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Three Rivers District Level 1 Strategic Flood Risk Assessment

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This report describes work commissioned by Three Rivers District Council, by an instruction dated 29 October 2025. The Client's representative for the contract was Marko Kalik of the Three Rivers District Council. Fiona Barraclough and Jasmine Mukkath of JBA Consulting carried out this work.

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The methodology adopted and the sources of information used by JBA in providing its services are outlined in this Report. The work described in this Report was undertaken between (October and February 2026) and is based on the conditions encountered and the information available during the said period. The scope of this Report and the services are accordingly factually limited by these circumstances.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by JBA has not been independently verified by JBA, unless otherwise stated in the Report.

Acknowledgements

We would like to acknowledge the assistance of Three Rivers District Council and Hertfordshire Council.

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Abbreviations

ADEPT	Association of Directors of Environment, Economy, Planning & Transport
AEP	Annual Exceedance Probability
AIMS	Asset Information Management System
BNG	Biodiversity Net Gain
CaBA	Catchment Based Approach
CC	Climate Change
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
CIA	Cumulative Impact Assessment
CIL	Community Infrastructure Levy
CIRIA	Construction Industry Research and Information Association
ColneCAN	River Colne Catchment Action Network
DCG	Design and Construction Guidance
Defra	Department for Environment, Food and Rural Affairs
DWMP	Drainage and Wastewater Management Plan
EA	Environment Agency
EU	European Union
FAA	Flood Alert Area
FCERM	Flood and Coastal Erosion Risk Management
FFL	Finished Floor Level
FFR	Flood Risk Regulation
FMfP	Flood Map for Planning
FRA	Flood Risk Assessment
FRAP	Flood Risk Activity Permit
FRMP	Flood Risk Management Plan
FWA	Flood Warning Area
FWMA	Flood and Water Management Act
GI	Green Infrastructure
GSPZ	Groundwater Source Protection Zone
JBA	Jeremy Benn Associates
LASOO	Local Authority SuDS Officer Organisation

LFRMS	Local Flood Risk Management Strategy
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LNRS	Local Nature Recovery Strategies
LPA	Local Planning Authority
mAOD	metres Above Ordnance Datum
NFM	Natural Flood Management
NLP	New Local Plan
NPPF	National Planning Policy Framework
NRD	National Receptor Database
NVZ	Nitrate Vulnerable Zone
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
RAG	Red-Amber-Green
RBD	River Basin District
RBMP	River Basin Management Plan
REUL	Retained EU Law
RFCC	Regional Flood and Coastal Committee
RMAs	Risk Management Authorities
RoFSW	Risk of Flooding from Surface Water
SFRA	Strategic Flood Risk Assessment
SHELAAs	Strategic Housing and Economic Land Availability Assessments
SoP	Standard of Protection
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
WCS	Water Cycle Study
WFD	Water Framework Directive
WRMP	Water Resources Management Plan

Definitions

1D model: One-dimensional hydraulic model.

2D model: Two-dimensional hydraulic model.

Annual Exceedance Probability: The probability (expressed as a percentage) of a flood event occurring in any given year.

Brownfield: A previously developed parcel of land.

Climate change: Long term variations in global temperature and weather patterns caused by natural and human actions.

Design flood: A flood event of a given annual flood probability, which is generally taken as: fluvial (river) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or surface water flooding likely to occur with a 1% annual probability (a 1 in 100 change each year), plus an appropriate allowance for climate change, against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.

Flood defence: Infrastructure used to protect an area against floods such as floodwalls and embankments; they are designed to a specific Standard of Protection (SoP) (design standard).

Green infrastructure: A network of multi-functional green and blue spaces and other natural features, urban and rural, which is capable of delivering a wide range of environmental, economic, health and wellbeing benefits for nature, climate, local and wider communities and prosperity.

Greenfield: An undeveloped parcel of land.

Lead Local Flood Authority: The unitary authority for the area or if there is no unitary authority, the County Council for the area.

Main river: A watercourse shown as such on the statutory main river map held by the Environment Agency (EA). They are usually the larger rivers and streams. The EA has permissive powers (not duties) to carry out maintenance and improvement works on main rivers).

Major development: Defined in the National Planning Policy Framework (NPPF) as a housing development where 10 or more homes will be provided, or the site has an area of 0.5 hectares or more, or as a non-residential development with additional floorspace of 1,000m² or more, or a site of 1 hectare or more, or as otherwise provided in the Town and Country Planning (Development Management Procedure) (England) Order 2015 (gov.uk).

Natural Flood Management (NFM): Techniques that work with nature to reduce the risk of flooding for communities.

Ordinary watercourse: Any river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows but which does not form part of a main river. The local authority or Internal Drainage Board (IDB) has permissive powers (not duties) on ordinary watercourses.

Permissive powers: Authorities have the power to undertake flood risk management activities, but not a duty to do so. This will depend on priorities in flood risk management.

Return period: 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.

Riparian owner: A riparian landowner, in a water context, owns land or property, next to a river, stream or ditch.

Risk Management Authority (RMA): The EA; a Lead Local Flood Authority; a District Council in an area where there is no unitary authority; an internal drainage board; a water company and a highway authority.

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.

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.

Sustainable Drainage Systems (SuDS): Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques, such as grates, gullies, and channels.

Windfall site: A site which becomes available for development unexpectedly and therefore not included as allocated land in a planning authority's Local Plan.

Executive Summary

This report provides a comprehensive and robust evidence base on flood risk issues to support the review and update of the planning policies for Three Rivers District. The review process is known as the New Local Plan (NLP). This report uses the best available information, including input from key stakeholders. The SFRA applies the latest national planning policy and guidance, including:

- National Planning Policy Framework (NPPF) (gov.uk), last updated in December 2024.
- Planning Practice Guidance (PPG): Flood risk and coastal change (gov.uk) updated in September 2025.
- The latest Environment Agency climate change guidance (gov.uk) (updated in July 2021 and May 2022).
- The Environment Agency 'How to prepare a strategic flood risk assessment' (gov.uk) guidance, last updated in August 2025.
- The Association of Directors of Environment, Economy, Planning & Transport (ADEPT) 'Strategic flood risk assessment good practice guidance' (adeptnet.org.uk).

Introduction

To support the review and NLP for Three Rivers District Council (referred to hereafter as the Council), the key objectives of the assessment are:

- To collate and analyse the latest available information and data for current and future (i.e., climate change) flood risk from all sources, and how these risks may be mitigated against.
- To inform decisions in the emerging NLP, including informing the sustainability appraisal, the selection of development sites, and planning policies.
- To provide evidence to support the application of the Sequential Test for the allocation of new development sites, to support the Council in the preparation of the NLP.
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the NLP.
- To help decide when a Flood Risk Assessment (FRA) will be required for individual planning applications.
- To provide advice for applicants carrying out site-specific FRAs, including those at risk from sources other than river flooding, or at risk of flooding in the future due to climate change, and outline specific measures or objectives that are required to manage flood risk.
- To provide the basis for applying the Sequential Test on planning applications, including by identifying sources of flooding other than those in 'Flood Zones' and those at risk of flooding in the future.

- To identify opportunities to reduce the causes and impacts of flooding and gather information on the land that is likely to be required for flood risk management structures.

Summary of the district and flood risk

The Local Plan Area covers the administrative area of Three Rivers District, in South West Hertfordshire. The district is named after the three watercourses of the Rivers Colne, Chess and Gade, which form a confluence in Rickmansworth, the largest town. Other key settlements include South Oxhey, Croxley Green, Abbots Langley, Chorleywood, Leavesden and Garston, and Mill End.

Flood risk from all sources has been assessed in this SFRA. Parts of the district are shown to be at risk of flooding from the following sources: fluvial, surface water, groundwater, canals, reservoirs and sewers. This study has shown that the most significant sources of flood risk across the district are fluvial, surface water and groundwater. The points below summarise the findings:

Fluvial: Fluvial flood risk in Three Rivers District is concentrated in the floodplains of the three major watercourses: the Rivers Colne, Chess and Gade. The area of most extensive fluvial flood risk in the district is the low-lying valley of the River Colne, which affects Rickmansworth and Batchworth. The steeper topography of the River Chess and Gade catchments results in fluvial flood risk being closely confined to the river valleys, although the floodplain of the River Chess extends into the settlement of Loudwater. The heavily urbanised southern tributaries of the Colne, Moor Park Stream, Hartsbourne Stream, and Oxhey Brook, pose a flood risk to the residential areas which they pass through in the southeast of the district.
Fluvial flood risk is discussed in Section 0 and the flood extents are shown in Appendix C.

Surface Water: Surface water flood risk is largely confined to the urban areas of Three Rivers District. Flow paths form on the steep slopes and in river valleys and follow the natural topography through residential areas including Eastbury, South Oxhey, Carpenders Park and Rickmansworth, before entering the River Colne. At Croxley Green, overland flows are routed in two directions, eastwards to the River Gade and southwards into the Colne.
Surface water flood risk is discussed in Section 4.5 and the flood extents are shown in Appendix C.

Climate Change: Areas at risk of flooding today are likely to become at increased risk in the future and the frequency of flooding will also increase in such areas, due to climate change. Flood extents will increase; in some locations this may be minimal, but flood depth, velocity and hazard may have more of an impact due to climate change. This SFRA provides an assessment of the impacts of climate change on fluvial and surface water flood risk. The approach to climate change is discussed in Section 5 and the flood extents are also shown in Appendix C.

Sewer: Thames Water provide water and sewerage services across the district and have provided details of historic sewer flooding across the district. Settlements with the greatest historic risk of sewer flooding include Oxhey, Carpenders Park, Rickmansworth, Chorleywood and Croxley Green.
Sewer flood risk is discussed in Section 4.6.

Groundwater: High groundwater flood risk within the district is concentrated in the floodplains of the Rivers Colne, Chess and Gade, where the chalk geology and gravel surface deposits can result in heightened groundwater levels at, or just below, the ground surface. The settlements identified as at highest risk of groundwater flooding are Rickmansworth, Croxley Green, Loudwater, Carpenders Park and Oxhey.
There is no national risk-based groundwater flood dataset of a suitable resolution to inform the areas at risk from groundwater flooding; however, emergence mapping when considered in conjunction with topography and surface water flow paths can indicate areas where groundwater is likely to emerge, and the flow paths it may take once above the ground. Groundwater flood risk is discussed in Section 4.7 the JBA emergence map is shown in Appendix C.

