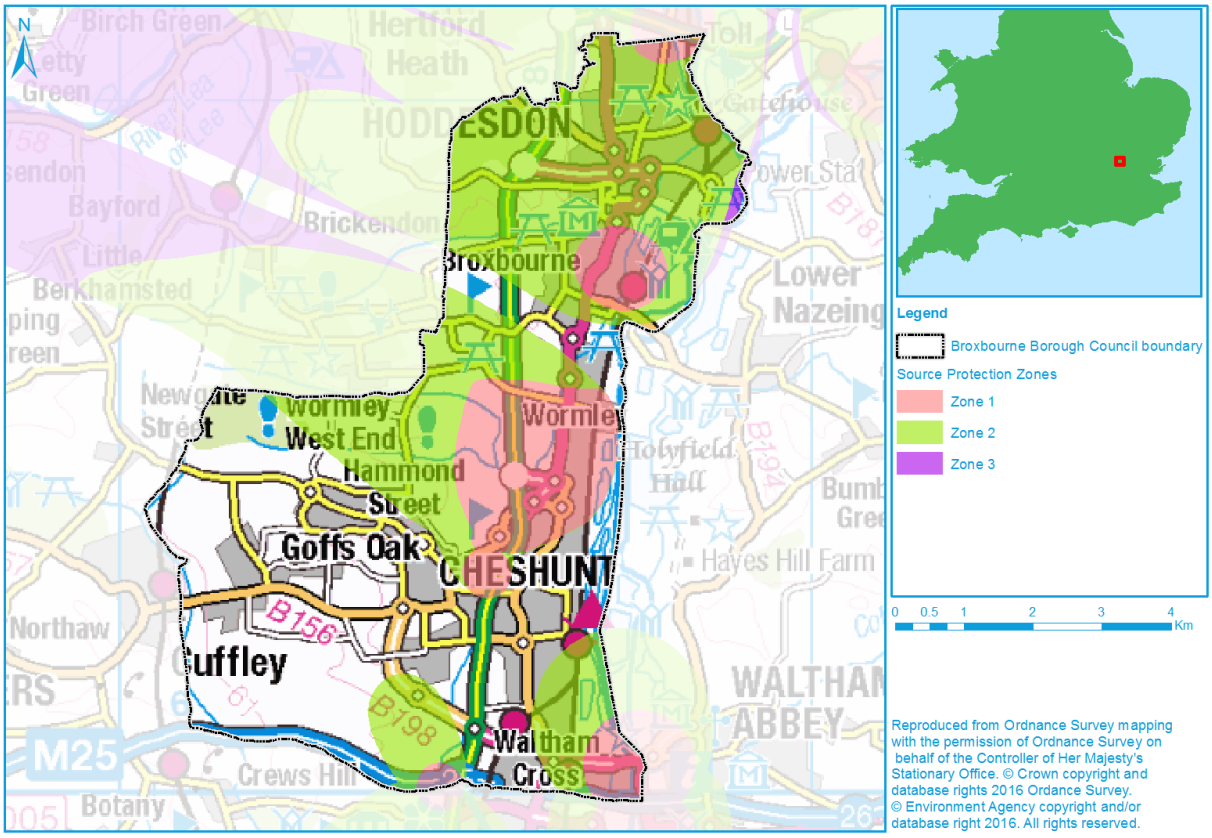
In addition to the AStGWF data the Environment Agency also defines Groundwater Source Protection Zones in the vicinity of groundwater abstraction points. These areas are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. The definition of each zone is shown below:

- **Zone 1 (Inner Protection Zone) –** Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
- **Zone 2 (Outer Protection Zone) –** Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a minimum radius around the source, depending on the size of the abstraction
- **Zone 3 (Total Catchment) -** Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. Individual source protection areas will still be assigned to assist operators in catchment management
- **Zone 4 (Zone of special interest) –** A fourth zone SPZ4 or 'Zone of Special Interest' usually represents a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone

The location of the Groundwater SPZs in relation to Broxbourne borough are shown in Figure 8-1. A large percentage of the northern, central and southern parts of the borough are located within a Zone 2 and Zone 1. An isolated area to the north-east is classified as Zone 3. The western area is not shown to be within any SPZs. Depending on the nature of the proposed development and

the location of the development site with regards to the SPZs, restrictions may be placed on the types of SuDS appropriate to certain areas; this is discussed further in Section 8.7. Any restrictions imposed on the discharge of site generated runoff by the Environment Agency will be determined on a site by site basis using a risk-based approach.

Figure 8-1: Groundwater Source Protection Zones




## 8.7 SuDS: infiltration constraints and guidance in Broxbourne

Due to the nature of the geology, groundwater vulnerability and Groundwater SPZs in the borough, it is unlikely that infiltration drainage will be suitable. For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration. Infiltration should be considered with caution within areas of possible subsidence or sinkholes.

Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable and guidance should be sought from the LLFA.

## 8.8 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies.

The level of nitrate contamination will potential influence the choice of SuDS and should be assessed as part of the design process.

The whole of the borough of Broxbourne area is classed as a surface water NVZ.

## 8.9 Role of the LLFA and Local Planning Authority in surface water management

From April 2015 local planning policies and decisions on planning applications relating to major development should ensure that SuDS for management of run-off are put in place (as per latest NPPG guidance, 6 April 2015). In March 2015 Hertfordshire County Council was made a statutory consultee on major development planning applications and, as a result, is required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Major developments are defined as:

- Residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known
- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of 1 hectare or more.

When considering planning applications, local planning authorities should consult LLFAs on the management of surface water, satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the development's lifetime.

It is essential that the consideration of sustainable drainage takes place at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These principles are:

- Quantity: should be able to cope with the quantity of water generated by the development at the agreed rate with due consideration for climate change via a micro-catchment based approach
- Quality: should utilise SuDS features in a "treatment train" that will have the effect of treating the water before infiltration or passing it on to a subsequent water body
- Amenity / Biodiversity: should be incorporated within "open space" or "green corridors" within the site and designed with a view to performing a multifunctional purpose

Local planning bodies should:

- Consult LLFAs on the management of surface water
- Promote the use of SuDS for the management of run-off
- Ensure their policies and decisions on applications support and compliment the building regulations on sustainable rainwater drainage, giving priority to infiltration over watercourses and then sewer conveyance
- Incorporate favourable policies within development plans
- Adopt policies for incorporating SuDS requirements into Local Plans
- Encourage developers to utilise SuDS through the use of appropriate planning conditions
- Develop joint strategies with sewerage undertakers and the Environment Agency to further encourage the use of SuDS

### 8.9.1 Hertfordshire County Council's SuDS Policy Statement

Hertfordshire County Council produced a SuDS policy statement in March 2015[26]. This is a guidance document which outlines the anticipated requirements of Hertfordshire County Council for developers needing to gain approval for drainage schemes. It involves three stages:

- Conceptual Drainage Design
- Outline Drainage Proposal
- Detailed Drainage Proposal

These stages are outlined below:

26 HCC SuDS Policy Statement: http://www.hertsdirect.org/docs/pdf/h/hccsudspolicies.pdf

### Conceptual Drainage Design

This stage ties in with the pre-application stage of the planning and policy. To gain approval the developer must do the following:

- Demonstrate and understand the drainage characteristics within and outside of the site
- Provide an outline assessment of existing geology, ground conditions, contaminant status and permeability. Soakage tests should ideally be conducted at this point
- Provide a flow route analysis for the existing and post development scenario
- Prepare a drainage plan outlining, the proposed management train, location of source controls and other SuDS, the destination of runoff and suggested betterment
- Provide a Preliminary SuDS Design Statement describing the SuDS proposals in general terms together with the SuDS Design Criteria agreed for the site and initial thoughts on how the site will be maintained

### Outline Drainage Proposal

The Outline Drainage Proposal is developed in conjunction with the LLFA prior to a full application and should be submitted alongside the detailed design of the application. It should include the following:

- The SuDS management train in detail
- Source control measures including how they are to be adopted
- Treatment stages of each sub catchment
- Conveyance techniques
- The storage hierarchy both spatial and for different return periods
- Details of how flows and volumes are controlled
- Final site runoff arrangements
- Soakaway test results
- Details of how contaminants will be dealt with onsite
- An initial Health and Safety assessment which assesses risks and proposes how these will be managed to an acceptable level

Additionally, they should be accompanied by the following:

- SuDS Design Statement describing the SuDS proposals in detail terms together with how they meet the SuDS Design Criteria agreed for the site at Concept Stage
- Climate Change Statement
- Key operation and maintenance principles.

### Detailed Drainage Proposal

At this final design stage, those seeking approval must provide all details necessary to demonstrate that the SuDS will function effectively now and in the future, such as:

- Levels data and/or drawings to show that runoff will flow in predictable pathways through the site
- Construction details and location plans that demonstrate practical, robust and simple structures for the collection, conveyance, cleaning and storage of runoff
- Details for inlets and outlets and flow control chambers to demonstrate how flows and volumes are managed. Details should include cover levels, inverts, soffit, base and crest; shown on plan, cross and long-section with relevant calculation or hydraulic model references as appropriate
- Cross and longitudinal profiles and planting details of all swales, basins, wetland and pond features together with SuDS sympathetic landscape proposals for the whole development
- All level data provided as metres above ordnance datum (m AOD)
- Specification notes for all SuDS installation

- An Operation and Maintenance Plan for the site
- A final SuDS Design Statement modified where necessary to include additional information or minor amendments
- A final Health and Safety Assessment which assesses risks and proposes how these will be managed to an acceptable level

Additional Design Criteria

- Proposals for SuDS must result in discharge into the ground, to a surface water body or, where these can be demonstrated to be impractical, to the storm sewer or combined sewer where no storm sewer is available.
- Proposals for SuDS must demonstrate how the frequency, rate and volume of run-off from the development will be managed to achieve a Greenfield rate. On previously developed land, a Greenfield rate must be achieved, except in exceptional cases which are agreed with the LLFA. Where Greenfield rates cannot be achieved, a betterment rate will be agreed with the LLFA.
- Proposals for SuDS must demonstrate the sufficient treatment stages are provided in line with the intended site use and sensitivity of receptor. Where the required number of treatment stages cannot be provided acceptable justification for derogations sought on the basis of the 'sensitivity' of receptors or not being 'reasonably practicable'.
- Flooding must not occur on any part of the site for a 1 in 30-year rainfall event.
- Flooding most not occur during a 1 in 100-year rainfall event in any part of: a building (including a basement, utility plant susceptible to water (e.g. pumping station or electrical sub-station) or on neighbouring. Flows that exceed design criteria must be managed in flood conveyance routes (exceedance routes) that minimise risks to people and property both on and off the site.

As well as the SuDS Policy Statement, Hertfordshire County Council has also provided a number of other SuDS-related documents to promote SuDS and to assist developers with their implementation. These documents provide guidance and policies which provide comprehensive information and advice and includes information on what information is expected as part of a surface water Drainage Assessment/FRA. The following documents are available on the Hertfordshire County Council website and are summarised in the following sections:

- LLFA Summary Guidance for developers[27]
- SuDS Design Guidance for Hertfordshire[28]

### 8.9.2 Hertfordshire County Council SuDS Design Guidance (2015)[29]

This document provides guidance for developers on the design and delivery of SuDS features throughout the SuDS design process. It gives details on considerations which would need to be made in the design of SuDS features, with reference to environmental considerations in Hertfordshire, quantity and quality criteria of SuDS features and local design principles.

### 8.9.3 Hertfordshire County Council Summary Guidance for developers

As the LLFA, Hertfordshire County Council have produced a factsheet to assist with the production of a satisfactory surface water drainage assessment and/ or FRA in accordance with national planning policy. There are six technical requirements that a drainage assessment / FRA must meet as detailed in the guidance for developers.

