Harlow District Council SFRA

Level 1 Strategic Flood Risk Assessment

Final Report

December 2016

Harlow Council

Working together for Harlow

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Revision History

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Contract

This report describes work commissioned by Harlow Council. Harlow Council's representative for the contract was Colin Endean. Thomas Allen and Claire Gardner of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

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- Harlow Council
- Essex County Council
- Environment Agency
- Thames Water
- Canal and River Trust

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Executive Summary

Introduction

This Strategic Flood Risk Assessment (SFRA) 2016 document replaces the previous SFRA published in 2011. The key objective of the SFRA update is to form part of the technical evidence base underpinning Harlow Council's Local Plan.

SFRA objectives

The following key requirements of the SFRA were

- to include an appraisal of national and local policy and a review of current methodologies and guidance; and
- to enable the local planning authority to
    - determine the variation in risks from all sources of flooding across their area, and also the risks to and from surrounding areas in the same flood catchment;
    - inform the sustainability appraisal of the Local Plan so that flood risk is fully taken into account when considering allocation options and in preparing plan policies;
    - apply the Sequential Test and, where necessary, Exception Test;
    - identify the requirements for site-specific flood risk assessments;
    - determine the acceptability of flood risk in relation to emergency planning capability; and
    - consider opportunities to reduce flood risk to existing communities and developments.

SFRA outputs

Level one outputs

- Maps showing the local planning authority area, Main Rivers, Ordinary Watercourses and Flood Zones, including Functional Floodplain
- Assessment of the implications of climate for flood risk allocated development sites over an appropriate period, as well as Harlow-wide climate change outlines where hydraulic models are available
- Maps showing the risk from other sources of flooding including surface water and groundwater
- An assessment of flood risk management measures
- An assessment of locations where additional development may significantly increase flood risk elsewhere
- Advice on the preparation of site-specific flood risk assessments
- Advice on the application of sustainable drainage systems

Level two outputs

Detailed site summary tables have been produced for each site taken forward to the Level 2 assessment. These tables include the following information:

- site area
- current land use
- proposed land use
- existing drainage features
- proportion of the site in each Flood Zone and description of fluvial flood risk
- proportion of the site in the three uFMfSW events and description of surface water flood risk
- whether the site would be at risk of inundation in the event of reservoir failure
- whether the site is shown to have flooded in the past
- appraisal of the defence type, standard of protection and condition as well as any residual risk considerations from overtopping or failure of flood risk management infrastructure

- emergency planning information including whether the site is covered by a flood warning area and whether there any potential access and egress issues for the site
- what the 2080s climate change allowances are for the area and the climate change implications for the site
- a broad scale assessment of suitable Sustainable Drainage (SuDS) techniques and considerations, including whether the site is in a source protection zone or a historic landfill site
- information on whether the Exception Test will be required and advice on appropriate policies for sites requiring the Exception Test
- advice on the requirements and preparation of for site-specific flood risk assessments

Summary of Level 1 Assessment

Flood risk

- Harlow is located within the River Stort catchment. Tributaries of the River Stort that flow through Harlow include Harlowbury Brook, Todd Brook, Parndon Brook, Canons Brook and Pincey Brook
- The most significant recorded fluvial flood event in Harlow was in 1947 where flooding occurred from the River Stort, Todd Brook and Canons Brook. Flooding events since 1947 have not had the widespread effects of the 1947 event with, flood events largely restricted to the functional flood plain
- Primary fluvial flood risk in Harlow is predominantly associated with the River Stort to the north of the town around Harlow Town station, Temple Fields north of the railway line, and south of the railway line at the A414 roundabout. These areas are located in Flood Zone 2. Some properties along Guilfords, in the east of Harlow, are also shown to be at risk from the Harlowbury Brook and are located in Flood Zone 2
- Flood risk from Todd Brook and Canons Brook is mainly restricted to rural land, with just a few isolated properties and gardens at risk. Parndon Brook poses more of a risk with some properties along Tithelands, Greygoose Park and Peacock Road shown to be in Flood Zone 3
- The uFMfSW predominantly follows topographical flow paths, particularly in the south of Harlow flowing towards Todd Brook. Another area that is shown to be significantly affected by surface water flooding is Temple Fields. Elsewhere, surface water flooding tends to be either flow paths or ponding along transport routes, or ponding of water in gardens or open land
- Although there are no reservoirs located within Harlow there are five reservoirs outside of the area which may potentially affect the town in the event of reservoir inundation. In the event of reservoir failure, inundation appear to be mainly confined to the floodplain of the River Stort and the Canons Brook
- Future development, both within and outside Harlow can have the potential to affect flood risk to existing development and surrounding areas. Whilst there are potential cross-boundary flood risk issues both from and to neighbouring authorities, conditions imposed by Harlow Council, neighbouring authorities and the LLFA 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. 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
- The River Stort is navigable throughout much of its course in Harlow. The level of water is controlled by the level and size of weirs. If the capacity of these control structures were exceeded, or if they become blocked, overtopping may occur

Impact of Climate change

Climate change modelling was undertaken to assess the impact of climate change on flooding in the future. The modelling results indicated:

- The increase in extent of the 1 in 100-year event for the River Stort is negligible, with even a 70% increase in flow having relatively minor increases in the flood extent
- The effect of climate change on the Harlowbury Brook is similar to that of the River Stort, with only small increases in the 1 in 100-year event seen. The greatest increase in flood extent is an area on the right bank (looking downstream) just north of the Oxleys
- Todd Brook and Canons Brook see the greatest increase in the 1 in 100-year flood extent as a result of climate change, particularly in the lower reaches of Canons Brook where it enters the River Stort. The increase in flood extent for these watercourses remains mainly within the floodplain and few additional houses are affected

Key policies

There are a number of relevant regional and local key policies which have been considered within the SFRA, such as the Catchment Flood Management Plans (CFMPs), Flood Risk Management Plans (FRMPs), the Preliminary Flood Risk Assessment (PFRA) and Local Flood Risk Management Strategy (LFRMS). Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments (FRAs) have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the Lead Local Flood Authority (LLFA) and the Environment Agency.

Surface water management and SuDS

A review of national and local guidance for surface water management and SuDS has been undertaken. Essex County Council as LLFA have produced a number of supporting documents and guidance for local flood risk and SuDS which have been documented and referenced in the SFRA.

Defences

A high-level review of existing flood defences was undertaken and found a small number of defences in the study area. These defences tend to have a relatively low standard of protection and appear to be designed to protect very localised areas / developments rather than the wider Harlow area.

Flood warning and emergency planning

The Environment Agency is the lead organisation for providing fluvial flood warnings for Main Rivers. Currently there is one Flood Alert and three Flood Warnings covering Harlow. Maps and information on flood warnings have been provided alongside information, advice and guidance for emergency planning.

Level 1 site screening

Potential development sites within the study area were screened against flood risk information to identify sites that would potentially need to be taken forward to a Level 2 SFRA. The screening also identified sites where additional modelling would be required, for example, sites where there is a watercourse that is not included in the Environment Agency's Flood Zone coverage, or where Flood Zones exist but further modelling was required to identify Flood Zone 3b and climate change as well as depth, velocity and hazard information. Jflow+ modelling was then undertaken to obtain this missing information.

On completion of the modelling, the sites were screened again to provide a summary of risk to each site including: the proportion of the site in each Flood Zone, Surface Water flooding scenario, reservoir inundation outlines and historic flood map.

Where sites were shown to be in Flood Zones, flood risk has been assessed and summarised in more detail in a series of detailed summary tables as part of the Level 2 SFRA. Only three of the 58 sites required Level 2 assessment.

Summary of Level 2 Assessment

Assessment methods

As part of the Level 2 SFRA, detailed site summary tables have been produced for each of the three potential development sites taken forward from the Level 1 assessment. These sites were those that were shown to be at risk of fluvial flood risk from watercourses running either through or adjacent to the site.

The summary tables set out the flood risk to each site, including maps of extent, depth and velocity of flooding as well as hazard mapping. Each table also sets out the flood risk implications for the site as well as guidance for site-specific FRAs. A broad scale assessment of possible SuDS constraints has also been provided giving an indication where there may be constraints to certain sets of SuDS techniques.

Flood risk information for the sites is from a combination of results from Environment Agency detailed hydraulic models, and additional 2D modelling using Jflow+ undertaken for the SFRA. Jflow+ modelling was undertaken for watercourses not covered by the existing Environment Agency Flood Zones.

Recommendations

Development control

Sequential approach to development

The National Planning Policy Framework (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 district.

New development and re-development of land should, wherever possible, seek opportunities to reduce overall level of flood risk at the site

Sequential and Exception tests

The SFRA has identified Harlow is at relatively low risk of flooding for fluvial sources, with the exception of areas to the north around Templefields which are at risk from the River Stort. The majority of proposed development sites, provided by Harlow Council, are shown to be in Flood Zone 1. However, three are shown to be at fluvial risk and will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. The Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

Developers should consult with the Council, Essex County Council, the Environment Agency and Thames Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

Site-specific flood risk assessments

The Level 2 SFRA is not intended to replace site-specific FRAs. Site specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), 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.

Windfall sites

The acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

Drainage assessments and promotion of SuDS

Drainage strategies and SuDS

Planners should be aware of any 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:

- 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. 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 Source Protection Zones 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, and the LLFA's SuDS guidance and requirements
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure
- Responsibilities for future maintenance of SuDS systems should be clearly defined

Infrastructure and Access

Safe access and egress will need to be demonstrated at all development sites; the development should be above the 1 in 100-year flood level, plus an allowance for climate change, and access for emergency vehicles should be possible during times of flood. Finished Floor Levels should be above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.

Emergency planning

It is recommended that any household considered at risk of flooding signs-up to the Environment Agency's Flood Warning Service. 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.

The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements within Harlow.

Future flood management in Harlow

Developers should include an assessment of the residual risk if developments are located in areas benefitting from defences. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping. Any improvements to defences should ensure they are in keeping with wider catchment policy.

Local policy recommendations

The Harlow Local Development Plan will replace the Adopted Replacement Harlow Local Plan (2006). Sections on flood risk and flood risk policies in the 2006 Plan have been reviewed and the following recommendations made for policies in the new Local Plan:

- It is recommended that a policy should be included relating to water management. This should include directing development to locations at the lowest risk of flooding, applying the Sequential and, where necessary, Exception Tests and applying appropriate mitigation measure where development is proposed in flood risk areas. This could take the form of a standalone policy or could be included as part of a wider sustainable development policy
- It is recommended that a policy specifically relating to sustainable drainage is included. The policy should ensure new developments will be required to incorporate appropriate SuDS and ensure arrangements for ongoing maintenance are clear

Technical recommendations

- 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 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 site-specific FRA
- 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 Harlow Council, Essex County Council (in its role as LLFA), the Highways Authority, Thames Water or 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

Use of SFRA data

SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The SFRA has been developed using the best available information at the time of preparation.

The SFRA should be updated when new information on flood risk, new planning guidance or legislation becomes available.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated 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.

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Glossary and Abbreviations

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
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
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.
FWMA	Flood and Water Management Act
FZ	Flood Zones
Greenfield	Undeveloped parcel of land
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

Term	Definition
LFRMS	Local Flood 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
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
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.
PPG	National Planning Policy Guidance
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 District 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.
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.

Term	Definition
uFMfSW	Updated Flood Map for Surface Water
WFD	Water Framework Directive

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

> ***"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".*** (National Planning Policy Framework, paragraph 100)

This Strategic Flood Risk Assessment (SFRA) 2016 document replaces the previous SFRA published in 2011. The key objective of the SFRA update is to form part of the technical evidence base underpinning Harlow Council's Local Plan and has the following key requirements:

- Include an appraisal of national and local policy and a review of current methodologies and guidance
- Enable the local planning authority to
    - Determine the variation in risks from all sources of flooding across their area, and also the risks to and from surrounding areas in the same flood catchment
    - Inform the sustainability appraisal of the Local Plan so that flood risk is fully taken into account when considering allocation options and in preparing plan policies
    - Apply the Sequential Test and, where necessary, Exception Test
    - Identify the requirements for site-specific flood risk assessments
    - Determine the acceptability of flood risk in relation to emergency planning capability
    - Consider opportunities to reduce flood risk to existing communities and developments

1.2 Levels of SFRA

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

This SFRA fulfils the requirements of a Level 1 and a Level 2 SFRA.

1.3 SFRA outputs

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

1.3.1 Level one outputs

- Maps showing the local planning authority area, Main Rivers, Ordinary Watercourses and Flood Zones, including Functional Floodplain
- Assessment of the implications of climate for flood risk allocated development sites over an appropriate period, as well as Harlow-wide climate change outlines where hydraulic models are available
- Maps showing the risk from other sources of flooding including surface water and groundwater
- An assessment of flood risk management measures

- An assessment of locations where additional development may significantly increase flood risk elsewhere
- Advice on the preparation of site-specific flood risk assessments
- Advice on the application of sustainable drainage systems

1.3.2 Level two outputs

Detailed site summary tables have been produced for each site taken forward to the Level 2 assessment. These tables include the following information:

- Site area
- Current land use
- Proposed land use
- Existing drainage features
- Proportion of the site in each Flood Zone and description of fluvial flood risk
- Proportion of the site in the three uFMfSW events and description of surface water flood risk
- Whether the site would be at risk of inundation in the event of reservoir failure
- Whether the site is shown to have flooded in the past
- Appraisal of the defence type, standard of protection and condition as well as any residual risk considerations from overtopping or failure of flood risk management infrastructure
- Emergency planning information including whether the site is covered by a flood warning area and whether there any potential access and egress issues for the site
- What the 2080s climate change allowances are for the area and the climate change implications for the site
- A broad scale assessment of suitable SuDS techniques and considerations, including whether the site is in a source protection zone or a historic landfill site
- Information on whether the Exception Test will be required and advice on appropriate policies for sites requiring the Exception Test
- Advice on the requirements and preparation of for site-specific flood risk assessments

1.4 SFRA user guide

Table 1-1: SFRA report contents

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outputs, and the approach adopted
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.
4.The Sequential, risk based approach	Describes the Sequential approach and application of Sequential and Exception Tests.
4. Climate change	Outlines climate change guidance and the implications for Harlow
5. Sources of information used in preparing the SFRA	Outlines what information has been used in the preparation of the SFRA
6. Understanding flood risk in Harlow	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting Harlow Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered.
7. Flood defences	Information on flood defences in Harlow, including residual risk implications.

Section	Contents
8. FRA requirements and flood risk management guidance	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions set by the LLFA that should be followed.
9. Surface water management and SuDS	Advice on managing surface water run-off and flooding
10. Flood warning and emergency planning	Outlines the flood warning service in Harlow and provides advice for emergency planning, evacuation plans and safe access and egress.
11. Level 1 assessment of potential development sites	Summarise the flood risk from all sources to all sites supplied by Harlow Council for assessment in the SFRA. Outlines which sites have been taken forward to the Level 2 assessment.
12. Level 2 Assessment of potential development sites	Detailed assessment of specific sites to determine variations in flood risk across the site and identify any site-specific flood risk assessment requirements.
13. Summary	Review of the Level 1 and Level 2 SFRA.
14. Recommendations	Identifies recommendations for the council to consider as part of Flood Risk Management policy.
Appendix A: Detailed Site Summary Tables	Detailed Level 2 assessments for proposed development sites that are shown to be at flood risk.
Appendix B: Watercourses	Locations of Main Rivers and Ordinary Watercourses
Appendix C: Flood Zones	District-wide maps of Flood Zones
Appendix D: Climate change fluvial flood risk mapping	District-wide maps of the 2080s climate change allowances (to be updated following climate change modelling completion).
Appendix E: Surface water flood risk mapping	District-wide maps of the updated Flood Map for Surface Water.
Appendix F: Areas Susceptible to Groundwater Flooding	District-wide maps of the Areas Susceptible to Groundwater Flooding dataset.
Appendix G: Flood Warning Coverage	Maps showing the extent of the Environment Agency's Flood Warning Service.