Canals: The Grand Union Canal passes through the district from the northeast to southwest, and interacts with the River Gade at Croxley Green, as well as the Rivers Chess and Colne at Rickmansworth. There have been several incidents of canal overtopping between Rickmansworth and West Hyde, in response to heavy rainfall and raised levels or overtopping of the River Colne. However, these incidents largely affected the canal towpath, with no damage to property. Canal flood risk is discussed in Section 4.8.

Reservoirs: There are three reservoirs located within the district, and a further four located outside the district, which present a potential risk of flooding within the district. The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However, there is a residual risk of a reservoir breach, and this risk should be considered in any site-specific FRAs (where relevant) in accordance with the PPG: Flood risk and coastal change. Reservoir flood risk is discussed in Section 4.8.2. The 'Dry Day', 'Wet Day', and 'Fluvial Contribution' flood extents are shown in Appendix C.

Defences

The EA Asset Information Management System (AIMS) dataset provides information on flood defence assets across the district.
There are a series of flood defences in the district, most notably the Hartsbourne Flood Storage Area, an earth bund which impounds the Hartsbourne Stream above Oxhey Lane. It was constructed to alleviate flooding to properties and the road network in the Carpenders Park area. Elsewhere, there are a series of raised or reinforced walls and embankments on the Grand Union Canal at Batchworth, Hartsbourne Stream at Oxhey, the River Chess at Rickmansworth, and the River Colne from Rickmansworth to Maple Cross. Further information on defences across the district is available in Section 6.4 and shown in Appendix C.

How to use this report

The SFRA provides recommendations regarding all sources of flood risk across the district, which can be used to inform policy on flood risk within the emerging NLP. This includes how the cumulative impact of development should be considered.

It provides the latest flood risk data and guidance to inform the Sequential Test, for both allocations and individual planning applications (Appendix B) and provides guidance on how to apply the Exception Test.

This SFRA is a strategic assessment of flood risk and does not replace the need for site-specific FRAs, where required. The SFRA provides guidance for the development industry and development management officers to establish when an FRA is required and to assess whether site-specific FRAs meet the required quality standard (Section 7). This should be used alongside the EA's FRA Guidance (gov.uk). The SFRA can be used to help identify which locations and development may require emergency planning provision.

The SFRA will also be helpful for developing community level flood risk policies in high flood risk areas. Similarly, all known available recorded historical flood events across the district are listed in Section 4.3. This can be used to supplement local knowledge regarding areas worst hit by flooding. Ongoing and proposed flood alleviation schemes planned within the district are outlined in Section 6.5 and Section 8.5 discusses mitigations, resistance and resilience measures which can be applied to alleviate flood risk to an area.

Table 1-1 sets out the contents of the SFRA and how users should use the information provided through the document and appendices.

Mapping

The SFRA mapping highlights on a strategic scale flood risk from fluvial, surface water and reservoirs sources, and where groundwater emergence may occur; as well as where the effects of climate change are most likely. The maps are useful to provide a community level view of flood risk but may not identify if an individual property is at risk of flooding or depict small scale changes in flood risk. Local knowledge of flood mechanisms will need to be included to complement this mapping.

The mapping data should always be supplemented by direct consultation with the relevant wastewater company to ascertain if there is any site-specific risk from a public sewer. This is because sewer flood risk information is not publicly available and would need to be considered on a site-specific basis.

1 Introduction

1.1 Purpose of a Strategic Flood Risk Assessment (SFRA)

Three Rivers District Council as the Local Planning Authority (LPA) is responsible for producing a Local Plan, determining planning applications, enforcement in response to breaches of planning control, and supporting neighbourhood planning.

The Council is currently compiling the evidence base to support the development of its new Local Plan. The plan will set out how the Council will sustainably manage the housing, employment and infrastructure needs of the district until 2041.

As set out in the NPPF (Paragraph 171) "Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards."

This SFRA provides an update to the South West Hertfordshire Level 1 SFRA (2018), which was prepared for the LPAs of Dacorum Borough, St Albans City and District, Three Rivers District and Watford Borough. The updated Level 1 SFRA reflects the latest changes to the NPPF, PPG, flood risk guidance and new national flood risk mapping.

1.2 Relevance of the SFRA

The 'How to prepare a Strategic Flood Risk Assessment guidance' (gov.uk) (last updated in August 2025), sets out the requirements that the LPA must address within their SFRA and has been used to undertake this Level 1 SFRA.

This SFRA has been developed using the best available information, supplied at the time of preparation. Appendix 0 details the information supplied for the preparation of this SFRA. Over time new information will become available to inform planning decisions:

- The EA regularly reviews its hydrology, hydraulic modelling, and flood risk mapping.
- The EA published the new national flood risk mapping (NaFRA2) in early 2025 with regular updates and additional datasets released during 2025 and expected throughout 2026.
- Other datasets used to inform this SFRA may also be updated periodically and following the publication of this SFRA, new information on flood risk may be provided by Risk Management Authorities (RMAs).

Links have been provided for relevant guidance documents and policies published by other Risk Management Authorities (RMAs) such as the Lead Local Flood Authority (LLFA) and the Environment Agency (EA). When using the SFRA to prepare FRAs it is important to check that the most up to date information is used.

As the data available for SFRAs and the relevant legislation is continually changing, an SFRA should be updated to reflect changes where applicable and reasonably practicable. Under any changes in guidance or legislation, the implications on the SFRA should be considered and a review undertaken where this is deemed reasonably necessary.

1.3 Levels of SFRA

The PPG: Flood risk and coastal change (gov.uk) identifies two levels of SFRA.

Level 1 SFRAs are high-level strategic documents and do not go into detail on an individual site-specific basis. Where potential site allocations are not at major flood risk and where development pressures are low, a Level 1 assessment is likely to be sufficient, without the LPA progressing to a Level 2 assessment. The Level 1 assessment should be of sufficient detail to enable application of the Sequential Test, to inform the allocation of development to areas of lower flood risk.

A Level 2 assessment is required where land outside flood risk areas cannot appropriately accommodate all necessary development, creating the need to apply the NPPF's Exception Test if relevant, or if an LPA believe they may receive high numbers of applications in flood risk areas on sites not identified in the Local Plan. In these circumstances the assessment should consider the detailed nature of the flood characteristics from all sources, both now and in the future.

This report fulfils the requirements of a Level 1 SFRA.

1.4 Local Plan Area

The Local Plan Area covers the administrative area of Three Rivers District, in southwest Hertfordshire. The district is named after the three watercourses of the Rivers Colne, Chess and Gade, which form a confluence in Rickmansworth, the largest town (**Error! Reference source not found.**). Other key settlements include South Oxhey, Croxley Green, Abbots Langley, Chorleywood, Leavesden and Garston, and Mill End.

Three Rivers District is bordered by Dacorum Borough and St Albans City and District to the north, Watford Borough and Hertsmere District to the east, the London Boroughs of Hillingdon and Harrow to the south, and the unitary authority of Buckinghamshire to the southwest and west (

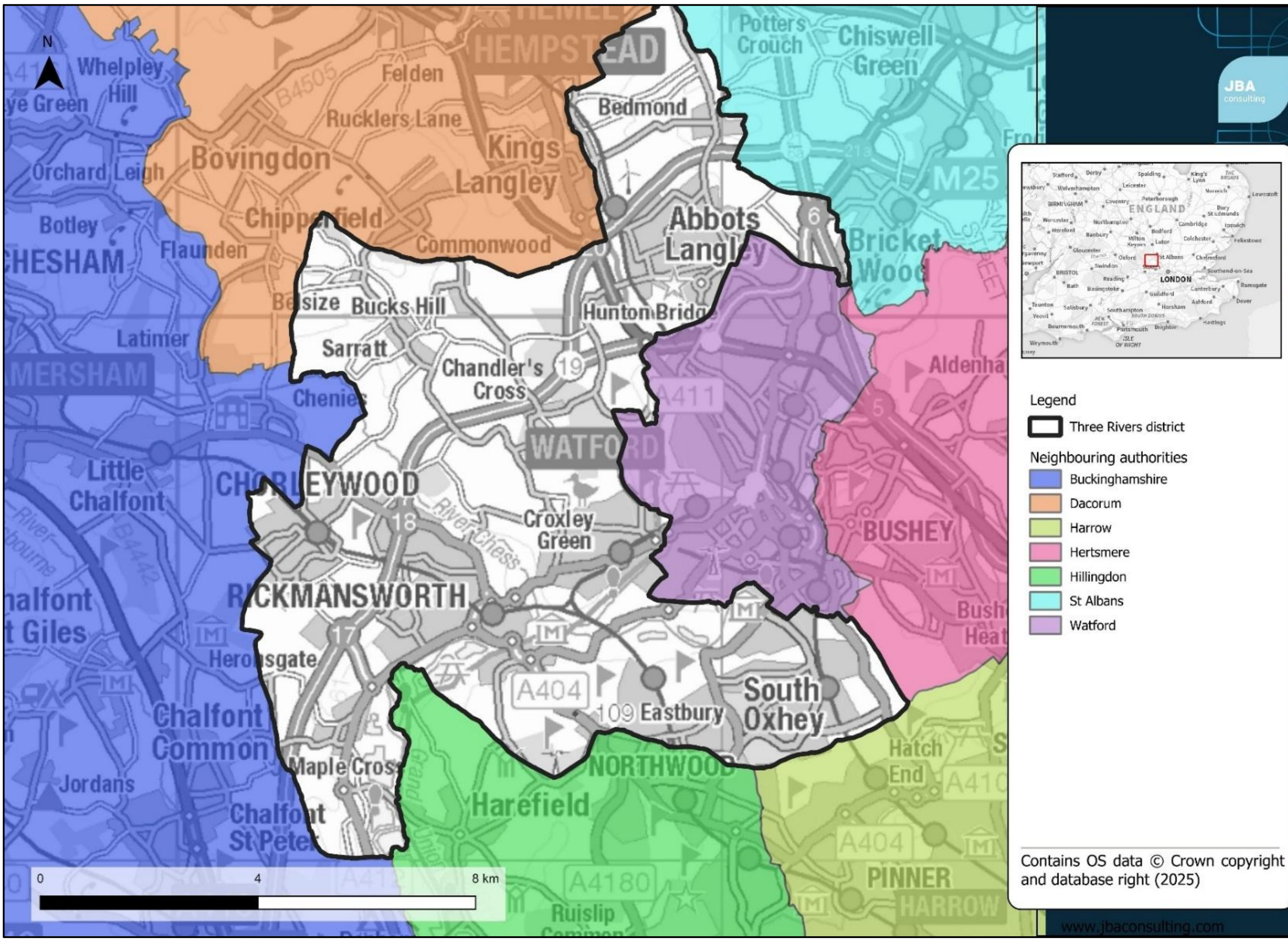


Figure 1-1).