These technical requirements are summarised below: this document also includes a checklist of technical information to be provided in a drainage assessment-.

This is now an adopted policy within the LFRMS, therefore the LPA, other stakeholders and developers must have due regard to these policies. The policies are not just for guidance.

27 LLFA Summary Guidance for developers: http://www.hertsdirect.org/docs/pdf/g/developerguide.pdf
28 Hertfordshire County Council SuDS Design Guidance for Hertfordshire (2015): http://www.hertsdirect.org/docs/pdf/s/hertssudsguide.pdf
29 HCC SuDS Design Guidance (2015): http://www.hertsdirect.org/docs/pdf/s/hertssudsguide.pdf

Hertfordshire County Council have produced a separate technical guidance document and also a 'developer's checklist' which can all be found online, as shown below.

Relevant web links:

- SuDS Guidance for Hertfordshire
  http://www.hertsdirect.org/services/envplan/water/floods/surfacewaterdrainage/sudsguidance/
- SuDS Policies (addendum to the LFRMS)
  http://www.hertsdirect.org/services/envplan/water/floods/surfacewaterdrainage/sudspolicies/
- Developers Guide and Checklist
  http://www.hertsdirect.org/services/envplan/water/floods/surfacewaterdrainage/developerguide/
- Pre-application service
  http://www.hertsdirect.org/services/envplan/water/floods/surfacewaterdrainage/preappguide/

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# 9 Flood Warning and Emergency Planning

## 9.1 Flood emergencies

The Hertfordshire Local Resilience Forum (also known as Hertfordshire Resilience) has identified flooding as a risk to the county, within the Community Risk Register[30]. This SFRA report further demonstrates that the borough of Broxbourne is not immune to flood risk and challenges remain to manage this risk.

Flooding can develop into an emergency situation; emergency planning is one option to help manage flood related incidents. Emergency planning is a core component of civil protection and public safety practices and seeks primarily to prevent, or secondly mitigate the risk to life, property, businesses, infrastructure and the environment. In the UK, emergency planning is performed under the direction of the 2004 Civil Contingencies Act (CCA).

From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding. In development planning, a number of these activities are already integrated in national building control and planning policies e.g. the NPPF.

**Emergency planning and flood risk management links**

- 2004 Civil Contingencies Act: http://www.legislation.gov.uk/ukpga/2004/36/contents
- DEFRA (2014) National Flood Emergency Framework for England: https://www.gov.uk/government/publications/the-national-flood-emergency-framework-for-england
- Government guidance for public safety and emergencies is available at: https://www.gov.uk/topic/public-safety-emergencies/emergencies-preparation-response-recovery

Safety is a key consideration for any new development and includes the likely impacts of climate change and, where there is a residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures. It is a requirement under the NPPF that a flood warning and evacuation plan is prepared for sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels)[31] and for essential ancillary sleeping or residential accommodation for staff required by uses in this category [water-compatible development], subject to a specific warning and evacuation plan. Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

## 9.2 Existing Flood Warning Systems

The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers) and coastal flooding in England. The Environment Agency supplies Flood Warnings via the Floodline Warnings Direct (FWD) service, to homes and business within Flood Zones 2 and 3. Using the latest available technology, Environment Agency staff monitor rainfall, river levels and sea conditions 24 hours a day and use this information to forecast the possibility of flooding. If flooding is forecast, warnings are issued using a set of four easily recognisable codes, shown below in Table 9-1. Generic advice and examples on actions to be taken on receipt of the warning are shown in the column called “What to do”.

Flood warnings are disseminated to people registered to receive flood warnings via the FWD service using the following communication methods; phone, text and / or e-mail. Warnings may also be reported in news and weather bulletins. The Environment Agency have a Floodline number (0345 988 1188) and a quick-dial number specific to the Flood Warning Area, which the public can call to receive more detailed information regarding the flood warning.

30 LRF Risk Register 2014: http://www.hertsdirect.org/docs/pdf/l/risk.pdf

31 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 056, Reference ID: 7-056-20140306) March 2014

It is the responsibility of individuals to sign-up this service, in order to receive the flood warnings via FWD. Registration and the service is free and publically available. It is recommended that any household considered at risk of flooding signs-up. Developers should also encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.

Table 9-1: Environment Agency Flood Warnings Explained

| Flood Warning Symbol | What it means | What to do |
|---|---|---|
|  | Flood Alerts are used to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early preparations. It is issued earlier than a flood warning, to give customers advice notice of the possibility of flooding, but before we are fully confident that flooding in Flood Warning Areas is expected. | • Be prepared to act on your flood plan<br>• Prepare a flood kit of essential items<br>• Monitor local water levels and the flood forecast on the Environment Agency website<br>• Stay tuned to local radio or TV<br>• Alert your neighbours<br>• Check pets and livestock<br>• Reconsider travel plans |
|  | Flood Warnings warn people of expected flooding and encourage them to take action to protect themselves and their property. | • Move family, pets and valuables to a safe place<br>• Turn off gas, electricity and water supplies if safe to do so<br>• Seal up ventilation system if safe to do so<br>• Put flood protection equipment in place<br>• Be ready should you need to evacuate from your home<br>• 'Go In, Stay In, Tune In' |
|  | Severe Flood Warnings warn people of expected severe flooding where there is a significant threat to life. | • Stay in a safe place with a means of escape<br>• Co-operate with the emergency services and local authorities<br>• Call 999 if you are in immediate danger |
| **Warnings no longer in force** | Informs people that river or sea conditions begin to return to normal and no further flooding is expected in the area. People should remain careful as flood water may still be around for several days. | • Be careful. Flood water may still be around for several days<br>• If you've been flooded, ring your insurance company as soon as possible |

+ Table adapted from Environment Agency "Flood Warnings – what they are and what they do" leaflet: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/311020/flood_warnings_LIT_5215.pdf

### 9.2.1 Broxbourne Flood Alert and Warning Areas

There are currently four Flood Alert Areas covering significant parts of the borough. There are seven Flood Warning Areas (FWAs); these tend to cover the main River Lee corridor within the eastern part of the borough.

Appendix F shows the FWA coverage for the borough. If a home or business falls within the FWA coverage, this means that the Environment Agency can provide flood warnings.

## 9.3 Lead times and onset of flooding

Flood Alerts and Warnings provide advanced notification that flooding is possible or expected. The time from when the alert or warning is issued to the onset of property flooding (termed the lead time) can provide time for people to prepare for flooding (see the "What to do" column in Table 9-1). The Environment Agency endeavour to give a two-hour lead time for issuing Flood Warnings; however, for fast responding catchments and areas at risk of flash flooding, this may not be possible.

A failure or breach of flood defences can cause immediate and rapid inundation to areas located near the vicinity of the breach or failure. Such incidents can pose a significant risk to life given the near lack of warning and lead time to prepare or respond.

For developers it is therefore important to consider how to manage the consequences of events that are un-foreseen or for which no warnings can be provided. A typical example would be managing the residual risk of a flood defence breach or failure.

## 9.4 Managing flood emergencies - local arrangements

### 9.4.1 Emergency Planning

In the borough of Broxbourne, emergency planning is managed by the District Resilience Team, a sub-branch of Hertfordshire County Council's Resilience Team. The Resilience Team is a member of the Community Protection Directorate (CPD), alongside Hertfordshire Fire and Rescue Service, Hertfordshire Trading Standards and the County Community Safety Unit. These organisations work together under the CPD, to make Hertfordshire a safe place to live, work and visit. The CPD publishes information on Hertfordshire County Council's website, under the Community Safety service. Hertfordshire County Council also works in partnership with numerous other local responders in the Hertfordshire Resilience (LRF), which aims to ensure co-ordination and co-operation in the event of an emergency, as well as establishing and promoting a resilience across the county.

### 9.4.2 Multi-Agency Flood & Reservoir Inundation Plan

The Multi-Agency Flood and Reservoir Inundation Plan (v2.2, March 2013) by Hertfordshire Resilience provides a strategic framework for the multi-agency response to a flood event within Hertfordshire. It sets out relevant issues, priorities and outlines procedures to help ensure that the multi-agency response is effective. This includes a reservoir breach, occurring either within or outside of the county, which affects any area of Hertfordshire.

The plan also identifies a number of operational details such as specific urbanised locations and infrastructure considered to be at risk from all types of flooding, including reservoir breach.

The plan is both hazard and site-specific and should be used at both the Strategic (Gold) Command level and the Tactical (Silver) Command level. The plan will be of use to those co-ordinating the response at a more local level, especially where a Strategic (Gold) Command is not in place.

The plan is only intended to provide guidelines; the multi-agency response will depend on circumstances at the time of the incident as the nature of flooding differs with each event.

The plan does not include flood risks from foul sewage, burst water mains, and private lakes and canals. It is important to note flooding does not have regard for political and administrative boundaries. As such this plan must be shared and liaison arrangements made with other neighbouring Local Resilience Forums (LRFs).

### 9.4.3 Multi-Agency Emergency Response Plan

The Hertfordshire Resilience Multi-Agency Emergency Response Plan (v3.3, November 2013) is a generic plan which has been produced in line with national guidance and helps Hertfordshire Resilience agencies fulfil their CCA requirements. It is important to be aware that the response will depend on circumstances at the time of the event.

The plan aims to:

- Set out the strategic response of the agencies that make up Hertfordshire Resilience to incidents requiring multi-agency co-ordination
- Ensure that if a major incident occurs, all the agencies that make up Hertfordshire Resilience are able to make a comprehensive, co-ordinated and effective response
- Outline the roles and responsibilities of agencies involved
- Provide guidance and advice for organisations involved in dealing with a major incident and to help officers from all services to fulfil their duties
- Briefly summarise other key plans and procedures produced through Hertfordshire Resilience which may be used in the event of a major incident and to give an overview of the response to ensure understanding within Hertfordshire Resilience

### 9.4.4 Broxbourne Borough Council's role

Broxbourne Borough Council is subject to the full set of duties, as a Category 1 responder under the CCA. In the emergency flood response, the Council will primarily be responsible for (but not limited to):

- Adjust sluices/weir on council land (where appropriate) to reduce the risk to property by flooding land.
- Provide practical assistance (e.g. deployment of sandbags, pumping blocked drains etc)
- Relocation and re-housing of local residents affected by flooding.
- Reception centre facilities.
- Building control services.
- Environmental health advice and services, including at temporary mortuaries.
- Provision of information and advice to local residents and communities.
- Co-ordination of clean up and recovery activities.
- Sandbag provision.
- Consider warning local residents and communities (ege. Door knocking)
- Assisting any multi-agency evacuation.
- Early consideration of recovery efforts (e.g. returning people home, preventing further vulnerability etc)

The Council's position on the supply of sandbags is contained within a statement which is available to view on their **website**. The Environment Agency have produced guidance on how use sandbags for property flood protection which can be viewed on their website.

The Environment Agency has produced a guidance document, to advice on how to use sandbags properly for flood protection, downloadable from their website.

The Council is also the decision maker and will decide whether or not to grant planning permission for development applications in its administrative area. It should be noted that proposed new development that places additional burden on the existing response capacity of the Council will not normally be considered to be appropriate.

## 9.5 Emergency planning and development

### 9.5.1 NPPF

The NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. It is essential that any development which will be required to remain operational during a flood event is located in the lowest flood risk zones to ensure that in an emergency, operations are not impacted on by flood water. For example, the NPPF classifies police, ambulance and fire stations and command centres that are required to be operational during flooding as Highly Vulnerable development, which is not permitted in Flood Zones 3a and 3b and only permitted in Flood Zone 2 providing the Exception Test is passed. Essential infrastructure located in Flood Zone 3a or 3b must be operational during a flood event to assist in the emergency evacuation process. All flood sources such as fluvial, surface, groundwater, sewers and artificial sources (such as canals and reservoirs) should be considered. In particular sites should be considered in relation to the areas of drainage critical problems highlighted in the East Hertfordshire and Broxbourne SWMP, when this is published in late 2016.