1.5 Use of SFRA data

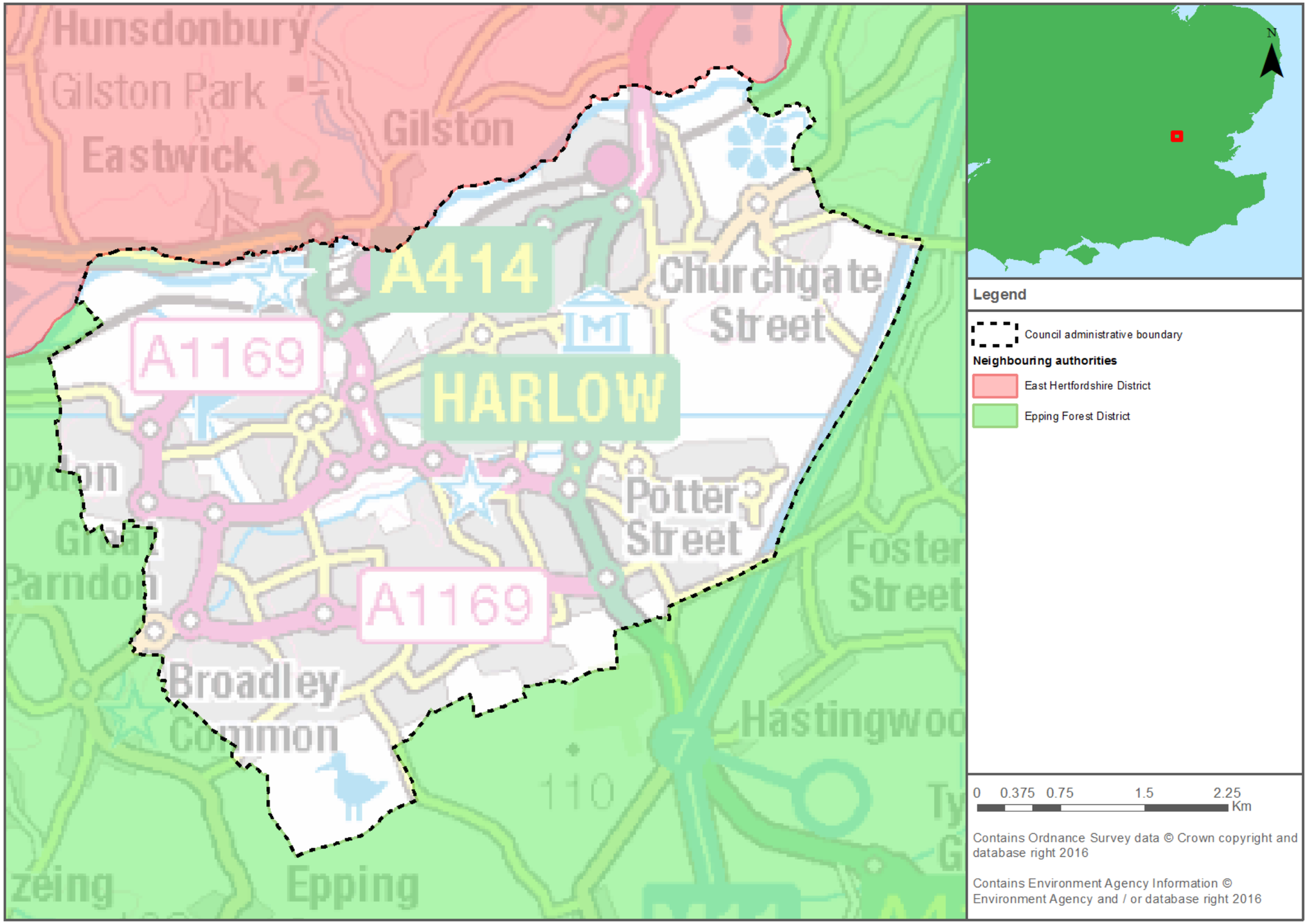
It is important to recognise that SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

SFRAs should be a 'living document', and as a result should be updated when new information on flood risk, new planning guidance or legislation becomes available. New information on flood risk may be provided by Harlow Council, the Highways Authority, Essex County Council, Thames Water and the Environment Agency. Such information may be in the form of

- new hydraulic modelling results;
- flood event information following a flood event;
- policy / legislation updates;
- Environment Agency flood map updates; and/or
- new flood defence schemes.

The Environment Agency regularly review 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 or annual 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 inclusion of any updated data.

Figure 1-1: SFRA 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 flood risk policy, flood risk responsibilities and the planning framework.

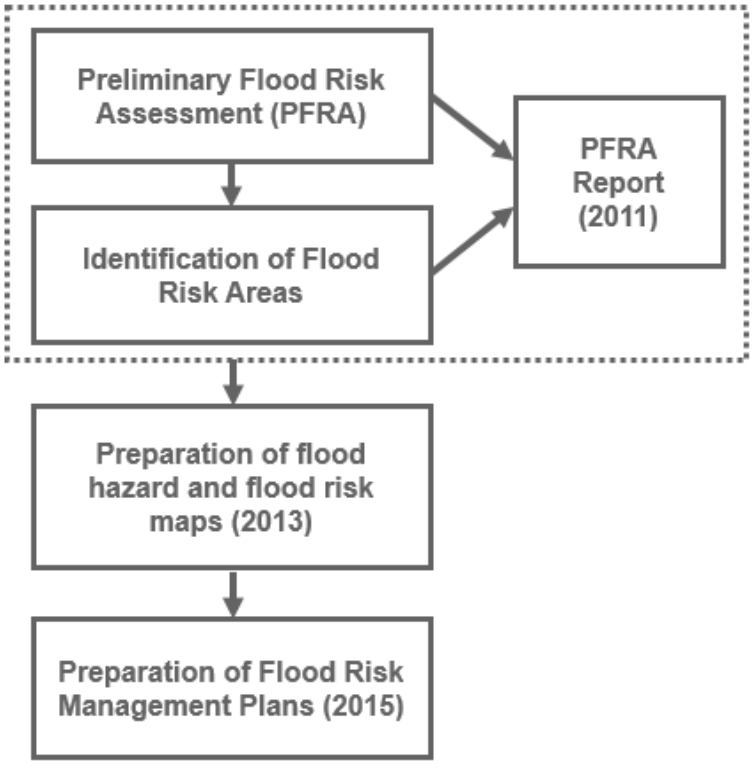
2.2 Flood Risk Regulations (2009) and Flood and Water Management Act (2010)

2.2.1 Flood Risk Regulations, 2009

The Flood Risk Regulations (2009) 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 Essex County Council.

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

Figure 2-1: Flood Risk Regulation Requirements



2.2.2 Preliminary Flood Risk Assessments (PFRAs)

In accordance with the Regulations, LLFAs had the task of preparing a Preliminary Flood Risk Assessment (PFRA) report.

PFRAs report on significant past and future flooding from all sources except from Main Rivers and reservoirs and sub-standard performance of the adopted sewer network. PFRAs are a high-level screening exercise and consider floods which had significant harmful consequences for human health, economic activity, the environment and cultural heritage. The PFRA document that covers the study area was published by Essex County Council in 2011.

The Regulations require the LLFA to identify significant Flood Risk Areas. The threshold for designating significant Flood Risk Areas was defined by Defra and the PFRA is the process by which these locations were identified. Of the ten national indicative Flood Risk Areas that were

identified by the Defra/Environment Agency, none encroach on the administrative area of Harlow Council.

2.2.3 Flood Risk Management Plans (FRMPs)

Under the Regulations the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. Instead they prepared and published Flood Risk Management Plans (FRMPs). The FRMPs summarise the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations. The final Thames River Basin District Draft FRMP was issued in March 2016 and covers the period of 2015 to 2021[1]. The FRMP draws on previous policies and actions identified in Catchment Flood Management Plans and also incorporates information from Local Flood Risk Management Strategies.

2.2.4 Flood and Water Management Act, 2010

Following the 2007 floods, Sir Michael Pitt was appointed to chair an independent review into the floods. The final report was published in June 2008. The Flood and Water Management Act (2010)[2] implements Sir Michael Pitt's recommendations and aims to create a simpler and more effective means of managing both flood risk and coastal erosion.

The FWMA established Lead Local Flood Authorities (LLFAs). LLFAs have the following duties:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations)
- Register of Flood Risk Features: LLFAs must 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
- Designation of Features: LLFAs may 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
- Consenting: When appropriate, LLFAs will perform consenting of works on Ordinary Watercourses

2.2.5 Essex Local Flood Risk Management Strategy (2013)[3]

Essex County Council is responsible for developing, maintaining, applying and monitoring a Local Flood Risk Management Strategy for Essex, which covers Harlow. The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management (FRM) 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 are

1. provide information on local flood risk as well as the organisations that are involved in their management;
2. explain the powers and responsibility of all major organisations;
3. summarise the information available on flood risk in Essex; and
4. support annual action plains which will be approved by the Essex Partnership for Flood Management.

The Strategy also sets out an action plan of how the LLFA intends to achieve these objectives. The action plan is updated annually. Key triggers for updates include amendments to partner responsibilities, updates to legislation, alterations in the nature or understanding of flood risk or a significant flood event.

1 Thames FRMP (2016)
2 Flood and Water Management Act (2010)
3 Essex County Council LFRMS (2013)

2.2.6 LLFAs, surface water and SuDS

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
- there are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

In March 2015 the LLFA was made a statutory consultee which came into effect on 15 April 2015. As a result, Essex County Council, will be 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; and
- 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.

2.2.7 The National Flood and Coastal Erosion Risk Management Strategy for England (2011)

The National Flood and Coastal Erosion Risk Management Strategy for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. It was prepared by the Environment Agency with input from Defra.

The Strategy builds on existing approaches to flood and coastal risk management and promotes the use of a wide range of measures to manage risk. It describes how risk should be managed in a co-ordinated way within catchments and along the coast and balance the needs of communities, the economy and the environment.

The strategy encourages more effective risk management by enabling people, communities, business, infrastructure operators and the public sector to work together to

- ensure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risk;
- manage flood and coastal erosion risks in an appropriate way, taking account of the needs of communities and the environment;
- ensure that emergency plans and responses to flood incidents are effective and that communities are able to respond effectively to flood forecasts, warnings and advice; and
- help communities to recover more quickly and effectively after incidents.

2.3 National Planning Policy and Guidance

The National Planning Policy Framework (NPPF)[4] was issued in 2012, to replace the previous documentation, as part of reforms to make the planning system less complex and more accessible, and to protect the environment and promote sustainable growth. It replaces most of the Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs) that were referred to in the previous version of the SFRA. The NPPF sets out the Government's requirements for the planning system and provides a framework within which local people and councils can produce distinctive local and neighbourhood plans to reflect the needs and properties of their communities. The NPPF must be taken into account by local planning authorities when preparing Local Plans and for applicants preparing planning submissions.

National Planning Practice Guidance (NPPG) was published in 2014 and sets out how the NPPF should be implemented. NPPG: Flood Risk and Coastal Change advises on how planning can account for the risks associated with flooding and coastal change in plan making and the

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

application process. It sets out Flood Zones, the appropriate land uses for each zone, flood risk assessment requirements, including the Sequential and Exception Tests and the policy aims for developers and authorities regarding each Flood Zone. Further details on Flood Zones and associated policy is provided in Table 3-1 and throughout this report. The Sequential and Exception tests are covered in greater detail in Sections 3.2 to 3.4.

The Sequential Test

"The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones, as refined in the Strategic Flood Risk Assessment for the area, provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required".

(National Planning Practice Guidance, paragraph 019)

The Exception Test

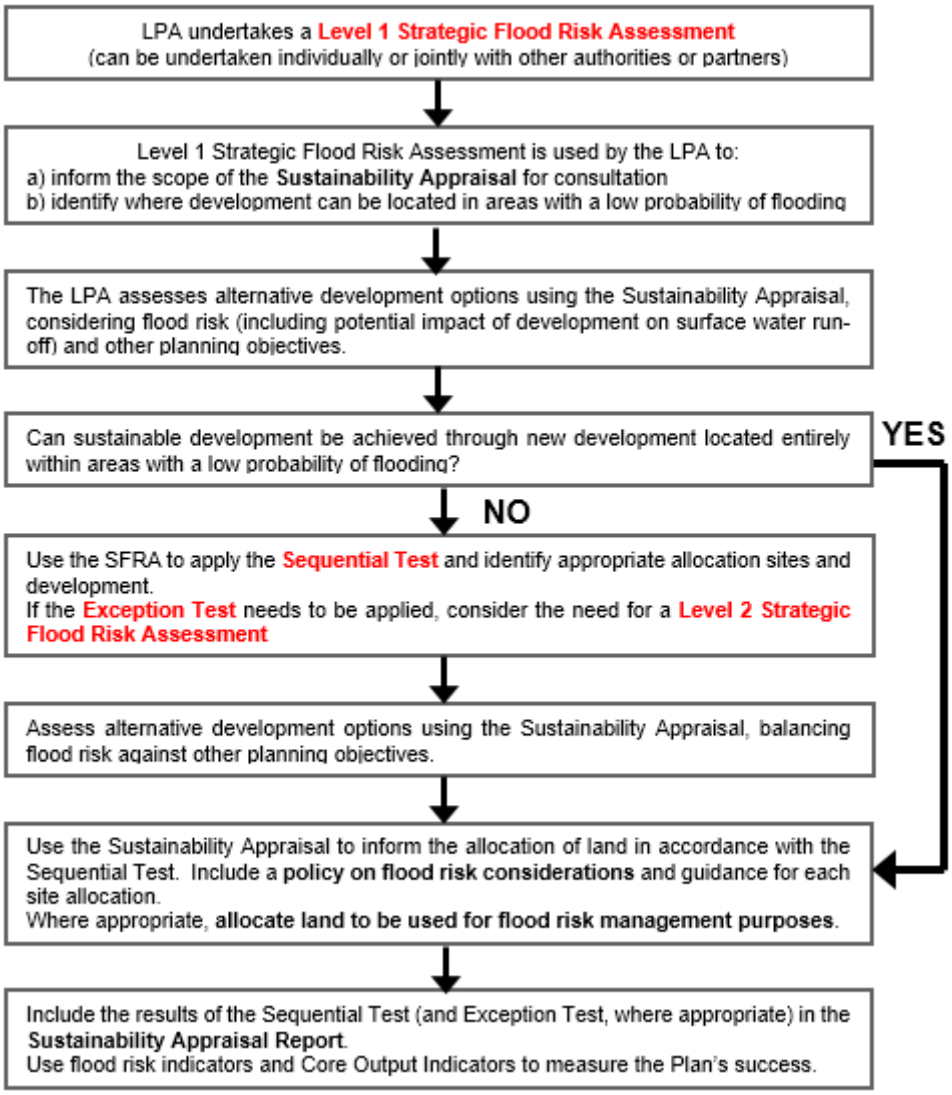
"The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

Essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.".

(National Planning Practice Guidance, paragraph 023)

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).

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



† Diagram 1 of NPPG: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-005-20140306) March 2014

2.4 Water Cycle Strategy

Climate Change is predicted to present unprecedented new challenges, such as more frequent and extreme rainfall events and rising global temperatures, which are expected to exert greater pressure on the existing infrastructure. Planning for water management therefore has to take these potential challenges into account. A large number of new homes for instance may cause the existing water management infrastructure to be overwhelmed which would result in adverse effects on the environment, both locally and catchment-wide.

Water Cycle Strategies assist Local Authorities to select and develop sustainable development allocations so that there is minimal impact on the environment, water quality, water resources, and infrastructure and flood risk. 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 Strategy (WCS) for Harlow District Council was published jointly with Stevenage Borough Council under the title of Rye Meads Water Cycle Strategy,[5] it was completed in December 2009. The strategy identified no overwhelming technical constraints to the proposed level of growth within the study area. However, it did identify a number of important issues which

5 Stevenage Borough Council and Harlow District Council, Water Cycle Strategy (2009) http://www.stevenage.gov.uk/content/15953/26379/43876/Water-Cycle-Study-Summary.pdf

need to be overcome if growth is to be sustainable. In Harlow this included limited additional sewerage capacity, but it is also recognised that a major strategic sewerage upgrade was planned at the time (2009) to increase capacity in line with expected growth up to the time frame of 2021 based on the (now revoked) Regional Spatial Strategy[6]. In addition, the WCS recommended a Surface Water Management Plan be undertaken for Harlow.

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 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.

2.5.1 Harlow SWMP (2013)

The final draft SWMP for Harlow was published in July 2013. The document has not yet been published online but is available, on request, from Essex County Council.

As part of SWMP assessments, areas where the flood risk is considered to be most severe Critical Drainage Areas (CDAs) are identified. 13 CDAs were identified for Harlow. The SWMP sets out preferred options for the management of localised flooding in each of the CDAs.

Table 2-1: Critical Drainage Areas in Harlow

CDA	Name
001	Sumners
002	Kingsmoor
003	West Passmores
004	Stewards
005	Latton Bush
006	Brays Grove
007	Victoria Gate
008	Little Parndon
009	Rivermill
010	Netteswell
011	Altham Grove
012	Temple Fields
013	Old Harlow

An Action Plan was also developed which outlines a wide range of recommended measures that should be undertaken to manage surface water within Harlow more effectively. It outlines the responsibilities and implications of preferred options and details the methods, timescales and responsibility of each proposed action. Preferred options include

- Adaptation of spatial planning policy
- Improved maintenance of the drainage network
- Improve drainage network capacity
- Improve community resilience
- Improve flood warning systems
- Emergency planning (flood incident management)
- Permeable paving
- Rainwater harvesting

[6] The 2008 Revision to the Regional Spatial Strategy (RSS) for the East of England

- Retrofitting bio-retention / rain gardens
- Hydrometric monitoring
- Preferential overland flow paths (urban blue corridors)
- Raising community awareness

Developers should refer to the SWMP and Action Plan to determine if any of the preferred options or actions could be included as part of development, and to ensure proposals are consistent with both the CDA and wider district management strategy.

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 six national policies are listed below:

1. No active intervention (including flood warning and maintenance). Continue to monitor and advise
2. Reducing existing flood risk management actions (accepting that flood risk will increase over time)
3. Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline)
4. Take further action to sustain the current level of flood risk (responding to the potential increases in risk from urban development, land use change and climate change)
5. take action to reduce flood risk (now and/or in the future)
6. Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment

2.6.1 Thames CFMP (2011)

The study area is covered by the Thames CFMP[7].

The primary policy unit for Harlow is Policy Option 6. This option applies to areas of low to moderate flood risk where the Environment Agency can take action alongside others to reduce flood risk. The principle proposed policy measure in this area consists of storing water or managing run-off in locations that provide overall flood risk reduction or environmental benefits. In general, these communities will not be a priority for funding of large scale flood defences.

The proposed actions to implement this policy are the following

- maintain the existing capacity of the river systems in developed areas that reduces the risk of flooding from more frequent events;
- identify locations where the storage of water could benefit communities by reducing flood risk and providing environmental benefits and encourage flood compatible land uses and management;
- work with local planning authorities to retain the remaining floodplain for uses that are compatible with flood risk management and put in place policies that lead to long term adaptation of urban environments in flood risk areas;
- continue to increase public awareness; and
- help communities and local authorities to manage local flood risk.

7 Thames CFMP (2011)
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293903/Thames_Catchment_Flood_Management_Plan.pdf

2.7 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the Water Framework Directive (WFD) and assess the pressure facing the water environment in River Basin Districts. Harlow falls within the Thames River Basin District.