Hertfordshire County Council is the LLFA for the district and Thames Water is the water and sewage undertaker. The Grand Union Canal passes through the district, forming a confluence with the River Gade at Croxley Green, as well as the Rivers Chess and Colne at Rickmansworth.

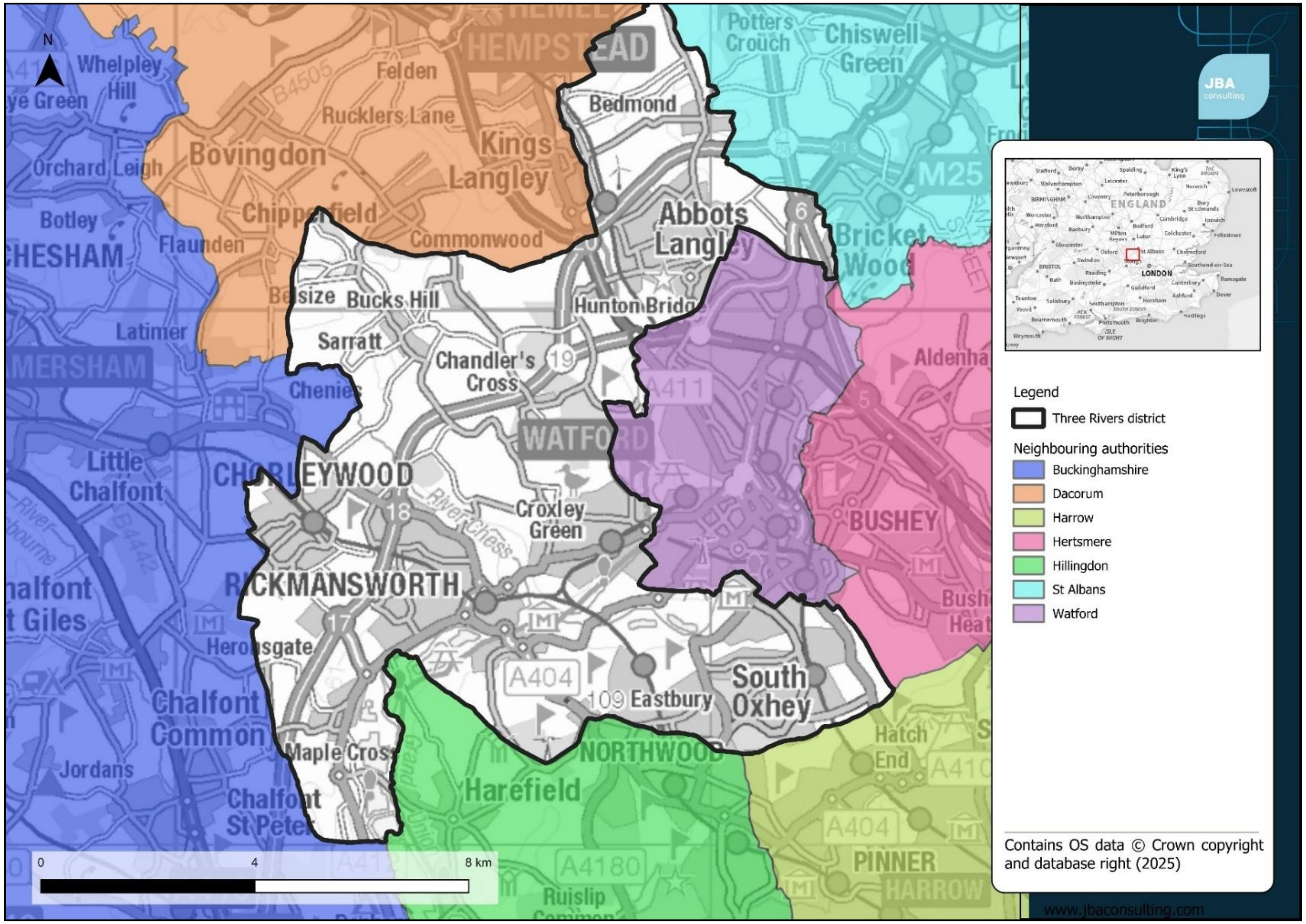


Figure 1-1: Three Rivers District and its neighbouring authorities.

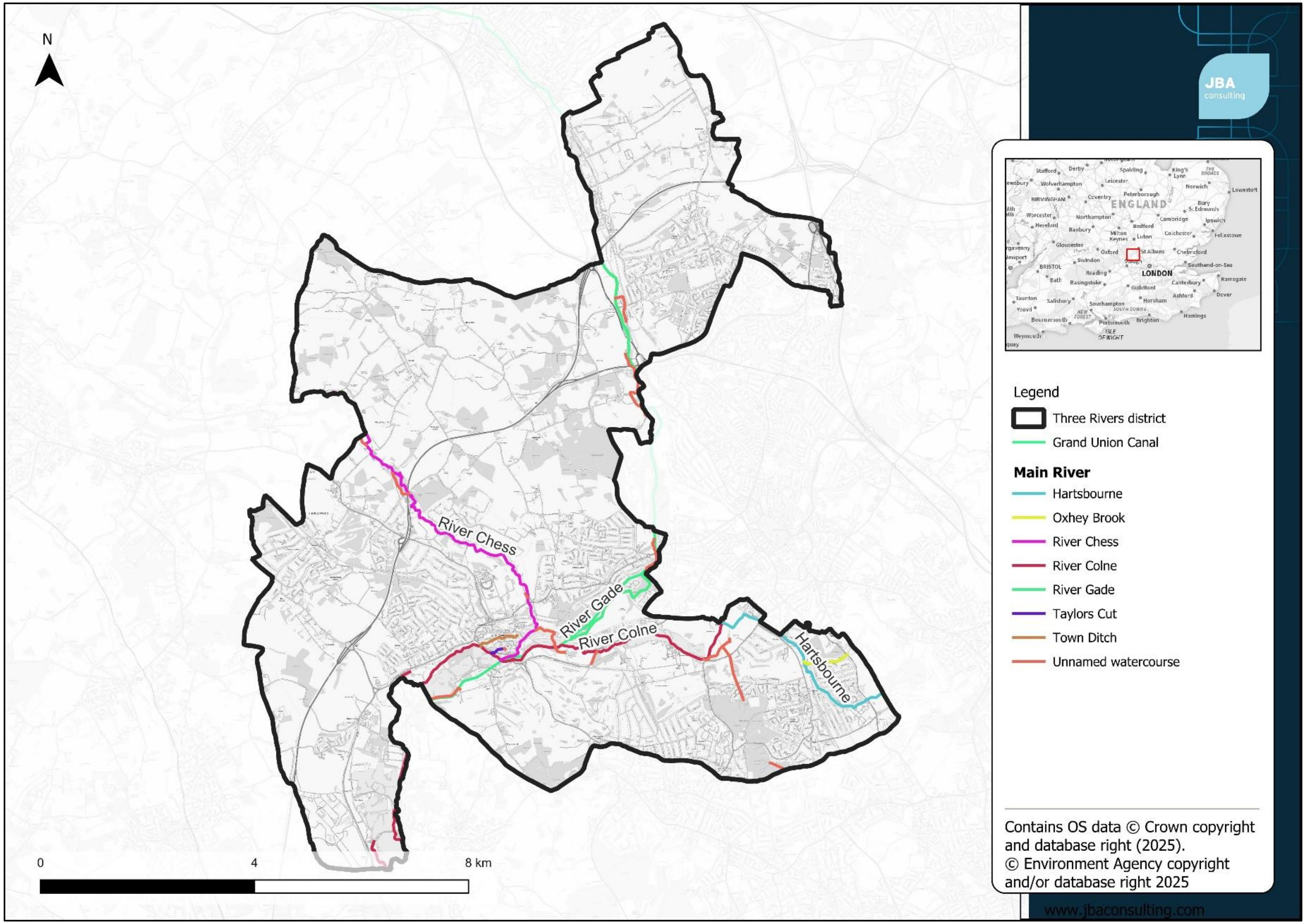


Figure 1-2: Main rivers and other watercourses across the district.

1.5 Consultation

SFRAs should be prepared in consultation with other RMAs. In addition to the LPA the following parties have been consulted during the preparation of this version of the SFRA through data requests and draft report reviews:

- Environment Agency
- Hertfordshire County Council as LLFA

In addition, the following parties were consulted through data requests during the preparation of this SFRA:

- Canal and River Trust
- Thames Water

1.6 Structure of this report

Table 1-1 sets out the contents of this Level 1 SFRA report and appendices, and how to use each section.

Table 1-1: Sets out the contents of the report and how to use each section.

Section	Contents	How to use
Executive summary	This section focuses on how the SFRA can be used by planners, developers, and neighbourhood planners.	Users should refer to this section for a summary of the Level 1 findings and recommendations.
1. Introduction	This section provides a background to the study, the Local Plan stage the SFRA informs, and the Local Plan Area. It also details the organisations involved in the SFRA.	Users should refer to this section for general information and context.
2. Policy and strategy for flood risk management	This section sets out the relevant legislation, policy, and strategy for flood risk management at a national, regional, and local level.	Users should refer to this section for any relevant policy which may underpin strategic or site-specific assessments.
3. Sequential and Exception Tests	This section provides an overview of national planning policy, application of the sequential approach, and the Sequential/Exception Test process. It provides guidance for the Council and developers on the application of the sequential and Exception Test for both allocations and windfall sites, at allocation and planning application stages.	Users should use this section to understand and follow the steps required for the Sequential and Exception Tests.
4. Understanding flood risk	This section introduces the concept of flood risk and provides an overview of the characteristics of flooding affecting the district and key risks including historical flooding incidents and flood risk from all sources, as well as characteristics that influence flood risk including topography, geology and soils.	This section should be used to understand all sources of flood risk across the district including where has flooded historically.