The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements within the borough. This includes the nominated rest and reception centres (and perspective ones), to ensure evacuees are outside of the high risk flood zones and will be safe during a flood event.

### 9.5.2 Safe access and egress

The NPPF Planning Practice Guidance outlines how developers can ensure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test[32]. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. The access and egress must be functional for changing circumstances over the lifetime of the development. The NPPF Planning Practice Guidance sets out that:

- Access routes should allow occupants to safely access and exit their dwellings in design flood conditions. In addition, vehicular access for emergency services to safely reach development in design flood conditions is normally required; and
- Where possible, safe access routes should be located above design flood levels and avoid flow paths including those caused by exceedance and blockage. Where this is unavoidable, limited depths of flooding may be acceptable providing the proposed access is designed with appropriate signage etc. to make it safe. The acceptable flood depth for safe access will vary as this will be dependent on flood velocities and risk of debris in the flood water. Even low levels of flooding can pose a risk to people in situ (because of, for example, the presence of unseen hazards and contaminants in floodwater, or the risk that people remaining may require medical attention).

As part of a FRA, the developer should review the acceptability of the proposed access in consultation with Broxbourne Borough Council, the LLFA (where relevant) and the Environment Agency.

### 9.5.3 Potential evacuations

During flood incidents, evacuation may be considered necessary. The NPPF Planning Guidance states practicality of safe evacuation from an area will depend on[33]:

1. the type of flood risk present, and the extent to which advance warning can be given in a flood event;
2. the number of people that would require evacuation from the area potentially at risk;

32 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014
33 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 057, Reference ID: 7-057-20140306) March 2014

3. the adequacy of both evacuation routes and identified places that people could be evacuated to (and taking into account the length of time that the evacuation may need to last); and
4. sufficiently detailed and up to date evacuation plans being in place for the locality that address these and related issues.

The vulnerability of the occupants is also a key consideration.

The Environment Agency and DEFRA provide standing advice for undertaking Flood Risk Assessments for planning applications. Please refer to the government website for the criteria on when to following the standing advice. Under these criteria, you will need to provide details of emergency escape plans for any parts of the building that are below the estimated flood level. The plans should show

- single storey buildings or ground floors that don't have access to higher floors can access a space above the estimated flood level, e.g. higher ground nearby;
- basement rooms have clear internal access to an upper level, e.g. a staircase; and
- occupants can leave the building if there's a flood and there's enough time for them to leave after flood warnings[34].

Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. developments located immediately behind a defence and at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop emergency plans.

### 9.5.4 Flood warning and evacuation plans

Flood warning and evacuation plans are a potential mitigation measure to manage the residual risk, as listed in the NPPF Planning Practice Guidance. It is a requirement under the NPPF that a flood warning and evacuation plan is prepared for

- sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels); and
- essential ancillary sleeping or residential accommodation for staff required by uses in this category [water-compatible development], subject to a specific warning and evacuation plan.

The Environment Agency provides practical advice and templates on how to prepare a flood plans for individuals, communities and businesses.

It is recommended that Emergency Planners at Broxbourne Borough Council are consulted prior to the production of any emergency flood plan.

**Guidance documents for preparation of flood response plans**

- Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups
  https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/292939/LIT_5286_b9ff43.pdf
- Environment Agency (2014) Community Flood Plan template
  https://www.gov.uk/government/publications/community-flood-plan-template
- Environment Agency Personal flood plans
  http://apps.environment-agency.gov.uk/flood/151256.aspx
- Flood Plan UK 'Dry Run' - A Community Flood Planning Guide
  http://www.floodplanuk.org/userfiles/file/AVI10_40%20Floodplan%20Guide.pdf

34 EA and DEFRA (2012) Flood Risk Assessment: Standing Advice: https://www.gov.uk/flood-risk-assessment-standing-advice

# 10 Cumulative impact of development and cross-boundary issues

When allocating land for development, consideration must be given to the potential cumulative impact of the loss of floodplain storage volume. The effect of the loss of volume should be assessed, at both the development and elsewhere within the catchment and, if required, the scale and scope of appropriate mitigation should be identified. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe.

Depending on the location, size and nature of development within the possible sites, there is the potential for loss of storage and floodplain connectivity in the upper reaches of these watercourses which could potentially increase flood risk downstream. However, conditions imposed by Broxbourne Borough Council should allow for mitigation measures so any increase in runoff as a result of development is properly managed and should not exacerbate flood risk issues either within, or outside of, the Council's administrative area.

The cumulative impact should be considered at the planning application and development design stages and the appropriate mitigation measures undertaken to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk.

## 10.1 Cross-boundary issues

Future large-scale development, both within and outside the borough of Broxbourne can have the potential to affect flood risk to existing development and surrounding areas. The borough of Broxbourne has boundaries with the following Local Authorities:

- Epping Forest District Council
- East Hertfordshire District Council
- Welwyn Hatfield Borough Council
- Enfield London Borough Council

The Lea Valley Regional Park Authority (LVRPA) also partially falls within the study area. Although the LVRPA is not a planning authority, it has a range of powers and duties in relation to the statutory planning process which include preparing a plan detailing proposals for future management and the development of the Regional Park.

Neighbouring authorities and the LVRPA were contacted and, where possible, Local Plans, Park Plans and SFRAs (if available) were reviewed to assess whether there are any proposed large-scale developments that may affect flood risk in the SFRA area.

The topography of the study area means that a large number of the watercourses rise either within the western part of the borough or within the neighbouring Welwyn Hatfield Council's and East Herefordshire District Council's administrative areas. In particular, the main River Lee rises within the East Hertfordshire District Council's administrative area, before flowing within the vicinity of the eastern boundary of the borough. The River Lee network is also fed by tributaries which rise in the western part of the borough as well as within the Epping Forest District Council administrative area to the east. Therefore, the neighbouring authorities which have the potential to affect flood risk within Broxbourne are Welwyn Hatfield Council, East Herefordshire District Council and Epping Forest District Council.

The River Lee network and Cuffley Brook leave the study area along the southern boundary and continue into the London Borough of Enfield administrative area. The River Lee network is also contained within the vicinity of the western boundary of the Epping Forest District Council administrative area. Therefore, the London Borough of Enfield and Epping Forest District Council may potentially be affected by flood risk within Broxbourne borough.

The Lea Valley Regional Park is situated in east London extending northwards from the River Thames to Ware in Hertfordshire. The boundary overlays nine riparian local authorities from within Essex, Hertfordshire and London, including the borough of Broxbourne. Therefore, the LVRPA has the potential to affect flood risk within Broxbourne and the LVRPA may also potentially be affected by flood risk within Broxbourne borough.

Of the neighbouring authorities approached, East Hertfordshire District Council and Welwyn Hatfield Council provided information on their Strategic Site Allocations within their Local Plans. The Lea Valley Regional Park Authority also provided information on their proposals as part of their Park Plan. These documents and sites are reviewed in detail in Sections 10.1.1 to 10.1.3, to identify potential cross-boundary issues.

### 10.1.1 East Hertfordshire District Council

The East Hertfordshire District Council Local Plan is still in development. Strategic Site Allocations were identified during the Consultation Phase of the 2014 Preferred Options version of the Local Plan and provide an indication of the site allocations in East Hertfordshire.

None of the potential site allocations fall on the Broxbourne Borough Council administrative boundary; five sites are located near the vicinity of the upper River Lee and / or its tributaries, in Hertford.

Due to the topography and the complex River Lee network of channels and control structures, development in the East Hertfordshire is unlikely to affect flood risk within the borough of Broxbourne, particularly if appropriate drainage is adopted at the site. It would be a requirement that consideration is given to the wider catchment implications of drainage mitigation measures, rather than just assessing immediate local effects.

### 10.1.2 Welwyn Hatfield Council

Welwyn Hatfield Council screened sites put forward in the Strategic Housing Land Available Assessment (SHLAA) in 2015. The SFRA report includes a basic screening of Welwyn Hatfield's SHLAA sites against sources of flood risk and a Level 2 SFRA of SHLAA Sites.

Welwyn Hatfield Council's Local Plan is currently under development and consultation on the Local Plan was undertaken in January to March 2015. The Level 1 and 2 SFRA prepared in 2015-16 will inform the Housing and Employment Land Availability Assessment (HELAA) and Site Selections. Therefore, although SHLAA sites were screened in the Level 1 and 2 SFRA, these sites may not necessarily form the final selected sites as part of Welwyn Hatfield Council's Local Plan.

Of the SHLAA sites considered in this Level 2 SFRA, four are located near the vicinity of the study area boundary, in the village of Cuffley (SHLAA Ref: Cuf1, Cuf3, Cuf3 Land in Broxbourne and No.95). In particular, one site has land positioned within Broxbourne (SHLAA Ref: Cuf3 Land in Broxbourne). This site is noted to have surface water flood risk issues; however, the SFRA recommends that the flood risk management hierarchy and the application of SuDS is used to help mitigate the impact of development and prevent increases in flood risk to third party land.

The SFRA states that the cumulative impact of the development listed above is likely to be low as all the developments are located on the fringe of Cuffley and adjacent to watercourses which will convey flows away from the urban centre. The SFRA concluded that the main issue is to ensure that cumulative development does not impact the quantity or quality of water received by the Hemphill Brook or Cuffley Brook.

The increase in impermeable area at these locations has the potential to increase runoff entering the Cuffley Brook. However, if appropriate drainage is adopted at the site, the likelihood of any significant effect on the level of flood risk within the borough of Broxbourne is low. It would be a requirement that consideration was given to the wider catchment implications of drainage mitigation measures, rather than just assessing immediate local effects.

### 10.1.3 Lea Valley Regional Park Authority

The Park Plan (2000) provides an overview of the water resource in relation to the Park and its functions. The second part of the Plan contained the proposals for development in the Park however, these proposals are intended to enhance conservation efforts, water corridors and recreation services within the Park and are not thought to increase the impermeable areas post-development.

The LVRPA has also adopted Areas Proposals for section of the Park south of the M25. Those of relevance to Broxbourne include:

- Area 6: 6.A.3 Lee Valley White Water Centre - develop the existing visitor centre. This includes the potential for hotel accommodation, outdoor café and new changing rooms.
- Area 6: 6.A.4 River Lee Country Park including:
    - South River Lee Country Park & Waltham Abbey Gardens - improve access by public transport to entrances to the Park.
    - Broxbourne Gateway and Visitor Hub - establish a visitor hub in Broxbourne.
    - Wharf Road - Create a new pedestrian spine parallel with the Broxbourne Ditch corridor.
- Area 7: 7.A.1 Wetland Park: West Spitalbrook, Admirals Walk Lake & Dobbs Weir - improve access to the park including cycle, pedestrian and public transport routes and expand provision of visitor accommodation at Lee Valley Caravan Park.

The proposals discussed above may potentially increase impermeable areas at these locations and therefore have the potential to increase runoff entering the River Lee network. However, if appropriate drainage is adopted at the sites, the likelihood of any significant effect on the level of flood risk within the borough of Broxbourne is low. It would be a requirement that consideration was given to the wider catchment implications of drainage mitigation measures, rather than just assessing immediate local effects.

