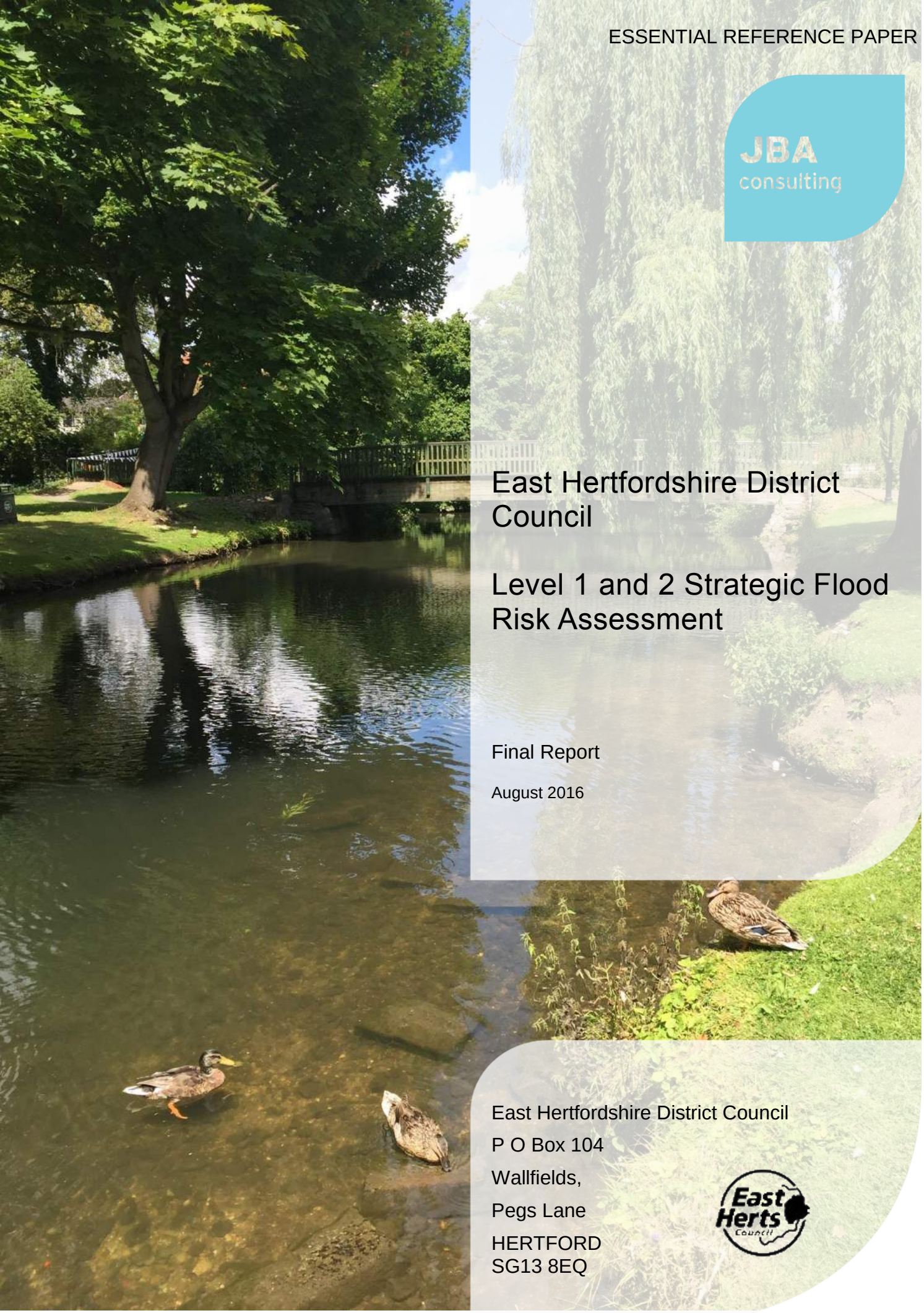

East Hertfordshire District Council

Level 1 and 2 Strategic Flood Risk Assessment

Final Report

August 2016

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1.0 / August 2016		Chris Butcher, East Hertfordshire District Council
Final v1.0 / August 2016		Chris Butcher, East Hertfordshire District Council

Contract

This report describes work commissioned by East Hertfordshire District Council. The Council's representative for the contract was Chris Butcher.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to East Hertfordshire District Council.

Acknowledgements

We would like to acknowledge the assistance of:

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

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Executive Summary

Introduction

This Level 1 and 2 Strategic Flood Risk Assessment (SFRA) replaces the Level 1 SFRA originally published by East Hertfordshire District Council in November 2008 and provides appropriate supporting evidence for the emerging District Plan. This report also includes a Level 2 SFRA of sites identified for potential allocation within the emerging District Plan.

SFRA objectives

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

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

The objectives of this SFRA update are to:

1. To take into account most recent policy and legislation in the National Planning Policy Framework.
2. To take into account the latest available flood risk information and data.
3. To investigate and identify the extent and severity of flood risk from all sources presently and in the future within the local planning authority area of East Hertfordshire District Council.
4. To provide a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the emerging District Plan.
5. To provide individual flood risk analysis, for potential development sites identified by the Council, through a Level Two SFRA.

The following outputs have been prepared to meet the objectives:

Level 1 SFRA outputs

- District-wide appraisal of all potential sources of flooding, including fluvial, surface water, groundwater, sewer and reservoir inundation
- Review of historical flooding incidents.
- Mapping of location and extent of functional floodplain.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- An assessment of the potential increase in flood risk due to climate change.
- An assessment of the surface water management issues, how these can be addressed through site allocation and development management policies and the application of Sustainable Drainage Systems (SuDS).
- Areas at risk from other sources of flooding, for example groundwater or reservoirs.
- An assessment of existing flood warning and emergency planning procedures.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.
- High-level screening of proposed development sites against flood risk information.

Level 2 SFRA outputs

The Level Two assessment includes detailed assessments of Proposed Site Allocations. These include:

- An assessment of all sources of flooding including fluvial flooding, surface water flooding, groundwater flooding, mapping of the functional floodplain and the potential increase in fluvial flood risk due to climate change.

- Reporting on current conditions of flood defence infrastructure, including the protection provided by the feature
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff
- Advice on appropriate policies for sites which could satisfy the first part of the Exception Test and on the requirements that would be necessary for a site-specific Flood Risk Assessment supporting a planning application to pass the second part of the Exception Test

Summary of Level 1 SFRA

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

The assessment has concluded the following:

- Flood history shows that East Hertfordshire has been subject to flooding from several sources of flood risk.
- The primary fluvial flood risk is located along the River Lea and River Stort corridors. The main urban areas at risk include Hertford, Ware Stanstead Abbots and Bishop's Stortford. The main tributaries of the River Lea also present fluvial flood risk to rural communities within the district. The floodplain associated with the tributaries of the River Lea network are generally narrow until reaching the urban areas and / or towards the confluences with the River Lea network.
- East Hertfordshire has experienced a number of historic surface water flooding incidents. Bishop's Stortford, Hertford, Much Hadham, Walkern and Buntingford are shown to have five or more records of surface water flooding. The uFMfSW further shows a number of prominent overland flow routes in the district; these predominantly follow topographical flow paths of existing watercourses or road networks, with some isolated ponding located in low lying areas.
- The Thames Water DG5 register indicates a total of 179 recorded incidents of sewer flooding in East Hertfordshire administrative area. The more frequently flooded postcodes are SG14 3, with 21 records, followed by SG12 8 with 18 records.
- There have been incidents of historic groundwater flooding in East Hertfordshire which is thought to primarily be caused by the underlying geology. Although the incidents are largely isolated, the settlement with the greatest recorded number of incidents is Ware and Tewin/ Tewin Wood.
- In relation to artificial sources of flooding, there are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low.
- There are no records of a canal overtopping along the Lea Navigation Channel. There are however, seven records of overtopping of the River Stort navigation channel; the majority of these being caused by heavy rainfall causing the River Stort to overtop its banks. For development applications located in the vicinity of a canal or navigation channel, it is recommended that overtopping and/ or breach of the structure is considered as part of a site-specific FRA to establish the residual risk to the development.

- A high level review has been undertaken of flood defences, using the Environment Agency AIMS database. The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is a factor that needs to be considered as part of the risk-based sequential approach and, in light of this, whether proposed land allocations are appropriate and sustainable.
- Emergency planning considerations have been included and the flood warning service coverage assessed; currently there are 25 Flood Alert Areas and 22 Flood Warning Areas (FWAs) covering significant parts of East Hertfordshire.

In February 2016 the Environment Agency published new climate change guidance which must now be considered for all new developments and planning applications. Climate change modelling and mapping has been undertaken as part of the SFRA 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. The 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.

The Sequential approach to development and flood risk has been defined with guidance provided for the application of the Sequential and Exception Tests for both the District Plan and for detailed, site-specific Flood Risk Assessments. This SFRA provides details of the FRA requirements and guidance for developers. These recommendations include those of the NPPF, Environment Agency standing advice, as well as reference to regional and local policy. In addition, specific recommendations following the findings of this level 1 SFRA have been put forward for development in Flood Zones 1, 2 and 3. Site-specific FRAs should include assessment of mitigation measures required to safely manage flood risk along with the along with promotion of SuDS to create a conceptual drainage strategy and safe access/ egress at the development in the event of a flood.

Summary of the Level 2 Assessment of Proposed Site Allocations

- Jflow modelling of drains was undertaken for the following sites: Bishops Stortford South and Employment Land, North West Road Sawbridgeworth, Hertford South, East of Welwyn, North and East of Ware (Left and Right) and Gilston Area. However, detailed hydraulic modelling would be required to confirm the flood risk to these sites.
- Four of the sites have detailed modelling available; Mead Lane North, The Goods Yard, South of West Road and the Causeway/Old River Lane.
- For all sites, with the exception of the Causeway/Old River Lane, the majority of the sites are located within Flood Zone 1.
- The site at the Causeway/Old River Lane falls 83% within Flood Zone 2 and 13% within Flood Zone 3
- Several sites have been identified as having surface water flood risk issues including:
    - Bishops Stortford South and Employment Land
    - Mead Lane North
    - The Goods Yard
    - East of Welwyn
    - North and East of Ware (Left and Right)
    - Gilston Area
    - Causeay/Old River Lane
- Climate change mapping indicates that the depths, velocities and hazard of flooding may increase as a result of climate change. The significance of the increase tends to depend on the climate change allowance used and the site topography.
- Many sites are located in groundwater SPZs. This means that special consideration needs to be taken with SuDS. A suitable level of treatment should be ensured prior to discharging, along with establishing an understanding of constraints to sites and how SuDS can be designed to overcome these from relevant bodies (e.g. LLFA)
- The site East of Welwyn is the only site which has areas within it designated by the Environment Agency as being landfill. For this, site ground investigation will be required to determine the extent of the contamination and the impact this may have on SuDS.

- A strategic assessment was conducted of SuDS options using regional data sets. Therefore, a detailed site-specific assessment of suitable SuDS techniques would need to be undertaken to understand which SuDS option would be best.
- None of the proposed allocation sites apart from the Causeway/Old River would benefit from the formal flood defences which are currently present within East Hertfordshire. Flood mitigation measures should only be considered if, after a sequential approach, development sites cannot be located further away from high risk areas. The Causeway/Old River is currently protected by two privately-owned embankments.
- For a number of sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites to how safe access and egress can be provided during high rainfall events.

Recommendations

Assessing Flood Risk and Developments

- The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the district.
- A site-specific FRA is required for all developments over 1ha in Flood Zone 1; for developments less than 1 ha in Flood Zone 1 where there is a change to vulnerability classification or where the development could be affected by sources of flooding; and for all developments located in an area which has been highlighted as having critical drainage problems. The FRA should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development.
- It is recommended that the impact of climate change to a proposed site is considered in a FRA and that the percentage increases which relate to the proposed lifetime of the development and the vulnerability classification of the development is accounted for.
- At site-specific level, for any developments shown to be at residual flood risk, for example from a breach or overtopping (e.g. reservoir, canal, perched watercourse), it is recommended that a detailed hydraulic modelling study is carried out using Environment Agency guidance to assess the residual risk.
- Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites, through reductions in the amount of surface water runoff generated on a site. The functional floodplain should be protected from development and returned to greenfield status (where possible).
- The Local Planning Authority (LPA), Environment Agency and Lead Local Flood Authority (LLFA) should be consulted to confirm the level of assessment required and to provide any information on any known local issues.
- When assessing sites not identified in the District plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as provide evidence to show that they have adequately considered other reasonably available sites.
- The FRA should demonstrate that developments do not increase the likelihood or intensity of flood risk to third party development.
- To demonstrate the Exception Test has been passed, flood resilience design and emergency planning must be accounted for including:

Future Developments

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

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

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

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

Promotion of SuDS

- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Where possible developments must utilise the most sustainable form of drainage systems, in accordance with the SuDS hierarchy.
- Development should aim to achieve Greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration.
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable and guidance should be sought from the LLFA.
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints.
- Where SuDS are provided as part of a development, applicants should detail how it will be maintained in the long term.

Infrastructure and Access

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

Green Infrastructure and Water Framework Directive

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

Future flood management in Hertfordshire

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

Use of SFRA data

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

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

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Abbreviations and Glossary of Terms

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

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

Term	Definition
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
uFMfSW	Updated Flood Map for Surface Water
WFD	Water Framework Directive

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1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

This Level 1 and 2 Strategic Flood Risk Assessment (SFRA) replaces the Level 1 SFRA originally published by East Hertfordshire District Council in November 2008 and provides appropriate supporting evidence for the emerging District Plan. This report also includes a Level 2 SFRA of sites identified for potential allocation within the emerging District Plan.

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

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

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

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

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

2. **To take into account the latest available flood risk information and data.**

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

   - Hertfordshire Preliminary Flood Risk Assessment (2011)
   - Hertfordshire County Council's SuDS Policy Statement (March 2015), Guidance for developers, and SuDS Design Guidance
   - Hertfordshire Local Flood Risk Management Strategy (Local Strategy) 2011
   - East Hertfordshire & Broxbourne SWMP (ongoing)
   - Availability of the updated Flood Map for Surface Water (uFMfSW)
   - River Thames Catchment Flood Management Plan (2010)
   - Thames River Basin Management Plan (2015)
   - Thames Flood Risk Management Plan (2016)
   - Hydraulic modelling studies across East Hertfordshire
   - Lower Lee Flood Risk Management Strategy (Revised 2013)
   - Rye Meads Water Cycle Strategy (2009)
   - Scoping Study of Hertfordshire LPA Planning Performance in relation to Climate Change (2009)
   - Strategic Land Availability Assessment (SLAA, 2012)
   - East Hertfordshire Sustainability Appraisal and Appropriate Assessment (2007)

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

   The SFRA will identify areas at risk of fluvial flooding and in particular, identify Flood Zones 2, 3a and 3b in order to allow the council to apply the Sequential Test. The impact of climate change on flood risk will be considered following Environment Agency climate change guidance published February 2016. An assessment will be made on flood defences and areas which these benefit. Flood risk from all other sources will be identified.

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

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

   - Main Rivers and ordinary watercourses
   - Drainage area information (geology, soils, topography)
   - Fluvial flood risk, including functional floodplain and climate change
   - Surface water risk
   - Groundwater risk
   - Reservoir Inundation
   - Flood warning coverage
   - Flood defences

5. **To provide individual flood risk analysis, for potential development sites identified by the Council, through a Level Two SFRA.**

   The SFRA will form part of the evidence base supporting the District Plan to inform site allocations so they are in accordance with the NPPF. The SFRA will support current policy development within the District Plan. Proposed site allocations have been provided by the Council to be assessed in the SFRA.

1.2 SFRA objectives

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

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

Level 1 SFRA outputs

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

- Identification of policy and technical updates, in particular the introduction of the National Planning Policy Framework and accompanying Planning Practice Guidance (any strategic flooding issues which may have cross boundary implications with neighbouring authorities must be considered as part of this review and appropriate consultation with neighbouring Local Authorities undertaken.)
- Review and update of new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc.).
- Appraisal of all potential sources of flooding, including fluvial, surface water, groundwater, sewer and reservoir inundation.
- Updated review of historical flooding incidents since 2008.

- Mapping of location and extent of functional floodplain.
- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- An assessment of the potential increase in flood risk due to climate change.
- An assessment of the surface water management issues, how these can be addressed through site allocation and development management policies and the application of Sustainable Drainage Systems (SuDS).
- Areas at risk from other sources of flooding, for example groundwater or reservoirs.
- An assessment of existing flood warning and emergency planning procedures.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.
- High-level screening of proposed development sites against flood risk information.

Level 2 SFRA outputs

The Level Two assessment includes detailed assessments of proposed site allocations. These include:

- An assessment of all sources of flooding including
    - Fluvial flooding, including depth velocity and hazard mapping
    - Definition and mapping of the functional floodplain
    - Potential increase in fluvial flood risk due to climate change
    - Surface water flooding
    - Groundwater flooding
- Reporting on current conditions of flood defence infrastructure, including the protection provided by the feature
- An appraisal of the probability and consequences of overtopping or failure of flood risk management infrastructure
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff
- Advice on appropriate policies for sites which could satisfy the first part of the Exception Test and on the requirements that would be necessary for a site-specific Flood Risk Assessment supporting a planning application to pass the second part of the Exception Test

1.3 Approach

1.3.1 General assessment of flood risk

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

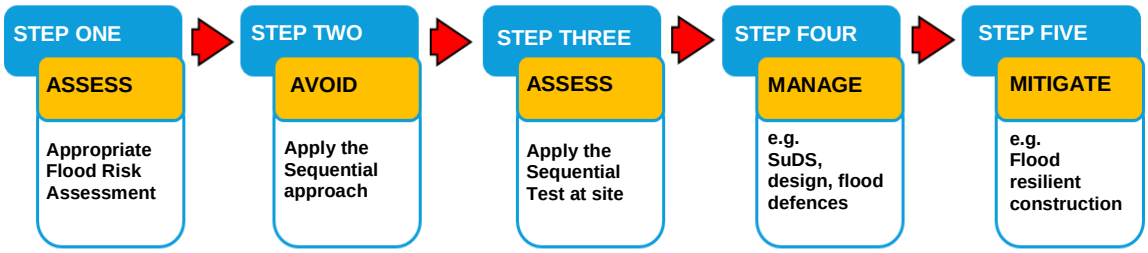
- the nature of the flood risk (the ***source*** of the flooding);
- the spatial distribution of the flood risk (the ***pathways*** and areas affected by flooding);
- climate change impacts; and
- the degree of vulnerability of different types of development (the ***receptors***).

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

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

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

Figure 1-1: Flood Risk Management Hierarchy



1.4 Consultation

The following parties (external to East Hertfordshire District Council) have been consulted during the preparation of this version of the SFRA:

- Environment Agency (Hertfordshire and North London area)
- Hertfordshire County Council
- Thames Water
- Canal & River Trust
- Highways
- Fire and Rescue
- Lea Valley Regional Park Authority
- Neighbouring authorities including:
    - Epping Forest District Council
    - Broxbourne Council
    - Welwyn Hatfield Council
    - North Hertfordshire District Council
    - Stevenage District Council
    - Uttlesford District Council
    - Harlow District Council

1.5 SFRA user guide

Table 1-1: SFRA report contents

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2 The Planning Framework and Flood Risk Policy	Covers local, national and European policy. Includes information on the implications of recent changes to planning and flood risk policies and legislation.
Level One Strategic Flood Risk Assessment	

Section	Contents
3. The sequential, risk based approach	Detailed how flood risk should be assessed. Summary of the modelling used for the assessment. Description of mapping that should be used for Sequential and Exception testing. Application of the Sequential Approach and Sequential/Exception Test process.
4. The Impact of Climate Change	Outlines climate change guidance published by the Environment Agency in February 2016
5. Understanding flood risk in East Hertfordshire	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting the district. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered.
6. Flood defences	Assessment of residual risk from flood defences, including future protection from climate change.
7. Flood risk from artificial waterbodies	Summarises flood risk from artificial water bodies including canals and reservoirs
8. Surface water management and SuDS	Advice on managing surface water run-off, and how SuDS play an important role.
9. Flood Warning and Emergency planning	Outlines the flood warning service available. Provides information on emergency planning considerations for developers and planners and associated recommendations.
10. FRA requirements and guidance for developers	Outlines requirements for FRAs as well as providing guidance for developers and information on how to reduce flood risk.
11. Screening of Proposed Site Allocations	Results of the screening exercise to assist application of the Sequential Test and determine what sites will require further assessment under the Level 2 SFRA.
12. Level 2 Assessment of Proposed Site Allocations	Outlines the methodology used in the assessment and the format of the summary tables. *Note: due to size of summary tables they are an Appendix to the main report*.
Summary and recommendations	
13. Summary	Summary of Level 1 and Level 2 assessments and key findings
14. Recommendations	Outlines key recommendations from the Level 1 and Level 2 assessments
Appendices	
Appendix A: Watercourses in East Hertfordshire	
Appendix B: Flood Zone mapping, including functional floodplain	
Appendix C: Climate change mapping	
Appendix D: Surface water flood risk mapping	
Appendix E: Groundwater flood risk mapping	
Appendix F: Reservoir Inundation Mapping	
Appendix G: Flood warning coverage	
Appendix H: Technical summary	
Appendix I: Level 2 SFRA detailed summary tables	

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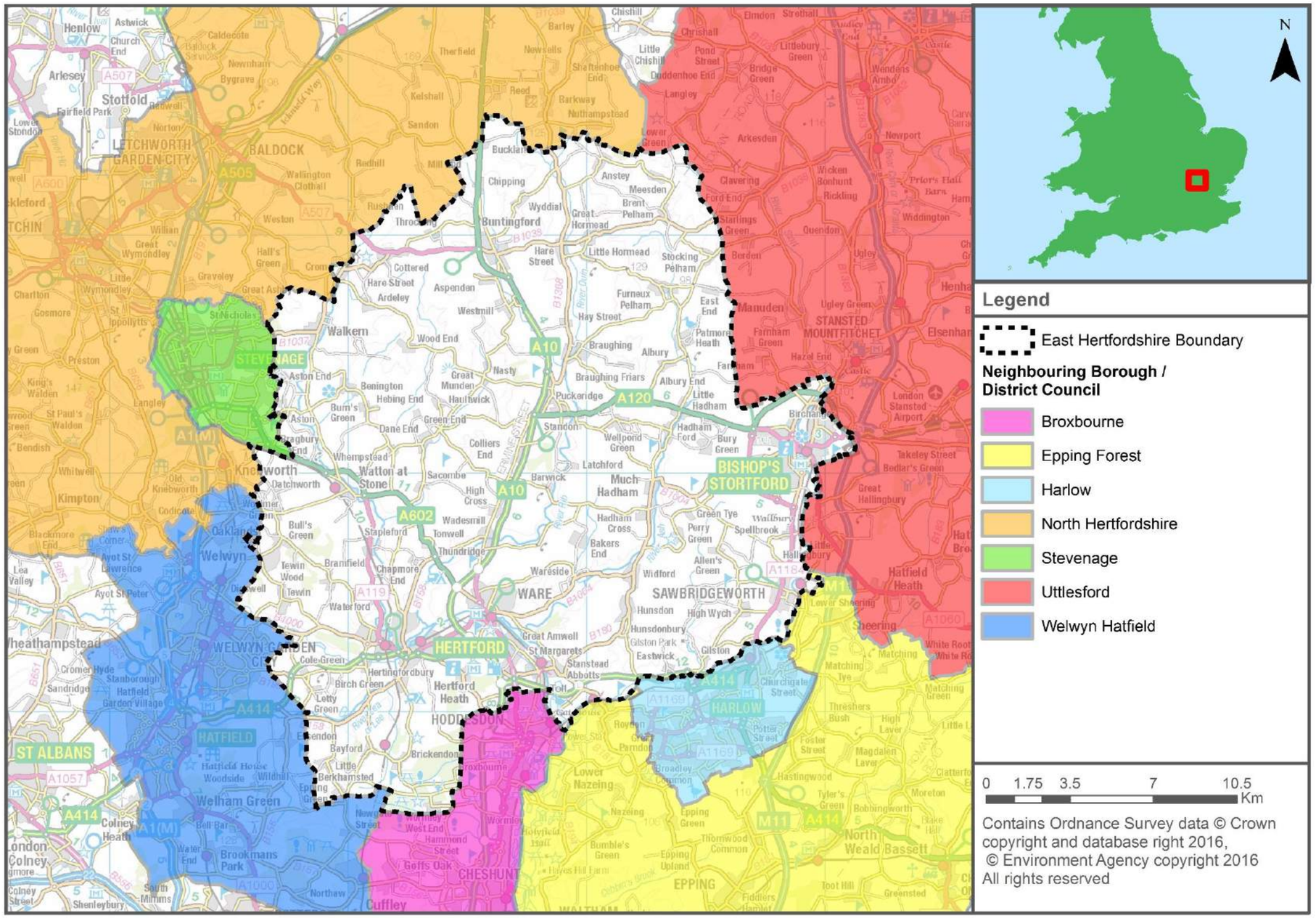
Figure 1-2: Study Area



2 The Planning Framework and Flood Risk Policy

2.1 Introduction

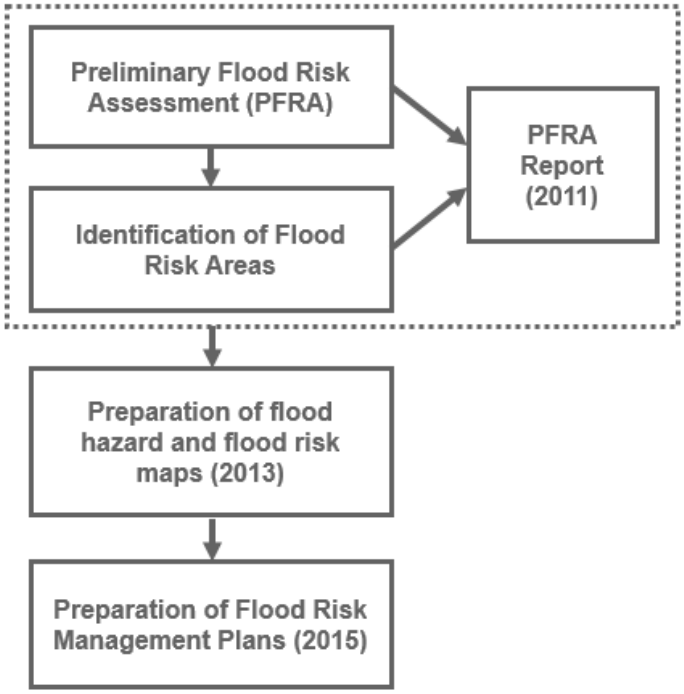
The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities.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

2.2 Flood Risk Regulations (2009)

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

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

Figure 2-1: Flood Risk Regulation Requirements



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

2.2.1 Hertfordshire Preliminary Flood Risk Assessment (PFRA), 2011

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

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

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

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

Based on this analysis no areas were identified in Hertfordshire that meet the national criteria to be designated as Flood Risk Areas (clusters with a total of more than 30,000 people affected by local sources of flooding). The three largest clusters within Hertfordshire are around Watford (11,946 people affected), Hemel Hempstead (5655 people affected) and Stevenage (5110 people affected).