Section	Contents	How to use
5. Impact of climate change	This section outlines the latest climate change guidance published by the EA and how this was applied to the SFRA. It also sets out how developers should apply the guidance to inform site-specific FRAs.	This section should be used to understand the climate change allowances for a range of epochs and conditions, linked to the vulnerability of a development.
6. Flood risk infrastructure	This section provides a summary of current flood defences and asset management and future planned schemes.	This section should be used to understand if there are any defences or flood schemes in a particular area, for further detailed assessment at site specific stage.
7. Flood risk management requirements for developers	This section contains guidance for developers on FRAs, considering flood risk from all sources, and principles of managing flood risk in developments.	Developers should use this section to understand requirements for FRAs and what conditions/guidance documents should be followed, as well as mitigation options.
8. Principles for site design and master planning	This section contains guidance for developers on principles of managing flood risk in developments through site design and master planning.	Developers should use this section to understand what should be considered within the site design and master planning stages of a development.
9. Surface water management and SuDS	This section provides an overview of SuDS, including signposting to relevant guidance, as well as guidance for developers on surface water drainage strategies, considering any specific local standards and guidance for SuDS from the LLFA.	Developers should use this section to understand what national, regional, and local SuDS standards are applicable. Hyperlinks are provided.
10. Flood warning and emergency planning	This section provides an overview of the requirements for emergency plans, include any local emergency planning arrangements, and an overview of the available flood alerts and warnings.	Developers should use this section to understand requirements for emergency planning.

Section	Contents	How to use
11. Cumulative Impact Assessment	This section details the cumulative impact assessment, which identifies which catchments are most likely to be sensitive to increased flood risk as a result of future development.	Planners should use this section to help develop policy recommendations for the cumulative impact of development
12. Strategic flood risk solutions	This section sets out wider strategic solutions that may offer potential to reduce flood risk across the district, including natural flood management. It also details current partnership working opportunities within the district.	Planners should use this section to help develop policy recommendations for strategic flood risk solutions to reduce flood risk across the district. Developers should use this section to consider options for strategic solutions and natural flood management techniques.
13. Summary, recommendations and next steps	This section summarises sources of flood risk in the district and outlines planning policy recommendations. It also sets out the next steps.	Developers and planners should use this as a summary of the SFRA. Developers should refer to the Level 1 SFRA recommendations when considering site specific assessments.
Appendix A	Details the data used to inform the SFRA, including when the data was provided, any associated licensing, and where the data can be obtained from.	Planners and developers should use this appendix to understand what data has been used in the SFRA, whether it has since been updated, and where to access the latest data from.
Appendix B	Sets out the methodology for the Sequential Test, including how each source of flood risk should be considered.	Planners should use this appendix to inform the application of the Sequential Test.
Appendix C	This section details the methodology for the cumulative impact assessment.	Planners should use this appendix, in conjunction with Section 12, to help develop policy recommendations for the cumulative impact of development

Section	Contents	How to use
Appendix D	Provides the flood risk mapping for the SFRA with an accompanying user guide detailing the information shown within the mapping.	Planners and developers should use these maps to identify key areas of flood risk from different sources.

2 Policy and strategy for flood risk management

This section sets out the flood risk management roles and responsibilities for different organisations and relevant legislation, policy, and strategy.

2.1 Roles and responsibilities

There are different organisations in and around the district that have responsibilities for flood risk management, known as RMAs. These are listed in Table 2-1 with a summary of their responsibilities.

Further information on the roles and responsibilities of the RMAs is available in Annex A of the National Flood and Coastal Erosion Risk Management Strategy (FCERM) (gov.uk) for England. The Local Government Association (gov.uk) also provide further information on the roles and responsibilities for managing flood risk.

The National flood risk standing advice for local planning authorities (gov.uk) provides advice on when to consult the EA.

Table 2-1: Roles and responsibilities for RMAs.

Risk Management Authority	Strategic Level	Operational Level	Planning role
EA	Strategic overview for all sources of flooding, National Strategy, and general supervision	Main River (e.g., River Colne) and reservoirs (Flood Risk Activity Permits (FRAPs), enforcement, and works)	Statutory consultee for certain development in Flood Zones 2 and 3 and all works within 20 metres of a main river.
Hertfordshire County Council as LLFA	Coordination of Local Flood Risk Management and maintaining a Local Flood Risk Management Strategy (LFRMS)	Surface water, groundwater, and ordinary watercourses (consenting, enforcement, and works)	Statutory consultee for major developments
Water Company	Asset Management Plans, supported by Periodic Reviews (business cases), develop Drainage and Wastewater Management Plans (DWMPs)	Public sewers and some reservoirs	Non-statutory consultee

Risk Management Authority	Strategic Level	Operational Level	Planning role
Highways Authorities - National Highways for motorways and trunk roads and Hertfordshire County Council for non-trunk roads	Highway drainage policy and planning	Highway drainage	Statutory consultee regarding highways design standards and adoptions

2.1.1 Riparian ownership

Land and property owners are responsible for the maintenance of watercourses either on or next to their properties, called Riparian Owners. Riparian Owners are also responsible for the protection of their properties from flooding as well as other management activities, for example by maintaining riverbeds/banks, controlling invasive species, and allowing the flow of water to pass without obstruction. More information can be found on the Government website in the EA publication 'Owning a watercourse' (gov.uk) and the Hertfordshire County Council leaflet 'Responsibilities of a riparian owner'.

When it comes to undertaking works to reduce flood risk, the EA, and Hertfordshire County Council as LLFA do have permissive powers, but limited resources must be prioritised and targeted to where they can have the greatest effect. Permissive powers mean that RMAs are permitted to undertake works on watercourses but are not obliged.

2.2 Key legislation for flood and water management in the district

2.2.1 Flood Risk Regulations (2009)

The Flood Risk Regulations (FRRs) 2009 translated the European Union (EU) Floods Directive into UK law setting the requirement for Member States to complete an assessment of flood risk, known in England as a Preliminary Flood Risk Assessment (PFRA). This information was then used to identify areas where there is a significant risk of flooding (Flood Risk Areas), where States had to undertake Flood Risk and Hazard Mapping and produce Flood Risk Management Plans (FRMPs). This cycle was repeated on a six-yearly basis.

As of 1 January 2024, the Retained EU Law (Reform and Revocation) Bill automatically repealed any Retained EU Law (REUL) not otherwise preserved or replaced in UK law before the end of 2023, including the FRRs 2009 which transposed the EU Floods Directive into legislation. This is because much of the FRRs duplicated existing domestic legislation, namely the Flood and Water Management Act 2010.

The Government expects to see continued implementation of the Flood Risk Management Plans 2021-2027, with funding for this still in place over the six-year period.

The Hertfordshire PFRA was published in 2011, with an addendum report published in 2017, and provides information on significant historic and predicted local flood risk. No Nationally Significant Flood Risk Areas were identified. However, the 2011 assessment estimated that 4,400 properties in Three Rivers District were potentially at risk of surface water flooding to a depth of 0.3m during a 1 in 200-year event.

2.2.2 Flood and Water Management Act (2010)

The Flood and Water Management Act (2010) (gov.uk) was passed in April 2010 following the recommendations made within the Pitt Review (2009) following the flooding in 2007. It aims to create a simpler and more effective means of managing both flood risk and coastal erosion, establishing the lead role for Local Authorities, as LLFAs, designed to manage local flood risk (from surface water, ground water and ordinary watercourses) and to provide a strategic overview role of all flood risk for the EA.

2.2.3 Water Framework Directive (2000)

The European Water Framework Directive (WFD) (2000) was transposed into English Law by the Water Environment Regulations (2017) (gov.uk). The WFD aims to deliver improvements across Europe in the management of water quality and water resources. This is enforced through a series of plans called River Basin Management Plans (RBMPs). The district falls within the Thames RBMP.

2.2.4 Environmental permitting

The Environmental Permitting Regulations (2016) (gov.uk) set out where developers will need to apply for additional permission (as well as planning permission) to undertake works to a Main River. This includes flood risk activities, for example:

- On or within 8 metres of a main river.
- On or within 8 metres of a non-tidal flood defence structure or culvert.
- Involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert; and
- In a floodplain more than 8 metres from the riverbank, culvert or flood defence structure and you don't already have Planning Permission.

Environmental permits may also be required from the EA to discharge runoff, trade effluent or sewage into a main river. They may also be required in relation to groundwater activities, where there may be a risk of groundwater contamination.

The Land Drainage Act (1991) (gov.uk) sets out where developers will need to apply for additional permission (as well as planning permission) to undertake works to an Ordinary Watercourse. Hertfordshire County Council provides guidance on works to Ordinary Watercourses which require consent.

2.2.5 Byelaws

Land Drainage Byelaws outline legal obligations and responsibilities when undertaking works on or close to a watercourse, for the purpose of preventing flooding, or mitigating any damage caused by flooding.

The district is covered by the Thames region flood defence and land drainage byelaws enforced by the EA. These byelaws apply to activities around main rivers, flood defences and floodplains.

2.2.6 Additional legislation

Additional legislation relevant to development and flood risk in the district include:

- Town and Country Planning Act (1990) (gov.uk), Water Industry Act (1991) (gov.uk), Land Drainage Act (1991) (gov.uk), Environment Act (1995) (gov.uk), which set out the regulations for development on land in England and Wales.
- The Environment Act 2021 (gov.uk) requires developers to provide Biodiversity Net Gain (BNG) and for LPAs to develop Local Nature Recovery Strategies (LNRS). Strategic site allocations in Local Plans which present opportunities for BNG or areas for habitat improvement/creation identified by the LNRS could have parallel opportunities to contribute to reduced flood risk from a range of sources.
- Other environmental legislation such as the Habitats Directive (1992) (gov.uk), Environmental Impact Assessment Directive (2014) (gov.uk), and The Environmental Assessment of Plans and Programmes (Amendment) Regulations 2020 (gov.uk) which apply as appropriate to strategic and site-specific developments to guard against environmental damage.
- The Planning and Compulsory Purchase Act (2004) (gov.uk) Section 19(1A) which requires LPAs to include in their Local Plans ‘policies designed to secure that the development and use of land in the local planning authority’s area contribute to the mitigation of, and adaptation to, climate change.’