## 10.2 Water quality considerations

In addition to cross-boundary issues regarding flood risk, there are also cross-boundary issues relating to water quality. Development should consider the quality of the water that is released from sites and the impact it may have on the water quality on any receiving water bodies. Of those principal watercourses under the WFD within the borough of Broxbourne, all are classed as 'moderate overall status' by the WFD requirements (see section 12.6). Development or agriculture in the upper catchments of watercourses that flow across boundaries into the borough of Broxbourne can potentially impact on the quality of water of these watercourses.

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# 11 FRA requirements and guidance for developers

## 11.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within the borough of Broxbourne. Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk at a site are fully addressed. Some sites may additionally be put forward for the Exception Test following the Sequential Test if the Sequential Test indicates the proposed development inappropriate or unsuitable. These will require further work in a detailed Flood Risk Assessment (FRA). Any site that does not pass the Exception Test should not be allocated for development.

It is normally the responsibility of the developer to provide an FRA with an application. However, a LPA can decide to commission a detailed, site-specific FRA to help them decide upon allocations in the high risk zone. A SFRA cannot provide this level of site-specific information.

It should be acknowledged that a detailed FRA may show that a site is not appropriate for development of a particular vulnerability or even at all. Where the FRA shows that a site is not appropriate for a particular usage, a lower vulnerability classification may be appropriate.

## 11.2 Planning consultees

There are a number of statutory consultees for planning matters; key stakeholders are listed below (note, this list is not exhaustive):

- Broxbourne Borough Council decides all planning matters, including those related to flood risk, in their decision whether or not to grant planning permission.
- The Environment Agency is a statutory consultee for applications in areas of flood risk.
- Hertfordshire County Council, provides technical advice on surface water drainage strategies and designs put forward for new 'major' developments.

The Lee Valley Regional Park Authority is not a planning authority; however; it has a range of powers and duties in relation to the statutory planning process. Sections 14 (subsections 4-7) of the Park Act requires local planning authorities to consult with the Authority on applications for planning permission which they consider could affect the Park.

## 11.3 When is an FRA required?

A FRA is required in the following circumstances:

- All developments located within Flood Zone 2 or 3. This includes minor developments such as non-residential extensions, alterations which do not increase the size of the building or householder developments. It also includes changes of use of an existing development
- All developments greater than 1 ha located in Flood Zone 1
- All developments less than 1 ha in Flood Zone 1 where a change of use in development type leads to a more vulnerable classification or where the development could be affected by sources of flooding other than rivers and the sea. This would include surface water, drains and reservoirs
- All developments located in an area which has been highlighted as having critical drainage problems by the Environment Agency

Advice should be sought from the LPA and the Environment Agency at the pre-planning application stage to determine the need for a site-specific FRA. DEFRA's Guidance notes *FD2320/TR2 'Flood Risk Assessment Guidance for New Development'*[35] and *FD2321/TR2 'Flood Risks to People'*[36] should also be consulted.

[35] http://sciencesearch.defra.gov.uk/Document.aspx?Document=FD2320_3364_TRP.pdf

[36] http://randd.defra.gov.uk/Document.aspx?Document=FD2321_3437_TRP.pdf

## 11.4 Requirements for flood risk assessments

The aim of an FRA is to demonstrate that the development is protected to the 1 in 100-year (1% AEP) event and is safe during the design flood event, including an allowance for climate change. This includes assessment of mitigation measures required to safely manage flood risk. Where appropriate, the following aspects of flood risk should be addressed in all planning applications in flood risk areas:

- The area liable to flooding
- The probability of flooding occurring now and over time
- The extent and standard of existing flood defences and their effectiveness over time
- The likely depth of flooding
- The rates of flow likely to be involved
- The likelihood of impacts to other areas, properties and habitats
- The effects of climate change
- The nature and currently expected lifetime of the development proposed and the extent to which it is designed to deal with flood risk

Development proposals requiring FRAs should therefore:

- Apply the Sequential and, when necessary, Exception Tests
- Not increase flood risk, either upstream or downstream, of the site, taking into account the impacts of climate change
- Not increase surface water volumes or peak flow rates, which would result in increased flood risk to the receiving catchments
- Use opportunities provided by new development to, where practicable, reduce flood risk within the site and elsewhere
- Ensure that where development is necessary in areas of flood risk (after application of Sequential and Exception Tests), it is made safe from flooding for the lifetime of the development, taking into account the impact of climate change
- All sources of flood risk, including fluvial, surface water, groundwater and drainage need to be considered

FRAs for sites located in the borough of Broxbourne should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Broxbourne Borough Council. In circumstances where FRAs are prepared for windfall sites then they should include evidence that demonstrates the proposals are in accordance with the policies described in the Local Plan.

In circumstances where FRAs are prepared for windfall sites then they should include evidence that demonstrates the proposals are in accordance with the policies described in the Local Plan.

### 11.4.1 Climate Change Guidance

The Environment Agency published new climate change guidance on **19 February 2016**[37], which must now be considered in all new developments and planning applications.

*The following information is provided as an excerpt from the guidance; full details of which can be found at the hyperlink below.*

**Peak River Flows**

The peak river flow allowances show the anticipated changes to peak flow by river basin district. A river basin map is provided, and a range of allowances based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it. The:

37 https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

- central allowance is based on the 50th percentile
- higher central is based on the 70th percentile
- upper end is based on the 90th percentile

**Decide which peak river flow allowances to use for different types of assessment**

The Environment Agency uses the following data and standards as the benchmarks for the advice it gives as a statutory consultee:

- peak river flow allowances by river basin district for both flood risk assessments and strategic flood risk assessments
- flood risk vulnerability classification for the type of development and Flood Zone, over the lifetime of the proposed development, in development plan allocations for strategic flood risk assessments
- flood risk vulnerability classification for the type of development and Flood Zone as a guide to decide which allowances to use based on the vulnerability of the development for flood risk assessments - the lifetime of the proposed development should be considered to decide which future time period to use.

The Environment Agency will want to see if it has been considered to apply 'high++ allowances' for a Flood Risk Assessment.

The peak rivers flows by the Thames River Basin District are shown in Table 5-8 in section 5.9.4.

The Flood Zone and appropriate flood risk vulnerability classification should be considered to decide which allowances applies to the development or plan. This will help the range of impact to be understood.

**In Flood Zone 2**

- essential infrastructure – use the higher central and upper end to assess a range of allowances
- highly vulnerable – use the higher central and upper end to assess a range of allowances
- more vulnerable – use the central and higher central to assess a range of allowances
- less vulnerable – use the central allowance
- water compatible – use none of the allowances

**In Flood Zone 3a**

- essential infrastructure – use the upper end allowance
- highly vulnerable – development should not be permitted
- more vulnerable – use the higher central and upper end to assess a range of allowances
- less vulnerable – use the central and higher central to assess a range of allowances
- water compatible – use the central allowance

**In Flood Zone 3b**

- essential infrastructure – use the upper end allowance
- highly vulnerable – development should not be permitted
- more vulnerable – development should not be permitted
- less vulnerable – development should not be permitted
- water compatible – use the central allowance

### Peak rainfall intensity allowance

Increased rainfall affects river levels and land and urban drainage systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments.

For FRAs, both the central and upper end allowances should be assessed to understand the range of impact.

The peak rainfall intensity allowance in small and urban catchments are shown in Table 5-9 in section 5.9.4.

To help decide which allowances to use to inform the flood levels that the flood risk management strategy will be based on for a development or development plan allocation, the following should be considered:

- likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s)
- vulnerability of the proposed development types or land use allocations to flooding
- 'built in' resilience measures used, for example, raised floor levels
- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach

**Temporary exceptions for transitional arrangements that apply as of 19 February 2016**

For assessments prepared using the previous allowances (published in 2013), the Environment Agency will base its advice on the previous allowances where development plans or proposals are well advanced. This will include:

- a development plan already submitted for examination
- a valid planning application already submitted to the local planning authority

If a development is particularly sensitive to flood risk or in a vulnerable location, Environment Agency will base its advice on the allowances in this advice.

It is recommended that the impact of climate change to a proposed site is considered as part of a detailed Flood Risk Assessment and uses percentage increases which relate to the proposed lifetime of the development and the vulnerability classification of the development. The Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice. Contact your local Environment Agency office for a consultation. Contact the Lead Local Flood Authority for advice on flood risk from local watercourses, surface, or groundwater.

## 11.5 Mitigation measures

In accordance with the Flood Risk Management Hierarchy described in Figure 1-1, mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

Often the determining factor in deciding whether a particular development is appropriate is the practical feasibility, financially viability and long term maintenance implications of flood risk mitigation rather than technical limitations. Detailed technical assessments are required in the FRA to assess the practical feasibility, together with a commercial review by the developer of the cost of the mitigation works and how contributions will be made for their long term maintenance. At the SFRA stage, broad assumptions must be made regarding the feasibility of flood risk mitigation to highlight sites with greater development potential. The formulation of measures that not only provides an appropriate standard of protection to new development, but also reduces the risk to existing communities will be an important consideration.

There should be no interruption to flood flows or loss of flood storage as a result of any proposed development. Flood storage compensation may be appropriate for sites on the edge of the existing floodplain or within a flood cell.

Attention must also be paid to the provision of safe access and egress during flood events, including climate change, and how this is linked to flood warning and emergency evacuation where necessary (see Section 9.5 for further information relating to emergency planning and the NPPF). The Emergency Services and local authority should be consulted on the evacuation and rescue capabilities and any advice or requirements included.

Finished Floor Levels (FFL) are usually recommended in line with the Environment Agency's Guidance on Flood Risk, which require a minimum FFL of 600mm above the 1 in 100-year (1% AEP) with allowance for climate change (accounting for latest guidance). This additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". In

line with Part H of the Building Regulations, it is also recommended that FFL should be set at least 150mm above the surrounding ground levels to prevent flooding from flowing or ponding storm-water near doorways and other ingress routes. It should be noted that further recommendations for FFL may arise from other sources of flood risk which may require a higher FFL.

Surface water flood risk mitigation should also be considered, in the form of an outline drainage strategy, which seeks to ensure the surface water drainage system employed at the new development will provide flood risk mitigation within the development and will not cause an increase in flood risk to other nearby areas. The frequency, rate and volume of run-off from the development should be managed to achieve a Greenfield rate. On previously developed land, a Greenfield rate must be achieved, except in exceptional cases which are agreed with the LLFA. Where Greenfield rates cannot be achieved, a betterment rate will be agreed with the LLFA.

The minimum acceptable standard of protection against flooding for new residential property within flood risk areas is the 1 in 100-year event for fluvial flooding and 1 in 100-year storm for surface water flooding. Developments susceptible to flood risk resulting from blockage or exceedance of structures should be protected beyond the 1 in 100-year plus climate change scenario. An allowance for climate change over the lifetime of the development must be made when assessing each of these scenarios, in line with the new government guidance on climate change allowances. The measures chosen will depend on the nature of the flood risk.

Whilst it might be possible to identify appropriate flood mitigation measures for some sites, it is worth noting that in some instances the findings of individual FRAs may determine that the risk of flooding to a proposed development is too great and mitigation measures are not feasible or appropriate. In these instances, the development is likely to be subject to an objection by the Environment Agency.

## 11.6 Reducing flood risk

### 11.6.1 Reducing flood risk through site layout and design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas. However, vehicular parking in floodplains should be based on the nature of parking, flood depths and hazard including evacuation procedures and flood warning.

Waterside areas, or areas along known flow routes, can act as Green Infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

The green infrastructure projects identified within the 2011 Hertfordshire Strategic Green Infrastructure Plan[38] forms a basis for evaluating future development proposals against the proposed green infrastructure network. Figure 4.1 within this document provides an overview of how green infrastructure can be embedded within the development management process.

### 11.6.2 Building design

Internal areas of new development should be designed to be dry during the 1 in 1,000-year (0.1% AEP) flood event.