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

2.2.2 River Basin Flood Risk Management Plans, 2016

Under the Flood Risk Regulations (2009), the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. This then made it a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP). The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans, in accordance with the Water Framework Directive (Section 2.11 contains further information on the Water Framework Directive and the River Basin Management Plans).

East Hertfordshire District Council falls within the Thames River Basin District FRMP (March 2016). The FRMP explains the risk from flooding from all sources alongside how risk management authorities will work with communities to manage flood risk from 2015 to 2021. The FRMP draws on previous policies and actions identified in Catchment Flood Management Plans and also incorporates information from Local Flood Risk Management Strategies (it should be noted that FRMPs do not supersede Catchment Flood Risk Management Plans). Each River Basin District is composed of a group of sub-areas or catchments and there are 17 catchments covered by the river Thames Basin. The majority of East Hertfordshire lies within the Upper Lee management catchment, with a small part of the south of the district being covered by the London management catchment area. The FRMP summarises the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations. The Thames Basin FRMP recommends management actions along the Lower Lee catchment as identified in the 2011 Lower Lee Flood Risk Management Strategy (see Section 2.8).

2.3 Flood and Water Management Act, 2010

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

- Develop a Local Flood Risk Management Strategy for Hertfordshire under the Act, in consultation with local partners. This is discussed further in Section 2.3.2. This Strategy acts as the basis and discharge of duty for Flood Risk Management co-ordinated by Hertfordshire County Council
- Develop, maintain, apply and monitor a Local Flood Risk Management Strategy (LFRMS) to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most
- When appropriate and necessary, investigate and report on flooding incidents
- Establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area
- When appropriate, exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it
- When appropriate, perform consenting of works on ordinary watercourses

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

The FWMA will also update the Reservoirs Act 1975 by reducing the capacity of reservoir regulation from 25,000m^3 to 10,000m^3. Phase 1 has been implemented in 2013 requiring large raised reservoirs to be registered to allow the Environment Agency to categorise whether they are 'high risk' or 'not high risk'.

2.3.1 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 ensure, through use of planning conditions or obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

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

Major developments are defined as:

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

2.3.2 Hertfordshire Local Flood Risk Management Strategy (LFRMS)

Hertfordshire County Council as a LLFA is responsible for developing, maintaining, applying and monitoring a Local Flood Risk Management Strategy for Hertfordshire[2]. The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management on a day to day basis. The Strategy also sets measures to manage local flood risk. The high-level objectives proposed in the Strategy for managing flood risk include:

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

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

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

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

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

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

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

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

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

2.4 National Planning Policy Framework

The National Planning Policy Framework (NPPF)[3] was issued on 27 March 2012 to replace the previous documentation as part of reforms to the planning system. It replaces most of the Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs), in particular PPS25, which were referred to in the previous version of the SFRA. The NPPF is a source of guidance for local planning authorities to help them prepare Local Plans and in the decision making process. With regards to plan-making and flood risk, the principal provisions of the NPPF are set out in paragraph 100.

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

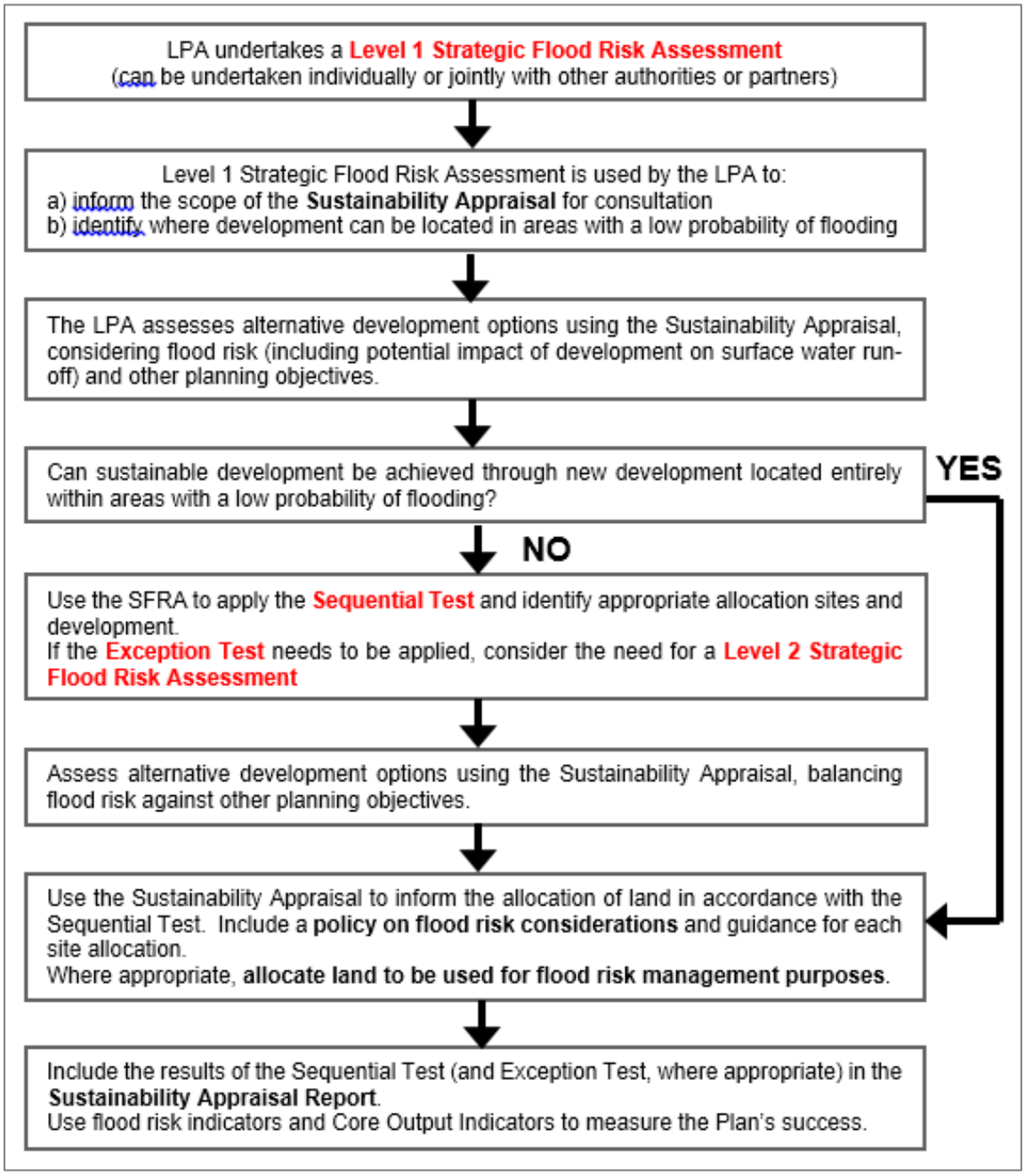
Paragraph 100 of the NPPF:

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

Planning Practice Guidance[4] on flood risk was published alongside the NPPF in March 2014 and sets out how national policy should be implemented. This was subsequently updated on April 6 2015 to take into account the new statutory role of the LLFA and the requirement for surface water drainage assessments for all 'major' developments. A description of how flood risk should be taken into account in the preparation of Local Plans is outlined in Diagram 1 contained within the Planning Practice Guidance (Figure 2-2).

4 Planning Practice Guidance (March 2014) http://planningguidance.communities.gov.uk/

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



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

2.5 Water Cycle Studies

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

The Rye Meads Water Cycle Strategy covering East Hertfordshire was completed in October 2009. The study sets out recommendations in relation to housing growth and water infrastructure to 2021 and beyond.

2.6 Surface Water Management Plans

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

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

Since the production of the 2008 SFRA, there have been numerous documents published relating to surface water management and SUDS including:

- SuDS Design Guidance for Hertfordshire, March 2015
- Hertfordshire Guidance for Developers
- The SuDS Manual (C753), published in 2007, updated in 2015
- DEFRA Non-statutory technical standards for sustainable drainage systems, 2015
- DEFRA National Standards for sustainable drainage systems Designing, constructing (including LASOO best practice guidance), operating and maintaining drainage for surface runoff, 2011
- BS8582 Code of practice for surface water management for development sites
- The House of Commons: Written Statement HCWS161 on Sustainable Drainage Systems, 2014
- Lead Local Flood Authority SuDS Policy Statement; Meeting Sustainable Drainage System standards in Hertfordshire, March 2015.
- The Building Regulations, 2010 (Part H: drainage and waste disposal)

The previous 2008 SFRAs gives recommendations on how SuDS can be used to reduce flood risk and reviews local geology. However, this area of flood risk management has significantly progressed since 2008; there is now a national standard for sustainable drainage systems with supporting non-statutory technical standards, a code of practice for surface water management and local supplementary planning guidance / advice published by the Council on surface water drainage systems.

2.7 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 'Sub-areas'. These policies are intended to cover the full range of long-term flood risk management options that can be applied to different locations in the catchment.

The study area is covered by the River Thames CFMP[6]. East Hertfordshire falls within the sub-areas 1 and 4; Towns and villages in open floodplain (north and west) and Chalk and downland catchments.

In Sub-area 1, Towns and villages in open floodplain (north and west), the preferred policy option is option 6; Areas of low to moderate flood risk where we will take action with others to store water

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

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

or manage run-off in locations that provide overall flood risk reduction or environmental benefits. Across the sub-area there are over 100 separate communities where there are 10 properties or more at risk of flooding. Many of these are typically small clusters of properties where rivers meet or are crossed by bridges. Generally, these communities will not be a priority for funding for large scale flood defences, but activities will continue to maintain the flow of water in the rivers which pass through developed areas. The following actions are proposed in this sub-area to implement the preferred policy:

- 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 (by increasing the frequency of flooding) 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 polices that lead to long-term adaptation of urban environments in flood risk areas.
- Continue to increase public awareness, including encouraging people to sign-up for the free Floodline Warnings Direct service.
- Help communities and local authorities manage local flood risk, for example by flood resilience community flood plans that identify vulnerable people and infrastructure and community based projects.

For Sub-area 4, Chalk and downland catchments, the preferred policy option is option 3; Areas of low to moderate flood risk where we generally manage existing flood risk effectively. The CFMP also notes that there are over 50 separate communities in this sub-area where there are over 10 properties at risk of flooding. These communities will not be a priority for large scale flood defences and therefore activities to maintain the existing capacity of the rivers that pass through developed areas will be maintained. The following actions are proposed in this sub-area to implement the preferred policy:

- Maintain the existing capacity of the river systems in developed areas to reduce the risk of flooding from more frequent events.
- Work with partners to identify opportunities to make the existing systems more efficient (for example, where there are significant restrictions to flow from undersized culverts or bridges).
- Work with Local Planning Authorities to retain the remaining floodplain for uses that are compatible with flood risk management and put in place polices that lead to long-term adaptation of urban environments in flood risk areas.
- Continue to increase public awareness, including encouraging people to sign-up for the free Floodline Warnings Direct service.

2.8 Lower Lee Flood Risk Management Strategy (2013)

The Environment Agency's Lower Lee Flood Risk Management Strategy is used to review how fluvial flood risk associated with rivers in the Lower Lee catchment is managed now and long term (100 years).

The Lower Lee Flood Risk Management Strategy covers the area downstream of Hertford to the mouth of the Lee at Bow Creek. East Hertfordshire is covered by the Upper Lee sub-catchment within the strategy, from Ware to the River Stort Confluence. Within the Upper Lee sub-catchment there are an estimated 31 properties in Ware, Great Amwell and St Margarets at risk of fluvial flooding during the 1% AEP event. Measures relating to this sub-catchment as part of the management strategy include:

- Continuing operation and maintenance of the channel to ensure the current standard of protection is maintained. This will include maintaining the function of Hardmead and Stanstead sluices between Hertford and Ware.

- Continue to work in partnership with local communities and organisations to find opportunities to reduce flood risk, although no specific structural measures have been identified in this area. Individual property-level protection measures could be retro-fitted to existing properties which flood to a depth of less than 0.75m.
- Ensure that development proposals comply with current planning policy on development and flood risk to make sure that flood risk is not increased, and where possible, reduces flood risk overall.
- Continue to operate and maintain our flood warning service.
- Periodically review the strategy in future years to determine if additional intervention measures are required as a result of climate change.

2.9 Localism Act

The Localism Act outlines plans to shift and re-distribute the balance of decision making from central government back to councils, communities and individuals. The Localism Act was given Royal Assent on 15 November 2011.

In relation to the planning of sustainable development, provision 110 of the Act places a duty to cooperate on Local Authorities. This duty requires Local Authorities to "engage constructively, actively and on an ongoing basis in any process by means of which development plan documents are prepared so far as relating to a strategic matter".

The Localism Act also provides new rights to allow local communities to come together and shape new developments by preparing Neighbourhood Plans. This means that local people can decide not only where new homes and businesses should go and but also what they should look like. As neighbourhoods draw up their proposals, Local Planning Authorities will be required to provide technical advice and support.

2.10 East Herts District Plan

The current planning policies for East Hertfordshire are set out in the 2007 Local Plan. This is used by East Hertfordshire Council to determine planning applications and shape development across the district.

At the time of preparing this SFRA, the council were in the process of compiling a new local plan. The East Herts District Plan will replace the 2007 Local Plan and will set out the Council's vision on how the area will develop in the future to 2033. **Throughout this SFRA, the new local plan will be referred to as the emerging District Plan.** The plan is currently being developed in accordance with National Planning Policy Framework and will outline the principles that will guide future development. This SFRA will be used as an evidence base for the Council to inform policies in relation to development and flood risk.

2.11 Water Framework Directive

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

The WFD aims to achieve at least 'good' status for all water bodies; the default deadline for achieving this objective is by 2021 although, in some cases, where it is deemed more appropriate, less stringent objectives have been set with extended deadline of 2027 or beyond. The WFD requires the production of Management Plans for each River Basin District. These plans assess the pressures facing the water environment in each district. Each District is composed of a group of catchments termed river basins to which all water bodies are assigned.

Any adverse impacts can cause a waterbody's ecology to deteriorate and prevent environmental improvements from being undertaken. Nevertheless, in-channel works can also be beneficial if they can be designed to help achieve environmental improvements included in the RBMP, thus

enhancing the water environment for plants and animals. Any activity which has the potential to have an impact on the ecology of a waterbody will need consideration in terms of whether it could cause deterioration in its Ecological Status or Potential.

2.11.1 Thames River Basin Management Plan (RBMP), 2015

The Thames River Basin Management Plan (2015)[7] is prepared under the WFD and assesses the pressures facing the water environment in the Thames River Basin District. The 2009 version has been updated in December 2015.

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

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

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

2.11.2 Green Infrastructure

Although not in itself a policy, Green Infrastructure (GI) is a recurring theme in planning policy. GI can be defined as a strategically planned and managed network of greenspaces and environmental components, which connect and surround the urban built environment and rural settings and consist of:

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

The identification and planning of GI is critical to sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. It is central to climate change action and is referred to frequently in the planning policy. Identifying and planning for GI is intrinsic to sustainable growth and therefore, merits investment and consideration as much as other socio-economic priorities.

2.11.2.1 GI Strategies and Policies

The 2009 Water Cycle Study states that there is an opportunity to link the design of SuDS with Green Infrastructure Strategies, to provide an integrated network that relieves flood risk whilst enhancing biodiversity e.g. attenuation basins and wetlands.

The Hertfordshire Strategic Green Infrastructure Plan (HCC, 2011) details strategic planning and site design and management practices to inform spatial land planning and development management decisions. The Plan provides an overview of opportunities for GI, proposed GI projects and linking GI to local spatial planning.

The 2015 Hertfordshire County Council SuDS Design Guidance for Hertfordshire contains further advice and demonstrations of Green and Blue Infrastructure.

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

2.12 Insurance

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

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

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

2.12.2 FloodRe

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

2.13 Implications for East Hertfordshire District Council and other Risk Management Authorities

The responsibilities under the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009 are summarised in Sections 2.2 and 2.3.

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

Risk Management Authority (RMA)	Strategic Level	Operational Level
Environment Agency	National Statutory Strategy Reporting and supervision (overview role)	• Preliminary Flood Risk Assessment (per River Basin District)* • Managing flooding from Main Rivers and reservoirs and communication flood risk warnings to the public, media and partner organisations. • Identifying Significant Flood Risk Area* • 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 • Acting consistently with LFRMS in realising FRM activity and have due regard in the discharge of function of the strategy. • Designating authority of infrastructure with a

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

Risk Management Authority (RMA)	Strategic Level	Operational Level
		significant impact on flood risk from surface water and groundwater.
Lead Local Flood Authority (Hertfordshire County Council)	Input to National Strategy Formulate and implement the Hertfordshire Local Flood Risk Management Strategy	• Power for enforcing and consenting works for ordinary watercourses. • Managing local sources of flooding from surface 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 • Investigating certain incidents of flooding in the County in Section 19 Flood Investigations • 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 • Designating authority for Infrastructure with a significant impact on flood risk from surface runoff and groundwater
Lower Tier Authorities (East Hertfordshire District Council)	Input to National and Local Authority Plans and Strategy (e.g. East Herts District Plan – to develop a spatial strategy for growth within the district which accounts for flood risk)	• District Councils have the powers to carry out works on ordinary watercourses to reduce flood risk • Preparation of a Local Plan to guide development. • Acting consistently with LFRMS in realising FRM activity and have due regard in discharge of other functions. • 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.

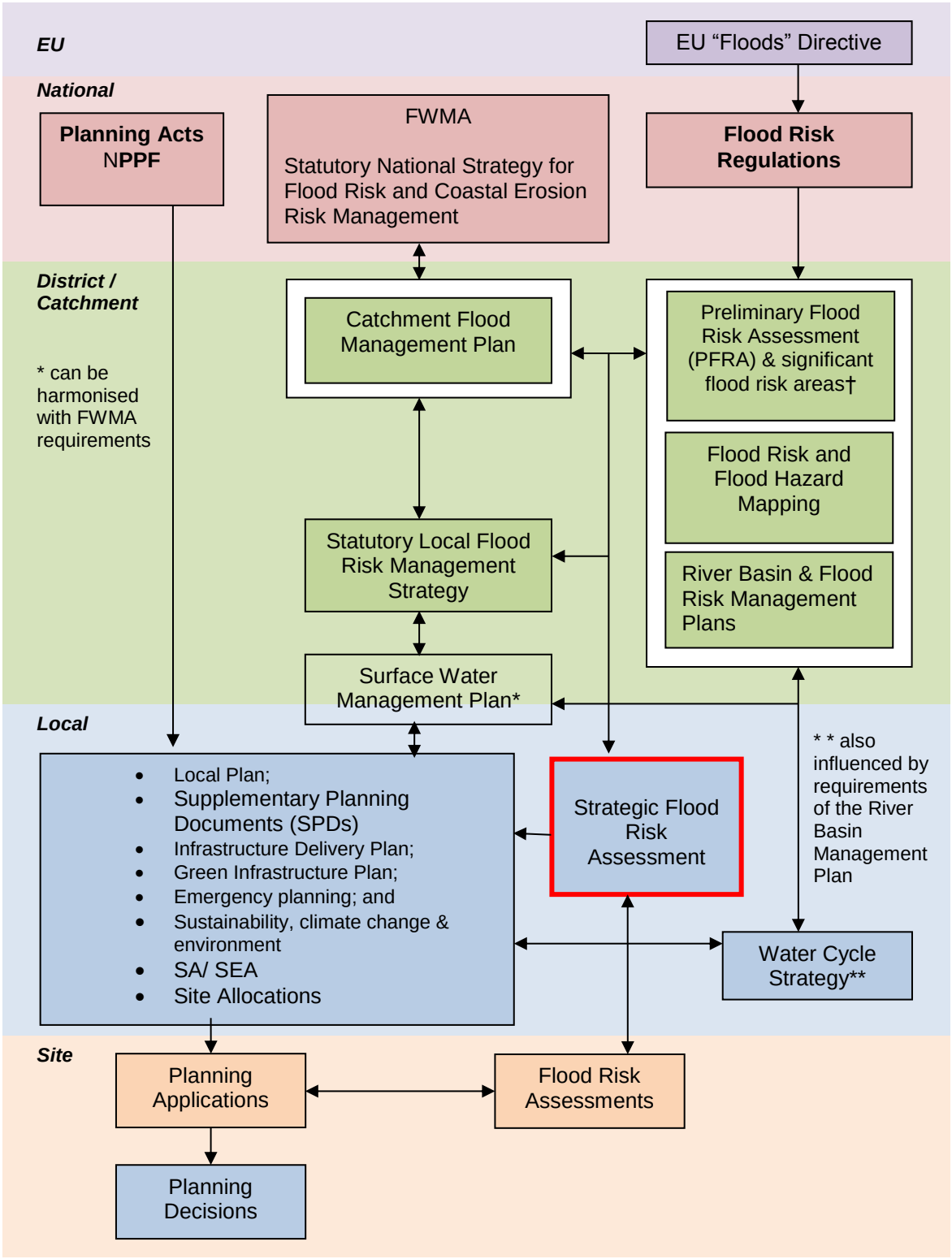
* Environment Agency did not prepare a PFRA; instead they exercised an exception permitted under the Regulations

2.13.1 Strategic Planning Links

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

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



Legend: Responsibilities are indicated using colour coding as follows

European Union	National Government	Local Planning Authority	EA/LLFA/Local Authorities	Developer

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

2.13.2 United Kingdom exit from the European Union

On 23rd June 2016, the advisory referendum on whether the United Kingdom should remain a member of the European Union (EU) resulted in a majority vote in favour of leaving the EU. At the time of writing, HM Government had not published a timetable for invoking Article 50 of the Lisbon Treaty, which sets out the procedures for a member state leaving the EU. The intention of the UK to leave the EU, however, raises several areas of uncertainty which may impact upon the future applicability of this study, including:

- National and regional economic performance
- Migration and population change
- The future status of EU directives relating to water, for example the Water Framework Directive and the Habitats Directive.