The updated 2015 Thames RBMP[8] identifies a number of pressures on the water environment and significant water management issues.

The RBMP describes how development and land-use planning needs to consider a number of issues relevant to the RBMP including sustainable drainage systems, green and blue infrastructure, sewage treatment options, water efficiency measures, infrastructure and development locations and the reduction of nutrients from diffuse pollution. The RBMP provides a summary of measures to protect and improve the water environment in the river basin district.

2.8 Implications for Harlow

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

Table 2-2: Roles and responsibilities in Harlow

Risk Management Authority (RMA)	Strategic Roles	Operational Level Roles
Environment Agency	National Statutory Strategy Reporting and supervision (overview role)	• Preliminary Flood Risk Assessment* • Managing flooding from main rivers and reservoirs and communication flood risk warnings to the public, media and partner organisations. • Identifying Significant Flood Risk Areas* • Preparation of Flood Risk and Hazard Maps • Preparation of Flood Risk Management Plans • Enforcement authority for Reservoirs Act 1975 • Managing RFCCs and supporting funding decisions, working with LLFAs and local communities. • Emergency planning and multi-agency flood plans, developed by local resilience forums
Lead Local Flood Authority (Essex County Council)	Input to National Strategy. Formulate and implement Local Flood Risk Management Strategies	• Responsible for enforcing and consenting works for Ordinary Watercourses • Managing local sources of flooding from surface water runoff and groundwater and carrying out practical works to manage flood risk from these sources where necessary. • Preparing and publishing a PFRA • Identifying Flood Risk Areas • Preparing Flood Hazard and Flood Risk Maps • Preparing Flood Risk Management Plans (where local flood risk is significant) • Investigating certain incidents of flooding in Section 19 Flood Investigations • Statutory roles in planning for surface water drainage. • Keeping asset registers of structures and features which have a significant effect on local flood risk. • Acting consistently with LFRMS in realising FRM activity and have due regard in the discharge of other functions of the strategy

8 Thames River Basin Management Plan (2015)

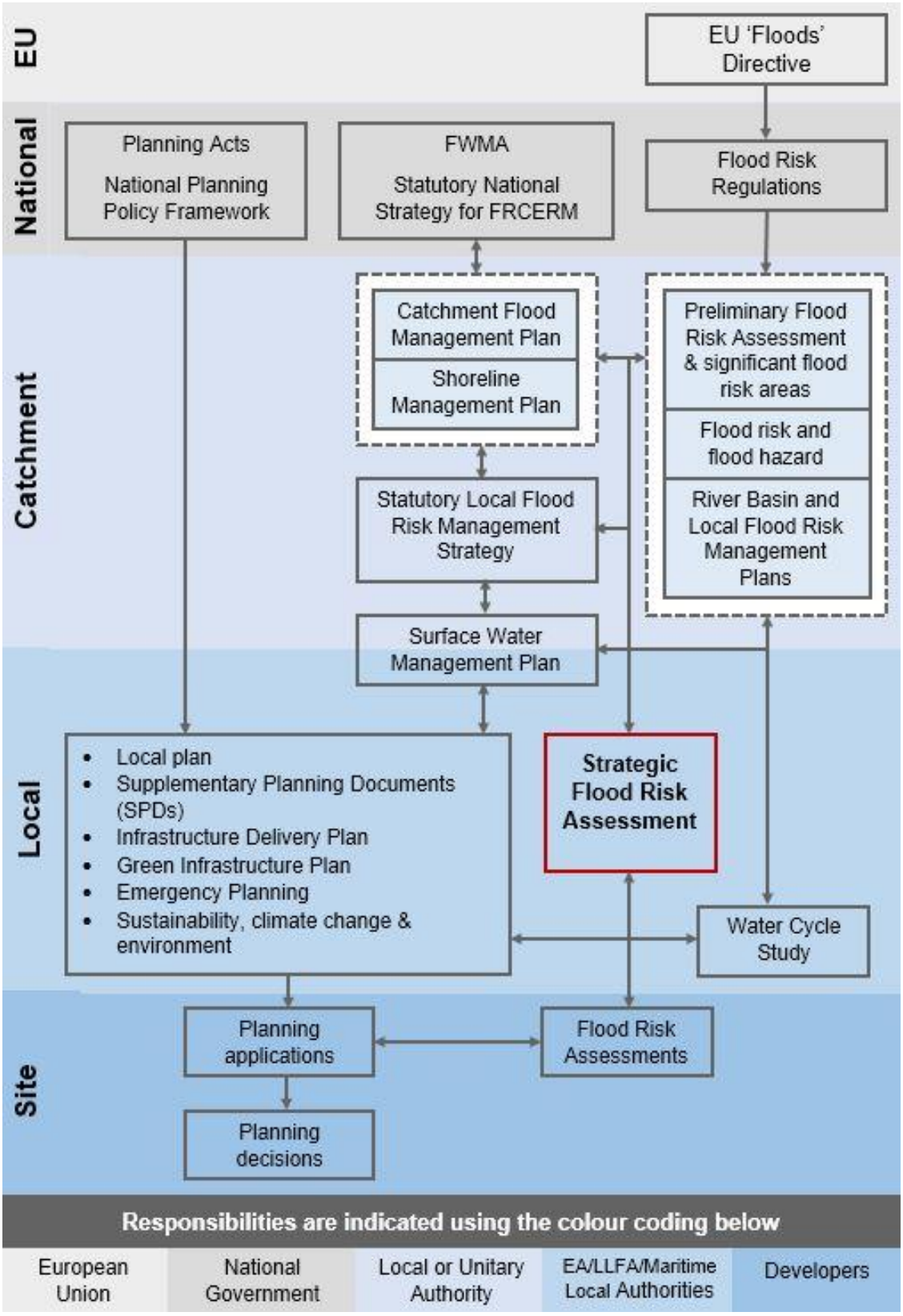
Risk Management Authority (RMA)	Strategic Roles	Operational Level Roles
Local Planning Authority (Harlow Council)	Input to National and Local Authority Plans and Strategy (e.g. Harlow Local Plan)	• Preparation of a Local Plan to guide development. • The competent determining authority for planning applications and have the ultimate decision on the suitability of a site in relation to flood risk and management of surface water run-off. • Responsibilities for emergency planning as a responder to a flood event. • 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

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, 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 Catchment Flood Management Plans (CFMPs), Shoreline Management Plans (SMPs), Surface Water Management Plans (SWMPs) and Water Cycle Strategies (WCSs).

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



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

3 The sequential, risk based approach

3.1 Flood Zones

Table 1 of NPPG Flood Risk and Coastal Change identifies the following Flood Zones. These apply to both Main River and Ordinary Watercourses. Flood risk vulnerability and flood zone compatibility is set out in Table 3 of the NPPG. Table 3-1 summarises this information and also provides information on when an FRA would be required.

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.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses are 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.
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 local authorities should seek to reduce the overall level of 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.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify areas of functional floodplain, in agreement with 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. They must also be safe for users and not increase flood risk elsewhere. Essential Infrastructure will only be permitted if it passes the Exception Test.
		All developments in this zone require an FRA.

3.2 The sequential, risk-based approach

The sequential risk-based 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.

The approach can be applied both between and within Flood Zones.

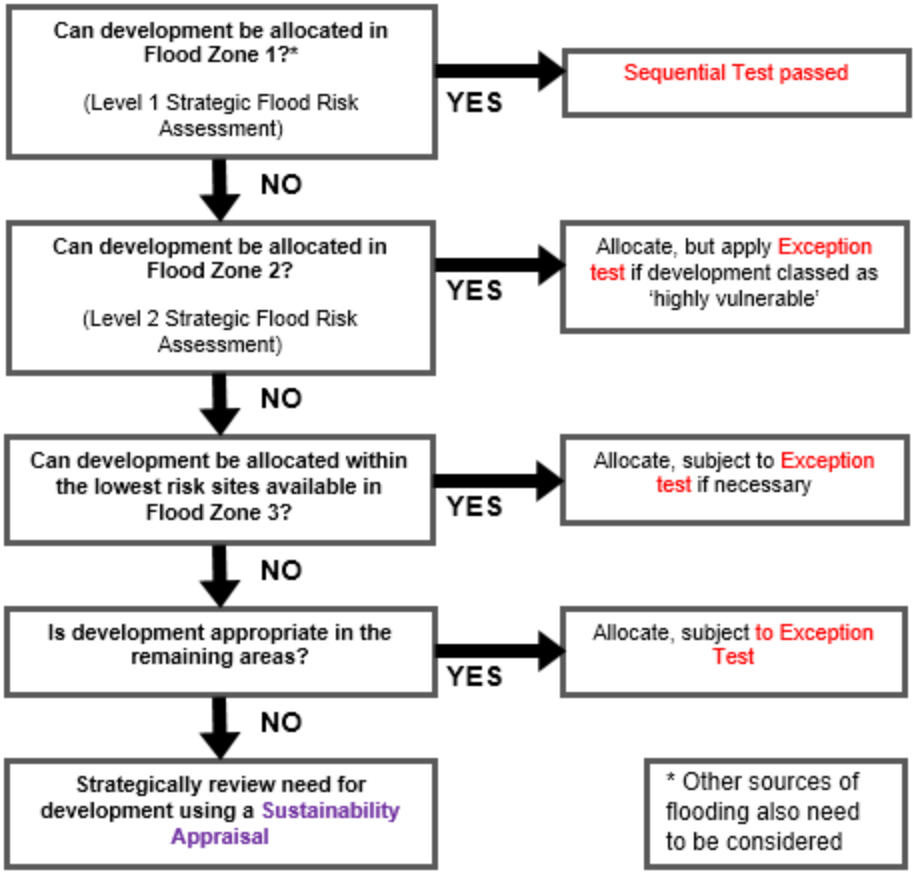
When drawing up a local plan, it is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic and a greater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

3.3 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 SFRAs to apply the Sequential and, where necessary, Exception Tests.

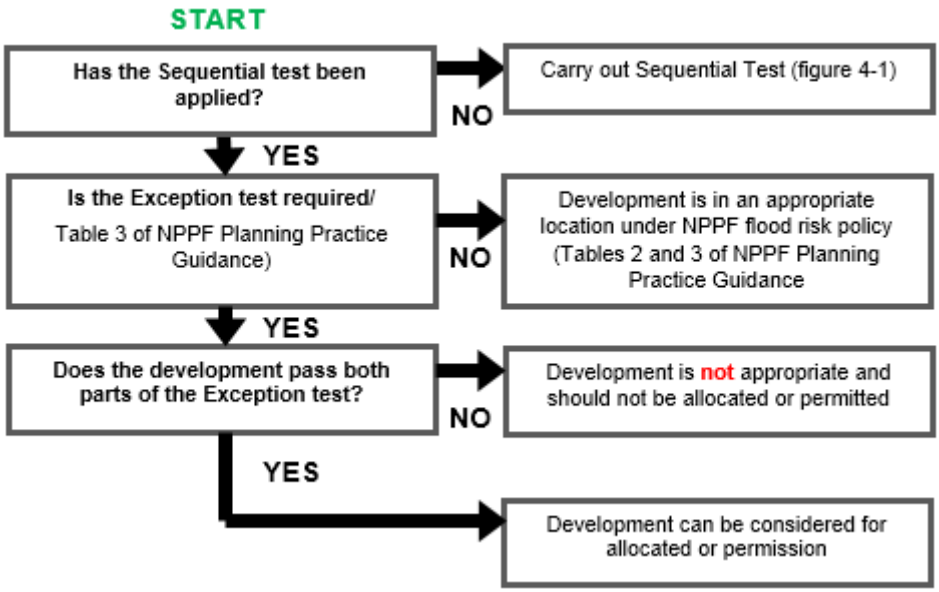
The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPG for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan (Figure 3-1).

Figure 3-1: Applying the Sequential Test in the preparation of a Local Plan



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

Figure 3-2: Applying the Exception Test in the preparation of a Local Plan



3.4 Applying the Sequential Test and Exception Test to individual planning applications

3.4.1 Sequential Test

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. A pragmatic approach should be taken when applying the Sequential Test.

Harlow 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 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.

3.4.2 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 uses, 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, the following two 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[9].

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[10]:

   - 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 NPPG provides detailed information on how the Test can be applied.

3.5 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) in any year; and
- residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% (1 in 200-year chance of flooding) in any year.

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

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

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. Over time the effects of climate change may reduce the standard of protection afforded by defences, due to increased river flows and levels, 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
- 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 a) the consequences of flooding need to be mitigated or b) where it is proposed to place lower vulnerability development in areas of flood risk

3.6 Impact of additional development on flood risk

When allocating land for development, consideration must be given to the potential cumulative impact of development on flood risk. The increase in impermeable surfaces and resulting increase in runoff increases the chances of surface water flooding if suitable mitigation measures, such as SuDS, are not put in place. Additionally, the increase in runoff may result in more flow entering watercourses, increasing the risk of fluvial flooding downstream.

Consideration must also be given to the potential cumulative impact of the loss of floodplain as a result of development. The effect of the loss of floodplain storage 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 increase in runoff, or loss in floodplain storage, from individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe without appropriate mitigation measures.

The cumulative impact of development 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.

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4 Climate change

4.1 Climate change and the NPPF

The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and NPPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

4.2 Revised climate change guidance

The Environment Agency published updated climate change guidance on 19 February 2016, which must now be considered in all new developments and planning applications. The document contains guidance on how climate change should be taken into account when considering development, specifically how allowances for climate change should be included in FRAs. 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.

4.3 Climate change allowances

By making an allowance for climate change it will help reduce the vulnerability of the development and provide resilience to flooding in the future.

The 2016 climate change guidance includes climate change predictions of anticipated change for peak river flow and peak rainfall intensity. There allowances are based on climate change projections and difference scenarios of carbon dioxide emissions to the atmosphere.

Due to the complexity of projecting climate change, there are uncertainties attributed to climate change allowances. As a result, the guidance presents a range of possibilities to reflect the potential variation in climate change impacts over three periods.

4.4 Peak river flows

Climate change is expected to increase the frequency, extent and impact of flooding, reflected in peak river flows. Wetter winters and more intense rainfall may increase fluvial flooding and surface water runoff and there may be increased storm intensity in summer. Rising river levels may also increase flood risk.

The peak river flow allowances show the anticipated changes to peak flow by river basin district which the subject watercourse resides. Once this is determined, guidance on uplift in peak flows are assigned for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the flood zones within which it resides.

These allowances (increases) are provided for three climate change ‘epochs’:

- 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)

The time period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years, whilst the lifetime of a non-residential development depends upon the characteristics of that development. Further information on what is considered to be the lifetime of development is provided in the NPPG.

The allowances for the Thames River Basin District are provided in Table 4-1.

Table 4-1: Peak river flow allowances for the Thames River Basin District

Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper end	25%	35%	70%
Higher central	15%	25%	35%
Central	10%	15%	25%

4.4.1 High++ allowances

High++ allowances only apply in assessments for developments that are very sensitive to flood risk and that have lifetimes beyond the end of the century. Further information is provided in the Environment Agency publication, Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.

4.4.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. The guidance states the following

Flood Zone 2

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	✓
Highly vulnerable		✓	✓
More vulnerable	✓	✓	
Less vulnerable	✓		
Water compatible	None		

Flood Zone 3a

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable		✓	✓
Less vulnerable	✓	✓	
Water compatible	✓		

Flood Zone 3b

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

4.5 Peak rainfall intensity allowance

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments. These allowances should be used for small catchments and urban drainage sites. For

catchments, larger than 5km^2, the guidance suggests the peak river flow allowances should be used.

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

Table 4-2: 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%

4.6 Using climate change allowances

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

4.7 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.

4.8 SFRA climate change modelling

Climate change modelling has been undertaken for all the Main Rivers flowing through Harlow for the '2080s' timeframe in the Thames River Basin District, i.e. 25%, 35% and 70% allowances. Detailed 1D-2D hydraulic models were used for the River Stort and Harlowbury Brook. The Todd Brook, Parndon Brook, Canons Brook and Pincey Brook were modelled using 2D modelling methods (Jflow+).

In addition to the Main Rivers, an Ordinary Watercourse flowing into Harlowbury Brook was also modelled using Jflow+ to determine the level of flood risk, as well as climate change, for once of the proposed development sites for the Level 2 assessment.

It should be noted that the climate change modelling has been undertaken to assist the Council with the preparation of their emerging District Plan. Developers will need to undertake a detailed assessment of climate change as part of the planning application process when preparing FRAs.

4.9 The impact of climate change in Harlow

Climate change mapping has been provided in Appendix D. The increase in extent of the 1 in 100-year event for the River Stort is negligible, with even a 70% increase in flow having relatively minor increases in the flood extent.

The effect of climate change on the Harlowbury Brook is similar to that of the River Stort, with only small increases in the 1 in 100-year event seen. The greatest increase in flood extent is an area on the right bank (looking downstream) just north of the Oxleys.

Todd Brook and Canons Brook see the greatest increase in the 1 in 100-year flood extent as a result of climate change, particularly in the lower reaches of Canons Brook where it enters the River Stort. The increase in flood extent for these watercourses remains largely within the floodplain and few additional houses are affected.

However, climate change does not just affect the extent of flooding. Even where extent does 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 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 Sources of information used in preparing the SFRA

5.1 Summary of SFRA mapping for all sources of flood risk

5.1.1 Fluvial

The data used to prepare the fluvial mapping for this study is based on Flood Zones and the results from hydraulic models either provided by the Environment Agency or prepared for the purposes of this SFRA. Hydraulic models, provided by the Environment Agency, cover the following watercourses:

- River Stort
- Harlowbury Brook

Jflow+ 2D modelling was undertaken for the Todd Brook, Parndon Brook, Canon Brook and Pincey Brook as no detailed hydraulic model was available.