The raising of floor levels within a development also avoids damage occurring to the interior, furnishings and electrics in times of flood, as discussed in Section 11.4.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels.

38 HCC Hertfordshire Strategic Green Infrastructure Plan, Final Report, March 2011: http://www.hertsdirect.org/docs/pdf/s/SHiP.pdf

The Environment Agency do not consider that putting a building on stilts is an acceptable means of flood mitigation for new development. However, it may be allowed in special circumstances if it replaces an existing solid building, as it can improve flood flow routes. In these cases, attention should always be paid to safe access and egress and a legal agreement should be entered into to ensure the ground floor use is not changed.

The Broxbourne Borough Council website has a section on design guidance and information; here, it lists what the Council and developers should take into account into order to work together to delivery high quality development (above and beyond flood risk issues). This includes taking into consideration design policies within the Local Plan.

#### Two or three storey properties

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days.

### 11.6.3 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution.

Temporary or demountable defences are not acceptable forms of flood protection for a new development but might be appropriate to address circumstances where the consequences of residual risk are severe. In addition to the technical measures the proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate.

### 11.6.4 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the risk is entirely from tidal flooding or the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property.

In most areas of fluvial flood risk, raising land above the floodplain would reduce conveyance or flood storage in flood cells and could adversely impact flood risk downstream or on neighbouring land.

Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary (unless the site is strategically allocated).

Raising ground levels can also deflect flood flows, so analyses should be performed to demonstrate that there are no adverse effects on third party land.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

### 11.6.5 Resistance and resilience

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above; for example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 1 in 100-year event (0.1% AEP). In these cases, and for existing development in the floodplain, additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not be relied on as the only mitigation method.

### Permanent barriers

Permanent barriers can include built-up doorsteps, rendered brick walls and toughened glass barriers.

### Temporary barriers

Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale, temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.

### Wet-proofing

Interior design measures to reduce damage caused by flooding. For example:

- Electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level
- Water-resistant materials for floors, walls and fixtures
- Non-return valves to prevent waste water from being forced up bathrooms, kitchens or lavatories
- If redeveloping existing basements for non-residential purposes, new electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level to minimise damage if the development floods

Resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by the FRA.

### Community Resilience Measures

These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

## 11.6.6 Developer contributions

In some cases, and following the application of the Sequential Test, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both the proposed new development and the existing local community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS).

Defra's Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[39] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme. FCRMGiA should not be used to enable new development to come forward, which should be bearing full costs itself.

The NPPF (Paragraph 204) also sets out legal tests required in order for planning obligations to be sought (where it is not possible to address unacceptable impacts through a planning condition). These are:

- Necessary to make the development acceptable in planning terms;
- Directly related to the development; and
- Fairly and reasonable related in scale and kind to the development.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer.

39 Principles for implementing flood and coastal resilience funding partnerships (Environment Agency, 2012)

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not mean the development is appropriate as other policy aims must also be met. Funding from developers should be explored prior to the granting of planning permission and in partnership with the LPA and the Environment Agency.

The appropriate route for the consideration of strategic measures to address flood risk issues is the LFRMS. The LFRMS should describe the priorities with respect to local flood risk management, the measures to be taken, the timing and how they will be funded. It will be preferable to be able to demonstrate that strategic provisions are in accordance with the LFRMS, can be afforded and have an appropriate priority.

The Environment Agency is committed to working in partnership with developers to reduce flood risk. Where assets are in need of improvement or a scheme can be implemented to reduce flood risk, the Environment Agency request that developers contact them to discuss potential solutions. The Partnerships and Strategic Overview Team who manage these partnerships can be contacted by calling 03708 506 506 (Mon-Fri, 8am - 6pm). There is also a minicom service available (03702 422 549 - National Customer Contact Centre).

## 11.7 Making Space for water

The NPPF sets out a clear policy aim in Flood Zone 3 to create space for flooding by restoring functional floodplain.

All new development close to rivers should consider the opportunity presented to improve and enhance the river environment. Developments should look at opportunities for river restoration and enhancement as part of the development. Options include backwater creation, de-silting, in-channel habitat enhancement and removal of structures. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

### 11.7.1 Buffer strips

The LFRMS Standing Condition ensures the provision of a buffer strip to ‘make space for water’, allow additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes.

It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult.

### 11.7.2 Drainage capacity

The capacity of internal drainage infrastructure is often limited and is at or near capacity of the piped network under existing conditions. Development that leads to increased peak runoff within the drainage catchments may lead to infrastructure capacity being exceeded, with the potential for increased flood risk. Development locations should be assessed to ensure capacity exists within both the on and off site network. Where suitable, SuDS should be utilised to reduce the impact of surface runoff entering the network and ease the pressure of the development on downstream systems.

## 11.8 Reducing flood risk from other sources

### 11.8.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk would be through building design (development form), ensuring floor levels are raised above the water levels caused by a 1 in 100-year plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream.

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk on or off of the site. Developers should provide evidence and ensure that this will not be a significant risk.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an acceptable solution.

### 11.8.2 Surface water and sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development must improve the drainage infrastructure to reduce flood risk on site and regionally. It is important that a drainage impact assessment shows that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled. The site should be designed so that these flow routes are preserved and building design should provide resilience against this residual risk.

When redeveloping existing buildings, the installation of some permanent or temporary flood-proofing and resilience measures could protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques.

### 11.8.3 Sustainable Drainage Systems (SuDS)

Surface water flood risk mitigation should also be considered, in the form of an outline drainage strategy, which seeks to ensure the surface water drainage system employed at the new development will provide flood risk mitigation within the development and will not cause an increase in flood risk to other nearby areas. The frequency, rate and volume of run-off from the development should be managed to achieve a Greenfield rate. On previously developed land, a Greenfield rate must be achieved, except in exceptional cases which are agreed with the LLFA. Where Greenfield rates cannot be achieved, a betterment rate will be agreed with the LLFA.

The inclusion of SuDS within developments should be seen as an opportunity to enhance water quality treatment, ecological and amenity value, and promote Green Infrastructure, incorporating above ground facilities into the development landscape strategy. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. Advice on best practice is available from the Environment Agency and CIRIA. Additionally, Hertfordshire County Council produced a SuDS Policy Statement in March 2015[40]. This documents are summarised in Section 8 in greater detail.

Certain SuDS techniques may be constrained due to the nature of the geology, groundwater vulnerability and groundwater SPZs in the borough. In this instance, it is unlikely that infiltration drainage will be suitable; this is discussed further in Section 8.7.

Developers and planning applications must adhere to development conditions imposed by the East Hertfordshire and Broxbourne Surface Water Management Plan, when this is published in late 2016.

40 Hertfordshire SuDS Policy Statement: http://www.hertsdirect.org/docs/pdf/h/hccsudspolicies.pdf

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# 12 Strategic flood risk solutions

## 12.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the borough. As described in Section 2.6 Broxbourne has been assigned Policy 5 under the Thames CFMP which means further actions can be taken to reduce flood risk. Of the actions identified in the CFMP all are applicable to Broxbourne.

The first relates to delivering actions recommended in the Flood Risk Management Strategies for the Lower Lee; the guidance for planners and developers set out within this document and by Broxbourne Borough Council should ensure this action is followed.

The second relates to encouraging partners to develop policies, strategies and initiatives to increase the resistance and resilience of all new development at risk of flooding and to adapt the existing urban environment to be more flood resilience. Guidance on resistance and resilience measures is contained within Section 11.6 and further details are provided in the following sections.

The third relates to the compatibility between urban open spaces and their ability to make space for rivers to expand and flood flows occur. Use of flood storage schemes and floodplain restoration can help towards achieving this action. Further details are provided in the following sections.

The fourth relates to emergency planning and public awareness. Local arrangements for emergency planning and national planning policy requirements in relation to emergency planning aspects of new developments, are contained within Section 9.

## 12.2 Flood defences

There are a number of formal flood defences present within Broxbourne borough (see Section 6 for further information).

Flood mitigation measures should only be considered if, after application of the Sequential Approach, development sites cannot be located away from higher risk areas. If defences are constructed to protect a development site, it will need be demonstrated that the defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.

## 12.3 Flood storage schemes

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding. Development increases the impermeable area within a catchment, creating additional and faster runoff into watercourses. Flood storage schemes aim to detain this additional runoff, releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include[41]:

- enlarging the river channel;
- raising the riverbanks; and/or
- constructing flood banks set back from the river.

Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area.

The construction of new upstream storage schemes as part of upstream catchment-based approaches on a number of watercourses within Broxbourne would provide one potential strategic solution to flood risk. Watercourses which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream. It should be noted that often such schemes are driven by requirements outlined by the LLFA and the Environment Agency.

41 http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide/Chapter10.aspx?pagenum=2

No new upstream flood storage areas for the River Lee are proposed within the Lower Lee FRMS; it recommends maintaining the existing flood storage areas to Theobalds and Cheshunt North.

Essentially, opportunities to work with natural processes to reduce flood and erosion risk, benefit the natural environment and reduce costs of schemes should be sought, requiring integrated catchment management and involving those who use and shape the land. It also requires partnership working with neighbouring authorities, organisations and water management bodies.

Conventional flood prevention schemes listed above will likely still be preferred, but consideration of 're-wilding' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example. With flood prevention schemes, consideration needs to be given to the impact that flood prevention has on the WFD status of watercourses. It is important that any potential schemes do not have a negative impact on the ecological and chemical status of waterbodies.

### 12.3.1 Promotion of SuDS

Surface water flood risk is present in the borough. By considering SuDS at an early stage in the development of a site, the risk from surface water can be mitigated to a certain extent within the site as well as reduce the risk that the site poses to third party land. Regionally SuDS should be promoted on all new developments to ensure the quantity and quality of surface water is dealt with sustainably to reduce flood risk. Given the detailed policies and guidance produced by the LLFA (summarised in Section 8) Broxbourne Borough Council should actively promote developers to use this information to produce technically proficient and sustainable drainage solutions.

## 12.4 Floodplain restoration

Compared to flood defences and flood storage, floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains working with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures should be adopted:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the river and the floodplain. There are a number of culverted sections of watercourse located throughout the borough which if returned to a more natural state would potentially reduce flood risk to the local area
- Apply the Sequential Approach to avoid new development within currently undefended floodplain.

For those sites considered within the Local Plan and / or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain. This is particularly important for the sites located on the tributaries of the River Lee, in the western part of the borough. Loss of floodplain connectivity in the upper reaches of these tributaries which flow through urban areas in the borough, could potentially increase flooding within these areas. This will also negate any need to build flood defences within the sites. It is acknowledged that sites located on the fringes of urban areas within the borough are likely to have limited opportunity to restore floodplain in previously developed areas.

## 12.5 Green Infrastructure and Blue Corridors

### 12.5.1 What is Green Infrastructure and Blue Corridors?

There are multiple definitions of Green Infrastructure (GI); GI can be defined as a strategically planned and managed network of greenspaces and environmental components, which connect and surround the urban built environment and rural settings and consist of

- open spaces – lakes, nature reserves, woodland, parks, wetlands, and formal gardens;
- connections \ linkages – greenways, canals and river corridors, pathways and cycle routes; and/or
- "urban green" networks – green roofs, private gardens, street trees and verges.

The NPPF defines GI as: *"a network of multi-functional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities."*[42]

GI is a multi-functional resource; it is capable of proving numerous services and benefits across many different sectors including climate change and sustainable development. It is central to climate change action and is referred to frequently in the planning policy. Identifying and planning for GI is intrinsic to sustainable growth and therefore, merits investment and consideration as much as other socio-economic priorities.