Given these increased uncertainties, it becomes even more important that water companies, planners and regulators co-operate and share information, and to attempt to account for uncertainty in their planning.

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3 The sequential, risk based approach

3.1.1 Flood Risk definition

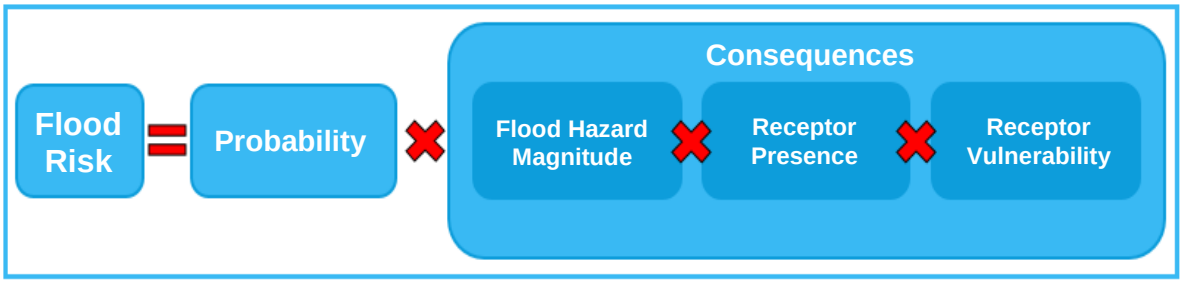
Section 3 (subsection 1) of the FWMA defines the risk of a potentially harmful event (such as flooding) as:

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

Thus it is possible to summarise flood risk as:

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

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



Using this definition it can be seen that:

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

3.1.2 Flood Zones

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

Table 3-1: Flood Zone descriptions

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

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

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

Important note on Flood Zone information in this SFRA

Appendix B:

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

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

Flood Zone 3b - The SFRA identifies this Flood Zone as land which would flood with an annual probability of 1 in 20 years; where detailed modelling exists, the 1 in 20-year flood extent has been used to represent Flood Zone 3b (provided by the Environment Agency). In the absence of detailed hydraulic model information, a precautionary approach has been adopted with the assumption that the extent of Flood Zone 3b would be equal to Flood Zone 3a (i.e. indicative extent of Flood Zone 3b). 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.

3.1.3 The sequential, risk-based approach

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

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

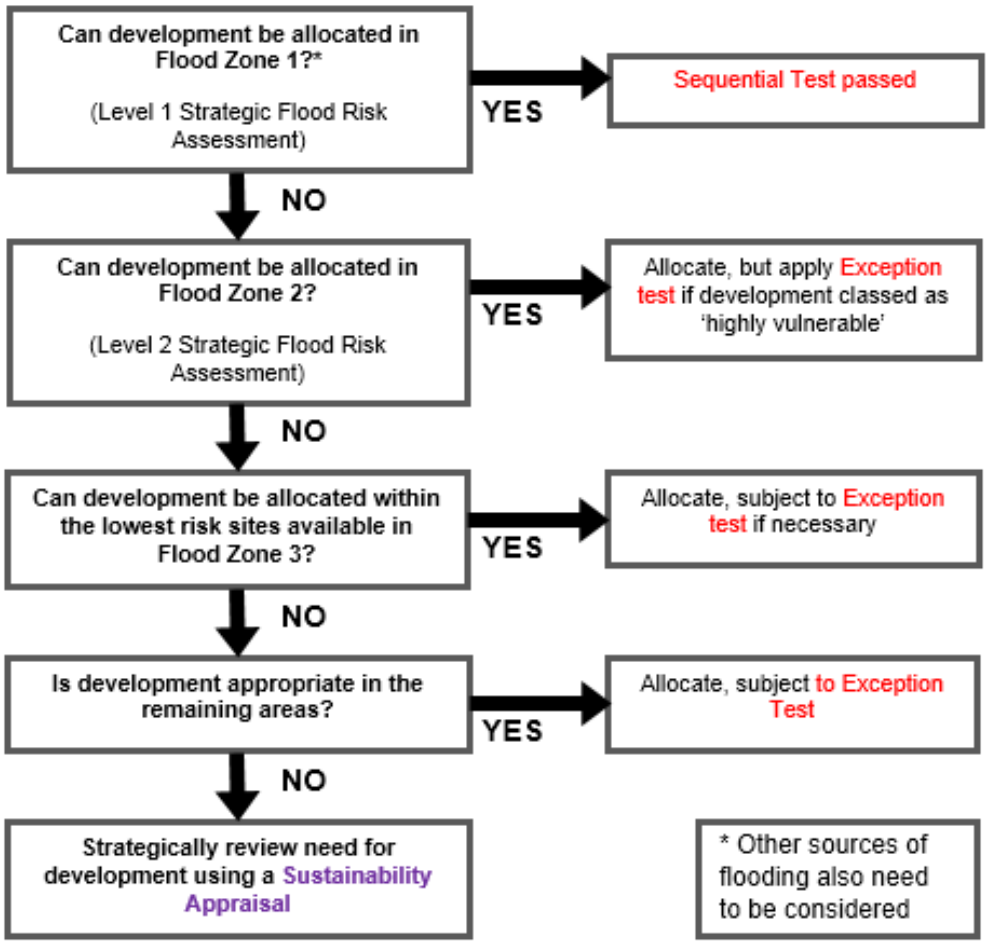
It is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic and a greater understanding of the scale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

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

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

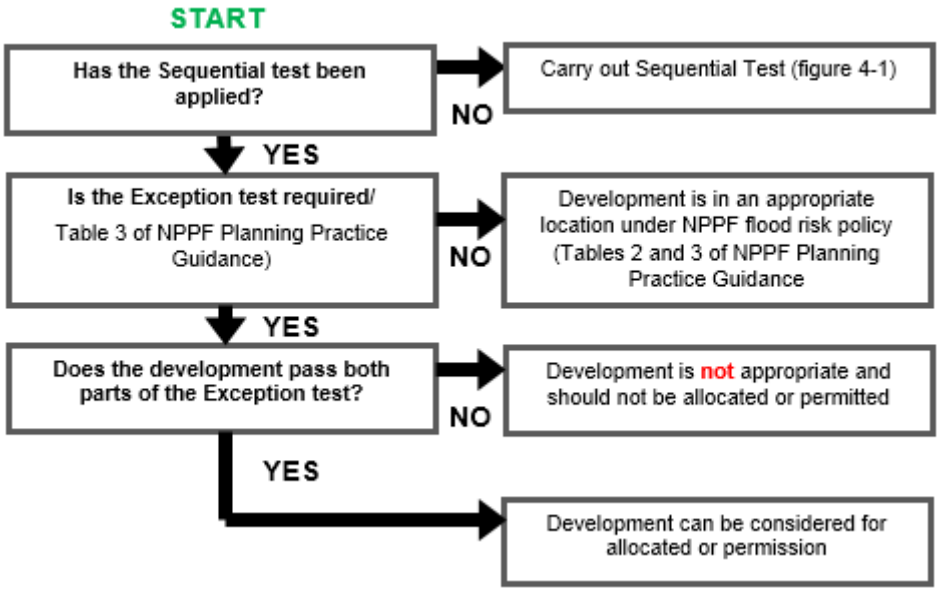
The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through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

Figure 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 NPPF Planning Practice Guidance: Flood Risk and Coastal Change. The NPPF PPG 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



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

3.3.1 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.

East Hertfordshire District 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.

3.3.2 Exception Test

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

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

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

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

- Resident awareness.
- Flood warning and evacuation procedures.
- Any funding arrangements required for implementing measures.
-

The NPPF and Technical Guidance provide detailed information on how the Test can be applied.

3.4 Actual and residual flood risk

3.4.1 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.

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 will erode the present day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

3.4.2 Residual flood risk

Residual risk refers to the risks that remain in circumstances 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.

Chapter 6 considers this risk in more detail.

4 The impact of climate change

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050 and to put in place measures to adapt to climate change. In 2009, Stage 1 of the Scoping study of Hertfordshire LPA planning performance in relation to climate change was published. This study gives and assessment of the state of Hertfordshire's planning regime in relation to CO2 and climate change matters. It also provides a list of recommendations to take forward to Stage 2.

On a national level, the Government published a UK Climate Change Risk Assessment in 2012, which was based on evidence studies including the UK Climate Projections published in 2009 (UKCP09).

4.1 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 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. The LLFA should be contacted for advice on flood risk from local watercourses, surface, or groundwater.

4.2 Peak River Flows

The peak river flow allowances show the anticipated changes to peak flow by river basin district. East Hertfordshire's watercourses are located within the Thames river basin district. 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 peak river flow allowances show the anticipated changes for the three future epochs and percentiles, as shown in Table 4-1 for the Thames river basin district.

Table 4-1: Peak river flow allowances by river basin district

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)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

4.2.1 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.

4.2.2 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	✓		

4.3 Peak rainfall intensity allowance

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

For 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%

4.4 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

The impact of climate change in East Hertfordshire, and how climate change has been assessed as part of this SFRA, is addressed in Section 5.9.

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5 Understanding flood risk in East Hertfordshire

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

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

Table 5-1: Overview of supplied data for East Hertfordshire SFRA

Source of flood risk	Data used to inform the assessment	Data Supplied By
Historic (all sources)	Historic Flood Map and Recorded Flood Outlines Hydraulic Modelling Reports	Environment Agency
	2008 SFRA	East Hertfordshire District Council
	2011 PFRA Section 19. Flood Investigation Reports	Hertfordshire County Council
	Historic flood incidents / records	East Hertfordshire District Council; Canal and River Trust
	DG5 Register	Thames Water
Fluvial (including climate change)	River Lee 2D Modelling Study (CH2MHill, 2014) Puckeridge Tributaries Mapping and Modelling Study (JBA, 2015) Stort Tributaries Mapping and Modelling Study (JBA, 2015) A120 Bypass Little Hadham Hydraulic Modelling (JBA, 2014) River Lee Model Maintenance Stage 2 (Halcrow, 2010) Stort Modelling and Mapping Flood Risk (Halcrow, 2010) River Rib Flood Mapping Study (Mott MacDonald, 2009) River Beane Flood Mapping Study (Halcrow, 2008) River Ash Flood Risk Management Strategy (Atkins, 2006) Flood Zone mapping	Environment Agency
Surface water	Updated Flood Map for Surface Water	Environment Agency
	Reported flood incident data	Hertfordshire County Council - Highways
Groundwater	Areas Susceptible to Groundwater flooding Bedrock geology / superficial deposits maps	Environment Agency
Sewer	DG5 Register	Thames Water
Reservoir	National Inundation Reservoir Mapping	Environment Agency
Canal	GIS Data showing incidents of overtopping	Canal and River Trust

5.1.1 Hydraulic modelling used in the SFRA

Environment Agency detailed modelling

Fluvial flood risk within East Hertfordshire District Council has been assessed using results from hydraulic models supplied by the Environment Agency (to determine Flood Zone 3b) and existing Environment Agency Flood Zone mapping.

The Environment Agency's Flood Zone maps include the undefended outputs of the models outlined below. The following models were supplied:

- River Lee 2D Modelling Study (CH2MHill, 2014) – *comprising 14 models and 2 sub models. Only the M01, M02, M14, Hertford cut model and Ware cut model were supplied for this study.*
- Puckeridge Tributaries Mapping and Modelling Study (JBA, 2015)
- Stort Tributaries Mapping and Modelling Study (JBA, 2015) – *comprising 6 models including the Harlowbury brook, Lawrence Avenue Drain, Sawbridgeworth Brook, Spellbrook, Stickling Green Brook, Stortford Hall Park Personage Lane Ditch.*
- A120 Bypass Little Hadham Hydraulic Modelling (JBA, 2014)
- River Lee Model Maintenance Stage 2 (Halcrow, 2010)
- Stort Modelling and Mapping Flood Risk (Halcrow, 2010)
- River Rib Flood Mapping Study (Mott MacDonald, 2009)
- River Beane Flood Mapping Study (Halcrow, 2008)
- River Ash Flood Risk Management Strategy (Atkins, 2006)

Figure 5-1 shows the extent of these detailed hydraulic models. In some areas, model domains overlap each other, such as along the River Lea. Confirmation of which models should be run for which areas has been provided by the Environment Agency.

The Ash Strategy, River Rib and Lee Maintenance models are 1D-only. However, the majority of the Lee Maintenance model has now been updated to 1D-2D in the River Lee 2D Modelling Study. The remainder of the supplied hydraulic models are 1D-2D, providing a more accurate representation of flood risk. These models are available from the Environment Agency if developers are required to simulate different scenarios as part of a detailed Flood Risk Assessment (FRA).

To understand the impact of climate change, these detailed hydraulic models have been re-run following the updated Environment Agency climate change guidance. The modelling approach to climate change is discussed further in Section 5.9.1.

5.1.2 Surface Water

Mapping of surface water flood risk in East Hertfordshire has been taken from the updated Flood Map for Surface Water (uFMfSW) published online by the Environment Agency. This information is based on a national scale map identifying those areas where surface water flooding poses a risk. Surface water flood risk is subdivided into the following four categories:

- High: An area has a chance of flooding greater than 1 in 30 (3.3%) each year.
- Medium: An area has a chance of flooding between 1 in 100 (0.1%) and 1 in 30 (3.3%) each year.
- Low: An area has a chance of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%) each year.
- Very Low: An area has a chance of flooding of less than 1 in 1,000 (0.1%) each year.

5.1.3 Groundwater

Mapping of surface water flood risk has been based on the Areas Susceptible to Groundwater Flooding (AStGWF) dataset. The AStGWF dataset is 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 likelihood 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.

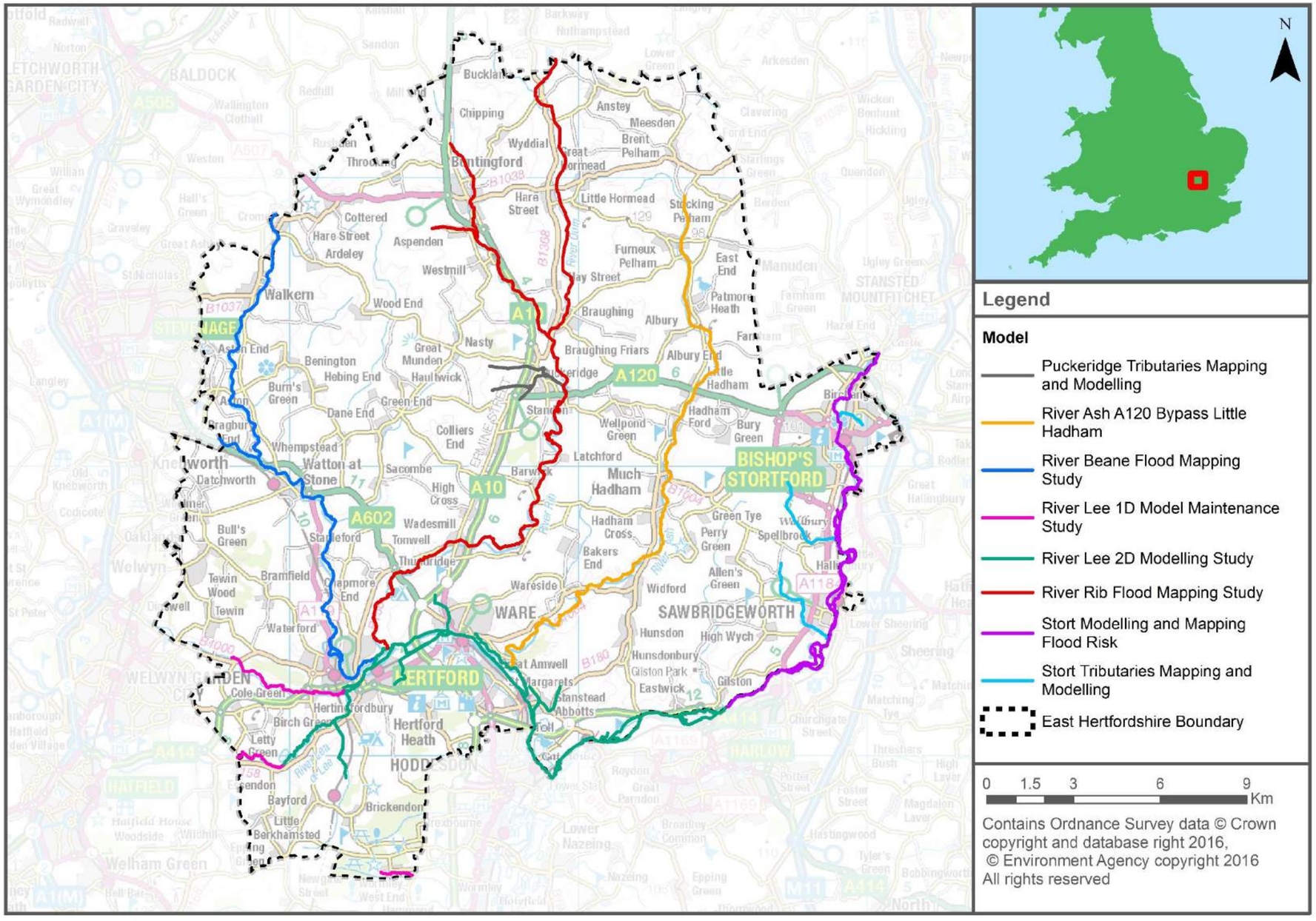
5.1.4 Sewers

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. For confidentiality reasons this data has been supplied on a postcode basis.

5.1.5 Reservoirs

Mapping of the risk of reservoir inundation has been based on the National Inundation Reservoir Mapping supplied by the Environment Agency. These maps show the extent which may be affected in the unlikely event that a reservoir dam fails.

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



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 A: Watercourses in the East Hertfordshire District
- Appendix B: Environment Agency Flood Zone Mapping, including functional floodplain
- Appendix C: Climate Change Mapping
- Appendix D: Surface Water Mapping
- Appendix E: Groundwater flood risk mapping
- Appendix F: Reservoir Inundation Mapping
- Appendix G: Flood warning coverage
- Appendix H: Technical Summary
- Appendix I: Level 2 site assessments detailed summary tables

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

- River Thames Catchment Flood Management Plan (2009) – Environment Agency[11].
- Hertfordshire Local Flood Risk Management Strategy – Hertfordshire County Council[12]
- Lower Lee Flood Risk Management Strategy – Environment Agency[13]
- Hertfordshire Preliminary Flood Risk Assessment (2011) – Hertfordshire County Council[14]
- Flood Risk Management Plan in accordance with the Flood Risk Regulations (available in 2015) – Environment Agency and Lead Local Flood Authority
- Environment Agency's Asset Information Management System (AIMS) – users should note that recently completed schemes may not yet be included in this dataset.

5.2 Data Gaps

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

- Most of the settlements deemed to be at fluvial flood risk are covered by hydraulic models. However, there are some locations identified which lie outside of detailed model extents, but which the Flood Zones show properties at flood risk. Locations of note are: Properties along Dane End Tributary (a tributary of the River Beane), properties in Barwick along the Barwick Tributary (a tributary of the River Rib) and properties north of Brent Pelham along the River Ash. It may be beneficial to investigate flood risk in these areas in the future.
- The Environment Agency's Flood Zone maps do not cover every watercourse (for example if <3km^2 catchment area), or Ordinary Watercourses. Hydraulic modelling may be required for more detailed Flood Risk Assessment studies, or following on from Section 19 reports, or as part of the Level 2 SFRA, to provide the required detail to support a site's development. If a watercourse or drain is shown on OS mapping but is not covered by a Flood Zone, this does not mean there is no potential flood risk. A hydraulic model would be required at detailed site-specific level to confirm the flood risk to the site.
- Any existing hydraulic models which are 1D-only could be upgraded in future to 1D-2D hydraulic models, if it is deemed necessary (for example if properties are at flood risk or a flood event has occurred and more detailed information is required). This would provide

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

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

13 Lower Lee FRMS - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288611/Managing_flood_risk_in_the_Lower_Lee_catchment_3131d9.pdf

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

a greater level of floodplain flood risk information, for example depths, velocity and hazard in the floodplain.

- Locations where surface water flooding is the predominant flood risk, this could be investigated further by use of surface water hydraulic modelling, or in combination with fluvial modelling, to assess the interactions between the two in more detail. Similarly, for any locations which suffer from sewer flooding or sewer capacity issues; this data can be incorporated into hydraulic models to more accurately represent the surface water system.
- At site-specific level, for any developments shown to be at residual flood risk, for example from a breach or overtopping (e.g. reservoir, canal, perched watercourse), it is recommended that a detailed hydraulic modelling study is carried out using Environment Agency guidance to assess the residual risk. There are a number of reservoirs within and outside of the East Hertfordshire boundary which may pose a residual flood risk to development. In addition, the New River water supply aqueduct, the River Lee Navigation Channel and the River Stort Navigation Channel are also located within East Hertfordshire.

5.3 Historical flooding

Historical records of flooding in the study area have been informed from Environment Agency Historic Flood Map and Recorded Flood Outline datasets, previous studies including the 2011 PFRA, the previous East Hertfordshire 2008 SFRA, hydraulic modelling studies and information supplied through consultation with stakeholders. It is noted that at the time of preparing this SFRA, none of the Hertfordshire Council Council's Section 19 Flood Investigation Reports covered communities within the study area.

5.3.1 Fluvial flooding

Table 5-2 displays the recorded / observed historic fluvial flood events known to have affected the district of East Hertfordshire. The most notable incident of widespread flooding is the 1947 event which caused significant flooding throughout Hertfordshire and the River Lea catchment. The River Lea is noted to have a long history of flooding and following the 1947 event a Flood Relief Channel was constructed along the River Lea just outside of the East Hertfordshire District[15].

Other notable events affecting large parts of East Hertfordshire include those during September 1968, May 1978, July 1987, October 1993 and October 2001. In addition, in 1974 widespread flooding occurred along the River Stort, and in May 2008 large parts along the River Beane were affected by flooding.

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

Table 5-2: Historic fluvial flood events in the district of East Hertfordshire

Watercourse	Event Date
Aston End Brook	May 1947, May 2008, Dec 2013
Black Ditch	May 1947, Aug 1987
Brickendon Brook	May 1947, July 1987, Dec 2000
Canons Brook	May 1947, Dec 2000
Dane End Tributary	May 1947, Sep 1968, Oct 2001, Feb 2014
Hunsdon Brook	May 1947, Dec 2000
Puckeridge Tributary	Feb 2014
River Ash	May 1947, Sep 1968, Nov 1974, May 1978, Feb 1979, Oct 1982, Aug, Sep and Oct 1987, Jan 1988, Oct 1993, Oct 2000, Oct 2001, Feb 2009, Feb 2010, Feb 2014
River Beane	May 1947, Sep 1968, July 1987, Oct 1993, Dec 1995, May 2008, Feb 2009, Feb 2014
River Lea	May 1947, Sep 1968, May 1978, June 1983, July 1987, Feb 1990, Dec 2000, March 2007, May 2007, Feb 2009, Feb 2014
River Mimram	May 1947, July 1987, July 1996, Dec 2000
River Quin	May 1947, Sep 1968, Aug 1987, Oct 1993
River Rib	May 1947, Sep 1968, Nov 1974, May 1978, Feb 1979, June 1983, July 1987, Jan 1988, Feb 1990, Oct 1993, Oct 2000, Oct 2001, Feb 2014
River Stort	May 1947, Sep 1968, Nov 1974, May 1978, Dec 1982, July 1987, Oct 1987, Sep 1992, Oct 1992, Oct 1993, Jan 1994, Jan 1995, Oct, Nov and Dec 2000, Feb 2001, Oct 2001, Jan 2003, Feb 2009, Feb 2010, Jan 2011, Feb 2014
Stevenage Brook	May 1947, May 1992, Oct 1993, May 2008, Dec 2013

In addition, the following tributaries experienced flooding during the May 1947 event: Ardeley Brook, Barwick Tributary, Bourne Brook, Braughing Bourne, Fanhams Tributaries, Great Hormead Brook, Haley Hill Ditch, Manifold Ditch, New River, Spital Brook, Stanstead Mill Stream, Stapleford Marsh Ditch, The Bourne, The Cuts, The Old Bourne, Thistley Vale Brook, Toll House Stream, Woollens Brook and the Wormleybury Brook.