2.3 Key national, regional, and local policy documents and strategies

Table 2-2 summarises relevant national, regional, and local flood risk policy and strategy documents and how these apply to development and flood risk. Hyperlinks are provided to external documents. These documents may:

- Provide useful and specific local information to inform FRAs within the local area.
- Set the strategic policy and direction for flood risk management and drainage – they may contain policies and action plans that set out what future flood mitigation and climate change adaptation plans may affect a development site. A developer should seek to contribute in all instances to the strategic vision for flood risk management and drainage in the district.
- Provide guidance and/or standards that inform how a developer should assess flood risk and/or design flood mitigation and SuDS.

The following sections provide further details on some of these documents and strategies.

Please note that the links to these documents may change over time and any requests for these documents should be directed toward the author.

Table 2-2: National, regional, and local flood risk policy and strategy documents.

Policy level	Document, lead author and date	Contextual information	Policy and measures	Development design requirements	Next update due
National	Flood and Coastal Management Strategy (EA) 2020 (gov.uk)	Yes	Yes	No	2026
National	National Planning Policy Framework updated in December 2024 (gov.uk)	Yes	Yes	Yes	-
National	Planning Practice Guidance (PPG): Flood risk and coastal change (gov.uk) updated in September 2025	Yes	Yes	Yes	-
National	Building Regulations Part H (MHCLG) 2010 (gov.uk)	Yes	No	Yes	-
Regional	Thames Catchment Flood Management Plan (EA) 2010 (gov.uk)	Yes	Yes	No	-
Regional	Thames River Basin District River Management Plan (EA) 2022 (gov.uk)	Yes	Yes	No	2028
Regional	Thames River Basin District Flood Risk Management Plan (EA) 2022 (gov.uk)	Yes	Yes	No	-
Regional	Affinity Water Water Resources Management Plan 2024	Yes	No	No	-
Regional	Thames Water Drainage and Wastewater management plan	Yes	No	No	-
Regional	Climate change guidance for development and flood risk (EA) last updated May 2022 (gov.uk)	Yes	No	Yes	-
Local	Hertfordshire Preliminary Flood Risk Assessment (2011)	Yes	No	No	-
Local	Hertfordshire Preliminary Flood Risk Assessment Addendum (2017) (gov.uk)	Yes	No	No	-
Local	Hertfordshire Local Flood Risk Management Strategy	Yes	Yes	No	2029

2.3.1 The National Flood and Coastal Erosion Risk Management Strategy for England (2020)

The National Flood and Coastal Erosion Risk Management Strategy for England (gov.uk) provides the overarching framework for future action by all RMAs to tackle flooding and coastal erosion in England. The Strategy looks ahead to 2100 and the actions needed to address the challenge of climate change.

The Strategy has been split into three high level ambitions:

- Climate resilient places.
- Today's growth and infrastructure resilient in tomorrow's climate.
- A nation ready to respond and adapt to flooding and coastal change.

The Strategy was laid before parliament in July 2020 for formal adoption and published alongside a Policy Statement for Flood and Coastal Erosion Risk Management (gov.uk).

It can be expected that the implementation of the National Strategy will lead to the publication of new guidance and practice that is focused on resilience and adaptation over the coming years. It will be important to adjust the content of the SFRA so that changes in approach are captured in the delivery of the Local Plan.

2.3.2 Catchment Flood Management Plans

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

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

The Local Plan area is covered by the Thames CFMP.

2.3.3 Local Flood Risk Management Strategy

Local Flood Risk Management Strategies (LFRMS) set out how the LLFA will manage local flood risk i.e. surface water runoff, groundwater, and ordinary watercourses, for which they have a responsibility as LLFA and the work that other RMAs are doing to manage flood risk across the district.

The Hertfordshire LFRMS 2 (2019 - 2029) sets out six principles for managing local flood risk across the county. Those of particular relevance to the SFRA include:

- Working to reduce the likelihood of flooding where possible (5)
- Ensuring that flood risk arising from new development is managed (6)

2.3.4 Local policy and guidance for SuDS

The 2024 NPPF states that: 'Applications which could affect drainage on or around the site should incorporate sustainable drainage systems to control flow rates and reduce volumes of runoff, and which are proportionate to the nature and scale of the proposal.' (Paragraph 182) and 'development should only be allowed in areas at risk of flooding where… it can be demonstrated that… c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate' (Paragraph 181).

At the time of writing this SFRA, the following documents and policies are relevant to SuDS and surface water in the district. Hyperlinks are provided to external documents:

- SuDS Manual (C753) (ciria.org), published in 2007 and updated in 2015.
- Defra National standards for sustainable drainage systems (SuDS) (gov.uk), June 2025.
- Building Regulations Part H (MHCLG) (gov.uk), 2010.
- Hertfordshire LLFA Summary Guidance for developers - Management of Surface Water Drainage, August 2021.
- Hertfordshire LLFA SuDS Policy Statement: Meeting Sustainable Drainage System Standards in Hertfordshire. March 2015

Further information on SuDS requirements and design considerations can be found in Section 9.

2.3.5 Water Cycle Studies

Water Cycle Studies (WCSs) 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.

A Water Cycle Study Scoping Report for South West Hertfordshire was undertaken in 2010 to support the existing Local Plans, and recommended that water consumption is reduced to 105 litres per person per day (l/p/d) across the study area. The WCS also highlighted the restrictions in the capacity of Maple Lodge and Blackbirds Wastewater Treatment Works in accommodating the proposed levels of growth in Dacorum, St. Albans, Three Rivers and Watford. Upgrading of the sewerage infrastructure was also identified as a requirement to accommodate growth from Three Rivers District.

In addition, the Hertfordshire Water Study was undertaken in 2017, to provide a county-wide assessment of water supply, wastewater treatment and infrastructure needs up to 2050. The study assessed the immediate, medium and long-term impacts of water planning in Hertfordshire, with a view to water resource use beyond the boundaries and lifetimes of the current emerging local plans.

2.3.6 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location and establish a long-term action plan to manage surface water in a particular area. They are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning, and future developments.

The Three Rivers District SWMP (2021) focused on the five highest risk areas of the district: Batchworth, Eastbury, South Oxhey, Chorleywood and Prestwick Road, Brookdene Avenue and Raglan Gardens. Detailed hydraulic models were developed for the areas, and potential strategies identified within an action plan to alleviate surface water flood risk in each area. One of the key actions relevant to the SFRA was for surface water and groundwater flood risk issues to be considered at the planning application stage for both minor and major development proposals. Another aspect highlighted was determining the suitability of surface water drainage proposals for minor development.

2.3.7 Water Resources Management Plans (WRMPs)

Under the duties set out in sections 37A to 37D of the Water Industry Act 1991, all water companies across England and Wales must prepare and maintain a WRMP. This must be prepared at least every five years and reviewed annually.

WRMPs should set out how a water company intends to achieve a secure supply of water for their customers and a protected and enhanced environment.

The Affinity Water Water Resources Management Plan 2024 covers Three Rivers District.

2.3.8 Drainage and Wastewater Management Plans (DWMPs)

Water and sewage companies must produce a Drainage and Wastewater Management Plan (DWMP), covering a minimum of 25 years, which looks at current and future capacity, pressures, and risks to their networks such as climate change and population growth. They detail how a company plans to work with RMAs and drainage asset owners to manage future pressures. The water and sewage company for the district is Thames Water.

The Thames Water Drainage and Wastewater Management Plan (DWMP) for 2025-2050 covers Three Rivers District. A plan sets out an approach for sustainable water management, under the pressure of climate change and a growing population, including a focus on reducing the risk of sewer flooding to homes. Thames Water have prepared a regional (Level 1) DWMP which is supported by 13 catchment strategic plans (Level 2 DWMP). The Three Rivers District is located within Thames Water's Hertfordshire catchment strategic plan. The Hertfordshire catchment strategic plan is split into 8 tactical planning units (Level 3 DWMP). The tactical planning units are geographical areas in which a wastewater network drains to a single sewage treatment works (STW). Three Rivers District is in the Harpenden STW catchment area.

Internal flooding of sewers and sewer collapses are identified as the most significant risks to the Hertfordshire. Within the Harpenden STW, sewer flooding and STW permit compliance are outlined as the main challenges as this catchment is only served by one overflow.

It should be noted that the assessments carried out in this DWMP are prepared primarily for long term investment planning and not for the sequential placement of new development.

The mapping shows where certain wastewater systems would require investment. However, as there is no certainty about any potential investment and the benefits this may bring, it is not necessarily possible to conclude that this should be used as the basis for the Sequential Test. Additionally, the assessment results provide one risk category for each wastewater system, the actual level of risk within the areas shown might potentially vary substantially and thus the spatial resolution might not be appropriate for use in a comparative analysis of specific sites. The data resolution used as part of the DWMPs does not appear to be comparable to the river and sea flooding information and thus could not easily used alongside the existing data and mapping on a site-specific basis. Therefore, it is recommended that the DWMP information and mapping is not used to assess sewer flooding in the Sequential Test alongside river, sea and surface water flooding on the basis that the available information is not of appropriate resolution or format.

Further consultation with Thames Water should clarify the necessity and extent to which identified DWMP sewer flood risk should be addressed at sites where this is potentially an influential matter.

2.3.9 Neighbourhood plans

A neighbourhood plan is a document produced by a local community that sets out planning policies for their area and can be used to:

- Protect local green spaces;
- Encourage better designed places;
- Bring forward housing that meets local needs.

Neighbourhood planning groups can use the information in this SFRA to assess the risk of flooding to sites within their community.

There are currently three adopted neighbourhood plans in Three Rivers District, covering Croxley Green, Chorleywood and Batchworth, with plans also in the process of development for the Sarratt and Abbots Langley Neighbourhood Areas.

3 Sequential and Exception Tests

This section summaries national planning policy for development and flood risk and the application of the Sequential and Exceptions Tests for both planners and developers.

3.1 National Planning Policy Framework and Guidance

The NPPF (December 2024) (gov.uk) sets out the Government's planning policies for England. It must be considered in the preparation of Local Plans and is a material consideration in planning decisions. The NPPF advises on how flood risk should be considered to guide the location of future development and FRA requirements. The NPPF states that:

“Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards” (Paragraph 171).

The Flood Risk and Coastal Change PPG (gov.uk), last updated September 2025, sets out how the policy should be implemented. Diagram 1 in the PPG (Paragraph: 007 Reference ID: 7-007-20220825) sets out how flood risk should be considered in the preparation of Local Plans.