'Blue corridors' can be described as the environment located alongside a watercourse such as the banks and immediate floodplain either side. Its primary function is to allow the dispersion of flood water when the river channel becomes too full, and also provides natural habitat and amenity value to an area.

### 12.5.2 GI Strategies and Policies

Broxbourne Borough Council will encourage the enhancement of blue corridors and green infrastructure in all development across Hertfordshire to help reduce flood risk as well as helping to meet the requirements of the WFD.

The 2010 Water Cycle Study states that there is an opportunity to link the design of SuDS with Green Infrastructure Strategies, to provide an integrated network that relieves flood risk whilst enhancing biodiversity e.g. attenuation basins and wetlands.

The Hertfordshire Strategic Green Infrastructure Plan (HCC, 2011)[43] details strategic planning and site design and management practices to inform spatial land planning and development management decisions. Within this Plan, the Broxbourne Woods Complex is listed as a strategic site and it is noted that Broxbourne has a proportionally higher than average provision of Accessible Natural Greenspace (as defined by Natural England). A proposed GI project in this Plan is the Lee Valley Regional Parks Lateral Links project which may offer flood management benefits. The 2015 Hertfordshire County Council SuDS Design Guidance for Hertfordshire contains further advice and demonstrations of Green and Blue Infrastructure.

### 12.5.3 Using this SFRA to support GI plans and strategies

The evidence base provided in this SFRA should be used to help inform any Green Infrastructure Plans or Strategies in Broxbourne. River corridors identified as functional floodplain can provide flood storage during a flood event. The Council GI strategies should also incorporate any areas identified within the urban environment or upstream of a critical surface water flood area. Creating flood storage areas or flow paths areas and improving accessibility to this land can help protect current and future property.

Potential development site locations, as identified by the Council, which have watercourses flowing through them, provide an opportunity to use the land as green infrastructure by adopting the Sequential design to locate development away from watercourses and Flood Zones, and by the use of SuDS. This can provide multiple benefits across a number of disciplines including flood risk and biodiversity / ecology and may provide opportunities to use the land for an amenity and recreational purposes.

Run-off from green space can cause flooding in developed areas and this should be considered in the Surface Water Management Plan proposed for Broxbourne.

42 NPPF (2012) National Planning Policy Framework: Annex 2: Glossary, page 50.

43 HCC Hertfordshire Strategic Green Infrastructure Plan, Final Report, March 2011: http://www.hertsdirect.org/docs/pdf/s/SHiP.pdf

## 12.6 Artificial or Heavily Modified Water Bodies

Whilst good ecological status is defined as a slight variation from undisturbed natural conditions in natural water bodies, artificial and heavily modified water bodies are unable to achieve natural conditions i.e. the Lee Navigation Channel. Instead, artificial and heavily modified have a target to reach Good Ecological Potential, which recognises their important uses, whilst making sure ecology is protected as far as possible. Ecological potential is also measured on the scale high, good, moderate, poor and bad. The chemical status of these water bodies is measured in the same way for natural water bodies.

Specific mitigation measures have been identified for each Artificial and Heavily Modified Waterbody and are listed in the RBMP. These mitigation measures are necessary to reduce the existing hydromorphological impacts on the waterbody and all measures need to be in place in order for the waterbody to achieve Good Ecological Status or Potential.

## 12.7 WFD Assessments

A detailed assessment should be undertaken to determine the effects that any proposed works within or adjacent to a watercourse could have upon Water Quality Elements. Any impacts identified should then be considered in relation to the Ecological, Hydromorphological and Chemical Status of the waterbody and the status objectives.

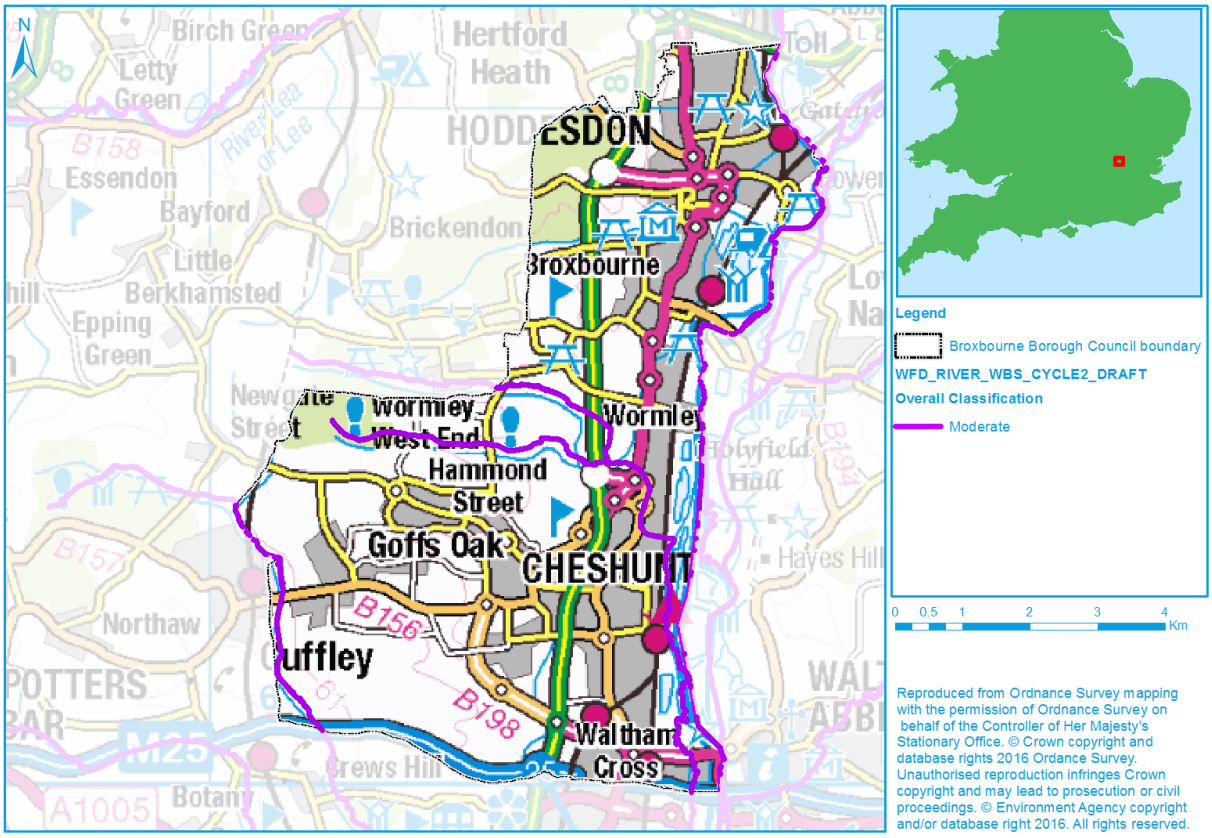
In order to establish whether the strategy complies with the WFD it is necessary to ascertain whether the preferred options have the potential to result in

- failure of a water body to achieve good ecological status or potential; or
- failure to prevent a deterioration in the ecological status or potential of a water body.

If the answer to these questions is ‘no’ the strategy can be considered WFD-compliant. If either of these failures is identified, further assessment may be required to identify if the strategy meets all of the conditions set out by the WFD Legislation.

A map showing the overall status of the main waterbodies in the Broxbourne Borough Council administrative area is shown in Figure 12-1. This is based on the classification status for water bodies reported in 2015. Note, not all the watercourses in the study area are shown on this map. All watercourses are classed as 'Moderate'; the Cuffley Brook, the Turnford Brook and the River Lee Navigation Channel. Future development should ensure there is no adverse impact on the quality of watercourses within the Council administrative area. Opportunities to improve the status of watercourses should also be considered.

Figure 12-1: WFD Classification of Watercourses




## 12.8 Example Restoration Options and assessments

### 12.8.1 Structure Removal and / or modification (e.g. Weirs)

Structures, both within watercourses and adjacent to them can have significant impacts upon rivers including, alterations to the geomorphology and hydraulics of the channel through water impoundment and altering sediment transfer regime, which over time can significantly impact the channel profile including bed and bank levels, alterations to flow regime and interruption of biological connectivity, including the passage of fish and invertebrates.

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose and opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring natural river processes, habitats and connectivity are vital adaptation measures. However, it also must be recognised that some artificial structures may have important functions or historical/cultural associations, which need to be considered carefully when planning and designing restoration work.

In the case of weirs, whilst weir removal should be investigated in the first instance, in some cases it may be necessary to modify a weir rather than remove it. For example by lowering the weir crest level or adding a fish pass. This will allow more natural water level variations upstream of the weir and remove a barrier to fish migration.

Further information is provided in the 'Trash and Security Screen Guide 2009'[44], published by the Environment Agency/ Defra, which should be used as evidence for any culvert assessment, improvement or structure retention.

44 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291172/scho1109brhf-e-e.pdf

### 12.8.2 Re-naturalisation

There is potential to re-naturalise a watercourse by re-profiling the channel, removing hard defences, re-connecting the channel with its floodplain and introducing a more natural morphology (particularly in instances where a watercourse has historically been modified through hard bed modification). Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response to any proposed channel modification.

### 12.8.3 Enhancing outfalls and bridge wing walls in the riparian environment

Concrete outfalls and bridge wing walls can be unsightly and un-sympathetic to the riparian environment. Outfalls can often create localised scour if they are installed at the wrong angle which can result in bank instability and sediment deposition downstream, as well as damage the habitat of the riparian ecology. In some instances, outfalls are also installed which are oversized for the purpose required.

In most cases the structural elements of outfalls and bridge wing walls must comprise pre-case concrete; however, the detail around the structure can be designed so as to fit in with the riparian environment and improve the visual amenity and habitat. Example sustainable techniques include:

- Gabions with natural stone facing with coir matting and planting at the surface; and
- Concrete bagwork around the pre-cast concrete which provides a more suitable surface for a variety of vegetation to establish.

### 12.8.4 Bank Stabilisation

It is generally recommended that bank erosion is avoided where possible and encourage all landowners to avoid using machinery and vehicles close to or within the watercourse.

There are a number of techniques that can be employed to restrict the erosion of the banks of a watercourse. In an area where bankside erosion is particularly bad and/or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow spiling, can be particularly effective. Live willow stakes thrive in the moist environment and protect the soils from further erosion allowing other vegetation to establish and protect the soils.

## 12.9 Engaging with key stakeholders

Flood risk to an area or development can often be attributed to a number of sources such as fluvial, surface water or groundwater. In rural areas the definition between each type of flood risk is more distinguished; however, within urban areas flooding from multiple sources can become intertwined. Where complex flood risk issues are highlighted it is important that all stakeholders are actively encouraged to work together to identify issues and provide suitable solutions.

Engagement with riparian owners is also important to ensure they understand their rights and responsibilities including:

- maintaining river beds and banks;
- allowing the flow of water to pass without obstruction; and
- controlling invasive alien species e.g. Japanese knotweed.

More information about riparian owner responsibilities can be found in the Environment Agency publication ‘Living on the Edge’ (2012)[45].

45 Living on the edge: a guide to your rights and responsibilities of riverside ownership (Environment Agency, 2014)

# 13 Flood risk management policy considerations

## 13.1 Overview

The following section set out recommendations for inclusion in Broxbourne Borough Council's policy for flood risk management and development control. The policy recommendations are not exhaustive and it is recommended the Council refer to the key policy and management documents outlined in Section 2 to fully inform the development of their flood policies.

## 13.2 Council-specific policies

### 13.2.1 Local Plan

Currently the Broxbourne Local Plan Second Review (covering the 2001 - 2011 period) is the adopted Local Plan and provides the framework for planning decisions throughout the borough in tandem with the then applicable National Planning Practice Guidance. This was adopted in 2005 and was automatically saved for three years. There are also supporting strategies for Hoddesdon Town Centre and Waltham Cross Town Centre.