The East Hertfordshire District Council Flood Incident Database brings together records of flood incidents from a variety of sources. In addition to fluvial flooding incidents, the database also has records of groundwater and surface water flooding in the district.

5.3.2 Groundwater

The East Hertfordshire District Council Flood Incident Database has recorded 13 incidents of groundwater flooding (see Table 5-3). Although the incidents are largely isolated, the settlement with the greatest recorded number of incidents is Ware and Tewin/ Tewin Wood. The location of the recorded groundwater incidents was compared with the geology of the study area; groundwater incidents tend to have been recorded where the underlying bedrock geology is classified as principal (layers of rock or drift deposits with high permeability and, therefore, provide a high level of water storage) – see Section 5.4.2.

Table 5-3: Historic groundwater flood events in the district of East Hertfordshire

Year	Number of incidents	Location
1993	1	Kettle Green
1995	1	Meesden
1999	1	Ware
2001	1	Tewin Wood
2006	1	Sawbridgeworth
2007	1	Bishop's Stortford
2010	1	Wareside
2013	1	Ardeley
2013	1	Buckland
Unknown	4	Little Berkhamsted, Ware, Tewin

5.3.3 Surface water

The East Hertfordshire District Council Flood Incident Database has recorded 76 incidents of where the source of flooding was reported to be purely surface water (see Table 5-4). Incidents of surface water flooding tend to be isolated. Settlements with five or more records of surface water flooding include Bishop's Stortford, Buntingford, Hertford, Much Hadham and Walkern.

Table 5-4: Historic surface water flood events in the district of East Hertfordshire

Year	Number of incidents	Location
1992	3	Buntingford, Bishop's Stortford, Hertford
1993	18	Buntingford, Puckeridge, Much Hadham, Allens Green, Bishop's Stortford, Hertford, Stansted Abbots, Ware, Bragbury End, Cottered, Dane End, Datchworth, Cole Green
1994	1	Bishop's Stortford
1995	1	Bishop's Stortford
1997	1	Bishop's Stortford
1998	1	Sawbridgeworth,
1999	2	Buntingford
2000	3	Bishop's Stortford, Much Hadham
2002	3	Hertford, Furneux Pelham
2003	3	Ware, Sawbrideworth, Walkern
2004	1	Buntingford
2006	3	Bishop's Stortford, Cottered
2007	2	Buntingford, Bishop's Stortford
2010	1	High Cross
2011	2	Meesden, Bishop's Stortford
2012	1	Bishop's Stortford
2013	1	Buntingford

2014	26	Tewin, Bayford, Little Hadham, High Cross, Bishop's Stortford, Much Hadham, Hunsdon, Albury, Wadesmill, Walkern, Datchworth, Cold Christmas, Hare Street, Colliers End, Luffenhall, Great Amwell, Tonwell, Ware
2015	3	Little Hormead, Ware, Hertford

5.3.4 Historic flood mechanisms

There are a number of historical flood mechanisms in East Hertfordshire including:

- Heavy storm events which cause high runoff and result in flashier flooding from small streams
- Poor antecedent conditions combined with heavy, prolonged rainfall.
- Culverting of watercourses causing localised flooding problems through the limited capacity of the culverts, surcharging and damage or blocked culverts.
- Historic urban extensions that rely on outlets into watercourses for surface water drainage and poor surface water management e.g. not considering the use of SUDS.
- Insufficient storm and combined drainage capacity.
- Insufficient road ditches / gully capacity and lack of maintenance.
- Lack of maintenance of the surface water system i.e. gullies, gully leads and adopted surface water sewers and other drains.
- Reliance on soakaways where there is a lack of available positive drainage outfalls
- Land drainage surface water runoff from fields.
- Groundwater flooding; in certain areas, this is thought to have been caused by the underlying geology and high water table.

5.4 Topography, geology, soils and hydrology

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

5.4.1 Characteristics of the District

East Hertfordshire is the largest district of the ten within Hertfordshire, covering an area of approximately 475km2 and with a population of approximately 141,07616. The largest urban area in the district is Bishop's Stortford, followed by Hertford, Ware, Sawbridgeworth and Buntingford. In addition, there are also a number of villages and hamlets scattered across the district, although the district is predominately rural.

The 2008 Landscape Character Assessment for East Hertfordshire17 identified some 67 distinct character areas within the district by describing their key characteristics and natural, historical and cultural features. On a broader scale, three landscape character regions were identified in East Hertfordshire; The East Herts Plateau, The Central River Valleys Region and a small part of The South Hertfordshire Plateau.

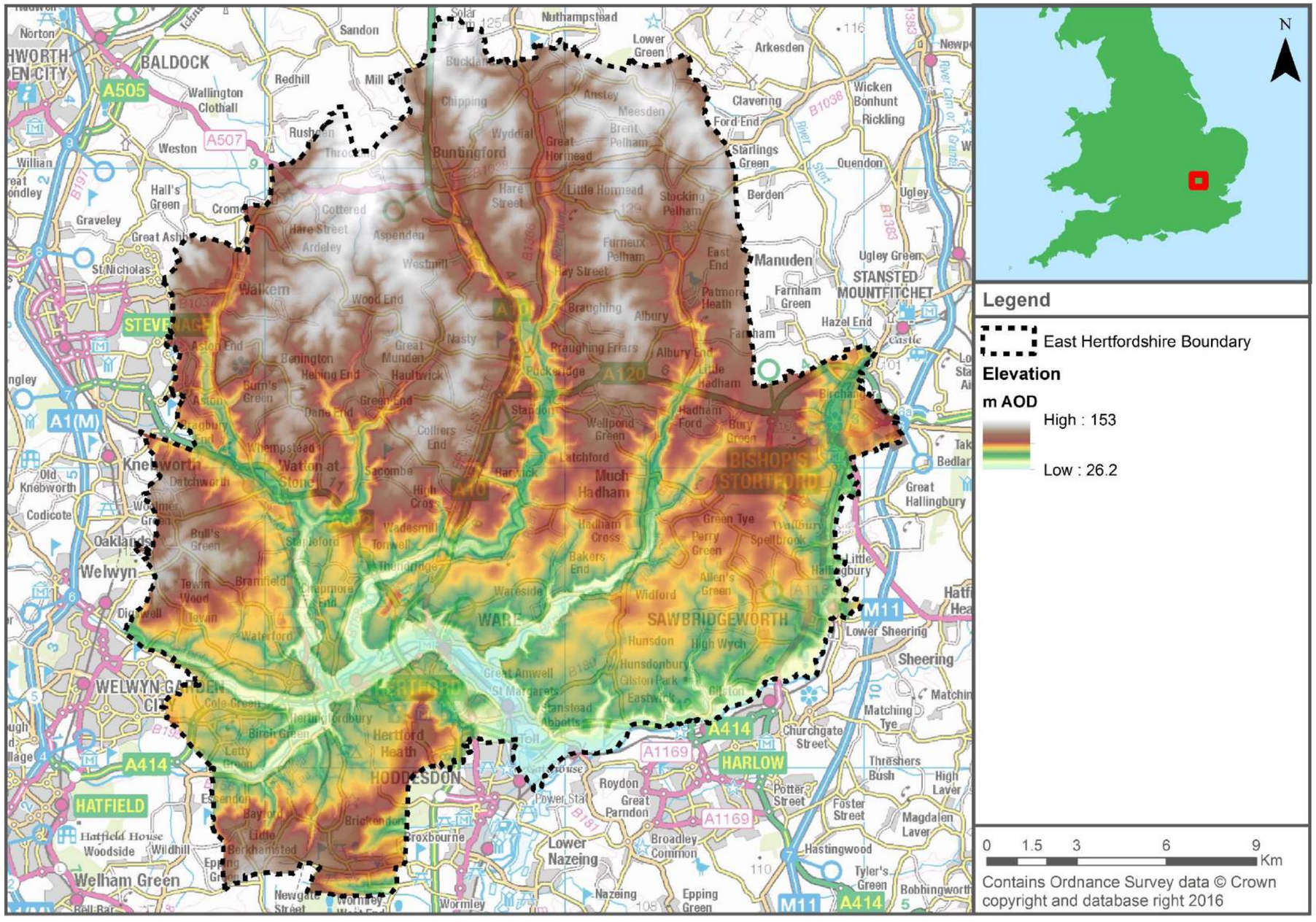
The topography of East Hertfordshire is diverse, with upland areas divided by river valleys and lowland areas. The highest ground is located to the north of the district with elevations reaching approximately 153m AOD. The southern part of the district is characterised by shallower elevations, especially along the River Lea Valley. The River Lea flows into the district from the west and flows in a north-easterly direction before turning southwards and flowing towards the southern boundary of the district. The main tributaries of the River Lea, namely the River Mimram,

[16] East Hertfordshire Annual Report 2014-2015
http://www.eastherts.gov.uk/media/28080/Annual-Report-2014-15/PDF/5429_-_Annual_Report_2014-15_LORES.pdf

[17] Landscape Character Assessment http://www.eastherts.gov.uk/media/6672/Adopted-LCA-SPD/PDF/LCA_SPD_PDF.pdf

River Beane, River Rib, River Ash and the River Stort originate from areas of higher ground in the northern part of the district and flow in a southerly direction towards their confluence with the River Lea in the southern part of the district. The topography of the study area can be seen in Figure 5-2.

Figure 5-2: The topography of the East Hertfordshire District



5.4.2 Geology and soils

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

Figure 5-3 shows the bedrock (solid permeable) formations in the District and Figure 5-4 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 bedrock in East Hertfordshire consists predominantly of Principal formations, with areas to the south of East Hertfordshire made up to Secondary A and unproductive strata. The British Geological Survey indicates the principal aquifers comprises chalk formations, the Secondary A of Woolwich and Reading Beds, and the unproductive of London Clay group formations. Chalk formations allow water to pass to and from groundwater aquifers and can be at risk of groundwater flooding.

Superficial deposits are predominately classed as Secondary A and Secondary (undifferentiated). There are a few outcrops of unproductive superficial deposits in the west and north of East Hertfordshire. Secondary A deposits are predominately located along river corridors in East Hertfordshire. The river corridor along the River Lea is typically comprised of Alluvium (Clay, Silt and Sand) whilst the rest of the district mainly comprises River Terrace deposits, Till and Diamicton and Sand and Gravel deposits.

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

Figure 5-3: Bedrock deposits in East Hertfordshire

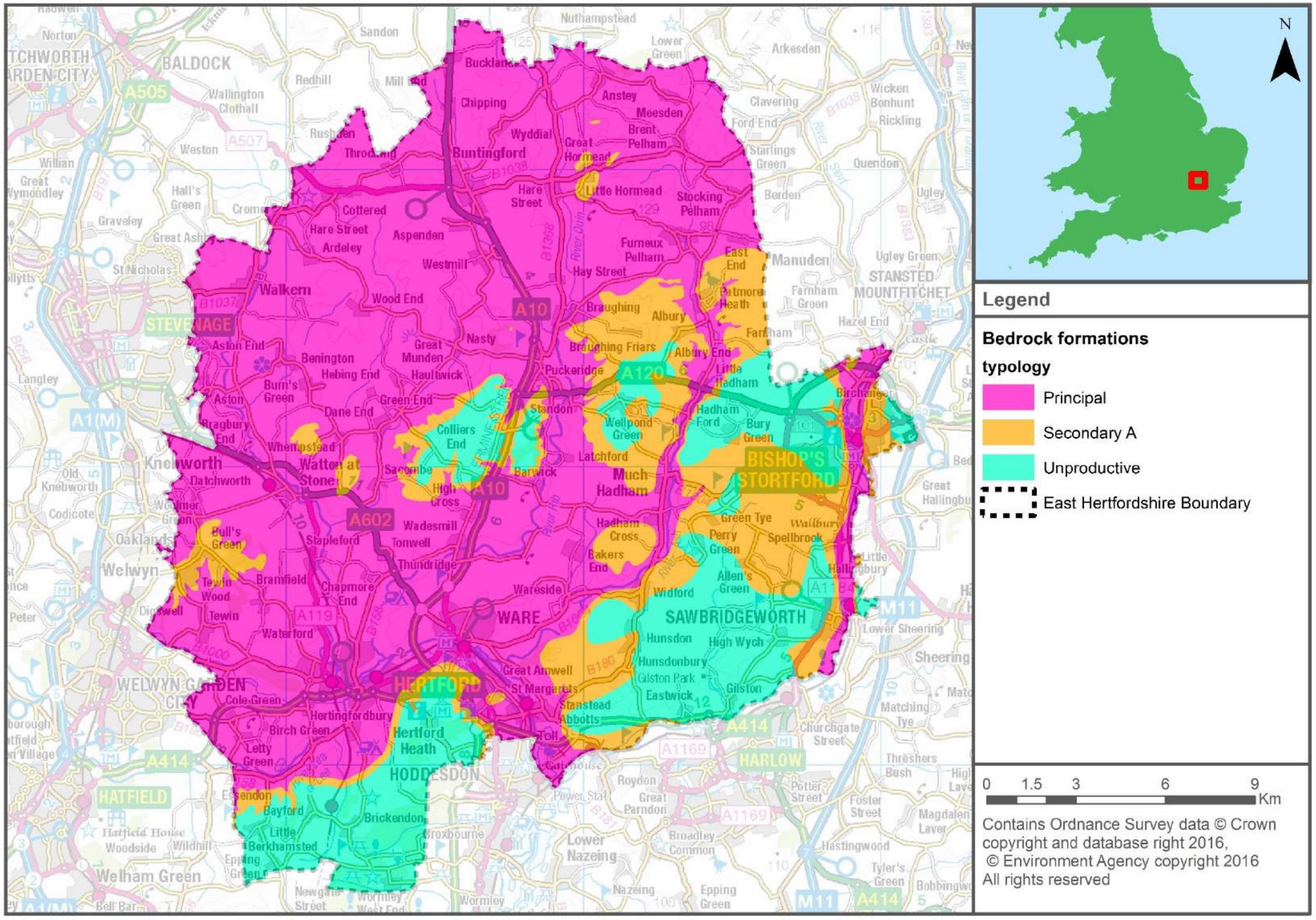
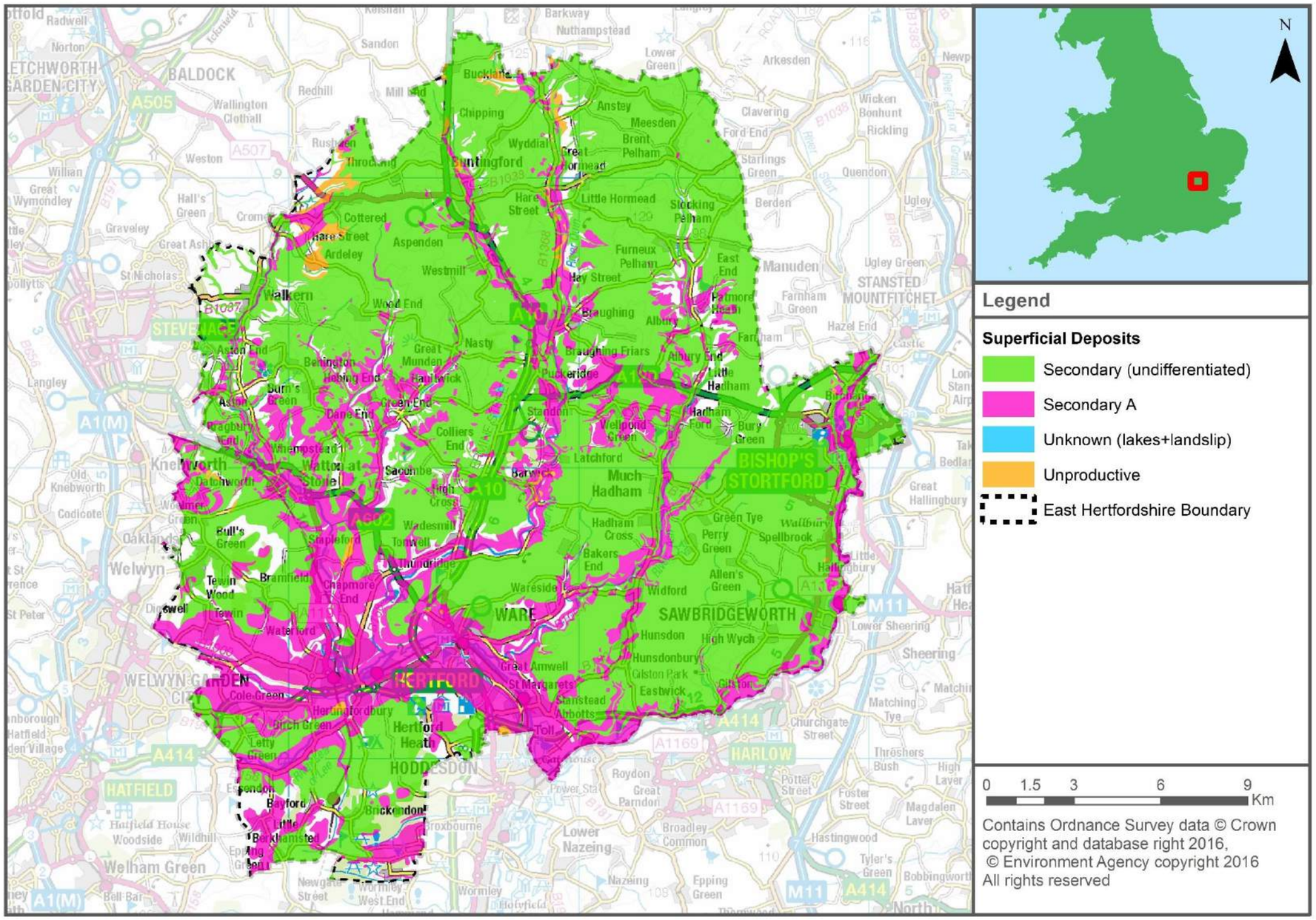


Figure 5-4: Superficial deposits in East Hertfordshire



5.4.3 Hydrology

East Hertfordshire lies within the River Lea and River Stort catchments (the River Stort, itself, a tributary of the River Lea); the entire study area falls within the Upper Lea catchment. The network of both the River Lea and the River Stort is complex, with a number of smaller Main Rivers, Ordinary Watercourses (which are named) and unnamed drains. Some of the most significant tributaries of the River Lea include the River Beane, the River Ash, the River Rib, and the River Mimram which converge with the River Lea towards the southern end of East Hertfordshire. A summary of the principal watercourses in the SFRA area is provided in Table 5-5. Appendix A shows the location of the main watercourses within the study area.

Table 5-5: Key watercourses in the study area

Watercourse name	Classification	Description
Ardeley Brook	Main River	A tributary of the River Beane, the Ardeley Brook rises south east of Cottered, flowing in a predominantly westerly direction, before joining the River Beane south of Cromer at TL 29519 27756.
Barwick Tributary	Main River	A small tributary of the River Rib, Barwick Tributary is shown to start near Colliers End in the centre of the district, flowing in a southerly direction, before joining a secondary branch of the Barwick Tributary and flowing east until its confluence with the River Rib in Barwick at TL 38637 19396. A second branch / watercourse called the Broxbourne Ditch is shown to rise north of High Cross, flowing predominantly north easterly for approximately a kilometre, before joining the Barwick Tributary at Barwick Lane TL 37435 19697.
Bayford Brook	Main River/ Ordinary watercourse	The Bayford Brook is shown to start as a series of unnamed drains in Ashendene in the south west of the district, flowing in a predominantly northerly direction, before joining the River Lea at Burrowfield. The most upstream reach of this watercourse is an Ordinary Watercourse, changing to Main River around Brickendon Lane, at TL 31590 08254.
Bourne Brook	Main River	The Bourne Brook enters the district north of the A120 at the Old Lime Works (TL 48600 23523) where it changes classification to a Main River and flows in a predominantly south easterly direction before joining the River Stort.
Braughing Warren Bourne	Main River / Ordinary watercourse	Fed by a spring in Cockhamsted, the Braughing Warren Bourne flows south till Braughing Friars where, south of Friars Road, it becomes a Main River. The river then continues south west until it joins the River Rib north of Standon TL 39345 23294.
Brickendon Brook	Main River / Ordinary watercourse	The Brickendon Brook starts west Mangrove Lane, flowing in a north westerly direction towards south Hertford. The watercourse is fed by a number of un-named drains. The Brook flows along Brickendon Lane, before joining the River Lea north of Hornsmill Road in Hertford.
Chelsings Tributary	Main River	A tributary of the River Rib, with their confluence south of Anchor Lane, west of Thundridge (TL 34467 16711), the Chelsings Tributary flows in a southerly direction from south of Sacombe Green's Marshall's Lane.
Dane End Tributary	Main River/ Ordinary watercourse	The Dane End Tributary rises as a series of un-named drains within the Cherry Green area. The watercourse flows in a south westerly direction, through Great Munden and Dane End, where it turns south to it confluence with The Cuts (TL 32632 18384)
Fanhams Tributaries	Main River/ Ordinary watercourse	Fanhams Tributaries begins on Ashridge common as two tributaries which join at TL 37987 15250 and flow south east to join the River Ash.
Fiddlers' Brook	Main River/ Ordinary watercourse	Fed by Gatney Spring, Fiddlers' Brook gently meanders south till it meets the Golden Brook north of Golden Grove. After approximately 2.3km of being the Golden Brook the watercourse returns to the being named the Fiddlers' Brook.
Golden Brook	Main River	Approximately 2.3km of Main River between two sections of the Fiddles' Brook, between north of Golden Grove (TL 44743 14784) and west of Home Wood (TL 44745 14781)
Great Hormead Brook	Main River	The Great Hormead Brook is a Main River which is fed by the ordinary watercourse the Black Ditch in the centre of Great Hormead. It flows predominately West for approximately 1.3km before joining the river Quin
Haley Hill Ditch	Main River/ Ordinary watercourse	Haley Hill Ditch begins as an unnamed ditch in Wyddial and flows approximately south past Buntingford where at TL 37327 29896 it changes designation to a main river, before continuing south to its confluence with the Main River Rib
Hunsdon Brook	Main River/ Ordinary Watercourse	The Hunsdon Brook rises as a series of unnamed drains in the high ground above Hunsdon, where below the Hudson Road in Hunsdonbury, after a lake, the Hunsdon Brook becomes a Main River. It then flows predominately south, merging with a series of unnamed drains and flowing through several pools before its confluence with the River Sort north of Roydon (TL 40733 10504).
Little Hormead Brook	Main River	A short stretch of Main river, starting west of little Hormead around Great Hormead Park and fed by unnamed drains in the area, Little Hormead Brook flows predominately west until it meets the River Quin.
Nimney Bourne	Main River	South west of Latchford and north of Bartram's Wood are Bartram's and Newbarns Springs which feed Nimney Bourne. The Nimney Bourne flows predominately south past Nobland Green and Baker's End until Wareside which is changes course west to meet with the River Ash.
Puckeridge Tributary	Main River	Beginning as two parallel tributaries north and south of Kings Wood the Puckeridge Tributaries flow west to their confluence with each other in Puckeridge (TL 38372 23101). They continue as a single watercourse south west to a confluence with the River Rib south of Kents Lane in Standon.