Jflow+ modelling was also undertaken for an unnamed ordinary watercourse that flows into the Harlowbury Brook in order to provide Flood Zones and climate change information as well as depth hazard and velocity information for the Level 2 SFRA assessment.

5.1.2 Surface Water

Mapping of surface water flood risk in Harlow has been taken from the updated Flood Map for Surface Water (uFMfSW) which is also published online by the Environment Agency. 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. It provides 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 (Table 5-1).

Table 5-1: 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.

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 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.

5.1.3 Groundwater

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. Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater (AStGWF) dataset. The AStGWF dataset is a strategic-scale map showing groundwater flood areas on a 1km square grid. It shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the probability of groundwater flooding occurring and 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.

5.1.4 Sewers

Historical incidents of flooding are detailed by Thames Water through their DG5 register. The DG5 database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding.

5.1.5 Reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area has been mapped using the outlines produced as part of the National Inundation Reservoir Mapping (NIRIM) study.

5.1.6 Suite of Maps

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

- Appendix B: Watercourses in Harlow
- Appendix C: Flood Zone Mapping
- Appendix D: Climate Change Mapping
- Appendix E: Surface Water Mapping
- Appendix F: Groundwater Mapping
- Appendix G: Flood Warning Coverage

5.2 Other relevant flood risk information

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

- Thames Catchment Flood Management Plan (2009)
- Essex County Council Preliminary Flood Risk Assessment (2011)
- Essex County Council Local Flood Risk Management Strategy (2013)
- Rye Meads Water Cycle Strategy (2009)
- Thames River Basin Flood Risk Management Plan (2015)
- Environment Agency's Asset Information Management System (AIMS) – users should note that recently completed schemes may not yet be included in this dataset.

6 Understanding flood risk in Harlow

6.1 Historical flooding

Harlow has a history of documented flood events with the main source being from fluvial sources. Historic flood events are presented in Table 5 1.

Table 5.1 Historic flood events in Harlow

Watercourse	Date	Source	Additional Information
River Stort, Canons Brook, Todd Brook, Parndon Brook	March 1947	Environment Agency Recorded Flood Outlines dataset	Extensive flooding in the area of the River Stort valley and affected Templefields. In addition, both Todd Brook and Parndon Brook flooded.
River Stort	September 1968	Environment Agency Recorded Flood Outlines dataset	Catchment-wide
River Stort, lower reaches of Canons Brook	November 1974	Environment Agency Recorded Flood Outlines dataset	Catchment-wide
River Stort, Harlowbury Brook near Gilden Way	May 1978	Environment Agency Recorded Flood Outlines dataset	Catchment-wide
Harlow, River Stort Valley	September 1992	Previous SFRA (2011)	Rural land to the east of Wyldwood Close, rural land between Fifth Avenue and Burntmill Lane
Todd Brook	October 1993	Environment Agency Recorded Flood Outlines dataset	Near Nettleswell Pond and Passmores House
River Stort	October 2001	Environment Agency Recorded Flood Outlines dataset	Catchment-wide
River Stort	January 2003	Environment Agency Recorded Flood Outlines dataset	Riverside Court
Harlow	June / July 2006	Harlow Council	Flooding at various locations throughout Harlow as a result of flooding from drains or sewerage.
River Stort	February 2009	Environment Agency Recorded Flood Outlines dataset	Riverside Court
River Stort	February 2010	Environment Agency Recorded Flood Outlines dataset	Riverside Court
River Stort	February 2014	Environment Agency Recorded Flood Outlines dataset	Riverside Court, Parndon Lock
Harlow, Berecroft and Cooks Spinney	August 2014	Essex Fire and Rescue Incident Report[11]	Heavy downpours cause flooding around Berecroft and Cooks Spinney.

6.2 Demographics

Harlow as an administrative area covers an area of approximately 31km^2 and has a population of approximately 81,944 (2011 census). There are 11 wards in Harlow, the three most populous consist of Church Langley, Little Parndon and Hare Street and Bush Fair.[12]

6.3 Topography, geology, soils and hydrology

6.3.1 Topography

The topography within Harlow is shown in Figure 6-1 and is composed of higher elevations in the south of the area. These areas reach approximately 108 metres Above Ordnance Datum

11 Essex Fire and Rescue Incident Report (2014) http://www.essex-fire.gov.uk/incidents/10082014/ (accessed 15/07/2016)

12 Harlow Council, Statistics about Harlow, https://www.harlow.gov.uk/statistics

(mAOD), decreasing in a northerly direction. Lower lying elevations tend to correspond with the key watercourses in the area and their floodplains.

6.3.2 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.

Figure 6-2 shows the bedrock (solid permeable) formations in the District and Figure 6-3 shows the superficial (permeable, unconsolidated (loose) deposits. These are classified as the following:

- Principal: layers of rock or drift deposits with high permeability and, therefore, provide a high level of water storage
- Secondary A: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers
- Secondary B: lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater
- Secondary undifferentiated: rock types where it is not possible to attribute either category a or b
- Unproductive Strata: rock layers and drift deposits with low permeability and therefore have negligible significant for water supply or river base flow

The majority of the bedrock is classed as unproductive strata, associated with clay, silt, sand and gravel. There is a small area of Principal aquifer (chalk) to the north east as well as pockets of Secondary A (also clay, silt, sand and gravel). The superficial deposits comprise mainly of undifferentiated Secondary aquifer with areas of Secondary A formations along river corridors.

6.3.3 Hydrology

The principle watercourse flowing through the SFRA is the River Stort which flows along the north boundary of the Council's administrative area. Tributaries of the River Stort include Canons Brook and Harlowbury Brook. A summary of the principle watercourses within the SFRA is within Table 6-1. Mapping showing the location of these watercourses can be found in Appendix B.

Figure 6-1: Harlow topography

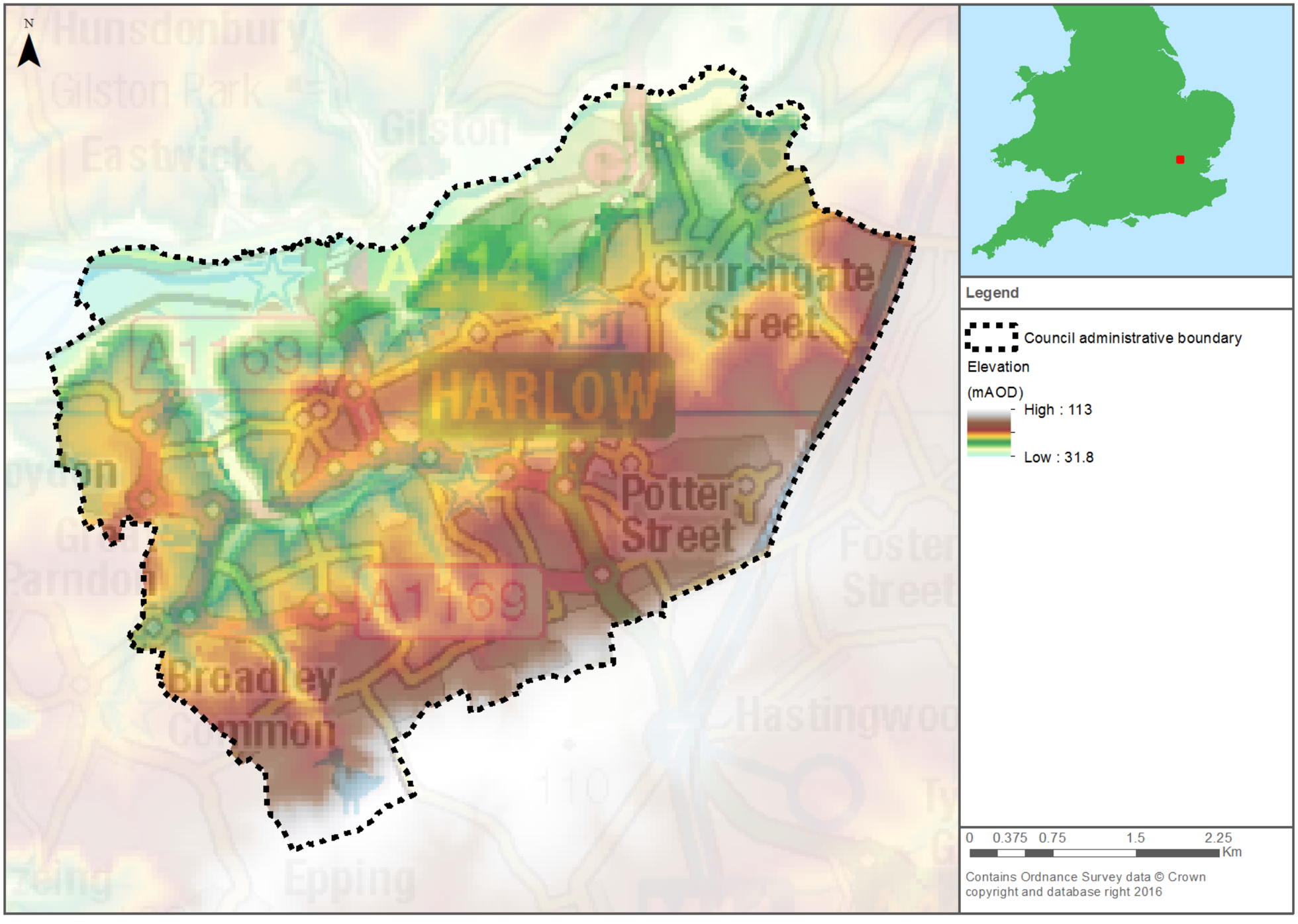


Figure 6-2: Bedrock aquifer classification in Harlow

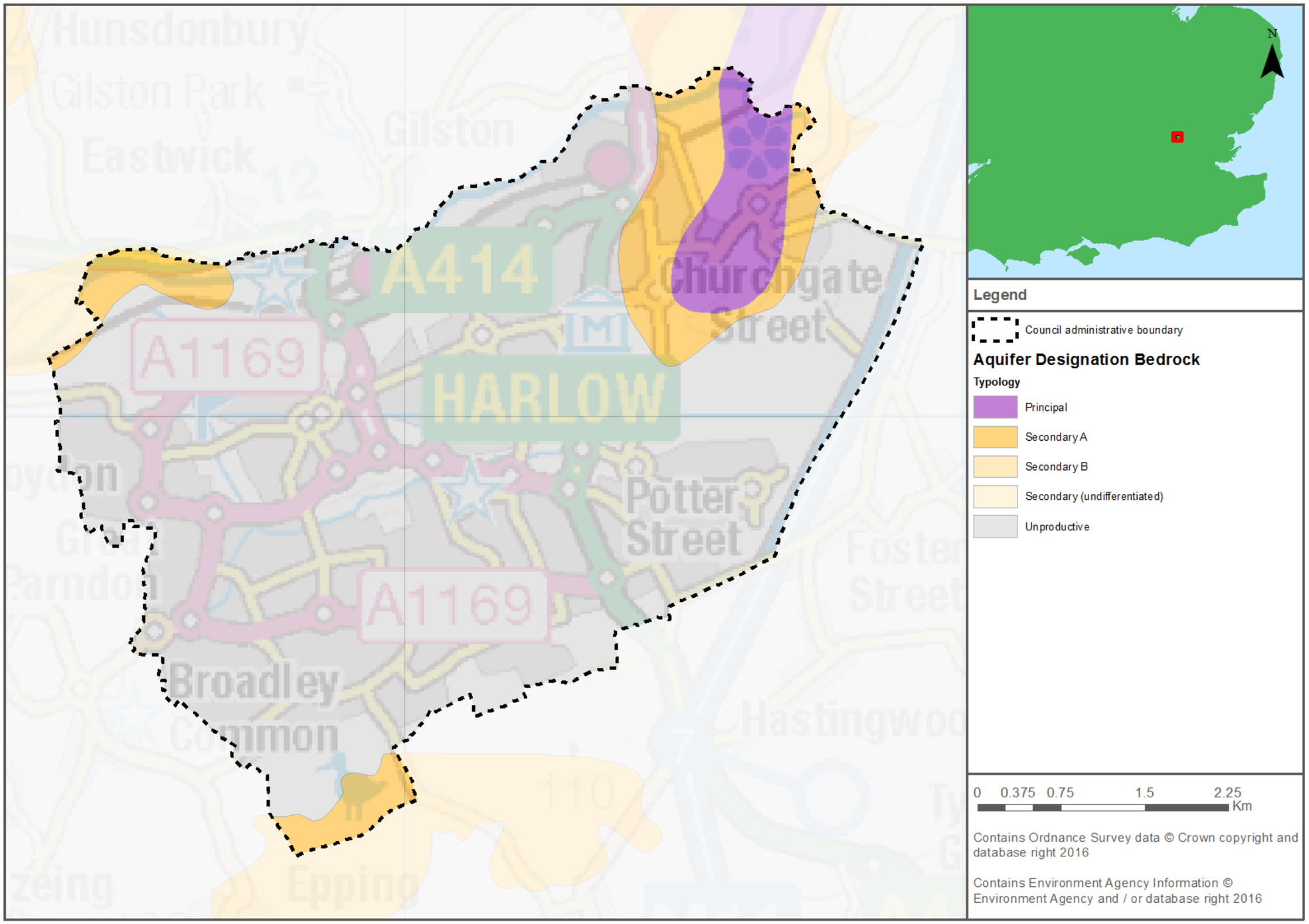


Figure 6-3: Bedrock aquifer classification in Harlow

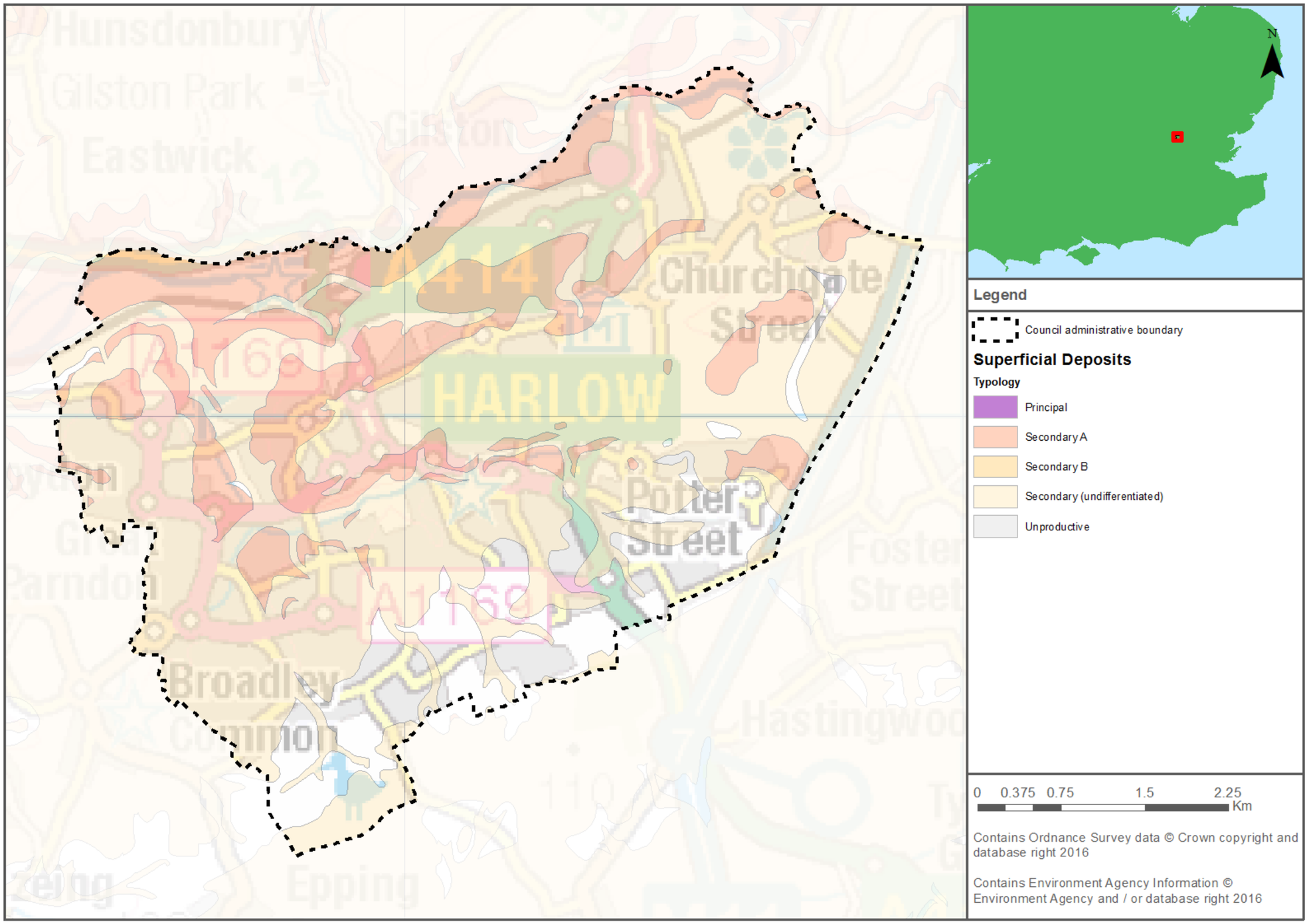


Table 6-1: Watercourses in the study area

Watercourse	Classification	Description
River Stort / River Stort (Navigation)	Main River	The River Stort flows in a westerly direction across the northern boundary before leaving the study area. The River Stort has been modified in order to make it navigable in areas; as a result, there are splits in the channel with navigable canal sections that include locks flowing for periods in parallel with the natural watercourse. There are numerous tributaries that have confluences with the River Stort within the study area.
Parndon Brook	Main River / Ordinary Watercourse	Parndon Brook enters the study area to the south of Katherines and flows in a north easterly direction, until its confluence with Canons Brook, north of Great Parndon.
Todd Brook	Main River / Ordinary Watercourse	Todd Brook's source is located in the vicinity of Malkin Drive in the south east of the study area. It flows initially northward in a culverted system before surfacing south of the laboratories near Markhall Wood. It then proceeds to flow in a predominately western direction before its confluence with Canons Brook, north of Great Parndon.
Canons Brook	Main River	Canons Brook starts to the north of Great Parndon where Parndon and Todd Brook join. Canons Brook then proceeds to flow northwards through the golf courses situated between Little Parndon and Pinnacles before its confluence with the River Stort.
Pincey Brook	Ordinary watercourse	Pincey Brook flows along the shared boundary with Epping Forest to the east of the study area before having its confluence with the River Stort Navigation, on the boundary between Harlow, Epping Forest and East Hertfordshire.
Harlowbury Brook	Main River / Ordinary Watercourse	Harlowbury Brook rises to the east of the study area within Epping Forest and flows into the study area in the proximity of Franklins Farm. It proceeds to flow in a north west direction before joining the River Stort (Navigation) in the vicinity of Harlow Mill Bridge.