3.2 The Sequential Test

Firstly, land at the lowest risk of flooding from all sources should be considered for development. A test is applied called the ‘Sequential Test’ to do this. Figure 3-1 summarises the Sequential Test.

The LPA will apply the Sequential Test to strategic allocations. For all other developments, evidence must be supplied to the LPA, with a planning application, that the development has passed the test if any proposed building, access and escape route, land-raising or other vulnerable element will be:

- In Flood Zone 2 or 3;
- In Flood Zone 1 and the SFRA shows it will be at increased risk of flooding during its lifetime; or
- Subject to sources of flooding other than rivers or sea,

The requirements for developers are set out in the FRA Standing Advice (gov.uk).

The LPA should define a suitable search area for the consideration of alternative sites in the Sequential Test. 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/Employment Land Availability Assessments.

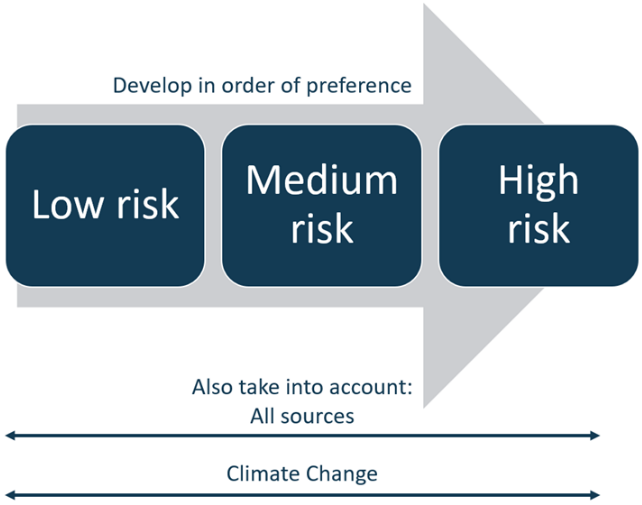


Figure 3-1: The Sequential Test.

Whether any further work is needed to decide if the land is suitable for development will depend on both the vulnerability of the development and the Flood Zone it is proposed for. Table 2 of the PPG (gov.uk) (Paragraph: 079 Reference ID: 7-079-20220825) shows whether, having applied the Sequential Test first, the vulnerability of development is not compatible with a particular Flood Zone and where the Exception Test is required to determine the suitability of that vulnerability of development to the Flood Zone.

Figure 3-2 illustrates the Sequential Test as a process flow diagram using the information contained in this SFRA to assess potential development sites against areas of flood risk and development vulnerability compatibilities. This is a stepwise process, but a complex one, as several of the criteria used are qualitative and based on experienced judgement. The process must be documented, and evidence used to support decisions recorded.

In addition, the risk of flooding from other sources and the impact of climate change must be considered when considering which sites are suitable to allocate. Appendix B addresses the use of flood risk information in the performance of the Sequential Test.

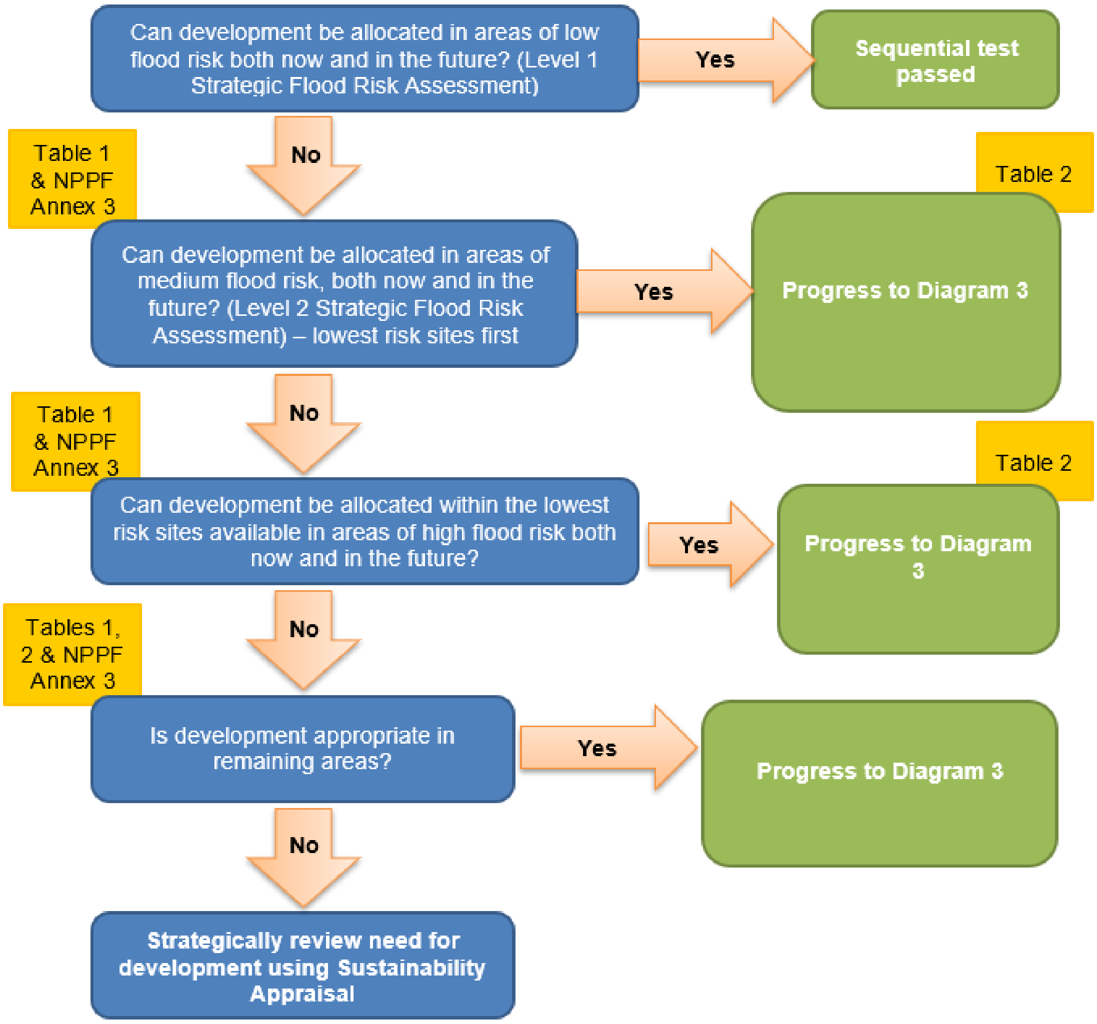


Diagram 2 of PPG: Flood Risk and Coastal Change (paragraph 026, Reference ID 7-026-20220825) Revised August 2022.

Figure 3-2: Application of the Sequential Test for plan preparation.

3.2.1 The risk-based approach

Paragraph 172 of the NPPF states that *"All plans should apply a sequential, risk-based approach to the location of development – taking into account* ***all sources of flood risk*** *and the* ***current and future impacts of climate change*** *– so as to avoid, where possible, flood risk to people and property".*

Appropriate mapping should be prepared for the Sequential Test to enable logical comparison of the flood risk from different sources at alternative locations, both now and in the future, as this is fundamental to establishing a logical "risk sequence".

Appendix B describes the implications of including different sources of flooding both now and in the future in the Sequential Test. It also highlights matters to be considered, including certain circumstances where the Sequential Test would not be required, and identifies a preferred approach.

3.3 The Exception Test

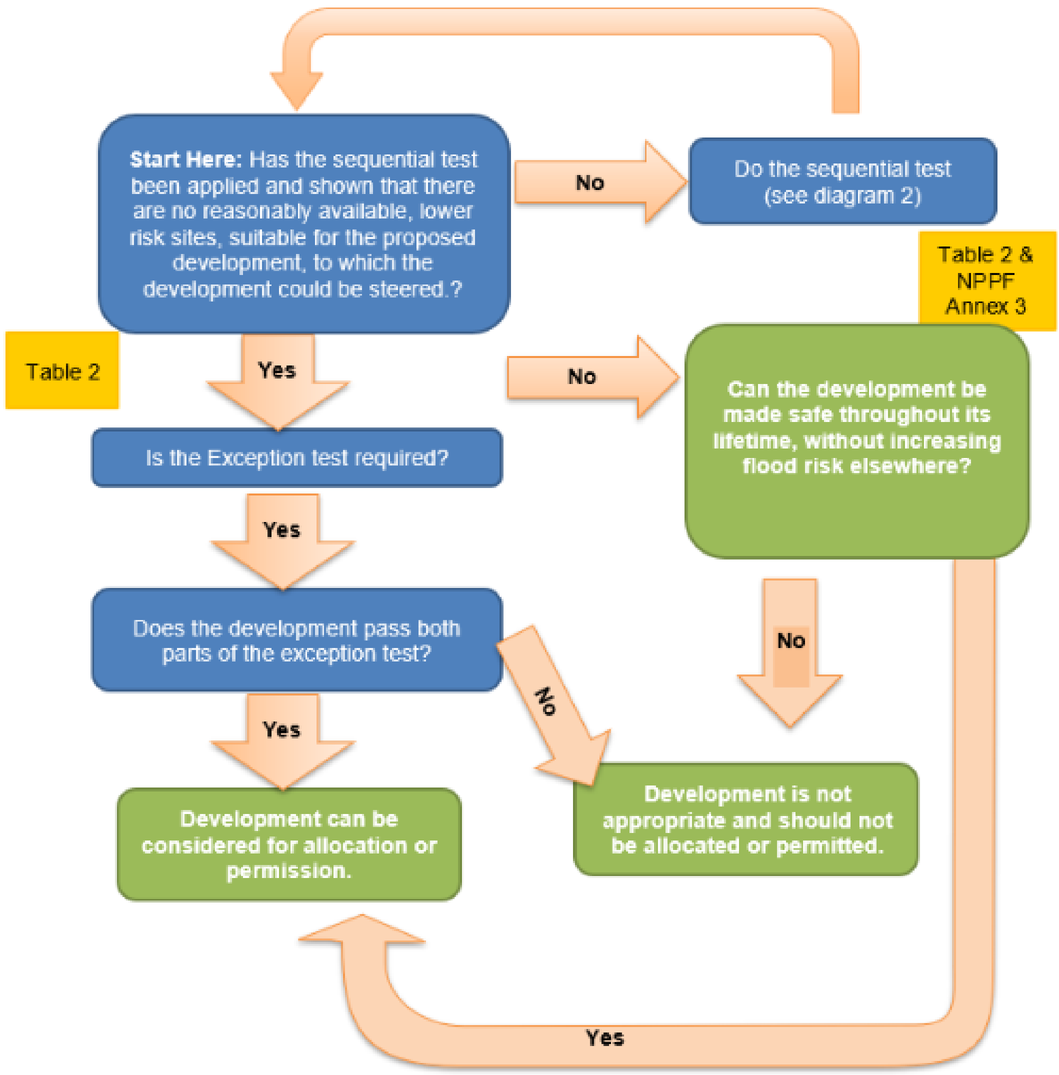
It will not always be possible for all new development to be located on land that is not at risk from flooding. To further inform whether land should be allocated, or planning permission granted, a greater understanding of the scale and nature of the flood risks is required. In these instances, the Exception Test will be required. Diagram 3 of the PPG (gov.uk) (Paragraph: 033 Reference ID: 7-033-20220825) summarises the Exception Test (Figure 3-3).