At the time of preparing this SFRA, Broxbourne Borough Council were in the process of compiling a new Local Plan aimed at shaping development between 2016 and 2031. This SFRA will be used as an evidence base, to support the production of the new Local Plan and inform the Council's policies in relation to development and flood risk. These will eventually replace the saved policies from the 2005 District Plan.

All planning matters and applications should refer to Broxbourne Borough Council's adopted Local Plan, and in the interim of the new Local Plan being established, take into account saved and emerging Council policies on development and flood risk including drainage and surface water.

### 13.2.2 Site Allocations

Site Allocations were screened to provide a summary of flood risk to each site (see Appendix H), including:

- The proportion of the site in each Flood Zone
- Whether the site is shown to be at risk in the uFMfSW and, if so, the lowest return period from which the site is at surface water flood risk
- Whether the site is within, or partially within, the Environment Agency's Historic Flood Map.

Where a site is shown to be in either Flood Zone 2 and/or 3, and/or has an ordinary watercourse running through or adjacent to it, the flood risk to the sites is recommended to be investigated in more detail as part of a Level 2 SFRA. These sites are highlighted in orange in Appendix H.

Inclusion of Site Allocations in the SFRA does not mean that development can be permitted without further consideration of the Sequential Test. The required evidence should be prepared as part of a Local Plan Sustainability Appraisal or alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan. The assessments undertaken for this SFRA will assist the Council when they undertake the Sequential Test.

## 13.3 NPPF: Development control considerations

The following recommendations have been identified for flood risk policy for new development. The first recommendations are relevant to all development regardless of the Flood Zone they are in. The remaining recommendations are relevant to specific Flood Zones (note some policies are relevant to more than one flood zone and hence will have been repeated).

Recommendations relevant for development in all Flood Zones (1, 2, 3a, 3b)

- At the planning application stage, developers need to undertake more detailed hydrological and hydraulic assessments where Flood Zones do not currently exist for smaller watercourses and drains. This is to verify flood extent, inform development zoning

within the site and prove, if required, whether the Exception Test can be passed. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

- A FRA is required for all developments over 1ha and should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development. FRAs should account for flooding from all sources including rivers, directly from rainfall on the ground surface and rising groundwater, overwhelmed and blocked sewers/drainage systems and from reservoirs, canals and lakes and other artificial sources. The LPA and Environment Agency should be consulted to confirm the level of assessment required and to provide any information on any known local issues. Local requirements may be imposed on an FRA if there is a high risk of flooding from a particular source.
- Guidance on the preparation of FRAs is provided in the NPPF Planning Practice Guidance Flood Risk and Coastal Change.
    - If a small watercourse (i.e. catchment area less than 3 km2) is located within 100m of a site, more detailed assessment of this watercourse should be undertaken so the flood risk from the site can be defined.
    - The Local Planning Authority should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding.
- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water, allowing for climate change effects. They should also show that flood risk elsewhere will not be exacerbated by increased levels of surface runoff. Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems.
- Post development runoff volumes and peak flows should attenuate back to Greenfield discharge rates, and where possible aim to reduce this. Total volume reduction should be agreed with the LLFA.
- Surface water runoff management should be undertaken, through the utilisation of appropriate SuDS techniques, prioritising the use of surface SuDS features which provide additional benefits (e.g. biodiversity, amenity space)
- Normally no buildings should be constructed within eight metres of the banks of watercourses. This will allow access for maintenance, as well as providing an ecological corridor.

**Recommendations for Flood Zone 1**

Fluvial flood risk is not a significant constraint to development within Flood Zone 1. However, there are a number of locations in Zone 1 where flooding from ordinary watercourses or drains are not shown on Environment Agency flood maps and this should be reviewed and assessed as appropriate. There is also residual risk, in some locations, from reservoirs within the borough.

- A FRA is required for all developments over 1ha.
- Reference should be made to the Hertfordshire Local Flood Risk Management Strategy and the Lower Lee Local Flood Risk Management Strategy and consideration given to requirements for the management of local flood risk.

**Recommendations for Flood Zone 2**

Most development is permitted in Flood Zone 2 with the exception of Highly Vulnerable development. Highly vulnerable development is only permitted if it has passed the Exception Test.

- A FRA is required for all developments within this zone.
- Development design should incorporate mitigation measures, to manage any flood risk to the development, including residual risk. FFLs should be above the 1 in 100-year (1% AEP) flood level, with an allowance for climate change, plus a minimum freeboard of 600mm.
- The layout of buildings and access routes should adopt a sequential approach, steering buildings towards areas of lowest risk within the site. Safe access to and from the development should be above the 1 in 100-year flood level, plus an allowance for climate change, and emergency vehicular access should be possible during times of flood.
- Climate change guidance published in February 2016 should be consulted and an approach agreed with the Environment Agency in terms of its application to the FRA (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances).

**Recommendations for Flood Zone 3a**

Development in Flood Zone 3a is significantly constrained by flood risk. Highly Vulnerable development is not permitted within this zone and More Vulnerable development and Essential Infrastructure are only permitted if the Exception Test can be passed.

- A FRA is required for all developments within this zone.
    - It should be demonstrated that flood defences provide an acceptable standard of protection, including an allowance for climate change for the lifetime of the development.
    - Residual risks should be assessed, and the Environment Agency consulted regarding whether there is a need for a breach analysis to map a rapid inundation zone.
- Climate change guidance published in February 2016 should be consulted and an approach agreed with the Environment Agency in terms of its application to the FRA (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances).
- The layout of buildings and access routes should adopt a sequential approach, steering buildings towards areas of lowest risk within the site. Where rapid inundation zones have been identified, development should be avoided in these areas. Safe access to and from the development should be above the 1 in 100-year flood level, plus an allowance for climate change, and emergency vehicular access should be possible during times of flood.
- Development should not impede flow routes, reduce floodplain storage or consume flood storage in a 'flood cell' within a defended area. If the development does result in a loss of storage, compensatory floodplain storage may need to be provided on a 'level for level' and 'volume for volume' basis in an undefended area.
- Sustainable Drainage Systems should be located outside of Flood Zone 3.
- If existing defences are to be upgraded as part of the development, an assessment should be undertaken to ensure it does not result in an increase in flood risk elsewhere.
- It is recommended that all types of new development behind flood defences is avoided, where possible, due to the residual risks of breach and overtopping
- Consideration should be given to the type of building that will be permitted, for example single-storey buildings and basements should be avoided. No built development on stilts should be considered in Flood Zone 3a.
- Development design should incorporate mitigation measures, to manage any flood risk to the development, including residual risk for the lifetime of the development. FFLs should be above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.
- With regards to the SFRA Flood Zones, it is important to note that the SFRA identified Flood Zone 3b as land which would flood with an annual probability of 1 in 20 years, where detailed modelling exists. In the absence of detailed hydraulic model information, a precautionary approach has been adopted with the assumption that the extent of Flood Zone 3b would be equal to Flood Zone 3a. If development is shown to be in Flood Zone 3a, further work should be undertaken as part of a detailed site specific flood risk assessment to define the extent of Flood Zone 3b.

**Recommendations for Flood Zone 3b (Function Floodplain)**

Development is highly constrained within Flood Zone 3b. Only Essential Infrastructure and Water Compatible uses are permitted in this zone, and only if the Exception Test has been passed.

Functional floodplain is vital for the conveyance and storage of floodwater. Development within this zone will potentially impede the flow of floodwater as well as result in a loss of flood storage, increasing flood risk both within the area and further downstream. Consideration should be given to 'rolling back' development in this zone, withdrawing development from the floodplain and allowing it to return back to a natural floodplain. This has an additional benefit of reducing flood risk to communities further downstream.

Where flood outlines of Flood Zone 3b are not available, Flood Zone 3 should be considered as Flood Zone 3b unless, following further work as part of a site-specific FRA, and in consultation with the Environment Agency, it can be proven as Flood Zone 3a.

- Essential infrastructure and water-compatible development should only be allocated in this zone if no reasonable alternative sites are available in areas of lower flood risk.
- A detailed site-specific Flood Risk Assessment (FRA) is required for Essential Infrastructure and water-compatible development within this zone and should include evidence to demonstrate the Exception Test has been passed. Should the site pass the Exception Test, it 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
- Development should not impede flow routes or reduce floodplain storage. If the development does result in a loss of storage, compensatory floodplain storage may be required, if agreed, on a 'level for level' and 'volume for volume' basis.
- Development design should incorporate mitigation measures, to manage any flood risk to the development, including residual risk. Floor levels should be above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.
- Climate change guidance published in February 2016 should be consulted and an approach agreed with the Environment Agency in terms of its application to the FRA (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances).

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# 14 Summary

## 14.1 Level 1 SFRA

### 14.1.1 Sources of flood risk

- Flood history shows that the borough of Broxbourne has been subject to flooding from several sources of flood risk, with the principal risk from fluvial sources throughout the borough. Additionally, the uFMfSW shows a notable surface water flood risk throughout the study area and historic flood records include surcharging culverts and local drains. Though limited, there have also been historic cases of groundwater flooding.
- The principal watercourses flowing through the study are the River Lee network including the Lee (Upper), Small River Lee and Lee Navigation Channel (Lower) and its tributaries including the Spital Brook, Turnford Brook, College Brook, Rags Brook and Windmill Lane Ditch. The majority of recorded fluvial flood events are associated with these watercourses.
- Since the 1947 flood, a number of measures have been constructed across the Lower Lee catchment, to alleviate the risk of flooding. Of particular note is the Lower Lee Flood Relief Channel and the Turnford and Rags Brook Improvements Schemes. However, a number of the recorded flood events dated post-1947 show the flood relief channel almost reached capacity in 1987, 1993 and 2000.
- The primary fluvial flood risk is located along the River Lee corridor, around the eastern boundary of the borough. Flood Zone 3 is generally contained east of the railway line; however, Flood Zone 2 extends west of the railway line, posing flood risk to a significant number of properties. The floodplain associated with the tributaries of the River Lee network are generally narrow until reaching the urban areas and / or towards the confluences with the River Lee network.
- The borough of Broxbourne has experienced a number of historic surface water / drainage related flooding caused by a number of mechanisms from insufficient storm and combined drainage capacity to poor surface water management. The uFMfSW further shows a number of prominent overland flow routes in the borough; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. In addition, a number of these follow local road infrastructure. Of particular note are urban areas within the Rosedale, Flamstead End and Churchgate triangle which are shown to be at significant risk within the uFMfSW.
- The Thames Water DG5 register indicates a total of 36 recorded flood incidents in Broxbourne Borough Council administrative area. The more frequently flooded postcodes are EN8 8, with 15 records, followed by EN10 7 with six records.
- There have been incidents of historic groundwater flooding in the borough of Broxbourne which is thought to primarily be caused by the underlying geology. The study area is known to have a high water table, and the bedrock geology of the study area indicates vulnerability to groundwater flooding.
- There are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low.
- There are two records of a canal overtopping along the Lee Navigation Channel (Lower) caused by higher water levels associated with debris from vegetation clearance and by water running from a footpath eroding the bank. The extent of the overtopping is unknown; however, it is thought that no properties were flooded.
- Site Allocations were screened to provide a summary of flood risk to each site.