Watercourse name	Classification	Description
River Ash	Main River	The River Ash is a large tributary of the River Lea, which flows predominately south to its confluence with the River Lea north east of Great Amwell at (TL 37742 13044). The River Ash I fed by numerous unanmed drains as well as the ordinary watercourses Fanhams Tributaries and the Nimney Bourne and flows past Brent Pelham, Furneux Pelham, Clapgate, Little Hadham, Much Hadham, Widford.
River Beane	Main River	The River Beane starts out of the district around Roe Green and initially enters the East Hertfordshire District in the north at TL 31068 30335 for approximately 1.2km before leaving west of Luffenhall at Tl 30250 29503. The watercourse renters the district south of Luffenhall where is meanders south past Cromer, Walkern, Aston, Watton at Stone, and Stapleford before flowing north east to its confluence with the River Lea, east of Bengeo, Hertford.
River Lea	Main River	With its source north of Luton outside of the district, the River Lea flows south east and enters the East Hertfordshire District to the south west north of the B158 at TL28187 09939. It flows in an arc in the south of the district through Hertsford and Ware and is joined by several main tributaries including the River Beane, River Rib and River Ash before leaving west of Hoddesdon (TL 39063 09228).
River Mimram	Main River	The River Mimram enters the district north east of Haldens in Welwyn Garden City at TL 25334 14602, flowing south of Tewin to Hertford where it joins the River Lea south of the A119 and Hertingfordbury Road roundabout.
River Quin	Main River	A tributary of the River Rib, which enters the district from the north and flows in a southerly direction to its confluence with the Rib north of Standon.
River Rib	Main River	The River Rib enters north of the district after rising as an unnamed drain in Hay Green and Kelshall outside of the district. It flows predominately south past Buntingford and Standon until east of Thundridge where is changes course west. At Tonwell it meanders south to its confluence with the River Lea.
River Stort	Main River	The River Sort starts north east of Nuthampstead outside of the district boundary. North east of Meesden is where is first enters the district and follows the boundary for approximately 1.2 km before leaving north west of Ford End. It re-enters the district south of Stansted Mountfitchet (TL50057 24125), flowing between New Town, Bishop's Stortford and Hockerill before following the district boundary until its confluence with the River Lea west of Roydon Park.
Stevenage Brook	Main River	The Stevenage Brook enters the district, west of Bragbury End, Broadwater and flows in an approximately westerly direction till the River Beane north west of Watton at Stone.
The Old Bourne	Main River/ Ordinary Watercourse	The Old Bourne flows south from its source on Haymead Hill being fed by several unnamed drains until its confluence with the Dane End Tributary south of Dane End.
NOTE: This table is based on information found within the Environment Agency's Detailed River Network (DRN) database and focuses on key watercourses, therefore not every watercourse is described above, and there may be a number of Ordinary Watercourses within the study area which are not included within this table.		

5.5 Fluvial flood risk

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

The primary fluvial flood risk in East Hertfordshire is along the River Lea and River Stort corridors. The principal urban centres at risk are Hertford, Ware, Stanstead Abbots and Bishop's Stortford. The main tributaries of the River Lea including the River Rib, River Beane, River Ash and River Mimram also present fluvial flood risk to rural communities within the district.

The main locations with associated flood risk in East Hertfordshire are detailed below:

- Hertford: The River Mimram, River Rib and River Beane all converge with the River Lea in Hertford. Flood risk in this area may originate from the River Lea or any of the aforementioned tributaries or a combination of both. Flood risk in Hertford is generally confined to north of the A119, although there are exceptions to this, particularly near the roundabout to the A414/ A119. There are numerous residential and commercial properties within Flood Zone 2 and 3 in Hertford. This includes: properties on Brickendon Lane and Tanners Crescent; properties in the vicinity of the River Mimram-River Lea confluence between Hertingfordbury Road and the river; properties along the River Beane, including those along Molewood Road and Port Vale and the surrounding area; properties in the vicnitiy of Mill Bridge and St Andrew Street; properties around the A414/A119 roundabout including Villiers Street, Fore Street and Market Street; properties between the Ware Road (A119) and the River Lea, including Mead Lane Industrial Estate.
- Ware: Flood risk in Ware is mainly driven by the River Lea, although flooding also occurs to properties along Pastures Ditch which converges with the River Lea just south of Priory Street. The River Lea's Flood Zones affect numerous properties in Ware, including properties to the north of Priory Street and west of Baldock Street; in the Broadmeads area and along Amwell End and Station Road; properties between the High Street and the River Lea; along Star Street, Cross Street, Plaxton Street and Clements Street and buildings in Crane Mead Business Park. To the south of Ware in Great Amwell, properties along Yearlings Close, Furlong Way and Bridle Way are within Flood Zone 2.
- Stanstead Abbots: Large areas of Stanstead Abbots are within Flood Zones 2 and 3 from the River Lea, where there is a broad floodplain. Properties to the west of Amwell Lane including those on Durham Close and Meridian Way and the industrial estate to the north are at risk of fluvial flooding. Properties along the B181, in particular in the High Street area and along Millers Street, South Street and Orchard Close are also within Flood Zones. Properties along Station Road, Hoddesdon Road and Lawrence Avenue and their adjoining cul-de-sacs are also at flood risk.
- Bishop's Stortford: The River Stort/ Stort Navigation flows through the centre of Bishop's Stortford. Properties in the north of Bishop's Stortford, at Stane Close, Bryan Road and Yew Tree Place are within the Flood Zones. Offices at Link Road, properties in the vicinity of the A1250/ Hockerill Street and properties to the west of South Street and South road are in Flood Zone 2. Stortford Hall Park Drain flows through Bishop's Stortford in a westerly direction towards the River Stort. Properties along the Stortford Hall Park Road, Dolphin Way and Cherry Garden are shown within Flood Zone 3.
- Sawbridgeworth: The River Stort/ Stort Navigation and the Sawbridgeworth Brook run through parts of Sawbridgeworth. In the north of Sawbridgeworth, properties along Lawrence Avenue, Northfield Road, Reedwings Way and Saffron Crescent are within Flood Zones. Some properties which lie along the banks of the Sawbridgeworth Brook are also within the Flood Zones.
- Spellbrook: In Spellbrook, properties in the vicinity of the confluence of the Spellbrook tributary and the River Stort are at risk of fluvial flooding.
- Watton at Stone: The River Beane flows along the north-eastern boundary of Watton at Stone. Properties between the High Street and the River Beane are at fluvial flood risk.

- Walkern: The River Beane flows along the eastern boundary of Walkern. Properties along Greenway, Finches End, Winters Lane and Church End are within the Flood Zones.
- Stapleford: Through Stapleford Flood Zone 3 is confined between the River Beane and Stapleford Marsh Drain. However, properties along the High Road and Clusterbolts are within Flood Zone 2.
- Dane End and Sacombe: Properties in Dane End and Sacombe are at fluvial flood risk from the Dane End Tributary which flows through both of these villages.
- Wadesmill: The River Rib and The Bourne, a tributary of the Rib flow through Wadesmill. Properties between The Bourne and the River Rib are within Flood Zone 3 whilst some along Ermine Street are at within Flood Zone 2.
- Barwick: The Barwick Tributary flows through Barwick to join the River Rib to the east of Barwick. Properties in the vicinity of the confluence are at risk of fluvial flooding.
- Puckeridge and Standon: The Puckeridge Tributary flows through Puckeridge to join the River Rib in Standon. Properties in Puckeridge including those in the vicinity of the High Street, Station Road Park Lane and Fishers Mead are with the Flood Zones. Properties in the vicinity of the confluence between the Puckeridge Tributary and the River Rib in Standon are also at risk of fluvial flooding.
- Buntingford: The River Rib flows through the centre of Buntingford. The Flood Zones indicate that although Flood Zone 3 is generally confined, Flood Zone 2 is broader and affects properties through Buntingford which are in the vicinity of the River Rib.
- Chipping: Chipping in the north of East Hertfordshire has a large proportion at flood risk from the River Rib. A large majority of the properties in Chipping are within Flood Zone 3.
- Great Hormead: The Black Ditch flows through Great Hormead and joins the River Quin to the west of the village. Although the Flood Zones are quite confined through Great Hormead there are some properties along the B1038 at fluvial flood risk.
- Little Hadham, Hadham Ford and Much Hadham: The River Ash flows through Little Hadham, Hadham Ford and Much Hadham. Properties are at risk of flooding including those between Oundle Lane and the River Ash in Much Hadham, properties along The Ford in Hadham Ford and properties in the centre of Little Hadham in the vicinity of the A120.
- Clapgate: The River Ash flows past Clapgate, to the north of Little Hadham. There are properties in Clapgate which are within Flood Zone 3.
- Furneux Pelham: The River Ash flows through Furneux Pelham. Properties along Violets Lane are at risk of fluvial flooding.
- Brent Pelham: The River Ash flows through the northern part of Brent Pelham. Properties in the vicinity of the River Ash in Brent Pelham are within Flood Zone 3.

5.6 Surface water flooding

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

5.6.1 Highways Data

Hertfordshire County Council Highways, Operations and Strategy Unit supplied historic flood records since 2011; this data records the frequency, the nature, location and the date of the reported flood incident. A summary of the record of flood incidents supplied by Highways for East Hertfordshire can be found in Table 5-6.

The data shows that 2014 and 2015 have the greatest incidents of reported property and road flooding across the district. In particular, 2014 was warmer and wetter than average for the south-east of England[18] which may account for the notable rise in reported property damage by flooding.

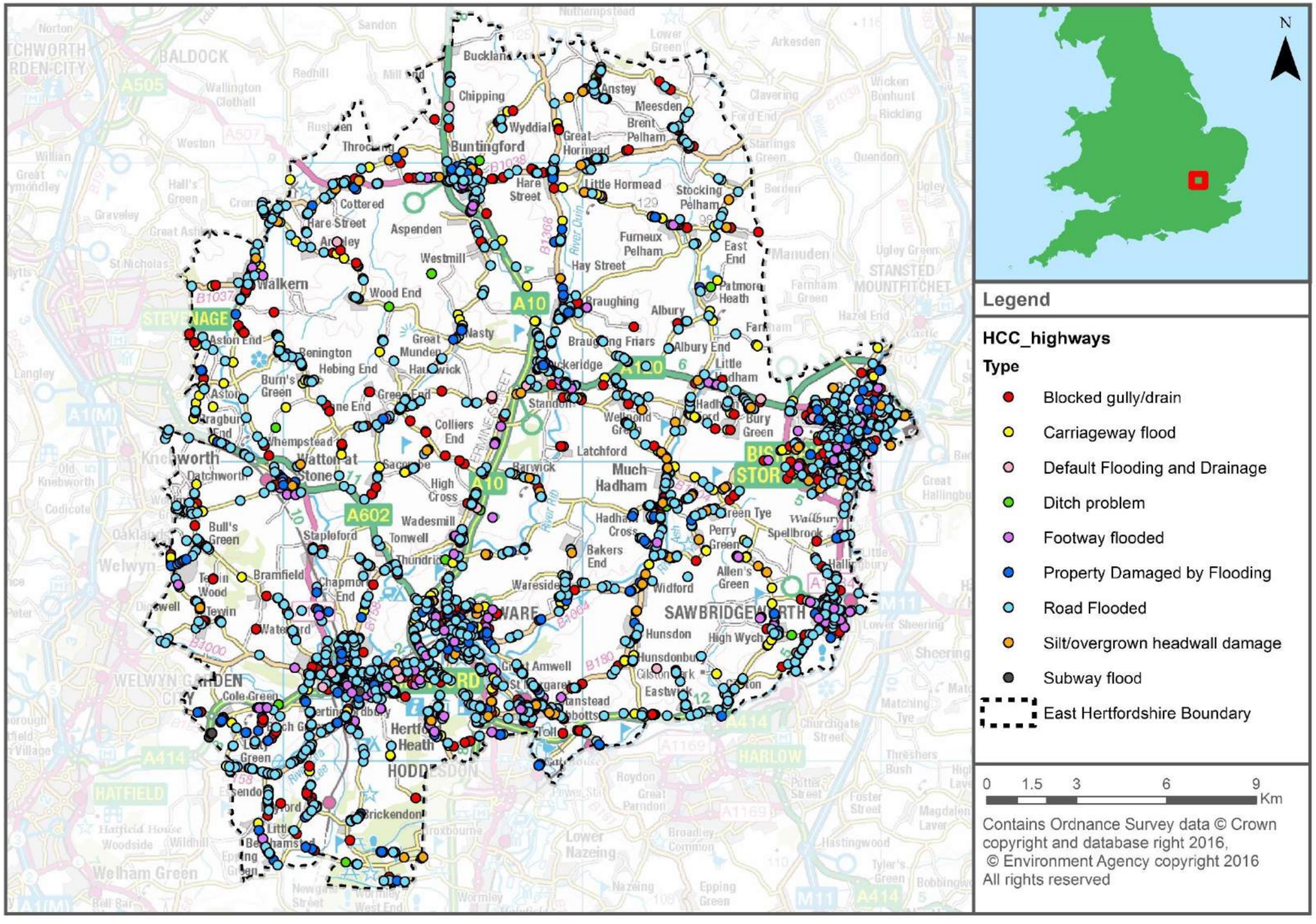
18 Met Office UK Climate Summarise: 2014 Annual

Table 5-6: Hertfordshire County Council Highways - summary of reported flood incidents

Count of Flooding Faults							
Count of Flooding Faults	2011	2012	2013	2014	2015	2016	**Grand Total**
Default Flooding and Drainage	0	0	0	24	16	6	**46**
Silt/overgrown Headwall damage	0	0	1	82	42	24	**149**
Footway flooded	6	31	41	97	87	45	**307**
Blocked gully/drain	196	153	125	0	0	0	**474**
Carriageway flood	115	309	264	0	0	0	**688**
Ditch problem	23	26	32	0	0	0	**81**
Subway flood	1	8	11	10	0	2	**32**
Property Damaged by Flooding	3	30	15	192	86	38	**364**
Road Flooded	0	0	57	986	603	362	**2008**
Grand Total	**344**	**938**	**955**	**1391**	**834**	**477**	**4939**

The location of the reported flood incidents between 2011 and 2016 are shown in Figure 5-5. In general, the majority of recorded incidents of property damage due to flooding occur in the urban areas of Hertford, Ware and Bishop's Stortford. The remaining incidents of property damage occur across the rest of East Hertfordshire, generally to properties along road networks.

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



5.6.2 Updated Flood Map for Surface Water

Mapping of surface water flood risk in East Hertfordshire has been taken from the updated Flood Map for Surface Water (uFMfSW) provided by the Environment Agency (and also found online on the Environment Agency's website). Surface water flood risk is subdivided into the four categories shown in Table 5-7.

Table 5-7: uFMfSW risk categories

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

The updated uFMfSW shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. Those areas at risk of surface water tend to correlate with the topography through East Hertfordshire; the land classified as flat land is vulnerable to surface water flooding whereas the land with moderate to steep slopes are less vulnerable. The uFMfSW maps can be used to determine surface water hotspots. Detailed uFMfSW maps are shown in Appendix D.

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

- There are many watercourses in East Hertfordshire which begin within or just outside of the district. Due the topography of the land, a large majority of the surface water flow paths follow watercourses, for instance through many of the urban areas in the north of East Hertfordshire such as Brent Pelham and Great Hormead.
- There are numerous overland flow routes through the main urban areas of Hertford and Ware. These tend to follow either watercourse networks or road networks. In particular, there are flow routes along the main roads of the A414, A119 and the roads adjoining these. In Ware, surface water flow paths along the road network tend to flow in a southerly direction towards the River Lea. In Hertford, there are areas of ponding on low-lying land, particularly to the south of the railway line between Herford and Ware and in the vicinity of the River Mimram-River Lea confluence.
- In Bishop's Stortford there are also numerous overland flow routes, which follow major and minor roads, including the A1250, Elm Road, Stanstead Road, Southmill Road and Stortford Hall Park. The majority of areas of surface water ponding in Bishop's Stortford occurs within the River Lea floodplain.
- In Buntingford, the majority of the surface water flow paths are along roads such as Baldock Road, Vicarage Road and Station Road. Here surface water flow paths are generally confined to roads and watercourses, although there are areas of ponding of surface water to the north of the town affecting isolated farm buildings.
- In some urban areas, surface water flow paths occur between two watercourses. For example in Puckeridge, surface water flow paths flow between the two branches of the Puckeridge tributary, affecting roads and properties in between. Also in Wadesmill, there are surface water flow paths flow between The Bourne and the River Rib.
- In some areas such as Walkern, surface water flow paths do not appear to follow defined watercourses but small field drains and ditches.
- Little Hadham and Puckeridge are vulnerable to surface water flooding due to areas of ponding on low lying ground.

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

- The overland flows routes noted during the 30-year and 100-year extents are more significant and cause more extensive flooding during the 1,000-year event.
- The majority of the urban areas in the vicinity of the River Lea or its tributaries are shown to be at risk during the 1,000-year event.
- In some urban areas such as Hertford, Sawbridgeworth and Stanstead Abbots, many more new areas are shown to be affected by surface water flooding during the 1,000-year event which were not affected in the 30-year or 100-year events.
- In Hertford, the surface water flood extent during the 1,000-year event around the River Mimram-Lea confluence, north of the A119 and in the vicinity of the railway line between Hertford and Ware is significant.

It is clear that areas of East Hertfordshire are sensitive to surface water flooding and this should be taken into consideration as part of future development. Chapter 7.2.1 discusses surface water management and sustainable drainage systems (SuDS).

5.7 Groundwater flooding

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

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

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

The AStGWF mapping for East Hertfordshire can be found in Appendix E. The AStGWF shows that the areas with the highest susceptibility to groundwater flooding occur in the vicinity of the River Lea and the confluence of its tributaries and along the River Stort corridor. The only areas to have a greater than 75% susceptibility to groundwater flooding in the district are in Hertford and Ware. Generally, areas along the main tributaries of the River Lea have a groundwater susceptibility of between 25% and 50%. Generally, areas of higher ground have a susceptibility of less than 25%.

There have been incidents of historic groundwater flooding in East Hertfordshire which is thought to primarily be caused by the underlying geology. Recorded incidents of groundwater flooding are presented in Section 5.3.2. There may be an implication on the suitability of certain types of SuDS due to the groundwater vulnerability in East Hertfordshire; this is discussed in further detail in Chapter 8.

5.8 Sewer flooding

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

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

Historical incidents of flooding are detailed by Thames Water through their DG5 register. This database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons this data has been supplied on a postcode basis. Data covers all reported incidences as of 12th July 2016. The DG5 register is shown in Table 5-8.

Table 5-8: DG5 Register recorded flood incidents

Post Code	Recorded Flood Incidents	Post Code	Recorded Flood Incidents
AL6 0	4	SG120	4
CM210	6	SG127	8
CM219	16	SG128	18
CM226	1	SG129	6
CM231	1	SG137	4
CM232	14	SG138	1
CM233	16	SG141	2
CM234	2	SG142	10
CM235	8	SG143	21
RH4 3	0	SG2 7	8
SG106	2	SG2 9	1
SG111	3	SG3 6	6
SG112	4	SG9 9	13
Total: 179			
Note: Based on information provided on 12/07/16			

The DG5 register indicates a total of 179 recorded flood incidents in the East Hertfordshire District. The more frequently flooded postcodes are SG14 3, with 21 records, followed by SG12 8 with 18 records. These two postcodes are located within the areas of Hertford and Ware.

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

increase the capacity of the network. As such the sewer flooding flood risk register is not a comprehensive 'at risk register'.

5.9 The impact of climate change in East Hertfordshire

Climate change mapping has been provided in Appendix C. The effect tends to be an increase in the mapped flood extent. Smaller watercourses in the study area tend to be in areas of steeper topography with quite confined floodplains, and in these cases increases in flow do not result in a significant increase in flood extent.

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

Chapter 10 provides further details on climate change for developers, as part of the FRA Guidance.

5.9.1 Climate change mapping methodology

For this SFRA update, the Environment Agency provided hydraulic models for watercourses within East Hertfordshire where detailed studies had been undertaken. Three scenarios were modelled to reflect the three climate change allowances for the '2080s' timeframe in the Thames River Basin District and i.e. 25%, 35% and 70% allowances.

For the Level 2 assessment, JFlow® modelling was used at sites which showed drains going through them on the OS mapping, but where they were not represented in the Environment Agency's Flood Zones, applying the relevant climate change factor to the 100-year event. JFlow® is JBA's proprietary 2D modelling software. A technical summary of how JFlow® works and how it has been used for this SFRA is provided in Appendix I.

The climate change modelling has been undertaken for the 100-year defended scenario, scaled up to the appropriate climate change percentage and therefore takes account for defences within the district. The modelling has been undertaken to assist the council with the preparation of their Local Plan. Developers will need to undertake a detailed assessment of climate change as part of the planning application process when preparing FRAs.

5.9.2 General impacts

The 2009 Hertfordshire Climate Change Scoping Study[19] details some of the general risks relevant to the Hertfordshire as a result of climate change. Those risks relating to flood risk and drainage are as follows:

- Increased levels of fluvial flooding which may affect the location and scale of new development and the associated drainage and sewerage schemes.
- A need to increase the capacity of wastewater treatment plants and sewers;
- Reduced rainfall may increase the burden of water resources
- Increased risk of subsidence on clay soils due to greater shrink and swell activity from prolonged dry periods and localised flooding.

5.9.3 Fluvial and pluvial flooding

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

The impact of an event with a given probability is also likely to become more severe. For example, as water depths, velocities and flood hazard increase, so will the risk to people and property. Although qualitative statements can be made as to whether extreme events are likely to increase

19http://www.eastherts.gov.uk/media/14459/Herts-Climate-Change-Scoping-Study/PDF/Herts_Climate_Change_Scoping_Study_September_2009.pdf

or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of the localised impact of these changes.

5.9.4 Groundwater

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

5.10 Cumulative impact of development and cross-boundary issues

5.10.1 Cumulative impact

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

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

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

5.10.2 Cross-boundary issues

Flood Risk

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

- Broxbourne Borough Council
- Epping Forest District Council
- North Hertfordshire District Council
- Stevenage Borough Council
- Welwyn Hatfield Borough Council
- Uttlesford District Council
- Harlow District Council

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

The topography of the study area means that a large number of the watercourses rise either within East Hertfordshire or within the neighbouring authority administrative areas including Welwyn Hatfield, Stevenage, North Hertfordshire, Uttlesford, and Harlow. Such neighbouring authorities have the potential to affect flood risk within East Hertfordshire.

The watercourses within the study area generally flow into the River Lea network and south, out of the study area. Therefore, the neighbouring authorities to the south of East Hertfordshire i.e. Broxbourne and the LVRPA may potentially be affected by flood risk within East Hertfordshire.

Depending on the location, size and nature of development within East Hertfordshire, neighbouring authority administrative areas and the LVRPA, there is the potential to increase the impermeable area at the development site and to increase runoff entering nearby watercourses. However; conditions imposed by East Hertfordshire District Council, neighbouring authorities and the LVRPA 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 on neighbouring authorities and the LVRPA that consideration is given to the wider catchment implications of drainage mitigation measures, rather than just assessing immediate local effects.

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 therefore produced River Basin Management Plans describing how the WFD will be achieved. All waterbodies have to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline.

Development or agriculture in the upper catchments of watercourses that flow across boundaries into East Hertfordshire can potentially impact on the quality of water of watercourses within the study area. 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 Ecological, Hydromorphological and Chemical Status of the waterbody and the status objectives. Opportunities to improve the status of watercourses should also be considered.

6 Flood Defences and Assets

6.1 Flood defences

A number of flood alleviation schemes (FAS) have been investigated and commissioned within East Hertfordshire.

Flood alleviation schemes identified within the SFRA area may involve formal defences, initiatives to improve drainage, and/or land management to reduce the risk of high velocity overland surface runoff.

The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is a factor that needs to be considered as part of the risk based sequential approach and, in light of this, whether possible site allocations for developments 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.

6.1.1 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 East Hertfordshire 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 the 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.