Table 2 of the PPG (gov.uk) sets out the requirements for the Exception Test but does not reflect the need to avoid flood risk from sources other than rivers and the sea. There is no guidance on how to consider other sources of flood risk. The Exception Test should only be applied, following the application of the Sequential Test, in the following instances:

- 'Essential infrastructure' in Flood Zone 3a or 3b.
- 'Highly vulnerable' development in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b).
- 'More vulnerable' development in Flood Zone 3a (this is NOT permitted in Flood Zone 3b).

While the Exception Test is not explicitly required for sites at risk from other sources of flooding, the LPA should follow a similar principle where sites are proposed that are at risk from other sources of flooding, carefully weighing up the wider benefits of development against the risk, ensuring that site users can be kept safe through the lifetime of the development and ensuring residual risk can be safely managed.

For sites proposed for allocation within the Local Plan, the LPA should use the information in this SFRA to inform the Exception Test. At the planning application stage, the developer must design the site such that it is appropriately flood resistant and resilient in line with the recommendations in national and local planning policy and supporting guidance and those set out in this SFRA. This should demonstrate that the site will still pass the flood risk element of the Exception Test based on the detailed site level analysis.



† Diagram 3 of PPG: Flood Risk and Coastal Change (paragraph 033, Reference ID 7-033-20220825) Revised August 2022.

Figure 3-3: Application of the Exception Test to plan preparation.

There are two parts to demonstrating a development passes the Exception Test that should be considered by the LPA when allocating development sites, and developers when required (see Section 3.4.2 for Exception Test requirements for individual planning applications).

Part A: Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk.

The LPA will need to set out the criteria used to assess the Exception Test and provide clear advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the LPA should consider whether the use of planning conditions and/or planning obligations could allow it to pass the Exception Test. If this is not possible, this part of the Exception Test has failed, and planning permission should be refused.

Wider sustainability objectives should be considered, such as those set out in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, housing, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.

The sustainability issues the development will address and how far doing so will outweigh the flood risk concerns for the site should also be considered, e.g., by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.

Part B: Demonstrating 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.

In circumstances where the potential effects of proposed development are material a Level 2 SFRA is likely to be needed to inform the Exception Test for strategic allocations to provide evidence that the principle of development can be supported. At the planning application stage, a site-specific FRA will be needed. Both will need to consider the undefended and residual risk and how this will be managed over the lifetime of the development.

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

3.4.1 Applying the Sequential Test

The LPA are responsible for considering the extent to which Sequential Test considerations have been satisfied.

Developers should consult with the LPA in the first instance before commencing on a site-specific FRA to determine the Sequential Test requirements for their site. Developers are required to apply the Sequential Test to all development sites, unless the site is:

- A strategic allocation and the test has already been carried out by the LPA as part of preparing the Local Plan, or
- A change of use (except to a caravan, camping or chalet site, or to a mobile home or park home site), or
- A minor development (householder development, small non-residential extensions with a footprint of less than 250m²), or
- A development in fluvial Flood Zone 1 unless there are other flooding issues in the area of the development (i.e. surface water, groundwater, reservoir, sewer flooding).

It should also be noted that residential sub-divisions are exempted from the definition of minor development and therefore, by default, should also be subject to the Sequential Test.

The SFRA contains information on all sources of flooding and considers the impact of climate change. This should be considered when a developer undertakes the Sequential Test, including the consideration of reasonably available sites at lower flood risk. However, it should be noted that the September 2025 update of the PPG advocates for a more proportionate to paragraph 175 of the NPPF. The PPG states that if a site-specific flood risk assessment can clearly demonstrate that the proposed development can remain safe from current and future surface water flood risk for its lifetime without increasing flood risk elsewhere, then the Sequential Test need not be applied.

Local circumstances must be used to define geographical scope of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). To determine the appropriate search area criteria, include the catchment area for the type of development being proposed. For some sites this may be clear, e.g. school catchments, in other cases it may be identified by other Local Plan policies. For some sites, e.g. regional distribution sites, it may be suitable to widen the search area beyond LPA administrative boundaries.

The sources of information on reasonably available sites may include but is not restricted to:

- Site allocations in Local Plans.
- Sites with planning permission but not yet built out.
- Strategic Housing and Economic Land Availability Assessments (SHELAAs)/five-year land supply/annual monitoring reports.
- Locally listed sites for sale.

It may be that a number of smaller sites or part of a larger site at lower flood risk form a suitable alternative to a development site at high flood risk.

Ownership or landowner agreement in itself is not acceptable as a reason not to consider alternatives.

3.4.2 Applying the Exception Test

Where a development proposal is in accordance with an allocation made in a Local Plan following the application of the Sequential and Exception Tests, the Exception Test will only be required to be repeated if:

- Elements of the development that were key to it satisfying the Exception Test at the plan-making stage (such as wider sustainability benefits to the community or measures to reduce flood risk overall) have changed or are not included in the proposed development; or
- The understanding of current or future flood risk has changed significantly.

For developments that have not been allocated in the Local Plan or where the Sequential Test was not applied at the development plan stage and new information becomes available that identifies a flood risk, developers must undertake the Sequential and Exception Tests and present this information to the LPA for approval. The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should investigate in more detail to inform the Exception Test for windfall sites.

The applicant will need to provide information that the application can pass both parts of the Exception Test.

4 Understanding flood risk

This section explores what flood risk is, key sources of flooding in the district, and the factors that affect flooding including topography, soils, and geology.

This is a strategic summary of the risk in the district to inform the application of the Sequential and Exceptions Tests. Developers should use this section to scope out the flood risk issues they need to consider in greater detail in a site-specific FRA to support a planning application. Information in this section should not be used to inform flood risk at a property-level.

4.1 Defining flood risk

Section 3 (subsection 1) of the Flood and Water Management Act 2010 (FWMA) (gov.uk) 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.' Figure 4-1 sets out this definition of risk.

Figure 4-1: Conceptual model depicting how risk can be defined.

4.1.1 Probability

The probability of flooding is expressed as a percentage based on the average frequency measured or extrapolated from records over many years. A 1% AEP indicates the flood level that is expected to be reached on average once in a hundred years, i.e., it has a 1% chance of occurring in any one year, not that it will occur at least once every hundred years.

4.1.2 Consequences

The consequences of flooding include fatalities, property damage, disruption to lives and businesses, with severe implications for people (e.g., financial loss, emotional distress, health problems). Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality), the receptors that are present and the vulnerability of these receptors (type of development, nature, e.g., age-structure, of the population, presence, and reliability of mitigation measures etc).

4.1.3 Source-Pathway-Receptor model

Flood risk can be assessed using the Source-Pathway-Receptor model (Figure 4-2) where:

- The source is the origin of the floodwater, principally rainfall.
- A pathway is a route or means by which a receptor can be affected by flooding, which includes rivers, drains, sewers, and overland flow.
- A receptor is something that can be adversely affected by flooding, which includes people, their property, and the environment.

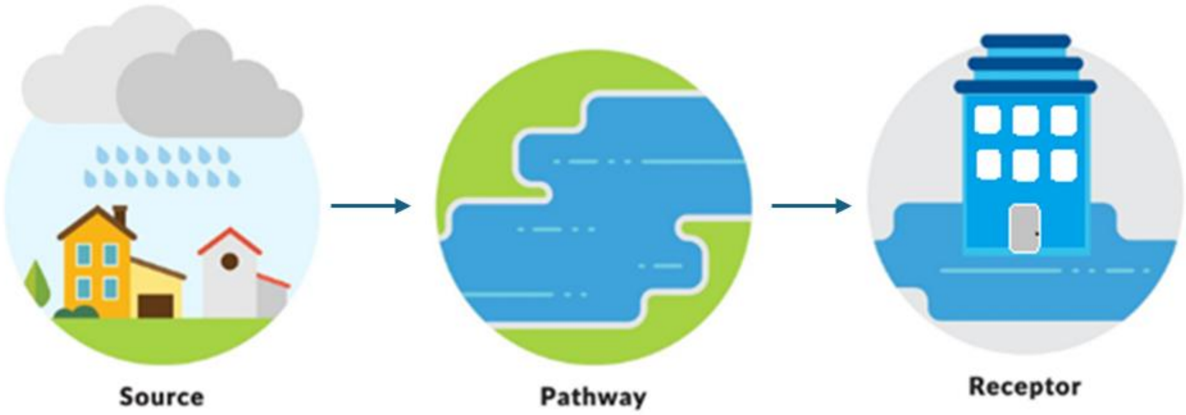


Figure 4-2: Source-Pathway-Receptor model.

This is a standard environmental risk model common to many hazards and should be the starting point of any assessment of flood risk. All these elements must be present for flood risk to arise. Having applied the Source-Pathway-Receptor model it is possible to mitigate the flood risk by addressing the source (often very difficult), blocking, or altering the pathway, or removing the receptor, e.g., steer development away.

The planning process is primarily concerned with the location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk. It is therefore important to define the components of flood risk to apply this guidance in a consistent manner.

4.2 Topography, geology, and soils

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.

4.2.1 Topography

The National LIDAR Programme (gov.uk) provides elevation data at 1m spatial resolution for all of England.

The topography of the district is variable. From the high elevations of the Chiltern Hills in the west and north, the land slopes in a south to south-easterly direction towards the low-lying valleys of the Rivers Chess, Colne and Gade. The areas that are located around river valleys such as Rickmansworth are at a low elevation relative to their surrounding area.