6.4 Fluvial flood risk

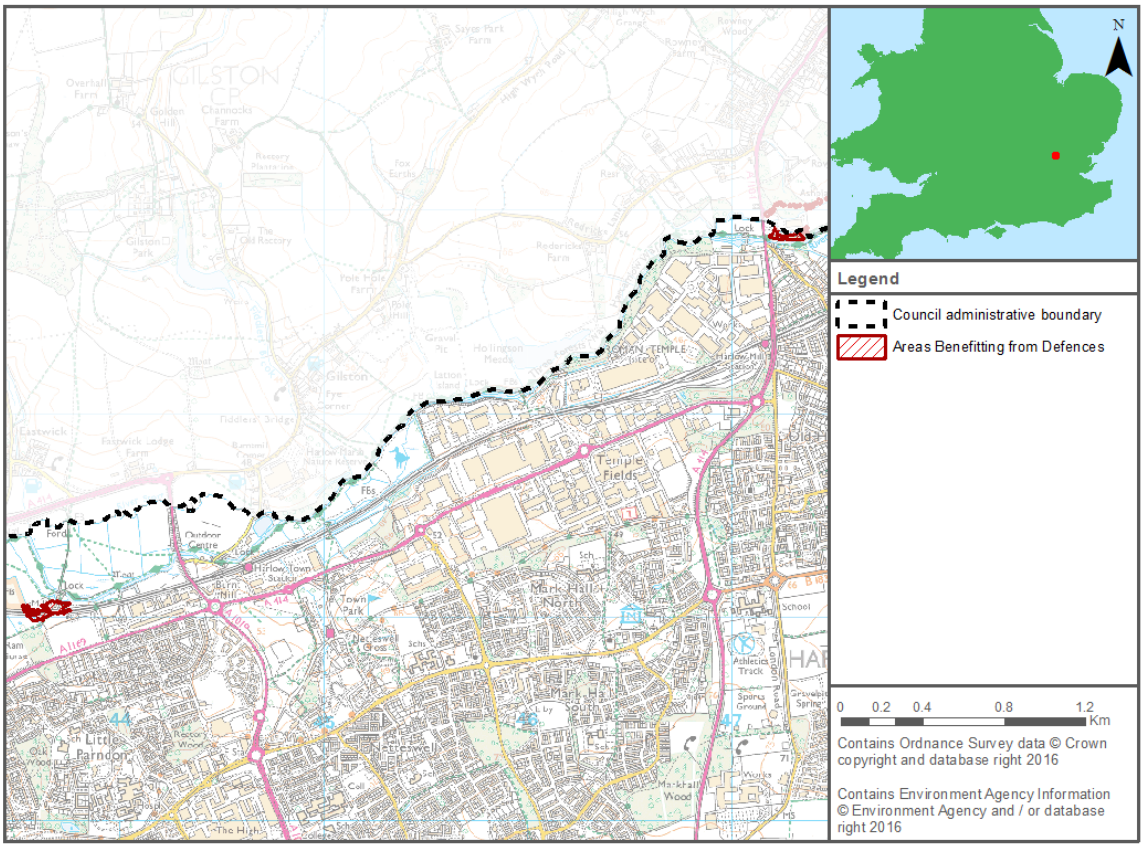
Overall, the risk to Harlow from fluvial flooding is relatively low. Fluvial flood risk in Harlow is predominantly associated with the River Stort to the north of the town around Harlow Town station, Temple Fields north of the railway line, and south of the railway line at the A414 roundabout. These areas are located in Flood Zone 2. Some properties along Guilfords, in the east of Harlow, are also shown to be at risk from the Harlowbury Brook and are located in Flood Zone 2.

Flood risk from Todd Brook and Canons Brook is mainly restricted to rural land, with just a few isolated properties and gardens at risk. Parndon Brook poses more of a risk with some properties along Tithelands, Greygoose Park and Peacock Road shown to be in Flood Zone 3.

6.4.1 Flood defences

The majority of flood defences within Harlow are located along the River Stort corridor, with a small number of defences located on Canons Brook. Figure 6-4 shows the areas benefitting from defences in Harlow as designated by the Environment Agency. The Environment Agency's dataset shows areas that benefit from flood defences in the event of a river flood with a 1% chance of happening in any one year. If the defences were not there, these areas would flood. The dataset may not yet include areas benefitting from recently completed schemes. Defences are covered in greater detail in Section 7.

Figure 6-4: Flood defences and areas benefitting from defences in Harlow



6.5 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.

The uFMfSW predominantly follows topographical flow paths, particularly in the south of Harlow flowing towards Todd Brook. Another area that is shown to be significantly affected by surface

water flooding is Temple Fields. Elsewhere, surface water flooding tends to be in the form of flow paths or ponding along transport routes, or ponding in gardens or open land.

The uFMfSW mapping for Harlow can be found in Appendix E.

6.6 Groundwater flooding

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.

Mapping of Harlow has been provided showing the AStGWF dataset and can be found in Appendix F.

6.7 Flooding from sewers

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.

6.8 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.

For development applications located in the vicinity of a canal, it is recommended that overtopping and / or breach is considered as part of a site-specific FRA to establish the residual risk to the development.

6.8.1 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. If the capacity of these control structures is exceeded, or they become blocked, overtopping may occur.

6.8.2 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.

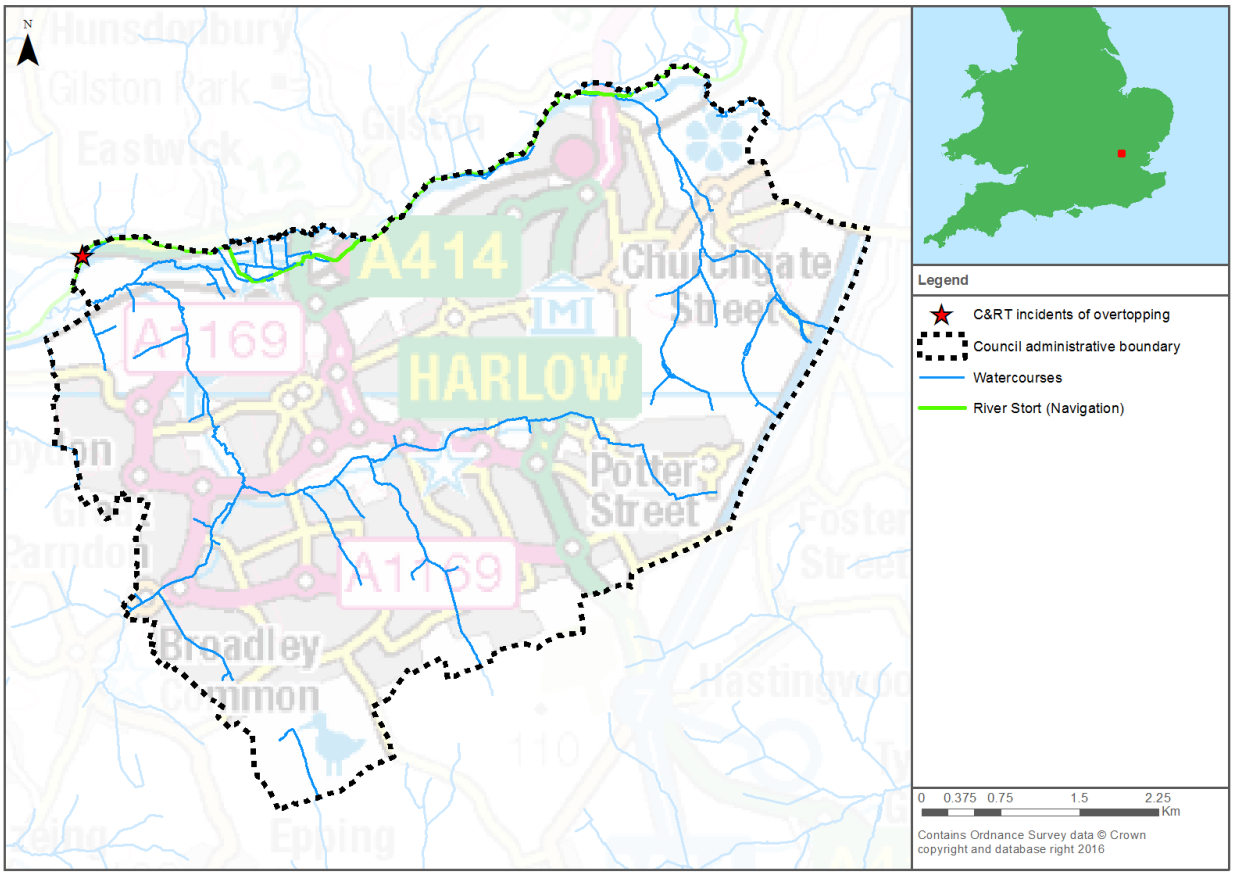
6.8.3 River Stort Navigation

The River Stort is navigable throughout much of its course in Harlow. The location of the Navigation is shown in Appendix B. The level of water in the River Stort navigational channel is normally controlled by the level and size of weirs.

The Canal and River Trust (C&RT), the navigation authority for the River Stort, have supplied records of overtopping incidents along this watercourse in Harlow. It should be noted that this information does not mean that the assets listed will necessarily have a significant (or any other) effect on flood risk. There have been two incidents of overtopping; both were recorded in 2010. The incidents were reported to have been caused by heavy rainfall which caused the River Stort to overtop its banks, flooding the adjacent tow paths.

Development applications located around the vicinity of the River Stort navigation, overtopping of this watercourse may need to be considered as part of a site-specific FRA to establish the residual risk to the development.

Figure 6-5: Canal overtopping incidents



6.9 Reservoir flood risk

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. The Environment agency is currently progressing a 'Risk Designation' process so that the risk is formally determined.

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 or 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 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. Although there are no reservoirs located within Harlow there are five reservoirs outside of the area which may potentially affect the town in the event of reservoir inundation. Details of the reservoirs are provided in Table 6-2. Figure 6-6 shows the reservoir inundation mapping for Harlow. In the event of reservoir failure, inundations appear to be mainly confined to the floodplain of the River Stort and Parndon Brook.

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.

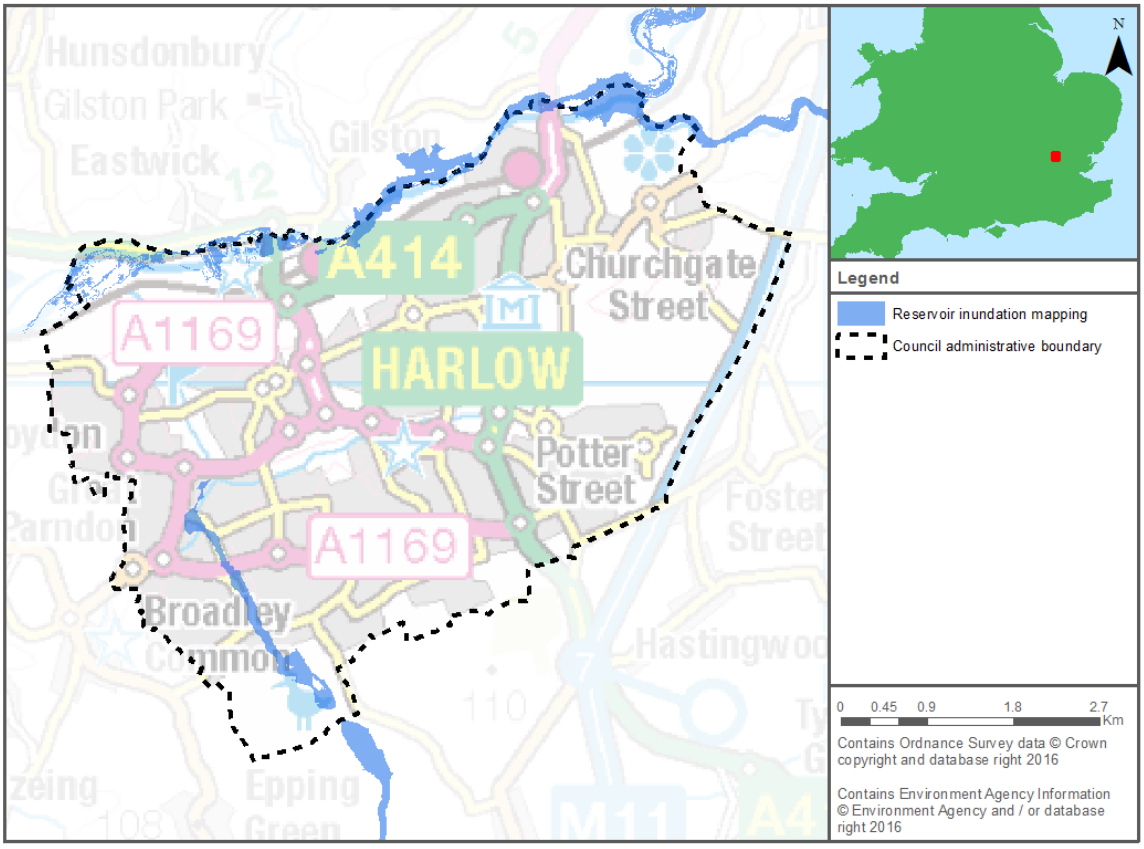
The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include
    - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
    - operation: discharge rates / maximum discharge;
    - discharge during emergency drawdown; and
    - inspection / maintenance regime.
- Developers should apply the sequential approach to locating development within the site. The following questions should be considered
    - can risk be avoided through substituting less vulnerable uses or by amending the site lay-out?
    - can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? and
    - can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?
- Consult with relevant authorities regarding emergency plans in case of reservoir breach
- In addition to the risk of inundation those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

Table 6-2: Reservoirs that may potentially affect Harlow in the event of a failure

Reservoir	Location	Reservoir Owner	Environment Agency area	Local Authority	In the District ?
Rye Hill 2	544972, 206451	Affinity Water	Hertfordshire and North London	Essex	No
Shrubbs Farm Reservoir	551864, 213504	Liddell			
Hatfield Forest Lake	554187, 219751	The National Trust			
Balancing Pond C	554966, 221427	Stansted Airport Ltd.			
Lancaster Lake	546691, 218404	Collins		Hertfordshire	

Figure 6-6: Reservoir inundation mapping



6.10 Cross boundary considerations

6.10.1 Flood risk

Future development, both within and outside Harlow can have the potential to affect flood risk to existing development and surrounding areas. Harlow has boundaries with the following Local Authorities:

- East Hertfordshire District Council
- Epping Forest District Council

The topography of the area means a couple of watercourses in Harlow have their source within the council boundary, with the exception of the River Stort and Parndon Brook. Therefore,

development in neighbouring authorities will have no impact on the level of flood risk from watercourses with their source in Harlow, for example Harlowbury Brook and Todd Brook.

The Parndon Brook rises in Epping Forest District. There is potential that development in the Parndon Brook catchment in this district has the potential to increase the impermeable area at the development site and to increase runoff to the Parndon Brook, potentially increasing the level of risk downstream in Harlow.

The River Stort flows through the north of Harlow. As the watercourse flows through the area, it means not only does development in neighbouring authorities have the potential to affect flood risk within Harlow, but that development in Harlow also has the potential to increase flood risk to neighbouring authorities downstream, if appropriate mitigations measures have not been implemented, to manage runoff.

Whilst there are potential cross-boundary flood risk issues both from and to neighbouring authorities, conditions imposed by Harlow Council, neighbouring authorities and the LLFA 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. 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.

6.10.2 Water quality

In addition to cross-boundary issues regarding flood risk, there are also cross-boundary issues relating to water quality.

In England, the Environment Agency is responsible for the delivery of the WFD objectives, and has produced RBMPs 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.

Development or agriculture in the upper catchments of watercourses can potentially impact on the quality of water of watercourses within the study area. Although Harlow is predominantly urban, the River Stort and Parndon Brook flow through rural land in neighbouring authorities. 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 waterbodies. Future development should ensure there is no adverse impact on the quality of watercourses within the Council administrative area. Any impacts identified should then be considered in relation to the WFD status of the waterbody and the status objectives. Opportunities to improve the status of watercourses should also be considered.

7 Flood defences

7.1 Flood defences

A number of flood alleviation measures have been identified within Harlow.

Flood alleviation schemes may take the form of defences, initiatives to improve drainage, and/or land management to reduce the risk of high velocity overland surface runoff.