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

Standard of Protection

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

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

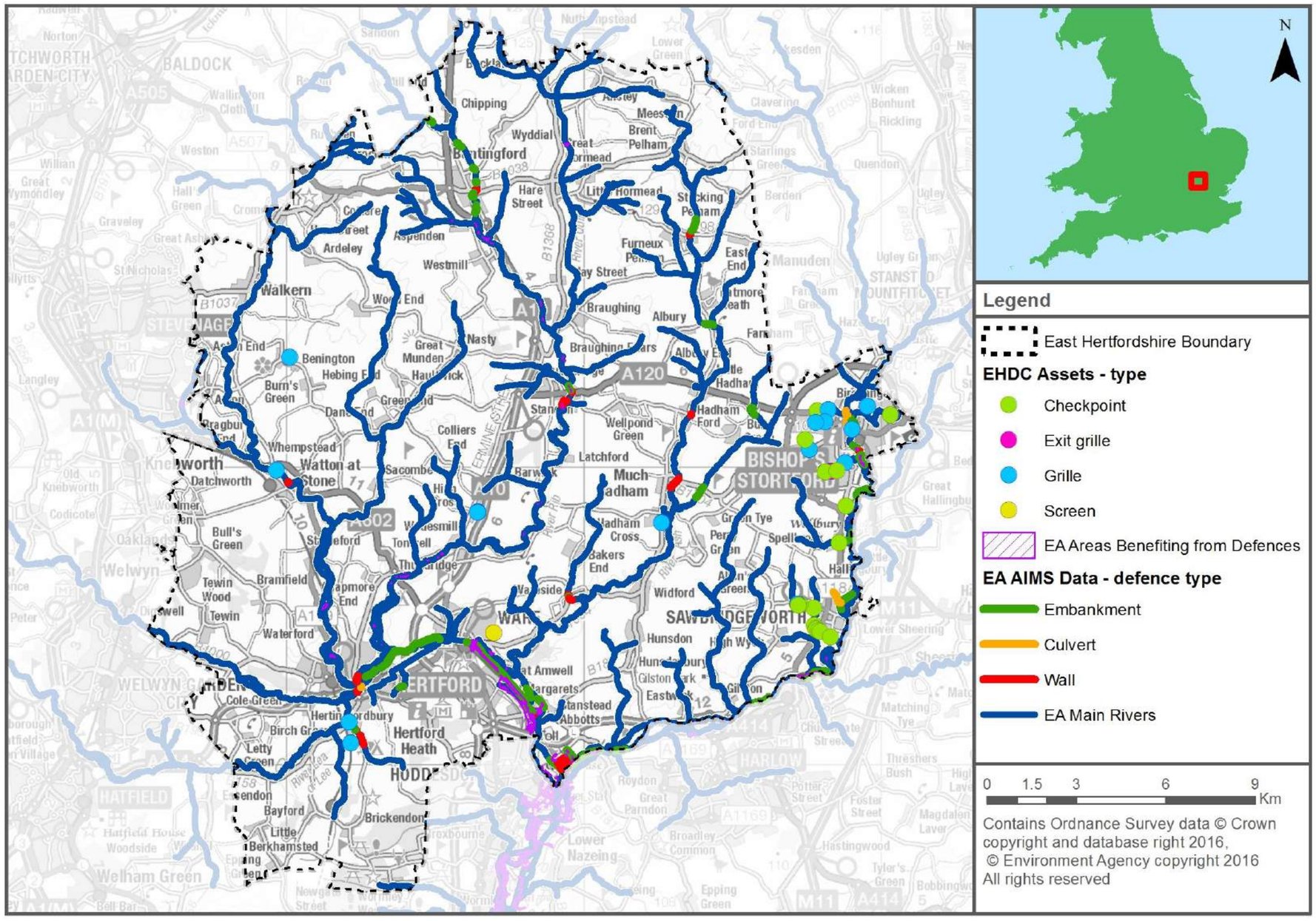
6.2 Overview of existing flood defences

An overview of existing flood defences has been undertaken using the Environment Agency's Asset Infrastructure Management System (AIMS) data, the Environment Agency Areas Benefiting from Defences dataset and East Hertfordshire District Council's 'grilles, checkpoints and screens' dataset.

Figure 6-1 provides an overview of existing flood defences in East Hertfordshire. The majority of the flood defences are primarily located in Hertford, Ware and Bishops Stortford; an overview of the flood defences at these locations is summarised below.

It should be noted that the standard of protection listed refers to the design standard; the actual standard of protection provided by the defence may have decreased, for example due to deterioration in condition or increases in flood risk due to climate change.

Figure 6-1: Flood defences in East Hertfordshire District

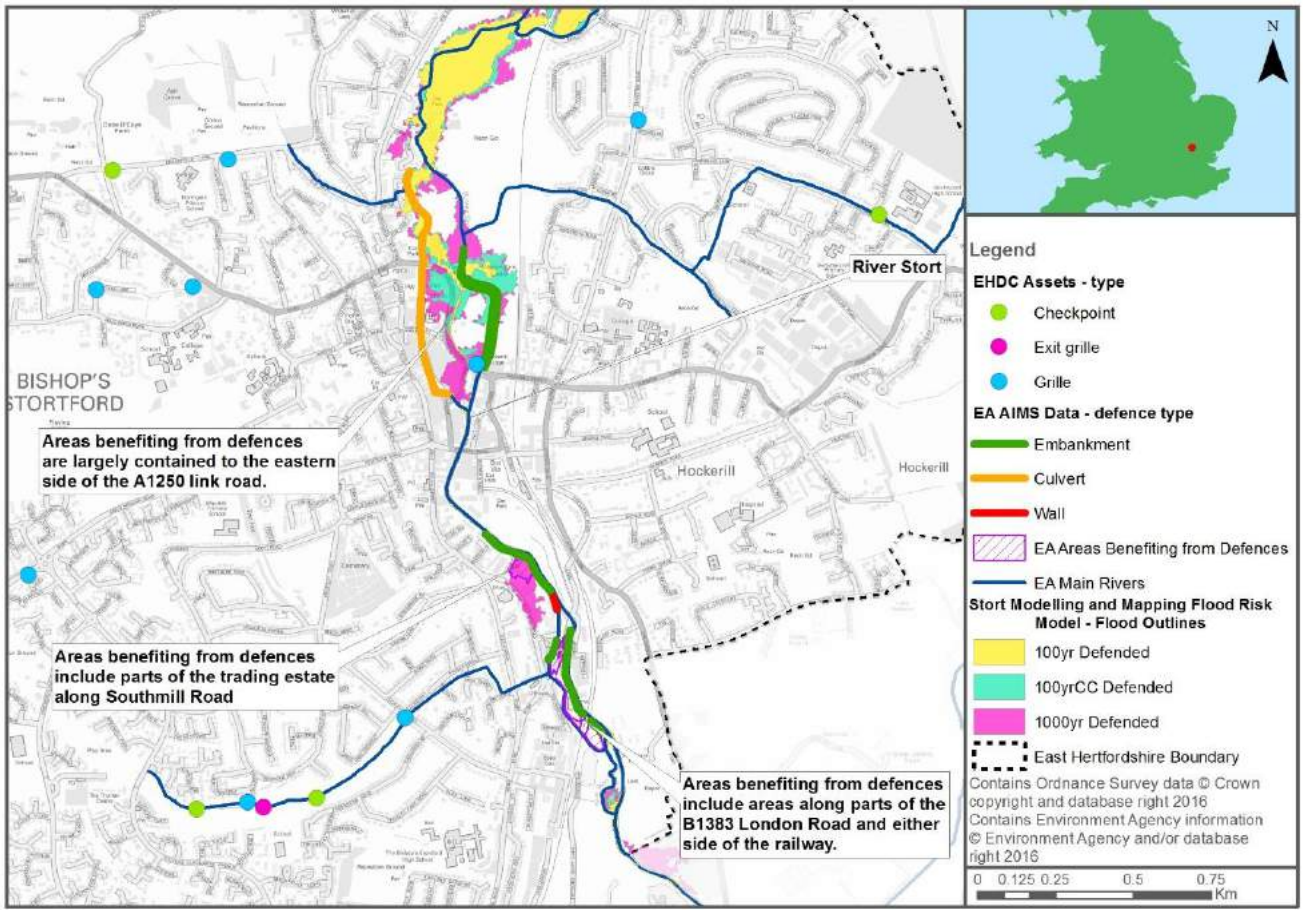


6.2.1 Bishop's Stortford

Parts of Bishop's Stortford, located in the east of East Hertfordshire District, benefit from flood defences (see Figure 6-2). There are a series of embankments, with a combined length of ~2.1km, providing between a 5-year and 1,000-year design standard of protection against fluvial flooding from the River Stort. All embankments are privately maintained. There is also a ~42m flood wall, maintained by the Environment Agency, providing a 1,000-year design standard of protection. The Environment Agency AIMS dataset also shows that there is a ~785m long culvert, maintained by the local authority, which provides a 1,000-year design standard of protection.

The defended model flood outlines shown in Figure 6-2 are taken from the River Stort Modelling and Mapping Flood Risk Study (2010). Note, the climate change results did not use the new climate change allowances.

Figure 6-2: Bishop's Stortford Flood Defences



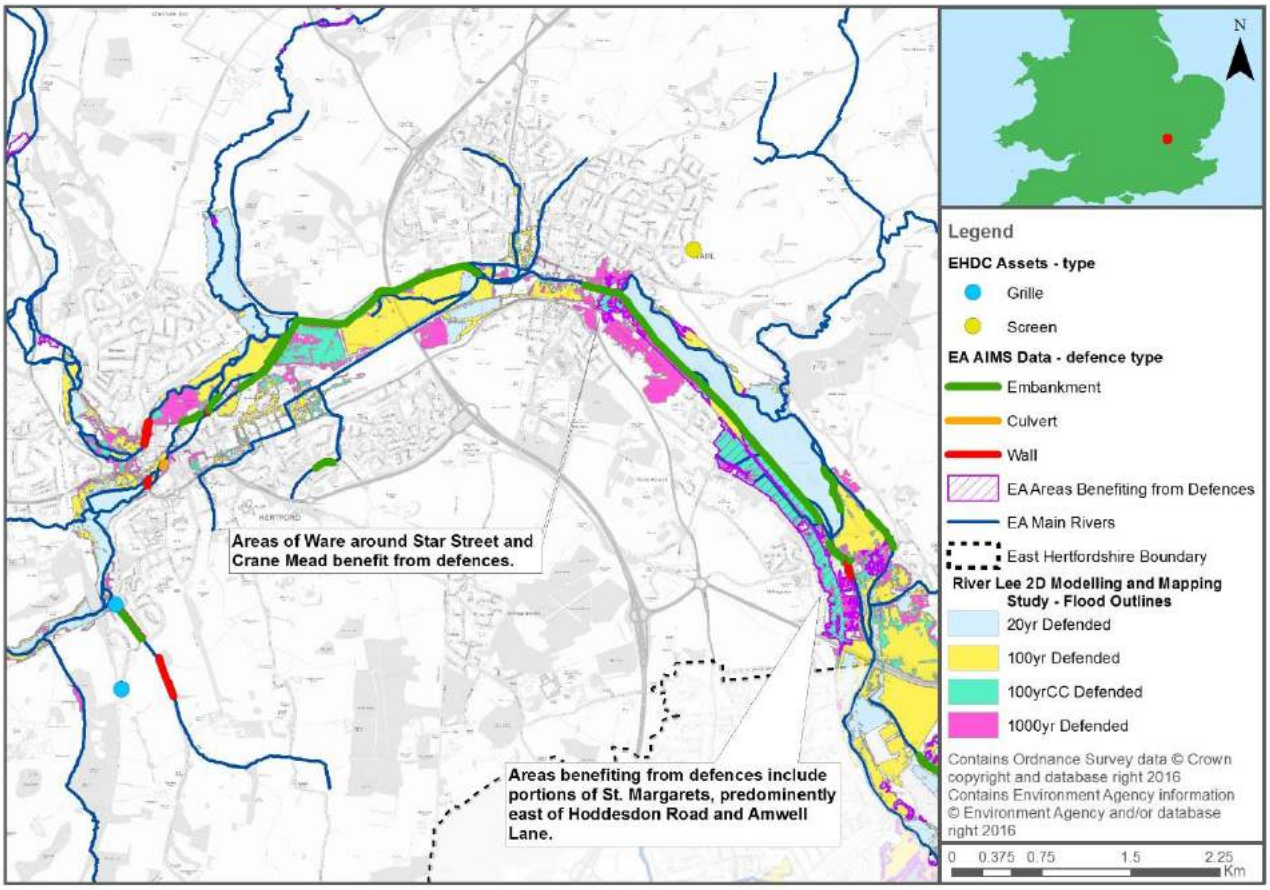
6.2.2 Hertford and Ware

The settlements of Hertford and Ware, located in the south of East Hertfordshire District, benefit from flood defences (see Figure 6-3). In Hertford, there are a series of embankments with a combined length of ~3.2km, providing between a 2-year and 20-year design standard of protection against fluvial flooding from the Brickendon Brook and the River Lea. Furthermore, there is a series of flood walls, with a combined length of ~0.5km, providing between a 2-year and 100-year design standard of protection against fluvial flooding from the Brickendon Brook, the River Beane and the River Lea. There is one ~37m long culvert, providing a 100-year design standard of protection against fluvial flooding from the River Lea. The assets are maintained by a combination of the Environment Agency, local authority and private owners.

In Ware, there are a series of embankments with a combined length of ~3.9km, providing between a 2-year and 200-year design standard of protection against fluvial flooding from the River Lea and Stanstead Mill Stream. A ~127m long flood wall, provides a 2-year design standard of protection against flooding from the River Lea. All assets are privately maintained. Ongoing investigations seeking to reduce flood risk to Stanstead Abbots are proposed; these are discussed further in Section 6.2.3.

The defended modelled flood outlines shown in Figure 6-3 are taken from the River Lee 2D Modelling and Mapping Study (2014). Note, the climate change results did not use the new climate change allowances.

Figure 6-3: Hertford and Ware Flood Defences



6.2.3 On-going Flood Alleviation Schemes

The Environment Agency has provided information on on-going Flood Alleviation Schemes in East Hertfordshire including:

1. **A120 (Little Hadham) Bypass and FAS:** Proposals have been put forward for a A120 bypass route around Little Hadham, East Hertfordshire. With the proposed bypass, there is the potential to build in measures to help reduce the risk of flooding from the River Ash and its tributaries, the Albury and the Lloyd Taylor Drain. Such features include using highway embankments to temporarily hold back flood water (i.e. a flood storage area but without any excavation) where the road is above existing ground levels and diverting the Lloyd Taylor Drain around the edge of the housing in Lloyd Taylor Close. The Environment Agency and Hertfordshire County Council are progressing with plans for these flood alleviation measures, with Arup involved in the highways engineering.
2. **Stanstead Abbotts:** Stanstead Abbotts Drain, a tributary of the River Lea, is the main source of fluvial flooding to Stanstead Abbotts. During the winter of 2013/14, significant flooding impacted the area on four separate occasions. A number of measures have been proposed to provide protection following an initial assessment of flood risk to the area. The various options have been shortlisted based on their technical viability, practicality and economic potential. These options will be appraised in detail during the next stage including a full assessment of residential and non-residential damages and detailed options economic assessment.
3. **Furneux Pelham:** Following an initial assessment on flood risk in Furneux Pelham from the River Ash, a number of measures have been proposed to provide protection to properties adjacent to the River Ash which have experienced flooding in recent years. These options have been shortlisted based on their technical viability, practicality and economic potential. Options will be appraised in detail during the next stage including a full assessment of residential and non-residential damages and detailed option economic assessment.

6.2.4 Future flood defences

The future of flood defences in East Hertfordshire is discussed in the following documents:

- Thames River Basin Flood Risk Management Plan, 2015 (see Section 2.11.1)
- Lower Lee Flood Risk Management Strategy, 2013 (see Section 2.8)
- Hertfordshire County Council Local Flood Risk Management Strategy, 2011 (see Section 2.3.2)
- River Thames Catchment Flood Management Plan, 2009 (see Section 2.7)

All of the above documents refer to the recommendations made in the 2013 Lower Lee Flood Risk Management Strategy regarding the future of flood risk management activities in the Lower Lee catchment (the recommendations are detailed in Section 2.8). The vast majority of the recommended measures for watercourses in East Hertfordshire revolve around a commitment to maintain, refurbish and replace existing flood defences and other flood risk management assets such as the Hardmead and Stanstead sluices.

6.3 Residual flood risk from defences

6.3.1 Flood defences

The residual risk of flooding in an extreme flood event or from failure of defences should be carefully considered. The definition of residual risk is discussed in Section 3.4.2. The residual risk can comprise:

- 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.
- 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.

Parts of East Hertfordshire rely on formal flood defences for protection against fluvial flooding; these are predominantly located along the River Lea in Hertford and Ware. Planned defence works will further increase the existing standard of protection offered to certain communities and will protect new parts of East Hertfordshire from fluvial flooding. Consequently, there are areas vulnerable to rapid inundation in the event of a breach / failure.

Any inundation resulting from a failure in raised embankments (which are not formal flood defences and no areas of development are currently indicated as benefiting from, or being reliant upon, these structures), it would be unlikely that flooding would extend beyond the Flood Zones or impact upon any existing development, or any future built development.

The impact of a breach or impoundment failure is dependent on the location, the magnitude of the event, and the type of breach. Siting of any built development downstream within close proximity should be avoided unless it can be demonstrated that flood risks due to rapid inundation may be eliminated or adequately mitigated. The Environment Agency should be consulted at site-specific development level for advice on breach/ overtopping parameters, if it is a requirement to model such an event.

6.3.2 Flood infrastructure maintenance

There is potential for the risk of flooding to increase in areas where flood alleviation measures are not maintained regularly and/or adequately. Breaches in raised flood defences are most likely to occur where the defence has been degraded or not maintained to its design standard. Drainage infrastructure in urban areas can also frequently become blocked with debris which can lead to blockages in culverts and backing up of a watercourse. It is therefore essential that all flood alleviation schemes and hydraulic structures are regularly maintained to their specified design standard. It is the responsibility of the riparian owner to maintain the watercourses or defences to a suitable standard. The Local Authority or Environment Agency has permissive powers to act should the riparian owner not satisfy their maintenance requirements.

6.4 LLFA Asset Register

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

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

Table 6-1: LLFA Asset Register within East Hertfordshire

Asset No.	Location	X	Y	Asset Type	Asset Description	Water source
01EHDC	Acorn Street, Hunsdon (outside Spellers House)	541680	213330	Culvert	Highways culvert	Unnamed watercourse
02EHDC	Robins Nest Hill junction with Lower Hatfield Road (B158)	529508	209585	Culvert	Highways culvert	Unnamed watercourse
The data shown above was extracted from the LLFA asset register. This list of structures which have a significant impact on local flood risk was last updated in 24 March 2015.						

7 Flood risk from artificial waterbodies

7.1 Flood risk from canals

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

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

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

7.1.1 Overtopping

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

7.1.2 Breach

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

- Culvert collapse.
- Overtopping.
- Animal burrowing.

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

7.1.3 Canals in East Hertfordshire

There is one canal within East Hertfordshire; the River Lee Navigation Channel which starts in Hertford, flowing parallel to the main River Lea channel, and through Ware and Stanstead Abbotts before leaving the study area to the borough of Broxbourne. Within the study area, the River Lee Navigation Channels is shown to be connected to the River Lea and as such would interact and has a potential to become a flow path, if the canal were overtopped or breached.

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

7.1.4 Navigational channels / other modified watercourses

River Stort (navigational)

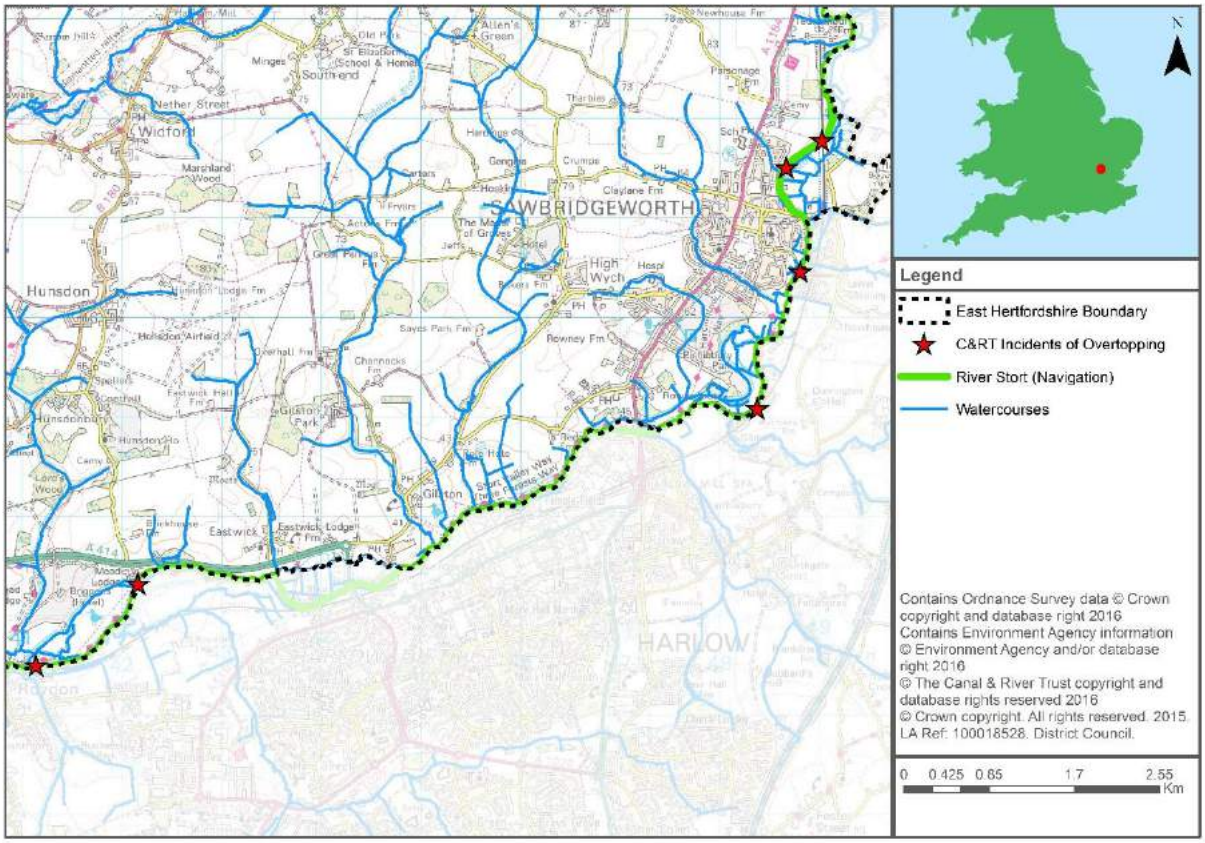
The River Stort is navigable throughout much of its course in East Hertfordshire. The level of water in the River Stort navigational channel is normally controlled by the level and size of weirs. When surface water enters the navigational channel, the level of water rises. The water level may then reach a point in which it discharges from the navigational channel through control structures, such as weirs. Should the capacity of these control structures be exceeded, or should they become blocked, overtopping may occur.

The Canal and River Trust, the navigation authority for the River Stort, have supplied records of overtopping incidents along this watercourse in East Hertfordshire which are displayed in Figure

7-1. 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 seven incidents of overtopping; three of the incidents were recorded in April 2012 and a further three incidents were recorded in November 2012. The majority of 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.

For proposed site allocations in the emerging District plan and / or 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 7-1: River Stort Navigation – incidents of overtopping



The New River

The New River is not a river but a water supply aqueduct, bringing drinking water from Hertfordshire to North London[20]. The New River is operated by Thames Water and regulated by sluice gates and boreholes which enable surplus treated water to be stored in chalk aquifers and pumped into the New River when extra water is required. As the New River is regulated, the flood risk posed by it is considered to be low. However, through St. Margaret's, the New River is perched above land from its right bank.

For proposed site allocations in the emerging District plan and / or development applications located around the vicinity of the New River, it is recommended that overtopping analysis, and where perched, a breach analysis is considered as part of a site-specific FRA to establish the residual risk to the development.

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

7.2 Flood risk from reservoirs

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

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

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

The risk of inundation to East Hertfordshire 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.

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?
- Developers should 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.

There are four reservoirs located within East Hertfordshire, including Lancaster Lake, Bomb Pond, Rye Meads Lagoons 10, 12, 14 & 16 and Bonnington's Lake.