### 14.1.2 Key policies

There are a number of regional and local key policies which have been considered within the SFRA. The regional policies include the River Thames CFMP (2009), the Thames River Basin Management Plan (2016) and the Lower Lee Flood Risk Management Strategy (2013). Key local policy documents include the following:

- Broxbourne Borough Council's policies include saved policies from the 2005 Local Plan and new local policies from the emerging Local Plan.
- Hertfordshire Local Flood Risk Management Strategy (2013 - 2016): The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management on a day to day basis and sets measures to manage local flood risk i.e. flood risk from surface water, groundwater and Ordinary Watercourses. The action plan shows how the LLFA intends to achieve high level objectives relating to flood risk.
- East Hertfordshire and Broxbourne SWMP (on-going): The SWMP is currently under development and will outline the main areas at risk, the preferred surface water management strategy in a given location and will set out further actions the Council will implement in the management of surface water.
- Water Cycle Study (2010): A Water Cycle Study – Scoping Study covering the Broxbourne was completed in April 2010. A new Water Project for Hertfordshire is currently being commissioned by Hertfordshire County Council with the aim of identifying the critical factors which affect robust water supply and wastewater treatment to 2051 in Hertfordshire. The scope of the study will only extend to flood risk, water quality and surface water management as far as necessary to take a holistic and integrated approach.

### 14.1.3 Cumulative flooding and cross-boundary issues

A high-level assessment has been undertaken of the potential impact of development in neighbouring authorities to the borough of Broxbourne. The location of the potential development locations has been assessed to in terms of where there is currently flood risk issues and where the impact of development has potential to make flood risk worse if preventative measures are not put in place. Neighbouring authorities and the Lea Valley Regional Park Authority were contacted and, where possible, Local Plans and SFRAs were reviewed to assess whether there are any proposed large-scale developments that may affect flood risk in the SFRA area. Assessment showed that the majority of developments in neighbouring boroughs would not impact flood risk within Broxbourne. Any potential issues should be mitigated against by adopting appropriate drainage on site.

### 14.1.4 Development and flood risk

A site-specific FRA is required for all developments which are located within the Environment Agency's Flood Zones, or for developments greater than 1ha in size (regardless of Flood Zone). They are also required for developments less than 1 ha in Flood Zone 1 where there is a change to vulnerability classification, where the development could be affected by sources of flooding or all developments located in an area which has been highlighted as having critical drainage problems.

Broxbourne Borough Council have defined their entire administrative area as the geographical area for which the Sequential Test is to be applied.

### 14.1.5 Defences and residual risk

A high-level review of existing flood defences was undertaken, including a more detailed assessment of the Turnford Brook and Rags Brook flood defences, the Trinity Marsh Ditch and Trinity Lane Flood Alleviation Scheme, Kings Weir Embankments and the River Lee Flood Relief Channel. Further, the condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is a factor that needs to be considered as part of the risk-based sequential approach and, in light of this, whether proposed land allocations are appropriate and sustainable.

It is important to reinforce that a number of the recorded flood events are dated post-1947 and the flood relief channel almost reached capacity in 1987, 1993 and 2000.

### 14.1.6 Flood warning and emergency planning

The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers). Currently there are four Flood Alert Areas and seven Flood Warning Areas (FWAs) covering significant parts of Broxbourne.

### 14.1.7 Green Infrastructure

The Hertfordshire Strategic Green Infrastructure Plan was published in 2011. Within this Plan, the Broxbourne Woods Complex is listed as a strategic site and it is noted that Broxbourne has a proportionally higher than average provision of Accessible Natural Greenspace (as defined by Natural England). A proposed GI project in this Plan is the Lee Valley Regional Parks Lateral Links project which may offer flood management benefits. The 2015 Hertfordshire County Council SuDS Design Guidance for Hertfordshire contains further advice and demonstrations of Green and Blue Infrastructure.

### 14.1.8 Water Framework Directive and strategic flood risk solutions

In England, the Environment Agency is responsible for the delivery of the WFD objectives, and has therefore produced River Basin Management Plans describing how the WFD will be achieved. All waterbodies have to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline.

A map showing the overall status of the main waterbodies in the Broxbourne Borough Council administrative area is provided in the main report, under section 12.6. This is based on the classification status for water bodies reported in 2015. Not all the watercourses in the Council administrative area are shown on this map. All watercourses are classed as 'Moderate'; the Cuffley Brook, the Turnford Brook and the River Lee Navigation Channel. Future development should ensure there is no adverse impact on the quality of watercourses. Opportunities to improve the status of watercourses should also be considered.

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# 15 Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA. Following this, several recommendations have been made for the Council to consider as part of their planning policy and flood risk management. These have been summarised below.

## 15.1 Site allocations

It is recommended that the outputs from this study are used as an evidence base for the allocation of potential development areas, directing new development to areas of lowest risk.

The Council should use the information provided within this SFRA to apply the Sequential Test to their potential site allocations. The required evidence should be prepared as part of a Local Plan Sustainability Appraisal or alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments.

Following the application of the Sequential Test, if land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development, the Exception Test will need to be applied. In these circumstances it is recommended that a Level 2 SFRA assessment is undertaken, considering the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding. Where a site allocation is shown to be in either Flood Zone 2 and/or 3, and/or has an ordinary watercourse running through or adjacent to it, the flood risk to the sites is recommended to be investigated in more detail as part of a Level 2 SFRA. These sites are highlighted in orange in Appendix H.

A Level 2 assessment should seek to identify the probable extent, depth and velocity of flooding as well as the hazard posed to people and inform more detailed guidance for site-specific FRAs. The Level 2 SFRA can also include a broadscale assessment of suitable SuDS options, providing an indication where there may be constraints to certain sets of SuDS techniques.

## 15.2 Assessing Flood Risk and Developments

- The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the borough
- A site-specific FRA is required for all developments over 1ha in Flood Zone 1; for developments less than 1 ha in Flood Zone 1 where there is a change to vulnerability classification or where the development could be affected by sources of flooding; and for all developments located in an area which has been highlighted as having critical drainage problems. The FRA should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development
- It is recommended that the impact of climate change to a proposed site is considered in a FRA and that the percentage increases which relate to the proposed lifetime of the development and the vulnerability classification of the development is accounted for. The Environment Agency and LLFA should be consulted to confirm a suitable approach to climate change in light of the latest guidance
- Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites, through reductions in the amount of surface water runoff generated on a site
- The Local Planning Authority (LPA), Environment Agency and Lead Local Flood Authority (LLFA) should be consulted to confirm the level of assessment required and to provide any information on any known local issues
- When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as provide evidence to show that they have adequately considered other reasonably available sites

### 15.2.1 Future Developments

Development must seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of surface water runoff based on Local Plan policy and LLFA Guidance
- Locating development to areas with lower flood risk
- Creating space for flooding.
- Integrating green infrastructure into mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

The Local Planning Authority should consult the National Planning Practice Guidance and Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', published in March 2014, when reviewing planning applications for proposed developments at risk of flooding.

At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances, published by the Environment Agency in February 2016), inform development zoning within the site and prove, if required, whether the Exception Test can be passed.

### 15.2.2 Promotion of SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan.

Wherever possible, SuDS should be promoted:

- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration.
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable and guidance should be sought from the LLFA.
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints.
- The LPA will need to consider drainage schemes for major applications, but it is advised developers utilise the LLFA's Polices and Guidance to develop their drainage scheme for minor applications.

### 15.2.3 Infrastructure and Access

- Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard should be identified and the use of developer contributions considered to fund improvements.
- Safe access and egress for residents and emergency and service vehicles will need to be demonstrated at all development sites

### 15.2.4 Green Infrastructure and WFD

Opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought. In addition, opportunities where it may be possible to improve the WFD status of watercourses, for example by opening up culverts, weir removal, and river restoration, should be considered. Green infrastructure should be considered within the mitigation measures for surface water runoff from development.

### 15.2.5 Strategic solutions

The information provided in the SFRA should be used as a base for investigating potential strategic flood risk solutions within the borough. Opportunities could consist of the following:

- Demonstration that defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.
- The construction of new upstream storage schemes as part of upstream catchment-based approaches on a number of watercourses within Broxbourne. Watercourses which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream. It should be noted that often such schemes are driven by requirements outlined by the LLFA and the Environment Agency. No new upstream flood storage areas for the River Lee are proposed within the Lower Lee FRMS; it recommends maintaining the existing flood storage areas to Theobalds and Cheshunt North.
- Floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, for example by bank stabilisation, re-naturalisation, structure removal/ modification and enhancing outfalls in the riparian environment.

### 15.2.6 Potential further studies

Based on the findings of this SFRA, it is recommended that:

- For development near the vicinity of culverts within the borough, as listed in Table 6-2, investigation of the fluvial and surface water flood extents in further detail as part of a detailed site-specific Flood Risk Assessment should be undertaken.
- For development near the vicinity of overland flow routes identified in the 30-year and 100-year uFMfSW, exploring rainfall-runoff modelling may be an option to establish the surface water flood risk to and from the development in greater detail.
- For development near the vicinity of the New River and / or the River Lee Navigation Channel (Lower), the residual risk of a breach i.e. detailed breach modelling, as part of a detailed site-specific Flood Risk Assessment (see Section 5.2) should be considered.
- Given the nature of the geology in the study area and records of historic groundwater flooding, it would be advised for planning applications to include a statement on the groundwater flood risk to their development site and where necessary, proposed measures of how this risk will be managed / mitigated throughout the lifetime of the development.
- It is recommended that flood risk management authorities / stakeholders in the borough of Broxbourne investigate the feasibility of conducting a borough-wide breach modelling analysis from the New River and the River Lee Navigation Channel Lower. For potential allocations in the emerging Local Plan and / or development applications located around the vicinity of the New River and / or the River Lee Navigation Channel (Lower), it is recommended that detailed breach modelling is undertaken as part of a site-specific FRA to establish the residual risk to the development.
- The River Lee 2D Modelling Study covers a significant proportion of the watercourses in the study area and covers reaches of the Turnford Brook, the College Brook and Theobalds Brook. It is recommended that the M07_M08 detailed hydraulic model is extended and re-run to cover the entire length of the Turnford Brook, the College Brook and Theobalds Brook and include the Wormleybury Brook and to establish the risk to any existing and potential development near these watercourses.

## 15.3 Future flood management in Hertfordshire

Hertfordshire County Council's Local Flood Risk Management Strategy identifies policies and procedures to assist them with achieving and delivering the LFRMS. Hertfordshire County Council will set out to achieve these by adopting a leadership role in FRM in Hertfordshire, working in collaboration with key stakeholders and partners.

## 15.4 Use of SFRA data and future updates

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The SFRA should be a 'living document', and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Broxbourne Borough Council, the Highways Authority, Canal and River Trust, Thames Water and the Environment Agency. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a future flood event
- Policy/ legislation updates
- Environment Agency flood map updates
- New flood defence schemes etc.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed internally on a quarterly basis, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information

**Note on the Environment Agency Flood Map for Planning**

Where outlines are not informed by detailed hydraulic modelling, the Flood Map for Planning is based on generalised modelling to provide an indication of flood risk. Whilst the generalised modelling is generally accurate on a large scale, they are not provided for specific sites or for land where the catchment of the watercourse falls below 3km$^2$. For this reason, the Flood Map for Planning is not of a resolution to be used as application evidence to provide the details of possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. Accordingly, for site-specific assessments it will be necessary to perform more detailed studies in circumstances where flood risk is an issue. Where the Flood Map for Planning is based on generalised modelling, developers should undertake a more detailed analysis and assessment of the flood risk at the planning application stage.

# Appendices

## A Watercourses in Broxbourne borough

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# B Environment Agency Flood Zone Mapping, including functional floodplain

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# C Climate Change Mapping

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# D Surface Water Mapping

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# E Groundwater flood risk mapping

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# F Flood warning coverage

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# G Artificial sources

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# H Site allocations

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# I Data Register

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Registered Office

South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

t:+44(0)1756 799919
e:info@jbaconsulting.com

Jeremy Benn Associates Ltd

Registered in England
3246693

Visit our website

www.jbaconsulting.com