7.1.1 Defence standard of protection and residual risk

One of the principal aims of this SFRA is to outline the present risk of fluvial flooding from watercourses across Harlow that includes consideration of the effect of flood risk management measures (including flood banks and defences). The fluvial flood risk presented in the SFRA is of a strategic nature for the purpose of preparing evidence on possible site options for development. In cases where a specific site risk assessment is required, detailed studies should seek to refine the current, broad, understanding of flood risk from all sources.

Consideration of the residual risk behind flood defences should be considered as part of detailed site specific flood risk assessments. The residual risk of flooding in an extreme flood event or from failure of defences should also be carefully considered.

Developers should also consider the standard of protection provided by defences and residual risk as part of a detailed 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

7.1.2 Defence condition

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 7-1.

Table 7-1: 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

The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is an issue that needs to be considered as part of the risk based sequential approach and, in light of this, whether possible site options for development are appropriate and sustainable. In addition, detailed Flood Risk Assessments (FRAs) will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired.

A review of key defences across Harlow, their condition and standard of protection is included in the following section.

7.2 Overview of defences

The location of defences in Harlow are shown in Figure 7-1. This includes the following defences:

- A privately maintained embankment along the left bank of the Stort Navigation at Eastwick Mead. The Stort Navigation Towpath Is conveyed along the crest of the defence. The Environment Agency's AIMs dataset has this embankment as providing protection against a 10% AEP flood event. The overall condition of the defence is good
- A privately maintained wall along the left bank of the Stort Navigation at Parndon Mill. The Environment Agency's AIMs dataset has this embankment as providing protection against a 10% AEP flood event. The overall condition of the defence is good
- A privately maintained wall along the left bank of the Stort Navigation at Burntmill Lane. The Environment Agency's AIMs dataset has this embankment and wall as providing protection against a 10% AEP flood event. The overall condition of the defence is fair
- A privately maintained embankment along the right bank of the River Stort Navigation at Moorhen Marina. The Environment Agency's AIMs dataset has this embankment as providing protection against a 10% AEP flood event. The overall condition of the defence is good
- Privately maintained embankment and wall on the right bank of the River Stort Navigation at Riverside Court. Environment Agency's AIMs dataset has the embankment as providing protection against a 10% AEP flood event with an overall condition of poor. The wall provides protection against a 5% AEP flood event and has an overall condition of good
- A privately maintained wall and embankment either side of the Canons Brook at Canons Brook Golf Club. The Environment Agency's AIMs dataset has this embankment and wall as providing protection against a 10% AEP flood event. The overall condition of the defence is fair
- A privately maintained earth embankment on the right bank of the Canons Brook. The embankment extends from a screen and weir complex. Flood water collects behind the embankment and pass through drains in the embankment into a ditch, acting as a retention for litter and debris. The Environment Agency's AIMs dataset has this embankment as providing protection against a 20% AEP flood event The overall condition of the defence is good

7.3 Residual flood risk

Residual risk refers to the risks that remain after measures have been taken to alleviate flooding (such as flood defences). 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; and/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.

Defences in Harlow are generally shown to have a lower standard of protection, typically against a 1 in 10-year flood event. They also appear to defend the immediate local area rather than the wider Harlow area.

In the event of a breach, depending on the extent and magnitude of the breach, water could rapidly inundate areas behind defences with little warning. Although the majority of areas protected by defences are within the Environment Agency's Flood Warning Service, the service does not provide a warning in the event of a breach.

There is also the potential that the risk of defences overtopping in the future may increase due to increased flows due to climate change.

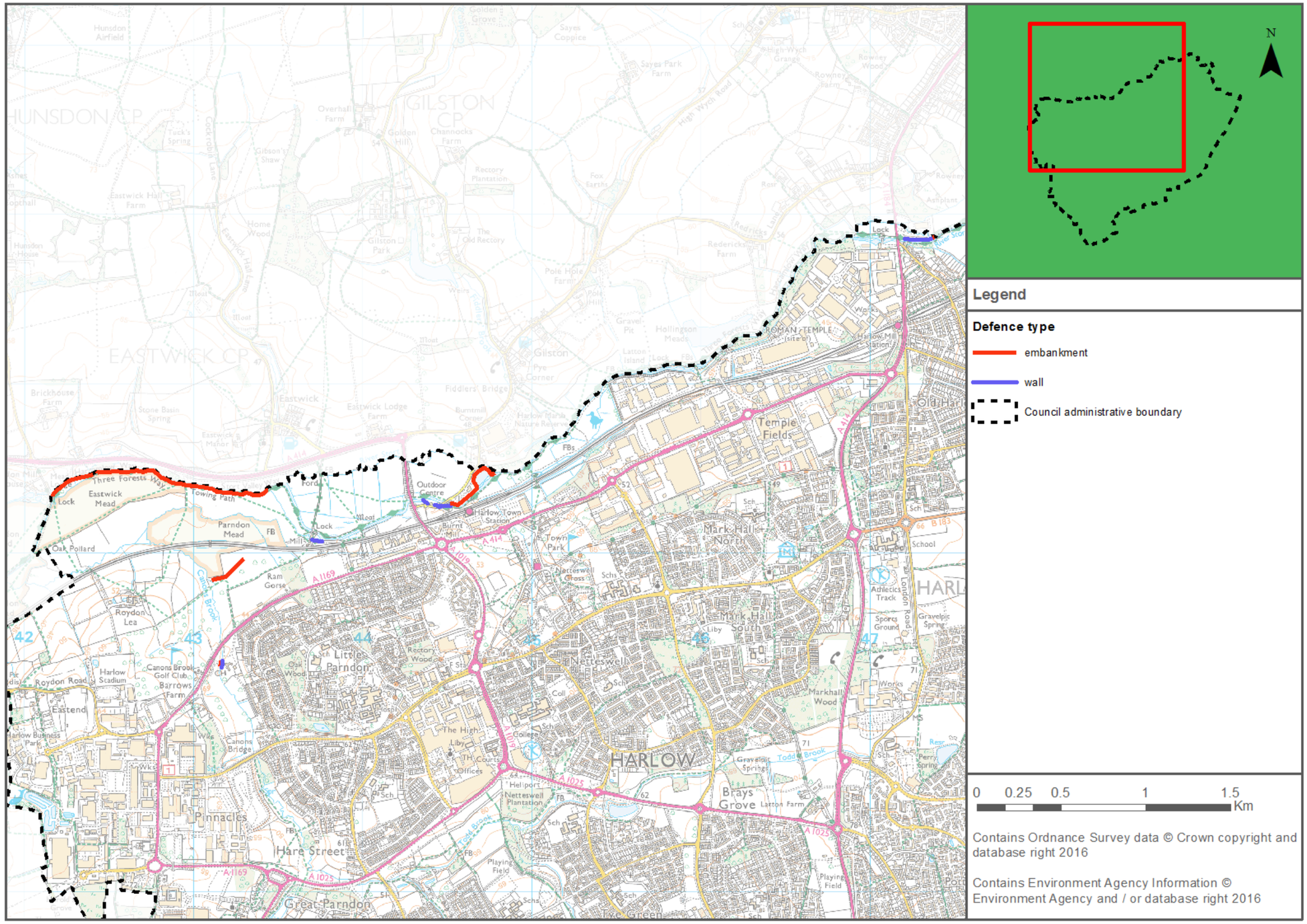
7.3.1 Implications for development

Should development be proposed in areas behind the defences or areas benefitting from the defences then 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.

Developers should include an assessment of the residual risk where developments are located in areas benefitting from defences. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping. Any improvements to defences should ensure they are in keeping with wider catchment policy.

None of the sites proposed for development, provided by Harlow Council are in locations benefitting from defences.

Figure 7-1: Flood defences in Harlow



8 FRA requirements and flood risk management guidance

8.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within Harlow. Due to the strategic scope of the study, prior to any construction or development, site-specific assessments will need to be undertaken for individual development proposals (where required) so all forms of flood risk at a site are fully addressed. It is the responsibility of the developer to provide an FRA with an application.

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.

8.2 Requirements for site specific flood risk assessments

8.2.1 What are site specific FRAs?

Site specific FRAs are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with planning applications and should demonstrate how flood risk will be managed over the development's lifetime, taking into account climate change and vulnerability of users.

8.2.2 When are site specific FRAs required?

Site specific FRAs are required in the following circumstances:

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

8.2.3 Objectives of site specific FRAs

Site specific FRAs should be proportionate to the degree of flood risk, as well as appropriate to the scale, nature and location of the development. Site specific FRAs should establish

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

FRAs for sites located in Harlow should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Harlow Council. Guidance and advice for developers on the preparation of site specific FRAs include:

- Standing Advice on Flood Risk (Environment Agency)
- Flood Risk Assessment for Planning Applications (Environment Agency)
- Site-specific Flood Risk Assessment: CHECKLIST (NPPF PPG, Defra)

Guidance for local planning authorities for reviewing flood risk assessments submitted as part of planning applications has been published by Defra in 2015 – Flood Risk Assessment: Local Planning Authorities

8.3 Flood risk management guidance – mitigation measures

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.

8.3.1 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 away from flood zones, 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.

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.

The provision of a buffer strip can ‘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.

8.3.2 Raised floor levels

The raising of internal floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood.

If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable finished flood levels should be set a minimum of 300mm above the 1% AEP plus climate change peak flood level. The additional height that the floor level is raised above the maximum water level is referred to as the “freeboard”. Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

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

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.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test. Access should be situated 300mm above the design flood level and waterproof construction techniques used.

8.3.3 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.

8.3.4 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 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 the floodplain 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.

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 or property.

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.

Any proposal for modification of ground levels will need to be assessed as part of a detailed flood risk assessment.

8.3.5 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 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)[13] 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.

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.

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 local planning authority and the Environment Agency.

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

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 also 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.

8.4 Flood risk management guidance – resistance measures

Measures designed to keep flood water out of properties and businesses.

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 1,000-year scenario. 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 normally be relied on for new development as an appropriate mitigation method. Most of the measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small scale pumping equipment to control the flood water that does seep through these systems. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system to user the measures are deployed in advance of an event. The following measures are often deployed:

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.

Community resistance 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.

8.5 Flood risk management guidance – resilience measures

Measures designed to reduce the impact of water that enters property and businesses.

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent damage is caused, the structural integrity of the building is not compromised and the clean up after the flood is easier.

Interior design measures to reduce damage caused by flooding include:

- 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 drains in bathrooms, kitchens or lavatories

8.6 Reducing flood risk from other sources

8.6.1 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.

8.6.2 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 the wider area. 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.

8.6.3 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) aim to mimic the natural processes of Greenfield surface water drainage by encouraging water to flow along natural flow routes and thereby reduce runoff rates and volumes during storm events while providing some water treatment benefits. SuDS also have the advantage of provided effective Blue and Green infrastructure and ecological and public amenity benefits when designed and maintained properly.

The inclusion of SuDS within developments should be seen as an opportunity to enhance 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 the Construction Industry Research and Information Association (CIRIA).

More detailed guidance on the use of SuDS is providing in Section 9

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9 Surface water management and SuDS

9.1 What is meant by Surface Water Flooding?

Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall.

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; and
- **overland flows entering the built up area from the rural/urban fringe:** includes overland flows originating from groundwater springs.

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

Local planning policies and decisions on planning applications relating to major development or major commercial development should ensure that sustainable drainage systems for management of run-off are put in place. The approval of sustainable drainage solution lies with the Local Planning Authority.

In April 2015 Essex County Council was made a statutory consultee on the management of surface water from major developments. They also provide pre-application advice on surface water drainage.

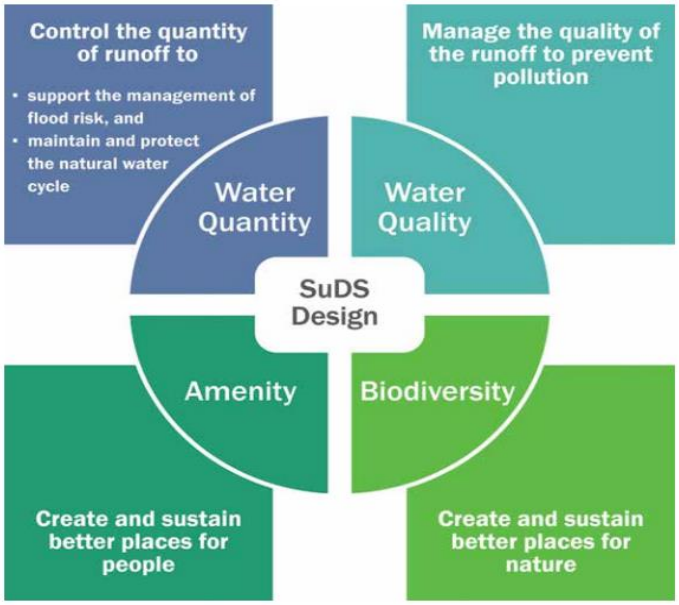
Major developments are defined as

- 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; and
- 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 seek advice from the relevant flood risk management bodies, principally the LLFA on the management of surface water (including what sort of SuDS they would consider to be reasonably practicable), 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. Judgement on what SuDS system would be reasonably practicable should be through reference to Defra's technical standards and should take into account design and construction costs.

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 four principles are shown in Figure 9-1.

Figure 9-1: Four pillars of SuDS design



Source: The SuDS Manual (C753)

9.3 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are designed to maximise the opportunities and benefits that can be secured from surface water management practices.

SuDS provide a means of dealing with the quantity and quality of surface water whilst offering additional benefits over traditional systems of improving amenity and biodiversity. The correct use of SuDS also allows developments to counteract the negative impact that urbanisation has on the water cycle by promoting infiltration and replenishing ground water supplies. SuDS if properly designed can improve the quality of life within a development offering addition benefits such as

- improving air quality;
- regulating building temperatures;
- reducing noise;
- providing education opportunities; and
- cost benefits over underground piped systems.

Given the flexible nature of SuDS they can be used in most situations within new developments as well as being retrofitted into existing developments. SuDS can also be designed to fit into the majority of spaces. For example, permeable paving could be used in parking spaces or rainwater gardens into traffic calming measures.

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.

9.3.1 Types of SuDS Systems

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (Table 9-1). 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) e.g. the CIRIA SuDS Manual C753 (2015).

Essex County Council has produce SuDS guidance[14] which includes information on different types of SuDS systems detailing practical issues, solutions and design considerations.

Table 9-1: 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	✓	✓	✓
Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains	✓	✓	
Gravelled areas	✓	✓	
Solid paving blocks	✓	✓	
Porous pavements	✓	✓	
Tanked systems	✓		
Over-sized pipes/tanks	✓		
Storm cells	✓		

9.3.2 Treatment

A key part of the four pillars of SuDS is to provide the maximum improvement to water quality through the use of the SuDS management train. To maximise the treatment within SuDS, CIRIA recommends[15] the following good practice is implemented in the treatment process:

1. **Manage surface water runoff close to source:** This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area
2. **Treat surface water runoff on the surface:** This allows treatment to be delivered by vegetated and sources of pollution to be more easily identified. It also helps with future maintenance work and identifying damaged or failed components of the management train
3. **Treat a range of contaminants:** SuDS should be chosen and designed to deal with the likely contaminants to a development and be able to reduce them to acceptably low levels
4. **Minimise the risk of sediment remobilisation:** SuDS should be designed to prevent sediments being washed into receiving water bodies or systems during events greater than what the component may have been designed
5. **Minimise the impact of spill:** Designing SuDS to be able to trap spills close to the source or provide robust treatment along several components in series

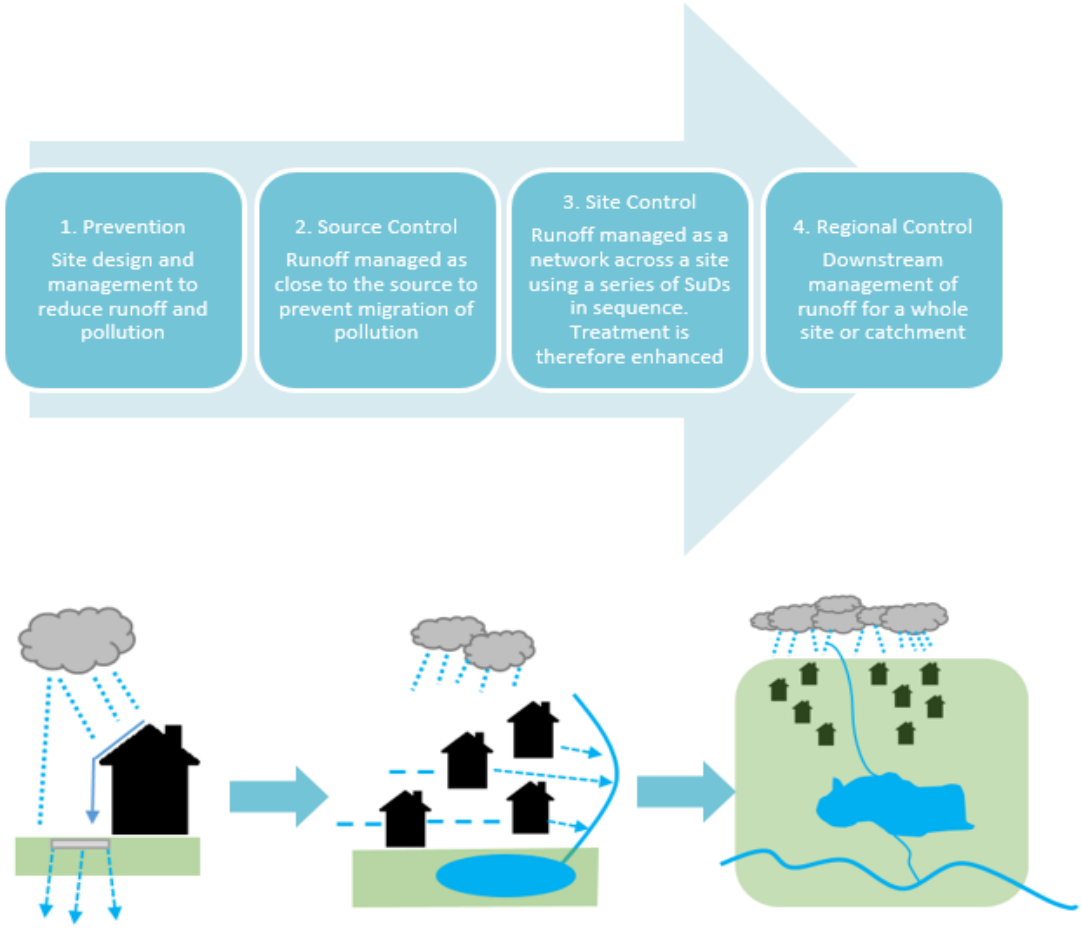
The number of treatment stages required depends primarily on the source of the runoff. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

14 Essex County Council (2014) SuDS Design Guide
15 C753 CIRIA SuDS Manual (2015)

9.3.3 SuDS Management Train

SuDS should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to discharge location. Collectively this concept is described as a SuDS Management Train (see Figure 9-2). SuDS components should be selected based on design criteria and how surface water management is to be integrated within the development and landscaping setting. By using a number SuDS features in series it is possible to reduce the flow and volume of runoff as it passes through the system as well as minimising pollutants which may be generated by a development.