There are also a number of reservoirs outside of the area whose inundation mapping is shown to affect East Hertfordshire, as detailed in Table 7-1 and shown in Appendix F.

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

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

Reservoir	Location (grid reference)	Reservoir owner	Environment Agency area	Local Authority	Reservoir located in East Hertfordshire?
Lancaster Lake	546691, 218404	Collins	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	Yes
Bomb Pond	547382, 218191	Collins	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	Yes
Shrubbs Farm Reservoir (ID395)	551864, 213504	Liddell	Environment Agency - Hertfordshire and North London	Essex County Council	No
Rye Meads Lagoons 11, 13, 15 & 17	538634, 209944	Thames Water Ltd	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	No
Rye Meads Lagoons 10, 12, 14 & 16	539232, 209756	Thames Water Ltd	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	Yes
Hatfield Forest Lake	554187, 219751	The National Trust	Environment Agency - Hertfordshire and North London	Essex County Council	No
Bonnington's Lake	541115, 212982	Dixon	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	Yes
Balancing Pond C	554966, 221427	Stansted Airport Ltd	Environment Agency - Hertfordshire and North London	Essex County Council	No
Aston Valley FSA	526581, 221696	Environment Agency	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	No
Ridlins Wood FSA	526493, 222277	Environment Agency	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	No
Wychdell FSA	526557, 221605	Environment Agency	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	No
Brocket Hall Lake	521471, 212579	Brocket Hall Estate	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	No
Luton Hoo Lake Lower	511645, 218603	Luton Hoo Park Ltd	Environment Agency - Hertfordshire and North London	Central Bedfordshire Council	No
Fairlands Lake	525211, 223760	Stevenage Leisure Ltd	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	No
The Broadwater	525098, 209795	The Gasgoine Cecil Estates	Environment Agency - Hertfordshire and North London	Hertfordshire County Council	No

7.2.1 Residual Risk from Reservoirs

In terms of impounding structures, considered in Section 7.2, although the probability of occurrence is low, there is the potential for the structures to fail suddenly, releasing significant volumes of floodwater within a short duration towards downstream areas. Consequences downstream are relatively high if there is residential and commercial development, and critical infrastructure. The terrain is also quite flat and low lying along the River Lea corridor, so this increases the potential for the floodwaters to spread wider.

Impoundments which fall under the Reservoirs Act are inspected and regularly maintained, and therefore the likelihood of failure is considered to be very low.

If the site is shown to be at risk of a reservoir failure (i.e. the site is located in the reservoir flood maps) it is recommended that at a site-specific development level that:

- The reservoir owners are contacted to confirm the Reservoir Risk Designation (if determined) and the inspection and maintenance regime of the reservoir.
- Consideration is given to the impact of a breach to persons and property on site.
- Where deemed necessary, consideration of a reservoir breach is included within a Flood Warning and Evacuation Plan (e.g. on site containment).
- If necessary, the Environment Agency are consulted for advice.

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8 Surface water management and SuDS

8.1 What is meant by Surface Water Flooding?

For the purpose of this SFRA, the definition of surface water flooding is that set out in the Defra SWMP guidance. Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall in urban areas, in addition to surface water runoff in rural areas, for example from steep slopes along the edge of the district.

Surface water flooding includes:

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

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

From April 2015 local planning policies and decisions on planning applications relating to major development 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 Hertfordshire 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, as defined in the Town and Country Planning (Development Management Procedure) (England) Order 2015, are considered to be where:

- The number of dwelling houses to be provided is 10 or more; or
- The development is to be carried out on a site having an area of 0.5 hectares or more and the number of dwelling houses to be constructed is not known;
- The provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or
- Development carried out on a site having an area of 1 hectare or more.

Minor applications are defined to be:

- Up to a maximum of 9 dwelling houses; or
- Under 0.5ha; or
- 999m^2 of non-residential property.

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 Non-Statutory Technical Standards[21] and should take into account design and construction costs.

8.3 Sustainable Drainage Systems (SuDS)

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. It is often found that SuDS are cheaper to construct and maintain that traditional piped drainage solutions, and a well-designed SuDS system can increase property values.

SuDS can take many forms, and can therefore be designed to fit into the majority of spaces within a development, either as a new-build or retrofit solution.

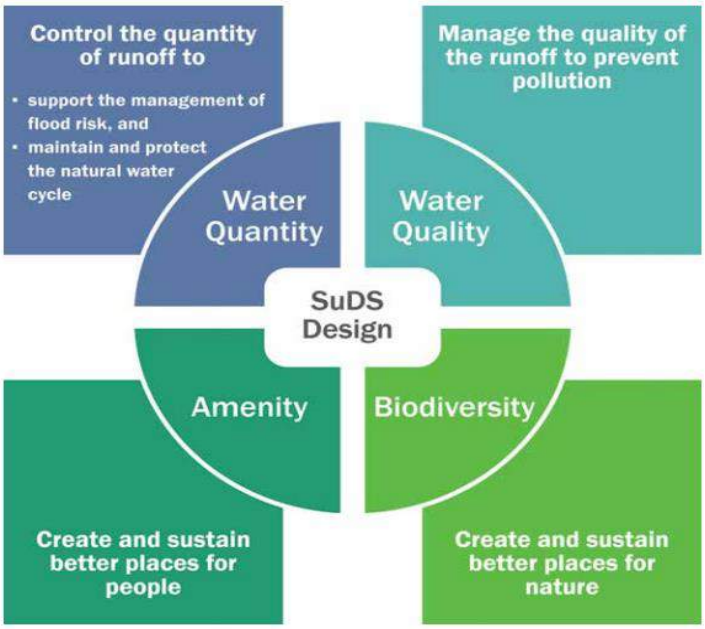
The correct use of SuDS also allows developments to counteract the negative impact that urbanisation has on the water cycle by promoting infiltration and replenishing ground water supplies. SuDS when properly designed can improve the quality of life within a development offering addition benefits such as:

- Improving air quality
- Regulating building temperatures
- Reducing noise
- Providing education opportunities

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.

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 8-1.

Figure 8-1: Four pillars of SuDS design



Source: The SuDS Manual (C753)

[21] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

8.4 Types of SuDS Systems

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (

Table 8-1). The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA) e.g. the CIRIA SuDS Manual C753 (2015).

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

SuDS Technique	Flood Reduction	Water Quality Treatment & Enhancement	Landscape and Wildlife Benefit
Living roofs	✓	✓	✓
Basins and ponds	✓	✓	✓
Constructed wetlands	✓	✓	✓
Balancing ponds	✓	✓	✓
Detention basins	✓	✓	✓
Retention ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices	✓	✓	✓
Soakaways	✓	✓	✓
Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains	✓	✓	
Gravelled areas	✓	✓	
Solid paving blocks	✓	✓	
Porous pavements	✓	✓	
Tanked systems	✓		
Over-sized pipes/tanks	✓		
Storm cells	✓		

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

The SuDS hierarchy establishes a preference for certain types of SuDS systems. The aim should be to discharge surface water run off as high up the hierarchy of drainage options as reasonably practical. The hierarchy of drainage which should be considered is:

1. Into the ground (infiltration)
2. To a surface water body
3. To a surface water sewer, highway drain, or another drainage system
4. To a combined sewer.

8.4.1 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[22] the following good practice is implemented in the treatment process:

22 C753 CIRIA SuDS Manual (2015)

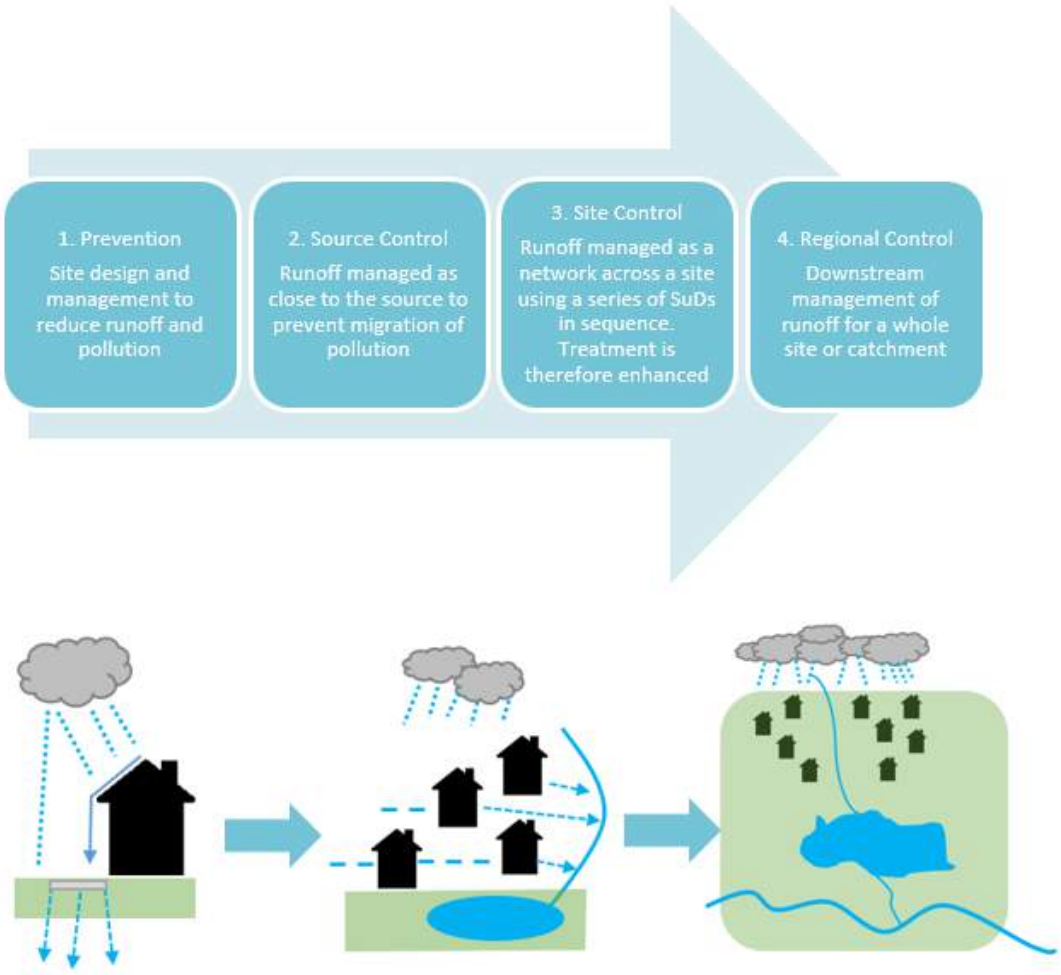
1. **Manage surface water runoff close to source:** This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area.
2. **Treat surface water runoff on the surface:** This allows treatment to be delivered by vegetated and sources 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.

8.4.2 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 8-2). The number of treatment stages required within the Management Train depends primarily on the source of the runoff and the sensitivity of the receiving waterbody or groundwater. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

Figure 8-2: SuDS management train



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 of 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, helping conform to the water quality objectives of the Water Framework Directive.

8.4.3 SuDS design considerations

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

- Topography, e.g. steep or shallow slopes
- Local Geology and soil permeability
- Development Density and available land area
- Former site use, e.g. ground instability, contaminated soils
- Location of existing and proposed services and utilities
- Groundwater conditions
- Proposed site use
- Landscape Character of the development and its surroundings
- Future adoption and maintenance arrangements

Table 8-2 details some considerations for the design of SuDS.

Table 8-2: SuDS Design Considerations

Consideration	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. If the gradient is still too shallow pumped systems can be considered as a last resort.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and dictate 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.

8.5 Hertfordshire SuDS Guidance

8.5.1 Hertfordshire County Council's SuDS Policy Statement

Hertfordshire County Council produced a SuDS policy statement in March 2015[23]. This is a guidance document which outlines the anticipated requirements of Hertfordshire County Council for developers needing to gain approval for drainage schemes. It involves three stages:

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

These stages are outlined below:

Conceptual Drainage Design

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

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

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

Outline Drainage Proposal

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

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

Additionally, they should be accompanied by the following:

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

Detailed Drainage Proposal

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

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

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

Additional Design Criteria

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

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

- LLFA Summary Guidance for developers[24]
- SuDS Design Guidance for Hertfordshire[25]

8.5.2 Hertfordshire County Council SuDS Design Guidance (2015)[26]

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

8.5.3 Hertfordshire County Council Summary Guidance for developers

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

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

This is now an adopted policy within the LFRMS, therefore the LPA, other stakeholders and developers must have due regard to these policies. The policies are not just for guidance. Hertfordshire County Council have produced a separate technical guidance document and also a 'developer's checklist' which can all be found online, as shown below.

24 LLFA Summary Guidance for developers: http://www.hertsdirect.org/docs/pdf/g/developerguide.pdf

25 Hertfordshire County Council SuDS Design Guidance for Hertfordshire (2015): http://www.hertsdirect.org/docs/pdf/s/hertssudsguide.pdf

26 HCC SuDS Design Guidance (2015): http://www.hertsdirect.org/docs/pdf/s/hertssudsguide.pdf

Relevant web links:

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

8.6 Additional SuDS Guidance

8.6.1 C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015)[27] 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 East Hertfordshire's SuDS Guidance.

8.6.2 Non-Statutory Technical Guidance, Defra (March 2015)

Nom-Statutory Technical guidance has been developed by Defra to sit alongside PPG to provide non-statutory standards as to the expected design and performance for SuDS.

In March 2015, the latest guidance was released providing amendments as to what is expected by the LPA to meet the National standards. The guidance provides a valuable resource for developers and designers outlining peak flow control, volume control, structural integrity of the SuDS, and flood considerations both within and outside the development as well as maintenance and construction considerations. It considers the following: flood risk inside and outside the development, peak flow, volume control, structural integrity, designing for maintenance considerations and construction. The LPA will make reference to these standards when determining whether proposed SuDS are considered reasonably practicable.

8.7 Other surface water considerations

8.7.1 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 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

27 C753 CIRIA SuDS Manual (2015):
http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

- **Combined groundwater vulnerability map:** this map displays both the vulnerability and aquifer designation status (principal or secondary). The aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

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

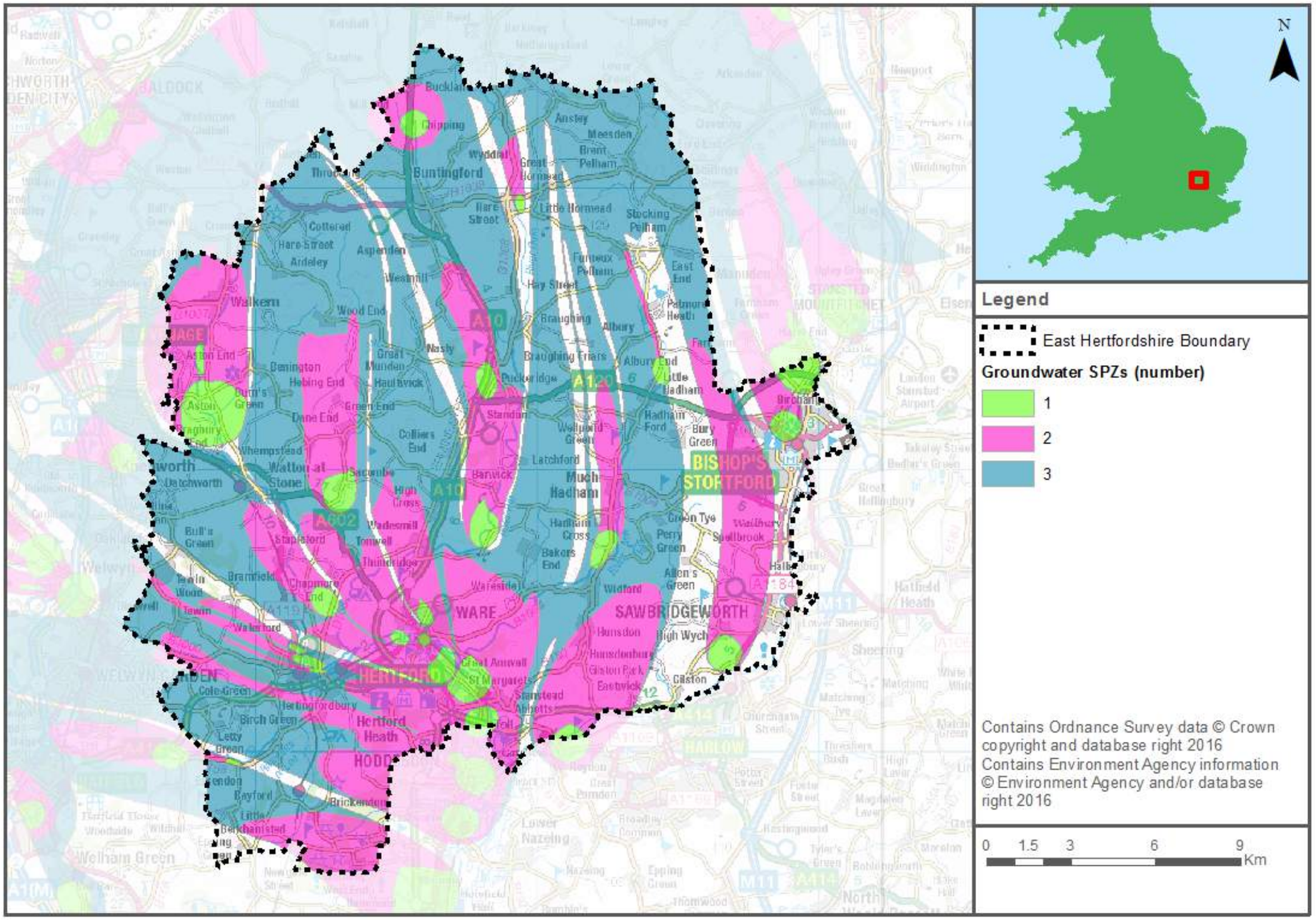
8.7.2 Groundwater Source Protection Zones (GSPZ)

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

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

The location of the Groundwater SPZs in relation to the East Hertfordshire district are shown in Figure 8-3. The majority of the district is located within a Groundwater Source Protection Zone. This is primarily Zone 3 however; the southern part of the district, particularly around Hertford, is located within Zone 2. Isolated areas are in Zone 1. Depending on the nature of the proposed development and the location of the development site with regards to the SPZs, restrictions may be placed on the types of SuDS appropriate to certain areas. Any restrictions imposed on the discharge of site generated runoff by the Environment Agency will be determined on a site by site basis using a risk-based approach.

Figure 8-3: Groundwater Source Protection Zones



8.7.3 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 East Hertfordshire District is classed as a surface water NVZ. Northern parts of the study area including the Buntingford and land east of Stevenage are located within the groundwater NVZ.

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9 Flood Warning and Emergency Planning

9.1 Flood emergencies

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

Emergency planning and flood risk management links

- 2004 Civil Contingencies Act
- DEFRA (2014) National Flood Emergency Framework for England
- Government guidance for public safety and emergencies

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.

9.2 Existing Flood Warning Systems

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

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

It is the responsibility of individuals to sign-up this service, in order to receive the flood warnings via FWD. Registration and the service is free and publicly 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.

9.2.1 East Hertfordshire Flood Alert and Warning Areas

There are currently 25 Flood Alert Areas covering significant parts of the district. There are 22 Flood Warning Areas (FWAs); these tend to cover the River Lea and its principal tributaries including the Dane End Tributary, River Rib, River Mimram, River Beane, River Ash and River Stort.

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

Table 9-1: Environment Agency Flood Warnings Explained

Flood Warning Symbol	What it means	What to do
	**Flood Alerts** are used to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early preparations. It is issued earlier than a flood warning, to give customers advice notice of the possibility of flooding, but before we are fully confident that flooding in Flood Warning Areas is expected.	✓ Be prepared to act on your flood plan ✓ 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

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

9.3 Lead times and onset of flooding

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

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

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

9.4 Managing flood emergencies - local arrangements

9.4.1 Emergency Planning

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

9.4.2 East Hertfordshire District Council's role

East Hertfordshire District Council is subject to the full set of duties, as a Category 1 responder under the CCA. The duties include preparing emergency plans and the assessment of local risks to inform emergency planning; the Council has procedures and plans, internally and as part of the wider partnership with the LRF, to manage flood emergencies.

East Hertfordshire District Council are not obliged to supply sandbags; properties at risk of being flooded are advised to consider keeping empty sandbags and sand / earth. Such materials can be obtained from a local builder's merchants or a DIY store. The Environment Agency have produced guidance on how use sandbags for property flood protection which can be viewed on their website.

East Hertfordshire District Council's website contains guidance advice on what to do if your property is flooded, reporting a flood, updates on severe weather and flooding and provides emergency contacts details[28].

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

9.5 Emergency planning and development

9.5.1 NPPF

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

The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements within the borough. This includes the nominated rest and reception

[28] EHDC Guidance advice:
http://www.eastherts.gov.uk/article/2621/What-to-do-if-your-property-is-flooded
http://www.eastherts.gov.uk/article/29376/Useful-Information-in-an-Emergency
http://www.eastherts.gov.uk/article/30490/Report-a-flood
http://www.eastherts.gov.uk/severeweather

centres (and perspective ones), to ensure evacuees are outside of the high risk flood zones and will be safe during a flood event.

9.5.2 Safe access and egress

The NPPF Planning Practice Guidance outlines how developers can ensure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test[29]. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. The access and egress must be functional for changing circumstances over the lifetime of the development. The NPPF Planning Practice Guidance sets out that:

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

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

9.5.3 Potential evacuations

During flood incidents, evacuation may be considered necessary. The NPPF Planning Guidance states practicality of safe evacuation from an area will depend on[30]:

1. the type of flood risk present, and the extent to which advance warning can be given in a flood event;
2. the number of people that would require evacuation from the area potentially at risk;
3. the adequacy of both evacuation routes and identified places that people could be evacuated to (and taking into account the length of time that the evacuation may need to last); and
4. sufficiently detailed and up to date evacuation plans being in place for the locality that address these and related issues.

The vulnerability of the occupants is also a key consideration.

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

- single storey buildings or ground floors that don't have access to higher floors can access a space above the estimated flood level, e.g. higher ground nearby;
- basement rooms have clear internal access to an upper level, e.g. a staircase; and
- occupants can leave the building if there's a flood and there's enough time for them to leave after flood warnings[31].

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

29 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014
30 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 057, Reference ID: 7-057-20140306) March 2014
31 EA and DEFRA (2012) Flood Risk Assessment: Standing Advice: https://www.gov.uk/flood-risk-assessment-standing-advice

against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop emergency plans.

9.5.4 Flood warning and evacuation plans

Flood warning and evacuation plans are a potential mitigation measure to manage the residual risk, as listed in the NPPF Planning Practice Guidance. Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

It is a requirement under the NPPF that a flood warning and evacuation plan is prepared for

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

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

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 East Hertfordshire District Council are consulted prior to the production of any emergency flood plan.

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10 FRA requirements and guidance for developers

10.1 Over-arching principles

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

It 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.

10.2 Planning consultees

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

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

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

10.3 Requirements for site-specific Flood Risk Assessments

10.3.1 What are site-specific Flood Risk Assessments?

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.

10.3.2 When is an FRA required?

A FRA is required in the following circumstances:

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

Advice should be sought from the LPA and the Environment Agency at the pre-planning application stage to determine the need for a site-specific FRA. DEFRA's Guidance notes *FD2320/TR2 'Flood*

Risk Assessment Guidance for New Development'[32] and *FD2321/TR2 'Flood Risks to People'*[33] should also be consulted.

10.3.3 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
- Whether, if applicable, the development will be safe and pass the Exception Test

FRAs for sites located in East Hertfordshire should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and East Hertfordshire District 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.

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

10.3.3.1 Climate Change Guidance

The Environment Agency published new climate change guidance on 19 February 2016, which must now be considered in all new developments and planning applications. Site-specific FRAs must consider the impact which climate change may have on the development in the future. The Environment Agency Climate Change Guidance in relation to watercourses within East Hertfordshire is discussed in more detail in Chapter 4.

10.4 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.

10.4.1 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

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

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

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.

10.4.2 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.

10.4.3 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.

10.4.4 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 (unless the site is strategically allocated).