Figure 9-2: SuDS management train



9.3.4 Overcoming 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. Table 9-2 details some possible constraints and how they may be overcome and includes information from both the SuDS Manual (C753) and Essex County Council SuDS Guidance.

For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough and a site-specific infiltration test is conducted early on as part of the design of the development. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to groundwater protection zones (GSPZs) or aquifers, further restrictions may be applicable and guidance should be sought from the LLFA.

Table 9-2: Overcoming SuDS constraints

Constraint	Solution
Land availability	SuDS can be designed to fit into small areas by utilising different systems. For example,

	features such as permeable paving and green roofs can be used in urban areas where space may be limited.
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.
High groundwater levels	Non-infiltrating features can be used. Features can be lined with an impermeable line or clay to prevent the egress of water into the feature. Additional, shallow features can be utilised which are above the groundwater table.
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.
Shallow slopes	Use of shallow surface features to allow a sufficient gradient. Infiltration systems may be more suitable and should be investigated. Pumped systems would not be accepted by the Environment Agency unless there were no other possible drainage solutions, and they would require the developer to demonstrate the consequences of pump failure and its impacts.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and indicate whether infiltration would be suitable or not.
Sites with deep backfill	Infiltration should be avoided unless the soil can be demonstrated to be sufficiently compacted. Some features such as swales are more adaptable to potential surface settlement.
Open space in floodplain zones	Design decisions should be done to take into consideration the likely high groundwater table and possible high flows and water levels. Features should also seek to not reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Facts such as siltation after a flood event should also be taken into account during the design phase.
Future adoption and maintenance	Local Planning Authority should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

9.4 Non statutory standards for SuDS

SuDS schemes should conform to the standards set out in Defra's non statutory SuDS standards[16] published in 2015. These should be used in conjunction with the NPPF and Planning Practice Guidance. The standards are summarised below:

9.4.1 Peak flow control

S2: For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1-year rainfall event and the 1 in 100-year rainfall event should never exceed the peak greenfield runoff rate for the same event

S3: for development which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1-year rainfall event and the 1 in 100-year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event

9.4.2 Volume control

S4: where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 1-100 year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event

S5: were reasonably practicable, for the development which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100-year, 6-hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event

[16] Non-Statutory Guidance for Sustainable Drainage Schemes (2015)

S6: where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Flood risk within the development

S7: the drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30-year event

S8: the drainage system much be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100-year rainfall event in any part of a building (including a basement) or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development

S9: the design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100-year rainfall event are managed in exceedance routes that minimise the risks to people and property.

9.4.3 Structural integrity

S10: components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirements for reasonable levels of maintenance

S11: the materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use

9.4.4 Designing for maintenance considerations

S12: pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity

9.4.5 Construction

S13: the mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system

S14: damage to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed

9.5 Sources of SuDS guidance

9.5.1 Essex County Council SuDS Design Guide (2014)

In 2014 Essex County Council produced their SuDS Design Guide. This is primarily intended to be used by developers, designers and consultants for implementing surface water drainage strategies including SuDS. The concept was for Essex County Council as the LLFA to provide guidance which complements national requirements but also includes localised needs.

The guide is formed of three key chapters:

1. A chapter which provides an overview of the design considerations, taking into account county issues such as the topography
2. An overview of the standards expected of SuDS. This includes flood prevention but also amenity, ecology and water quality
3. A number of case studies illustrating a number of worked examples for major type developments

It is recommended that this guidance is used in combination with national guidance. The LLFA Guidance is designed to build on the national standards by outlining the local expectations within Essex. This national guidance includes National Planning Practice Guidance[17], non-statutory technical standards for sustainable drainage schemes[18] and the SuDS Manual (C753)[19]. It

17 National Planning Practice Guidance (2015)
18 Non-Statutory Guidance for Sustainable Drainage Schemes (2015)

should be noted that since the SuDS guidance came out a new version of the SuDS Manual has superseded the document highlighted by the LLFA.

9.5.2 Essex County Council Developer Checklists

As part of the LLFA duty as a statutory consultee on surface water drainage for major developments, Essex County Council have developed checklists for an outline application[20] and detailed application[21]. The purpose of the document is to ensure that the necessary information is suppled to assess the suitability of the drainage system in line with NPPF. It is recommended that developers follow this guidance as failure to provide any of the requested information may result in the LLFA making the recommendation for refusal for the planning application based on insufficient information.

9.5.3 Essex County Council SuDS Adoption Policy (2015)

Essex County Council has the dual function of being both the LLFA and the Highway Authority. The Highway Authority is duty bound to adopt associated drainage from highways and manage risk of flooding to highways. In order to provide clarity and align the approach a SuDS Adoption Policy has been developed to outline when Essex County Council would consider the adoption of SuDS.

Typically, Essex County Council has the policy of not adopting SuDS unless under exceptional circumstances. The developer must demonstrate that that it is not possible for the SuDS to be adopted by a water company, even if design changes are necessary. Exceptional circumstances are considered to be where a developer has incorporated alleviation measures within their site that significantly improve flood risk and also fulfil one of the following requirements:

- There are known existing highway and/or property flooding problems
- There is a flood investigation for the area
- The site or area adjacent to the site is located in a Critical Drainage Area defined by a Surface Water Management Plan
- Significant areas are shown to be at risk in the uFMfSW.

It should be noted that the context of a significant improvement in flood risk by incorporated alleviation measures is something that would be judged on a site by site basis by the LLFA.

As part of the SuDS Adoption Policy Essex County Council outline the process which developers should follow to obtained approval for SuDS to be adopted. This process also includes information on fees, key design principles and specific adoption requirements. If further information is required, it is recommended that the developer contact Essex Highways via their contact highway.enquiries@essex.gov.uk.

9.5.4 C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015)[22] replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development. Guidance within the document complements information found within Essex County Council's SuDS Guidance.

9.6 Other surface water considerations

9.6.1 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

19 CIRIA SuDS Manual (2015)
20 SuDS Outline Drainage Checklist
21 SuDS Detailed Drainage Checklist
22 C753 CIRIA SuDS Manual (2015)

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

9.6.2 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 Harlow area is classed as a surface water NVZ.

10 Flood warning and emergency planning

10.1 Flood emergencies

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.

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)[23] and for essential ancillary sleeping or residential accommodation for staff. Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

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

10.2 Existing flood warning systems

The Environment Agency is the lead organisation for providing warnings of fluvial flooding for Main Rivers and coastal flooding in England. The Environment Agency supplies Flood Warnings via the Floodline Warnings Direct (FWD) service, to homes and businesses within Flood Zones 2 and 3. The different levels of warning are shown in Table 10-1.

It is the responsibility of individuals to sign-up to 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.

There is currently one fluvial Flood Alert Area and three fluvial Flood Warning Areas (FWAs) covering parts of Harlow. Appendix G shows the fluvial FWA coverage for the district.

[23] NPPG: Flood Risk and Coastal Change (paragraph 056, Reference ID: 7-056-20140306) March 2014

Table 10-1: 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 advance notice of the possibility of flooding, but before there is full confidence that flooding in Flood Warning Areas is expected.	✓ Be prepared to act on your flood plan ✓ Prepare a flood kit of essential items ✓ Monitor local water levels and the flood forecast on the Environment Agency website ✓ Stay tuned to local radio or TV ✓ Alert your neighbours ✓ Check pets and livestock ✓ 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 ✓ Turn off gas, electricity and water supplies if safe to do so ✓ Seal up ventilation system if safe to do so ✓ Put flood protection equipment in place ✓ Be ready should you need to evacuate from your home ✓ '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 ✓ Co-operate with the emergency services and local authorities ✓ 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 ✓ If you've been flooded, ring your insurance company as soon as possible

10.3 Emergency planning and development

NPPF 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. All flood sources should be considered. In particular sites should be considered in relation to any areas with critical drainage problems.

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

10.3.1 Safe access and egress

The NPPG 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[24]. 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

[24] NPPG: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014

access and egress must be functional for changing circumstances over the lifetime of the development. The NPPG 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 an FRA, the developer should review the acceptability of the proposed access in consultation with the Council and the Environment Agency. Site and plot specific velocity and depth of flows should be assessed against standard hazard criteria to ensure safe access and egress can be achieved.

10.3.2 Potential evacuations

During flood incidents, evacuation may be considered necessary. The Environment Agency and DEFRA's standing advice for undertaking flood risk assessments for planning applications states that details of emergency escape plans are required for any parts of the building that are below the estimated flood level. The plans should show

- single storey buildings or ground floors that do not 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 is a flood and there is enough time for them to leave after flood warnings[25].

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.

10.3.3 Flood warning and evacuation plans

Flood warning and evacuation plans are a potential mitigation measure to manage the residual risk. 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).

The Environment Agency provides practical advice and templates on how to prepare a flood plan for individuals, communities and businesses (see text box for useful links).

Guidance documents for preparation of flood response plans

- Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups
- Environment Agency (2014) Community Flood Plan template
- Environment Agency Personal flood plans
- Flood Plan UK 'Dry Run' - A Community Flood Planning Guide

It is recommended that emergency planners at Harlow Council are consulted prior to the production of any emergency flood plan.

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

10.4 Essex Resilience Forum

The Essex Resilience Forum brings together agencies involved in preparation and response to emergencies throughout the county to develop efficient and effective responses to a range of situations including flooding. The forum is made up of a number of partner organisations including the Environment Agency, health providers, Essex County Fire and Rescue Service, Essex Police, ambulance service, Coastguard, local authorities and the voluntary sector. The Forum's website contains a range of information to assist individuals, businesses and communities prepare for emergencies including flooding.

The forum has produced a Combined Operating Procedure for Essex (COPE) to enhance multi-agency response. In addition, there is a multi-agency flood plan that outlines the arrangements that should be put in place to ensure an efficient and effective multi-agency response to major flooding emergencies in Essex.

Essex Prepared is the website of the Essex Resilience Forum. Contained on this website is information on the risks facing the Essex county (as informed by the Community Risk Register) as well as guidance on 'preparing yourself', 'preparing your business' and 'preparing your community'. There is also an interactive community map which displays the locations of community workshops and events, community resilience plans, district emergency planning officers and hospital A&E departments.

Harlow has also published general guidance and advice on its' Emergency Planning pages aimed at helping residents and business preparing for emergencies there is also a webpage specifically addressing flooding, gales and thunderstorms.

11 Level 1 screening of potential development sites

11.1 Introduction

A number of potential development sites were provided by Harlow Council. These sites were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site (Table 11-1). Indication is provided on the proportion of a given site affected by different sources and levels of flood risk, along with whether historic incidences of flooding have been recorded, whether the site has been taken forward to the Level 2 assessment as well as the area of the site outside of Flood Zones.

The information provided is intended to enable a more informed consideration of the sites using the sequential approach. Three sites shown to be at fluvial flood risk or where further modelling is required to understand the level of risk have been taken forward to the Level 2 assessment.

11.2 Sequential testing

Table 11-1 summarises the flood risk to the supplied development sites. The majority of the sites are predominantly located within Flood Zone 1 or have a relatively small proportion of the site area within the Flood Zones. Surface water flooding is shown to be a risk, with varying extents, to the majority of sites.

Inclusion of these sites 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. NPPG 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.

Table 11-1: Summary of flood risk to Harlow potential development sites

Site code	Area (ha)	Proportion of site shown to be at risk (%)									Taken forward to Level 2 Assessment	Additional modelling undertaken for Level 2 SFRA	Area of site outside Flood Zones (ha)
		Flood Zones				Updated Flood Map for Surface Water			Historic Flood Map	Reservoir inundation mapping			
		FZ3b	FZ3a	FZ2	FZ1	30yr	100yr	1,000yr					
1	0.3	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.3
4	131.3	2%	1%	2%	95%	4%	5%	7%	0%	0%	Yes	Yes	130.4
9	13.8	0%	0%	0%	100%	8%	9%	14%	0%	0%	No	No	13.8
10	1.1	0%	0%	0%	100%	3%	6%	13%	0%	0%	No	No	1.1
11	2.5	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	2.5
13	0.7	0%	0%	0%	100%	9%	10%	12%	0%	0%	No	No	0.7
14	1.0	0%	0%	0%	100%	5%	5%	6%	0%	0%	No	No	1.0
15	12.6	0%	0%	0%	100%	1%	2%	4%	0%	0%	No	No	12.6
16	0.5	0%	0%	0%	100%	0%	0%	5%	0%	0%	No	No	0.5
20	0.7	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.7
22	3.4	0%	0%	0%	100%	4%	5%	21%	0%	0%	No	No	3.4
23	0.2	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.2
27	0.2	0%	0%	0%	100%	0%	0%	2%	0%	0%	No	No	0.2
30	1.9	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	1.9
31	1.6	0%	0%	0%	100%	0%	0%	27%	0%	0%	No	No	1.6
33	0.6	0%	0%	0%	100%	0%	0%	3%	0%	0%	No	No	0.6
36	0.3	0%	0%	0%	100%	70%	73%	76%	0%	0%	No	No	0.3
38	0.2	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.2
39	0.5	0%	0%	0%	100%	2%	2%	3%	0%	0%	No	No	0.5
40	0.3	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.3
45	0.4	0%	0%	7%	93%	52%	56%	79%	7%	0%	Yes	Yes	0.4
46	0.2	0%	0%	0%	100%	40%	42%	46%	0%	0%	No	No	0.2
48	0.2	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.2
52	0.3	0%	0%	0%	100%	5%	6%	24%	0%	0%	No	No	0.3
68	0.2	0%	0%	0%	100%	0%	0%	12%	0%	0%	No	No	0.2
70	0.2	0%	0%	0%	100%	0%	0%	20%	0%	0%	No	No	0.2
72	0.9	0%	0%	0%	100%	14%	15%	31%	0%	0%	No	No	0.9
73	2.0	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	2.0
74	0.5	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.5
76	2.4	0%	0%	0%	100%	0%	0%	1%	0%	0%	No	No	2.4
78	9.8	0%	0%	0%	100%	2%	2%	6%	0%	0%	No	No	9.8
88	3.6	0%	0%	0%	100%	5%	6%	6%	0%	0%	No	No	3.6
101	0.2	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	0.2
110	2.0	0%	0%	0%	100%	2%	0%	5%	0%	0%	No	No	2.0
142	1.5	0%	0%	0%	100%	5%	5%	29%	0%	0%	No	No	1.5
161	4.3	0%	0%	0%	100%	2%	9%	3%	0%	0%	No	No	4.3
171	2.4	0%	0%	0%	100%	1%	6%	4%	0%	0%	No	No	2.4
241	1.1	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	1.1
245	0.5	0%	0%	0%	100%	0%	10%	2%	0%	0%	No	No	0.5
251	0.4	0%	0%	0%	100%	0%	5%	0%	0%	0%	No	No	0.4
266	0.5	0%	0%	0%	100%	0%	2%	0%	0%	0%	No	No	0.5
284	0.1	0%	0%	0%	100%	5%	0%	39%	0%	0%	No	No	0.1
287	0.4	0%	0%	0%	100%	4%	0%	4%	0%	0%	No	No	0.4
301	0.3	0%	0%	0%	100%	5%	5%	12%	0%	0%	No	No	0.3
314	0.2	0%	0%	0%	100%	0%	0%	10%	0%	0%	No	No	0.2
327	0.2	0%	0%	0%	100%	0%	0%	6%	0%	0%	No	No	0.2
336	0.2	0%	0%	0%	100%	0%	0%	6%	0%	0%	No	No	0.2
343	0.8	0%	0%	0%	100%	38%	0%	67%	0%	0%	No	No	0.8

Site code	Area (ha)	Proportion of site shown to be at risk (%)									Taken forward to Level 2 Assessment	Additional modelling undertaken for Level 2 SFRA	Area of site outside Flood Zones (ha)
		Flood Zones				Updated Flood Map for Surface Water			Historic Flood Map	Reservoir inundation mapping			
		FZ3b	FZ3a	FZ2	FZ1	30yr	100yr	1,000yr					
347	0.5	0%	0%	0%	100%	2%	0%	17%	0%	0%	No	No	0.5
352	0.3	0%	0%	0%	100%	2%	73%	7%	0%	0%	No	No	0.3
361	0.4	0%	0%	0%	100%	4%	0%	14%	0%	0%	No	No	0.4
367	0.1	0%	0%	0%	100%	0%	2%	3%	0%	0%	No	No	0.1
369	1.7	0%	0%	0%	100%	0%	0%	0%	0%	0%	No	No	1.7
376	2.8	20%	6%	68%	6%	31%	56%	65%	93%	0%	Yes	Yes	0.2

12 Level 2 assessment of potential development sites

12.1 Introduction

The SFRA forms an integral part of Harlow Council's evidence base, in terms of identifying locations for development and preparation of flood risk policies in the Local Plan, with one of the objectives of an SFRA being to help inform site allocations so they are in accordance with the NPPF. Following the Level 1 screening assessment, a site was brought forward for a Level 2 assessment if it met the following criteria:

- The site is within Flood Zone 2 and/or 3
- An Ordinary Watercourse runs through or adjacent to the site

Level 2 SFRA assessment of sites helps to determine variations in flood risk across the Specified Sites, identifying site-specific FRA requirements and helping guide local policies to provide sustainable developments as well as reducing flood risk to existing communities.

12.2 Detailed site summary tables

As part of the Level 2 SFRA, detailed site summary tables have been produced for the sites listed below:

- ID: 4
- ID:45
- ID:376

Where available, the results from detailed hydraulic models were used in the assessment.

Where there are no detailed hydraulic models, 2D modelling was undertaken using Jflow+ to determine Flood Zone 3a, Flood Zone 3b and Flood Zone 2, as well as provide depth, hazard and velocity information and map the effects of climate change. Using this information combined with the uFMfSW, detailed site summary tables have been produced for the Specified Sites (see Appendix A). Each table sets out the following information:

- Site area
- Current land use
- Proposed land use
- Existing drainage features
- Proportion of the site in each Flood Zone and description of fluvial flood risk
- Proportion of the site in the three uFMfSW events and description of surface water flood risk
- Whether the site would be at risk of inundation in the event of reservoir failure
- Whether the site is shown to have flooded in the past
- Appraisal of the defence type, standard of protection and condition as well as any residual risk considerations from overtopping or failure of flood risk management infrastructure, where required
- Emergency planning information including whether the site is covered by a flood warning area and whether there any potential access and egress issues for the site
- What the 2080s climate change allowances are for the area and the climate change implications for the site
- A broad scale assessment of suitable SuDS techniques and considerations, including whether the site is in a source protection zone or a historic landfill site
- Information on whether the Exception Test will be required and advice on appropriate policies for sites requiring the Exception Test
- Advice on the requirements and preparation of for site-specific flood risk assessments

12.2.1 Note on SuDS suitability

As part of the assessment, an investigation has been undertaken to identify potentially suitable SuDS for each of the potential development locations taken forward to the Level 2 SFRA assessment.

This is based on catchment characteristics and additional datasets such as geology information and Soil maps of England and Wales which allow for a basic assessment of the soil characteristics on a site by site basis. Lidar was used as a basis for determining the topography and average slope across each potential development location. This data was then collated to provide an indication of particular groups of SuDS systems which might be suitable at a site.

Other datasets were used to determine other influencing factors on potential SuDS. These datasets include the following:

- Historic landfill sites
- Source Protection Zones

This data was then collated to provide an indication of particular groups of SuDS systems which might be suitable at a site. SuDS techniques were categorised into five main groups, as shown in Table 12-2, and are included in each site summary table as part of the Level 2 assessment. This assessment should not be used as a definitive guide as to which SuDS would be suitable but used as an indicative guide of general suitability. Further site-specific investigation should be conducted to determine what SuDS techniques could be utilised on a particular development.

Table 12-1: Summary of SuDS Categories

SuDS Type	Technique
Source Controls	Green Roof, Rainwater Harvesting, Pervious Pavements, Rain Gardens
Infiltration	Infiltration Trench, Infiltration Basin, Soakaway
Detention	Pond, Wetland, Subsurface Storage, Shallow Wetland, Extended Detention Wetland, Pocket Wetland, Submerged Gravel Wetland, Wetland Channel, Detention Basin
Filtration	Surface Sand filter, Sub-Surface Sand Filter, Perimeter Sand Filter, Bioretention, Filter Strip, Filter Trench
Conveyance	Dry Swale, Underdrained Swale, Wet Swale

The suitability of each SuDS type for the Specified Sites has been displayed using a traffic light colour system in the summary tables. The assessment of suitability is broad scale and indicative only; more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. The LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors.

Suitability	Description
	The SuDS Group and its associated techniques may be unsuitable
	The SuDS Group and its associated techniques may be suitable at the development but is likely to require additional engineering works
	The SuDS Group and its associated techniques are likely to be suitable

13 Summary

13.1 Overview

This Level 1 and 2 SFRA delivers a strategic assessment of risk from all sources of flooding in Harlow. It also provides an overview of policy and provides guidance for planners and developers.

13.2 Level 1 SFRA

13.2.1 Flood risk

- Harlow is located within the River Stort catchment. Tributaries of the River Stort that flow through Harlow include Harlowbury Brook, Todd Brook, Parndon Brook, Canons Brook and Pincey Brook
- The most significant recorded fluvial flood event in Harlow was in 1947 where flooding occurred from the River Stort, Todd Brook and Canons Brook. Flood events since 1947 have not had the widespread effects of the 1947 event with flood events largely restricted to the functional flood plain
- Primary fluvial flood risk in Harlow is predominantly associated with the River Stort to the north of the town around Harlow Town station, Temple Fields north of the railway line and south of the railway line at the A414 roundabout. These areas are located in Flood Zone 2. Some properties along Guilfords, in the east of Harlow, are also shown to be at risk from the Harlowbury Brook and are located in Flood Zone 2
- Flood risk from Todd Brook and Canons Brook is mainly restricted to rural land, with just a few isolated properties and gardens at risk. Parndon Brook poses more of a risk with some properties along Tithelands, Greygoose Park and Peacock Road shown to be in Flood Zone 3
- The uFMfSW predominantly follows topographical flow paths, particularly in the south of Harlow flowing towards Todd Brook. Another area that is shown to be significantly affected by surface water flooding is Temple Fields. Elsewhere, surface water flooding tends to be either flow paths or ponding along transport routes, or ponding of water in gardens or open land
- Although there are no reservoirs located within Harlow there are five reservoirs outside of the area which may potentially affect the town in the event of reservoir inundation. In the event of reservoir failure, inundation appear to be mainly confined to the floodplain of the River Stort and the Canons Brook
- Future development, both within and outside Harlow can have the potential to affect flood risk to existing development and surrounding areas. Whilst there are potential cross-boundary flood risk issues both from and to neighbouring authorities, conditions imposed by Harlow Council, neighbouring authorities and the LLFA 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. 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
- The River Stort is navigable throughout much of its course in Harlow. The level of water is controlled by the level and size of weirs. If the capacity of these control structures were exceeded, or they become blocked, overtopping may occur

13.2.2 Impact of climate change

Climate change modelling was undertaken to assess the impact of climate change on flooding in the future. The modelling results showed

- the increase in extent of the 1 in 100-year event for the River Stort is negligible, with even a 70% increase in flow having relatively minor increases in the flood extent;
- the effect of climate change on the Harlowbury Brook is similar to that of the River Stort, with only small increases in the 1 in 100-year event seen. The greatest increase in flood extent is an area on the right bank (looking downstream) just north of the Oxleys; and

- Todd Brook and Canons Brook see the greatest increase in the 1 in 100-year flood extent as a result of climate change, particularly in the lower reaches of Canons Brook where it enters the River Stort. The increase in flood extent for these watercourses remains mainly within the floodplain and few additional houses are affected.

13.2.3 Key policies

There are a number of relevant regional and local key policies which have been considered within the SFRA, such as the CFMPs, RBMPs, the PFRA and LFRMS. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

13.2.4 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and FRAs have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the LLFA and the Environment Agency.

13.2.5 Surface water management and SuDS

A review of national and local guidance for surface water management and SuDS has been undertaken. Essex County Council as LLFA have produced a number of supporting documents and guidance for local flood risk and SuDS which have been documented and referenced in the SFRA.

13.2.6 Defences and residual risk

A high-level review of existing flood defences was undertaken and found a small number of defences in the study area. These defences tend to have a relatively low standard of protection and appear to be designed to protect very localised areas / developments rather than the wider Harlow area.

13.2.7 Flood warning and emergency planning

The Environment Agency is the lead organisation for providing fluvial flood warnings for Main Rivers. Currently there is one Flood Alert and three Flood Warnings covering Harlow. Maps and information on flood warnings have been provided alongside information, advice and guidance for emergency planning.

13.2.8 Level 1 site screening

Potential development sites within the study area were screened against flood risk information to identify sites which would potentially need to be taken forward to a Level 2 SFRA. The screening also identified sites where additional modelling would be required, for example, sites where there is a watercourse that is not included in the Environment Agency's Flood Zone coverage, or where Flood Zones exist but further modelling was required to identify Flood Zone 3b, climate change as well as depth, velocity and hazard information. Jflow+ modelling was then undertaken for these sites.

On completion of the modelling, the sites were screened again to provide a summary of risk to each site including: the proportion of the site in each Flood Zone, Surface Water flooding scenario, reservoir inundation outlines and historic flood map.

Where sites are shown to be in Flood Zones, flood risk to the sites has been assessed and summarised in more detail in a series of detailed summary tables as part of the Level 2 SFRA (Appendix A).

13.3 Level 2 SFRA

13.3.1 Assessment methods

As part of the Level 2 SFRA, detailed site summary tables have been produced for each of the three potential development sites taken forward from the Level 1 assessment. These sites were those which are shown to be at risk of fluvial flood risk from watercourses running either through or adjacent to the site.

The summary tables set out the flood risk to each site, including maps of extent, depth and velocity of flooding as well as hazard mapping. Each table also sets out the flood risk implications for the site as well as guidance for site-specific FRAs. A broad scale assessment of possible SuDS constraints has also been provided giving an indication where there may be constraints to certain sets of SuDS techniques.

Flood risk information for the sites is from a combination of results from Environment Agency detailed hydraulic models, and additional 2D modelling using Jflow+ undertaken for the SFRA. Jflow+ modelling was undertaken for watercourses not covered by the existing Environment Agency Flood Zones.

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14 Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA, along with assessment of the proposed sites brought forward into the Level 2 assessment. Following this, several recommendations have been made for the Council to consider as part of Flood Risk Management in Harlow.

14.1 Development Control

14.1.1 Sequential approach to development

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 district.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by

- reducing volume and rate of runoff through the use of SuDS, as informed by national and local guidance;
- relocating development to zones with lower flood risk;
- creating space for flooding; and/or
- green infrastructure should be considered within the mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

14.1.2 Sequential and Exception tests

The SFRA has identified Harlow is at relatively low risk of flooding for fluvial sources, with the exception of areas to the north around Templefields which are at risk from the River Stort. The majority of proposed development sites provided by Harlow Council, are shown to be in Flood Zone 1. However, three are shown to be at fluvial risk and will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. The Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

Developers should consult with the Council, Essex County Council, the Environment Agency and Thames Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

14.1.3 Site-specific flood risk assessments

The Level 2 SFRA is not intended to replace site-specific FRAs. Site specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test. Although the majority of the proposed development sites in Harlow are not at risk from fluvial sources, they are shown to be at risk from surface water flooding. Site specific flood risk assessments are a requirement for any development greater than one hectare in Flood Zone 1 in which other sources of flooding, such as surface water, should be assessed.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of watercourses to verify flood extent (including latest climate change allowances), 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.

For development applications located in the vicinity of a canal, it is recommended that overtopping and / or breach is considered as part of a site-specific FRA to establish the residual risk to the development.

14.1.4 Windfall sites

Windfall sites are sites that have not been specifically identified in the Local Plan or other Council assessment documents, that do not have planning permission and have unexpectedly

become available. Local authorities can to make a realistic allowance for windfall development based on past trends.

The acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms[26].

14.1.5 Council review of planning applications

The Council 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. When considering planning permission for developments, planners may wish to consider the following:

- Will the natural watercourse system which provides drainage of land be adversely affected?
- Will a minimum 8m width access strip be provided adjacent to the top of both banks of any Main River (5m for Ordinary Watercourses), for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits?
- Will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up?
- Have SuDS been given priority as a technique to manage surface water flood risk?
- Will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk?
- Is the application compliant with the conditions set out by the LLFA?

14.2 Drainage assessments and promotion of SuDS

14.2.1 Drainage strategies and 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:

- 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. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All 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, and the LLFA's SuDS guidance and requirements
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure

[26] http://webarchive.nationalarchives.gov.uk/20140328084622/http:/www.environment-agency.gov.uk/static/documents/Sequential_test_process_4.pdf

14.2.2 Level 2 broad scale SuDS constraints assessment

The assessment included within the Level 2 site summary tables is indicative and more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. It may be possible that those SuDS techniques highlighted as possibly not being suitable can be designed to overcome identified constraints.

14.3 Emergency planning

It is recommended that any household considered at risk of flooding signs-up to the Environment Agency's Flood Warning Service. 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.

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

14.4 Infrastructure and Access

Safe access and egress will need to be demonstrated at all development sites; the development should be above the 1 in 100-year flood level, plus an allowance for climate change, and access for emergency vehicles should be possible during times of flood. Finished Floor Levels should be above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.

If development is located behind, or in an area benefitting from, defences, consideration should be given to the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

14.5 Future flood management in Harlow

Developers should include an assessment of the residual risk if developments are located in areas benefitting from defences. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping. Any improvements to defences should ensure they are in keeping with wider catchment policy.

14.6 Recommendations for Council policy

The Harlow Local Development Plan will replace the Adopted Replacement Harlow Local Plan (2006). Sections on flood risk and flood risk policies in the 2006 Plan have been reviewed and the following recommendations made for policies in the new Local Plan:

- It is recommended that a policy should be included relating to water management. This should include directing development to locations at the lowest risk of flooding, applying the Sequential and, where necessary, Exception Tests and applying appropriate mitigation measure where development is proposed in flood risk areas. This could take the form of a standalone policy or could be included as part of a wider sustainable development policy
- It is recommended that a policy specifically relating to sustainable drainage is included. The policy should ensure new developments will be required to incorporate appropriate SuDS and ensure arrangements for ongoing maintenance are clear
- The council should encourage developers to utilise opportunities to reduce wider flood risk within Harlow, for example using sustainable drainage to reduce flood risk not just at the development site but downstream.

14.7 Technical recommendations

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 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 site-specific FRA.

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 Harlow Council, Essex County Council (in its role as LLFA), the Highways Authority, Thames Water or 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.

Appendices

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A Level 2 Assessment Detailed Site Summary Tables

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B Watercourses in Harlow

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C Flood Zone mapping

The flood zone maps show the extents of Flood Zones 1, 2 3a and 3b in Harlow. The flood zones are defined as follows:

Zone 1: Comprised of land having a less than 1 in 1,000 annual probability of river or sea flooding in any year.

Zone 2: Comprised of land having between a 1 in 100 and a 1 in 1,000 annual probability of river flooding or 1 in 200 and 1 in 1,000 annual probability of sea flooding in any year.

Zone 3a: Comprised of land assessed as having a greater than 1 in 100 annual probability of river flooding or a greater than 1 in 200 annual probability of flooding from the sea in any year.

Zone 3b: Comprised of land where water has to flow or be stored in times of flood (the functional floodplain). The SFRA identified this Flood Zone as land which would flood with an annual probability of 1 in 20 years, where detailed hydraulic modelling exists.

Where detailed models are not available, it is not possible to identify what land would flood with an annual probability of 1 in 20 years. Instead, a precautionary approach should be adopted for these areas with the assumption that the extent of Flood Zone 3b is the same as that for 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.

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D Climate change mapping

Climate change modelling has been undertaken for all the Main Rivers flowing through Harlow for the three scenarios reflecting three climate change allowances for the '2080s' timeframe in the Thames River Basin District, i.e. 25%, 35% and 70% allowances. Detailed 1D-2D hydraulic models were used for the River Stort and Harlowbury Brook. The Todd Brook, Parndon Brook, Canons Brook and Pincey Brook were modelled using 2D modelling methods (Jflow+).

In addition to the Main Rivers, an Ordinary Watercourse flowing into Harlowbury Brook was also modelled using Jflow+ to determine the level of flood risk, as well as climate change, for once of the proposed development sites for the Level 2 assessment.

It should be noted that the climate change modelling has been undertaken to assist the Council with the preparation of their emerging District Plan. Developers will need to undertake a detailed assessment of climate change as part of the planning application process when preparing FRAs.

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E Surface water mapping

The updated Flood Map for Surface Water (uFMfSW) maps show the flooding that takes place from the 'surface runoff' generated by rainwater (including snow and other precipitation) which:

a) is on the surface of the ground (whether or not it is moving), and

b) has not yet entered a watercourse, drainage system or public sewer.

The uFMfSW will pick out natural drainage channels, rivers, low areas in the floodplain and flow paths between buildings but it will only indicate flooding caused by local rainfall.

The uFMfSW shows predictions of flooded area but does not show whether individual properties will be affected by surface water flooding or have been affected in the past. The uFMfSW should not be used to predict if individual properties will flood.

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F Groundwater mapping

The Areas Susceptible to Groundwater Flooding (AStGWF) maps are a set of strategic maps which show groundwater flood areas on a 1km square grid. The data was produced to annotate indicative Flood Risk Areas for Preliminary Flood Risk Assessment (PFRA) studies and allow the Lead Local Flood Authorities (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 condition show 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 ground water flooding.

The AStGWF data should only be used 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.

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G Flood Warning Coverage

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 advance notice of the possibility of flooding, but before we are fully confident that flooding in Flood Warning Areas is expected.

Flood Warnings warn people of expected flooding and encourage them to take action to protect themselves and their property.

Some areas may be covered by more than one flood warning area as they may be at risk of flooding from more than one watercourse.

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