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

10.4.5 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)[34] funding arrangements (introduced in 2011) do not make government funds available for any new development implemented after 2012. Accordingly, it is essential that appropriate funding arrangements are established for new development proposed in locations where a long term investment commitment is required to sustain Flood Risk Management (FRM) measures. The strategic investment commitment is required so that in future the FRM measures can be maintained and afforded for the lifetime of the development, since the available funds from FCRMGiA will potentially not reflect the scale of development that is benefitting. When appropriate the necessary land to enable affordable future flood risk management measures should also be secured.

FCRMGiA can be obtained by operating authorities (for example the Environment Agency, Local Authority and IDB) 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 (for example raised by the Regional Flood and Coastal Committee), special levy (raised by IDBs for drainage and water level management), local businesses, developers 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.

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

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

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.

The National Flood and Coastal Erosion Management Strategy[16] summarises the new system:

"In essence, instead of meeting the full cost of a limited number of schemes, a new partnership approach to funding could make government money available to pay a share of any worthwhile scheme. The amount in each case will depend on the level of benefits the scheme provides. For example, the number of households protected, or the amount of damage that can be prevented. The level of government funding potentially available towards each scheme can be easily calculated. Local authorities and communities can then decide on priorities and what to do if full funding isn't available. Projects can still go ahead if costs can be reduced or other funding can be found locally."

There are a number of potential impacts of this change in funding. The Government stated that its proposals will help to:

- Encourage total investment in Flood and Coastal Erosion Risk Management by operating authorities to increase beyond what is affordable to national budgets alone.
- Enable more local choice within the system and encourage innovative, cost-effective options to come forward in which civil society may play a greater role; and
- Maintain widespread uptake of flood insurance.

10.5 Flood risk management guidance – resistance measures

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

Permanent barriers

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

Temporary barriers

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

Community Resilience Measures

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

10.6 Flood risk management guidance – resilience measures

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent dame 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:

Wet-proofing

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent dame 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 bathrooms, kitchens or lavatories
- If redeveloping existing basements for non-residential purposes, new electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level to minimise damage if the development floods

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

10.7 Reducing flood risk from other sources

10.7.1 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.

10.7.2 Surface water and sewer flooding

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

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

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

10.7.3 Sustainable Drainage Systems (SuDS)

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).

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

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11 Screening of Proposed Site Allocations

11.1 Introduction

Proposed site allocations have been provided by East Hertfordshire District Council as part of the preparation of their emerging District plan. As part of this SFRA these sites have been screened to identify sites where additional modelling would be required as part of the Level 2 SFRA assessment, i.e. 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 have been screened again to provide a summary of risk to each site (see Table 11-1) including:

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

Sites were shortlisted for a Level 2 assessment where a site is shown to be in either Flood Zone 2 and/or 3, and/or has an ordinary watercourse running through or adjacent to it. Where there are drains shown on the OS mapping, but no detailed hydraulic models available, 2D modelling was undertaken using JFlow to determine Flood Zone 3a, Flood Zone 3b and Flood Zone 2, as well as the effects of climate change, for a number of ordinary watercourses flowing through or adjacent to sites. In some locations due to the nature of the watercourse, JFlow modelling was not possible due to the size of the catchments or their representation in the DTM. At these locations further investigation is needed by developers.

Flood risk to the shortlisted sites has been assessed and summarised in more detail in a series of summary tables as part of the Level 2 SFRA, provided in Appendix I. These sites are highlighted in green in Table 11-1.

11.2 Sequential Testing

Table 11-1 summarises the flood risk to the proposed site allocations. The majority of the sites are predominantly located within Flood Zone 1.

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. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan. The assessments undertaken for this SFRA will assist the council when they undertake the Sequential Test.

Table 11-1: Summary of flood risk to all proposed site allocations

Site name	Settlement	Site area (ha)	Proportion of site in Flood Zone 3b (%)	Proportion of site in Flood Zone 3a (%)	Proportion of site in Flood Zone Two (%)	Proportion of site in Flood Zone One (%)	Proportion of site in uFMfSW 30yr (%)	Proportion of site in uFMfSW 100yr (%)	Proportion of site in uFMfSW 1000yr (%)	OWC within 100m (Y/N)	Does drain go through site?	Is drain catchment shown on FEH CD-ROM?	Site within, or partially within, the EA's Historic Flood Map? (Y/N)
North of Buntingford: Ermine Street	Buntingford	12.40	0%	0%	0%	100%	1%	1%	6%	Yes	Yes	Yes	No
South of Buntingford: Depot Site	Buntingford	10.24	0%	0%	0%	100%	2%	4%	9%	Yes	No	Yes	No
Bishops Stortford North: ASR5	Bishops Stortford	19.16	0%	0%	0%	100%	0%	0%	1%	Yes	Yes	Yes	No
Bishops Stortford: ASR1-4	Bishops Stortford	108.57	2%	2%	6%	94%	2%	4%	9%	Yes	Yes	Yes	Yes
Mead Lane South***	Hertford	1.01	0%	0%	0%	100%	0%	0%	3%	Yes	No	Yes	No
East of Manor Links	Bishops Stortford	6.29	0%	0%	0%	100%	0%	0%	1%	Yes	Yes	No	No
North and East Ware (Centre)	Ware	4.98	0%	0%	0%	100%	0%	0%	0%	Yes	No	No	No
North	Hertford	1.69	0%	0%	0%	100%	0%	0%	0%	No	No	No	No
West B: South of Welwyn Road	Hertford	8.85	0%	0%	0%	100%	0%	1%	4%	No	No	No	No
West A: North of Welwyn Road	Hertford	11.92	0%	0%	0%	100%	0%	0%	3%	No	No	No	No
EMPLOYMENT LAND - Buntingford Business Park	Buntingford	6.91	0%	0%	0%	100%	6%	7%	13%	No	No	No	No
North Sawbridgeworth***	Sawbridgeworth	7.67	0%	0%	0%	100%	0%	0%	0%	Yes	No	No	No
East of Stevenage	Stevenage	37.46	0%	0%	0%	100%	1%	2%	5%	No	No	No	No
Hadham Road Reserve Secondary School Site	Bishop's Stortford	8.3	0%	0%	0%	100%	0%	0%	3%	No	No	No	No
Bishop's Stortford High School Site	Bishop's Stortford	6.7	0%	0%	0%	100%	0%	0%	2%	Yes	No	No	No
Bishops Stortford South (+ Employment Land)	Bishops Stortford	54.30	0%	0%	0%	100%	1%	2%	9%	Yes	Yes	Yes	No
Sawbridgeworth West: North West Road	Sawbridgeworth	5.91	0%	0%	0.2%	99.8%	0%	0%	2%	Yes	Along edge	Yes	No
Mead Lane North	Hertford	4.19	0.5%	8%	27%	73%	11%	22%	39%	Yes	Yes	Yes	No
Hertford, South	Hertford	4.89	0%	0%	0%	100%	2%	3%	6%	Yes	No	Yes	No
The Goods Yard	Bishop's Stortford	6.66	0.3%	0.3%	38%	62%	6%	16%	34%	Yes	n/a	n/a	Yes
East of Welwyn	WGC	75.34	0%	0%	0%	100%	1%	2%	8%	Yes	Yes	Yes	No
North and East of Ware (Left)	Ware	79.80	0%	0%	0%	100%	2%	4%	9%	Yes	Yes	Yes	No
North and East Ware (Right)	Ware	46.34	0%	0%	0%	100%	1%	3%	7%	Yes	Yes	Yes	No
The Causeway/ Old River Lane	Bishop's Stortford	1.37	0%	13.25%	83.24%	3.51%	7%	7%	69%	Yes	No	Yes	Yes
Lane to the South of West Road	Sawbridgeworth	9.79	0.36%	0.09%	1.76%	97.97%	2%	3%	8%	Yes	Yes	Yes	No
Gilston Area	Gilston	697.7	0%	2%	3%	95%	2%	2%	8%	Yes	Yes	Yes	Yes

Sites highlighted in Grey are locations which have already been granted planning permission. At these locations, a detailed summary report is not necessary and has therefore not been taken forward to a Level 2 assessment. * Bishops Stortford: ASR1-4 is located in Flood Zone 2 and 3 but as this has already been granted planning permission, this particular location will not be taken forward to a Level 2 assessment.
Sites highlighted in Red cannot be modelled using JFlow as the drainage catchment is not shown on the FEH CD-ROM and have therefore not been taken forward to a Level 2 summary table. Further investigation will be required by developers at the FRA stage to confirm flood risk at these sites.
Sites highlighted in Green are being taken forward to a Level 2 summary table, as they are either located in the Flood Zone maps, or have a drain shown to run through the site on OS mapping, and the catchment area is present on the FEH CD-ROM, therefore allowing Jflow modelling to be undertaken at these locations.
Sites highlighted in blue do not have a drain in the vicinity of the site and therefore have not been taken through to a Level 2 assessment.
***These sites do not have a drain running through the site but are close to flood zones. Although no Level 2 assessment was deemed necessary for these sites, developers should carefully consider the impact that climate change may have on the site.
To note: The Flood Zone 2 % includes the FZ3 extent.

12 Level 2 Assessment of Proposed Site Allocations

12.1 Introduction

The SFRA assesses the level of flood risk associated with proposed site allocations which have been identified within the emerging District Plan. A site was shortlisted for Level 2 assessment if it met the following criteria:

- The site is within Flood Zone 2 and/or 3; and/or
- An ordinary watercourse runs through or adjacent to the site.

This Level 2 SFRA assessment of sites helps to determine variations in flood risk across the proposed site allocations, 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 proposed site allocations below:

Table 12-1: List of Detailed Summary Tables

Site Ref	Settlement	Flood Zone Coverage (%)		OWC within 100m (Y / N)
		FZ3	FZ2	
Bishops Stortford South (+ Employment Land)	Bishops Stortford	0%	0%	Yes
Sawbridgeworth West: North West Road	Sawbridgeworth	0%	0.2%	Yes
Mead Lane North	Hertford	8%	27%	Yes
Hertford South	Hertford	0%	0%	Yes
The Goods Yard	Bishop's Stortford	0.3%	38%	Yes
East of Welwyn	WGC	0%	0%	Yes
North and East of Ware (Left)	Ware	0%	0%	Yes
North and East Ware (Right)	Ware	0%	0%	Yes
The Causeway/ Old River Lane	Bishop's Stortford	13%	83%	Yes
Lane to the South of West Road	Sawbridgeworth	0%	2%	Yes
Gilston Area	Gilston	2%	3%	Yes

Using this information combined with the uFMfSW, detailed site summary tables have been produced for the proposed site allocations. Each table sets out the following information:

- Site area
- Proportion of the site in each Flood Zone
- NPPF and Exception Test guidance
- Mapping including Flood Zones, climate change, surface water, depth, velocity and hazard mapping
- A broadscale assessment of suitable SuDS techniques and considerations
- The presence of any flood defences
- Whether the site is covered by a flood warning service
- Whether there are any access and egress issues for the site
- The potential impacts of climate change in the future
- Advice on the preparation of site-specific FRAs and considerations for developers.

12.2.1 Important note on Flood Zone within the summary tables

It is important to recognise that for the SFRA a number of different sets of data have been used to clarify the Flood Zones. Mapping shown in the detailed site summary tables shown in Appendix I as part of the Level 2 assessment may differ to the Environment Agency Flood Zones and 'Flood

Map for Planning' (Appendix B of this report) as the flood risk from ordinary watercourses flowing through proposed site allocations has been included in the summary table mapping. The Flood Zones presented in Appendix B are the same as those shown on the Environment Agency's 'Flood Map for Planning' Flood Zones, derived from additional generalised modelling.

12.3 Note on SuDS Suitability

The hydraulic and geological characteristics of each proposed site allocations were assessed to determine the constraining factors for surface water management. This assessment is designed to inform the early-stage site planning process and is not intended to replace site-specific detailed drainage assessments.

The assessment is based on catchment characteristics and additional datasets such as the AStGWF map and Soil maps of England and Wales which allow for a basic assessment of the soil characteristics on a site by site basis. LiDAR data was used as a basis for determining the topography and average slope across each development site. Other datasets were used to determine other influencing factors on potential SuDS. These datasets include the following:

- Historic landfill sites
- Source Protection Zones
- Groundwater Vulnerability Zones
- Detailed River Network
- Environment Agency Flood Zones
- OS open data on Sites of Special Scientific Interest (SSSI)

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 12-2: 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 proposed site allocations has been displayed using a traffic light colour system in the summary tables. The assessment of suitability is broadscale 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 considerations or engineering works
	The SuDS Group and its associated techniques are likely to be suitable

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13 Summary

13.1 Level 1 SFRA

13.1.1 Sources of flood risk

- Flood history shows that East Hertfordshire has been subject to flooding from several sources of flood risk, with the principal risk being fluvial flood risk from watercourses within the district. Additionally, there are recorded incidents of surface water flooding, particularly in the main urban areas of the district. Though limited, there have also been historic cases of groundwater flooding.
- East Hertfordshire lies within the River Lea and River Stort catchments (the River Stort, itself a tributary of the River Lea). The main tributaries of the River Lea include the River Beane, the River Ash, the River Rib and the River Mimram.
- The primary fluvial flood risk is located along the River Lea and River Stort corridors. The main urban areas at risk include Hertford, Ware Stanstead Abbots and Bishop's Stortford. The main tributaries of the River Lea also present fluvial flood risk to rural communities within the district. The floodplain associated with the tributaries of the River Lea network are generally narrow until reaching the urban areas and / or towards the confluences with the River Lea network.
- East Hertfordshire has experienced a number of historic surface water flooding incidents. Bishop's Stortford, Hertford, Much Hadham, Walkern and Buntingford are shown to have five or more records of surface water flooding. The uFMfSW further shows a number of prominent overland flow routes in the district; these predominantly follow topographical flow paths of existing watercourses or road networks, with some isolated ponding located in low lying areas.
- The Thames Water DG5 register indicates a total of 179 recorded incidents of sewer flooding in East Hertfordshire administrative area. The more frequently flooded postcodes are SG14 3, with 21 records, followed by SG12 8 with 18 records.
- There have been incidents of historic groundwater flooding in East Hertfordshire which is thought to primarily be caused by the underlying geology. Although the incidents are largely isolated, the settlement with the greatest recorded number of incidents is Ware and Tewin / Tewin Wood.
- There are four reservoirs located within East Hertfordshire and a number located outside of the area whose inundation mapping is shown to affect East Hertfordshire. There are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low.
- There are no records of a canal overtopping along the Lee Navigation Channel. There are however seven records of overtopping of the River Stort navigation channel; the majority of these being caused by heavy rainfall causing the River Stort to overtop its banks.
- Proposed site allocations were screened to provide a summary of flood risk to each site, informing which sites are taken forward to the Level 2 assessment.

13.1.2 The impact of climate change

In February 2016 the Environment Agency published new climate change guidance which must now be considered for all new developments and planning applications. Climate change modelling and mapping has been undertaken as part of the SFRA, to assist the Council with the preparation of their District Plan. Three scenarios have been modelled to reflect the three climate change allowances for the '2080s' timeframe in the Thames River Basin District and i.e. 25%, 35% and 70% allowances on top of the 100-year flow.

Developers will need to undertake a detailed assessment of climate change as part of the planning application process when preparing FRAs.

13.1.3 Key policies

There are a number of regional and local key policies which have been considered within the SFRA. The regional policies include the River Thames CFMP (2009), the Thames River Basin

Management Plan (2016), the Thames Flood Risk Management Plan (2015) and the Lower Lee Flood Risk Management Strategy (2013). Key local policy documents include the following:

- East Hertfordshire's policies include saved policies from the 2007 Local Plan and new local policies from the emerging District plan.
- Hertfordshire Local Flood Risk Management Strategy (2013 - 2016): The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management on a day to day basis and sets measures to manage local flood risk i.e. flood risk from surface water, groundwater and Ordinary Watercourses. The action plan shows how the LLFA intends to achieve high level objectives relating to flood risk.
- East Hertfordshire and Broxbourne SWMP (on-going): The SWMP is currently under development and will outline the main areas at risk, the preferred surface water management strategy in a given location and will set out further actions the Council will implement in the management of surface water.

13.1.4 Development and flood risk

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

13.1.5 Surface water management and SuDS

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.

There are a number of local guidance documents which can be considered in relation to SuDS in East Hertfordshire including; Hertfordshire County Council's SuDS Policy Statement, Hertfordshire County Council SuDS Design Guidance and Hertfordshire County Council Summary Guidance for Developers.

13.1.6 Defences and residual risk

A high-level review of existing flood defences was undertaken, including a more detailed assessment of the defences through Hertford, Ware and Bishop's Stortford. In addition, flood alleviation schemes are currently being proposed for Little Hadham, Stanstead Abbots and Furneux Pelham.

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

13.1.7 Flood warning and emergency planning

The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers). Currently there are 25 Flood Alert Areas and 22 Flood Warning Areas (FWAs) covering significant parts of East Hertfordshire.

13.2 Level 2 SFRA

13.2.1 Assessment methods

As part of the Level 2 SFRA, detailed site summary tables have been produced for each the 11 Proposed Site Allocations taken forward from the Level 1 assessment. These sites 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. Climate change mapping has also been produced for each site to indicate the impact which different climate change allowances may have on the site. Each table also sets out the NPPF requirements for the site as well as guidance for site-specific FRAs.

A broadscale assessment of suitable SuDS options has been provided giving an indication where there may be constraints to certain sets of SuDS techniques. This assessment 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.

For sites not covered by the EA Flood Zones but OS Mapping indicated a drain running across or adjacent to the site, Jflow modelling was conducted. However, this could only be carried out where the catchment area of the drain was present on the FEH CD-ROM, and therefore some of the sites which were not carried forward to the Level 2 assessment may still need detailed modelling to confirm the flood risk to the site from drains, which could not be modelled using strategic techniques.

It is important to recognise that a number of different sets of data have been used to clarify the Flood Zones. Mapping shown in the detailed site summary tables shown in Appendix I as part of the Level 2 assessment may differ to the Environment Agency Flood Zones and 'Flood Map for Planning' (Appendix B of this report), as the flood risk from ordinary watercourses flowing through proposed site allocations has been included in the summary table mapping. The Flood Zones presented in Appendix B are the same as those shown on the Environment Agency's 'Flood Map for Planning' Flood Zones, derived from generalised modelling.

13.2.2 Key Site Issues

- Jflow modelling of drains was undertaken for the following sites: Bishops Stortford South and Employment Land, North West Road Sawbridgeworth, Hertford South, East of Welwyn, North and East of Ware (Left and Right) and Gilston Area. However, detailed hydraulic modelling would be required to confirm the flood risk to these sites.
- Four of the sites have detailed modelling available; Mead Lane North, The Goods Yard, South of West Road and the Causeway/Old River Lane.
- For all sites, with the exception of the Causeway/Old River Lane, the majority of the sites are located within Flood Zone 1.
- The site at the Causeway/Old River Lane falls 83% within Flood Zone 2 and 13% within Flood Zone 3.
- Several sites have been identified as having surface water flood risk issues including:
    - Bishops Stortford South and Employment Land
    - Mead Lane North
    - The Goods Yard
    - East of Welwyn
    - North and East of Ware (Left and Right)
    - Gilston Area
    - Causeway/Old River Lane
- Climate change mapping indicates that the depths, velocities and hazard of flooding may increase as a result of climate change. The significance of the increase tends to depend on the topography of site and the percentage allowance used.
- Many sites are located in groundwater SPZs. This means that special consideration needs to be taken with SuDS. A suitable level of treatment should be ensured prior to discharging, along with establishing an understanding of constraints to sites and how SuDS can be designed to overcome these from relevant bodies (e.g. LLFA).
- The site East of Welwyn is the only site which has areas within it designated by the Environment Agency as being landfill. For this, site ground investigation will be required to determine the extent of the contamination and the impact this may have on SuDS.
- A strategic assessment was conducted of SuDS options using regional datasets. Therefore, a detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.
- None of the proposed allocation sites apart from the Causeway/Old River would benefit from the formal flood defences which are currently present within East Hertfordshire. Flood mitigation measures should only be considered if, after a sequential approach, development sites cannot be located further away from high risk areas. The Causeway/Old River is currently protected by two privately-owned embankments.

- For a number of sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites to how safe access and egress can be provided during high rainfall events.

14 Recommendations

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

14.1 Site allocations

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

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

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

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

14.2 Assessing Flood Risk and Developments

- The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the district
- A site-specific FRA is required for all developments over 1ha in Flood Zone 1; for developments less than 1 ha in Flood Zone 1 where there is a change to vulnerability classification or where the development could be affected by sources of flooding; and for all developments located in an area which has been highlighted as having critical drainage problems. The FRA should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development
- It is recommended that the impact of climate change to a proposed site is considered in a FRA and that the percentage increases which relate to the proposed lifetime of the development and the vulnerability classification of the development is accounted for. The Environment Agency and LLFA should be consulted to confirm a suitable approach to climate change in light of the latest guidance
- At site-specific level, for any developments shown to be at residual flood risk, for example from a breach or overtopping (e.g. reservoir, canal, perched watercourse), it is recommended that a detailed hydraulic modelling study is carried out using Environment Agency guidance to assess the residual risk. For development applications located in the vicinity of a canal or navigation channel or reservoir, it is recommended that overtopping and / or breach of the structure is considered as part of a site-specific FRA to establish the residual risk to the development.
- Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites, through reductions in the amount of surface water runoff generated on a site. The functional floodplain should be protected from development and returned to greenfield status (where possible).
- The Local Planning Authority (LPA), Environment Agency and Lead Local Flood Authority (LLFA) should be consulted to confirm the level of assessment required and to provide any information on any known local issues

- When assessing sites not identified in the District plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as provide evidence to show that they have adequately considered other reasonably available sites.
- The FRA should demonstrate that developments do not increase the likelihood or intensity of flood risk to third party development.
- To demonstrate the Exception Test has been passed, flood resilience design and emergency planning must be accounted for including:
    - The development will remain safe and operational under flood conditions;
    - A strategy for safe evacuation and / or safely remaining in the building under flood conditions;
    - Key services will continue to be provided under flood conditions; and
    - Buildings are designed for a quick recovery following a flood.

14.2.1 Future Developments

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

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

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

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

14.2.2 Promotion of SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the Council's policy. It is recommended that these policies should also be incorporated into the emerging District Plan.

Wherever possible, SuDS should be promoted:

- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- Development should aim to achieve Greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible.
- Where possible developments must utilise the most sustainable form of drainage systems, in accordance with the SuDS hierarchy.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration.
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable and guidance should be sought from the LLFA.
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders

at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints.

- The LPA will need to consider drainage schemes for major applications, but it is advised developers utilise the LLFA's Polices and Guidance to develop their drainage scheme for minor applications.
- Where SUDs are provided as part of a development, applicants should detail how it will be maintained in the long term.

14.2.3 Infrastructure and Access

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

14.2.4 Green Infrastructure and WFD

Opportunities to enhance green infrastructure (GI) and reduce flood risk by making space for water should be sought. With regards to flood risk, green spaces can be used to manage storm flows and free-up water storage capacity in existing infrastructure to reduce risk of damage to urban property. GI can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity. It should be considered as critical infrastructure embedded at the start of projects, and considered within the mitigation measures for surface water runoff from development.

River corridors identified as functional floodplain can provide flood storage during a flood event. The Council's GI strategies should also incorporate any areas identified within the urban environment or upstream of a critical surface water flood area. Creating flood storage areas or flow paths areas and improving accessibility to this land can help protect current and future property.

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

In addition, opportunities where it may be possible to improve the WFD status of watercourses, for example by opening up culverts, weir removal, and river restoration, should be considered.

14.2.5 Strategic flood risk solutions

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

- Floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, for example by bank stabilisation, re-naturalisation, structure removal/ modification and enhancing outfalls in the riparian environment.
- The construction of new upstream storage schemes as part of upstream catchment-based approaches could be considered on a number of watercourses within East Hertfordshire. Watercourses which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream. It should be noted that often such schemes are driven by requirements outlined by the LLFA and the Environment Agency. The Little Hadham Flood Storage Scheme is one such scheme currently proposed for the River Ash.
- If flood defences are to be constructed to protect a development site, it should be demonstrated that defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.

14.3 Use of SFRA data and future updates

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

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

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

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

Note on the Environment Agency Flood Map for Planning

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