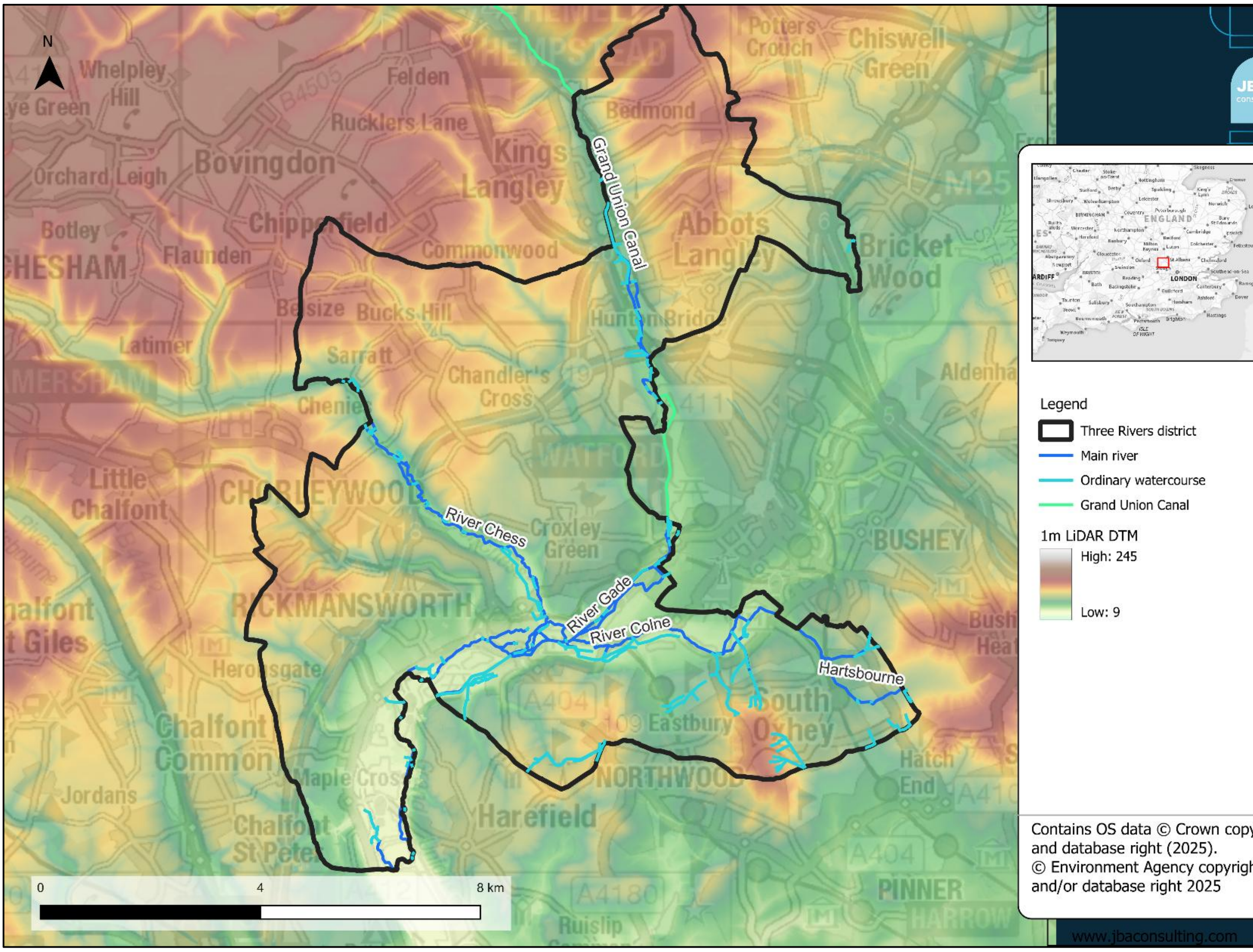


Figure 4-3 shows the topography of the district.

4.2.2 Geology

Permeable bedrock geology of the White Chalk Subgroup underlies the majority of the district. On the slopes of the river valleys in the district, the chalk is overlain by less permeable clays, silts, sands and gravels of the Lambeth Group and Thames Group, which impede drainage into the chalk. In the south of the District, the Lambeth Group forms a thick band south of the River Colne, with the Thames Group forming on higher ground at the southern boundary of the district. Smaller, isolated areas of Lambeth Group clays, silts, sands and gravels are located on the river valleys of the Gade and Chess in the north and west.

The bedrock geology is overlain by superficial deposits, which have a greater influence over surface water runoff. Permeable glacial sands and gravels are located on the higher ground in the north and west of the district. Lower permeability alluvium (clay, silt, sand and gravel deposited by rivers) and relatively impermeable clay-with-flints overlie the floodplains of the Rivers Chess, Colne and Gade.

A map detailing the extents of this bedrock and further superficial geology across the district can be viewed online in the British Geology Society Geology Viewer (bgs.ac.uk).

The EA also provides mapping of different types of aquifers, the underground layers of water-bearing permeable rock from which groundwater can be extracted. Aquifers are designated as either principal or secondary aquifers. Principal aquifers are designated by the EA as strategically important rock units that have high permeability and water storage capacity.

The London Basin Chalk Aquifer is located below much of the study area and is designated as a Principal Aquifer, which provides a significant proportion of the water supply for Hertfordshire. At some locations, the aquifer lies beneath a layer of London Clay. Due to the use of the aquifer for drinking water abstraction, the majority of the district is covered by Groundwater Source Protection Zones (GSPZs), where the Environment Agency provides guidelines to protect groundwater from sources of pollution. These are explained in further detail in Section 9.5.2.

In addition, the Rivers Chess and Gade are groundwater-fed chalk streams, which are fragile hydrological systems, dependent on seasonal rainfall patterns and are therefore prone to low flow conditions. This, alongside over abstraction of aquifers and the watercourses themselves, poses a threat to chalk stream habitats.

Figure 4-4 shows the bedrock geology of the district.

4.2.3 Soils

The soils across most of the district are medium to light sandy loam soils, which are freely draining. The upper slopes of the river valleys are covered by chalky, silty loam, which is likely to see more runoff during wet periods. This transitions to soils of clay, silt and sand on the floodplains of the rivers Chess, Gade and Colne, and heavier clay and silt-rich soils in the south of the district, which are likely to be less well-draining.

The British Geological Survey website (bgs.ac.uk) provides data on soils across the district.

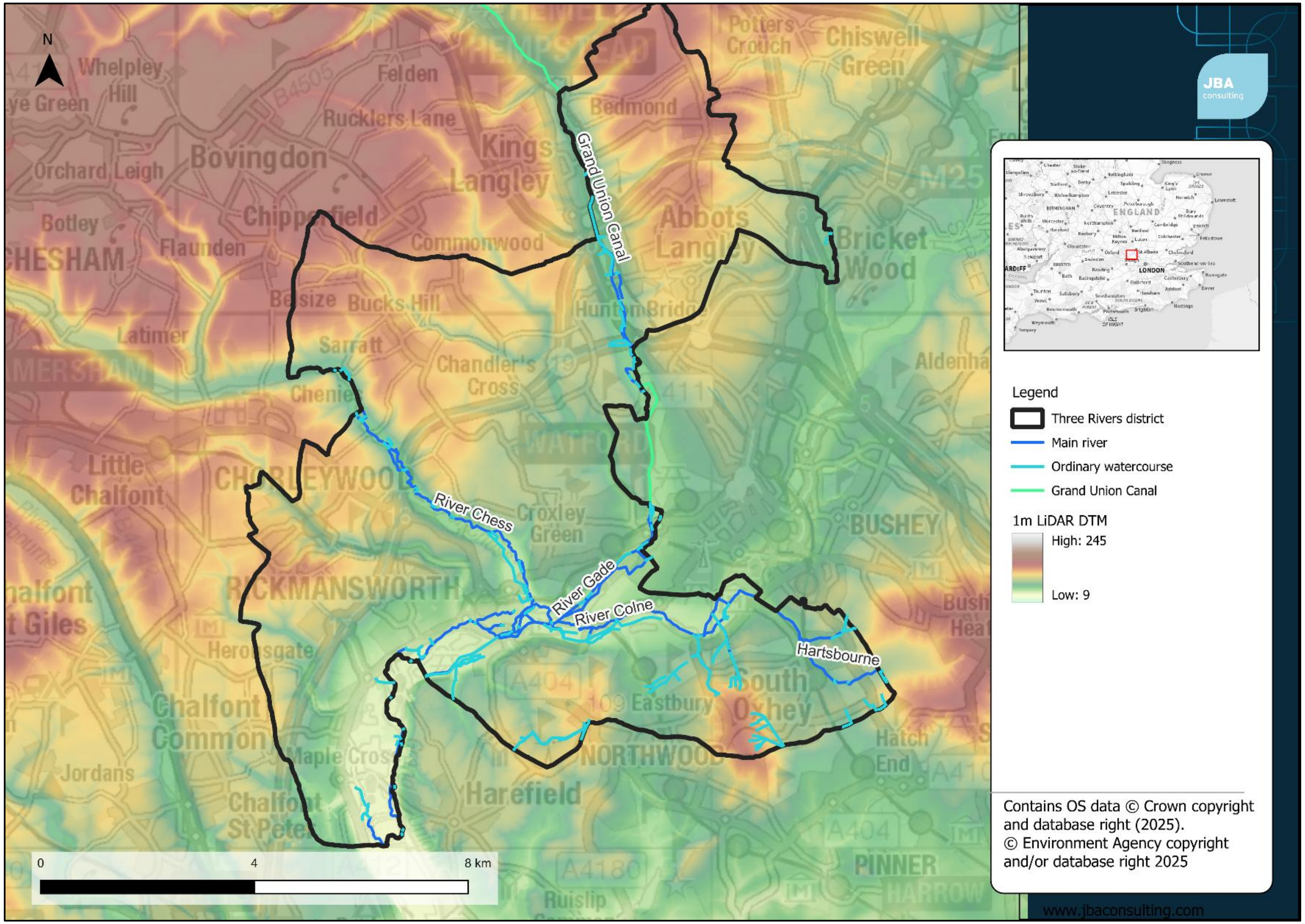


Figure 4-3: EA 1m LiDAR data showing the topography across the district.

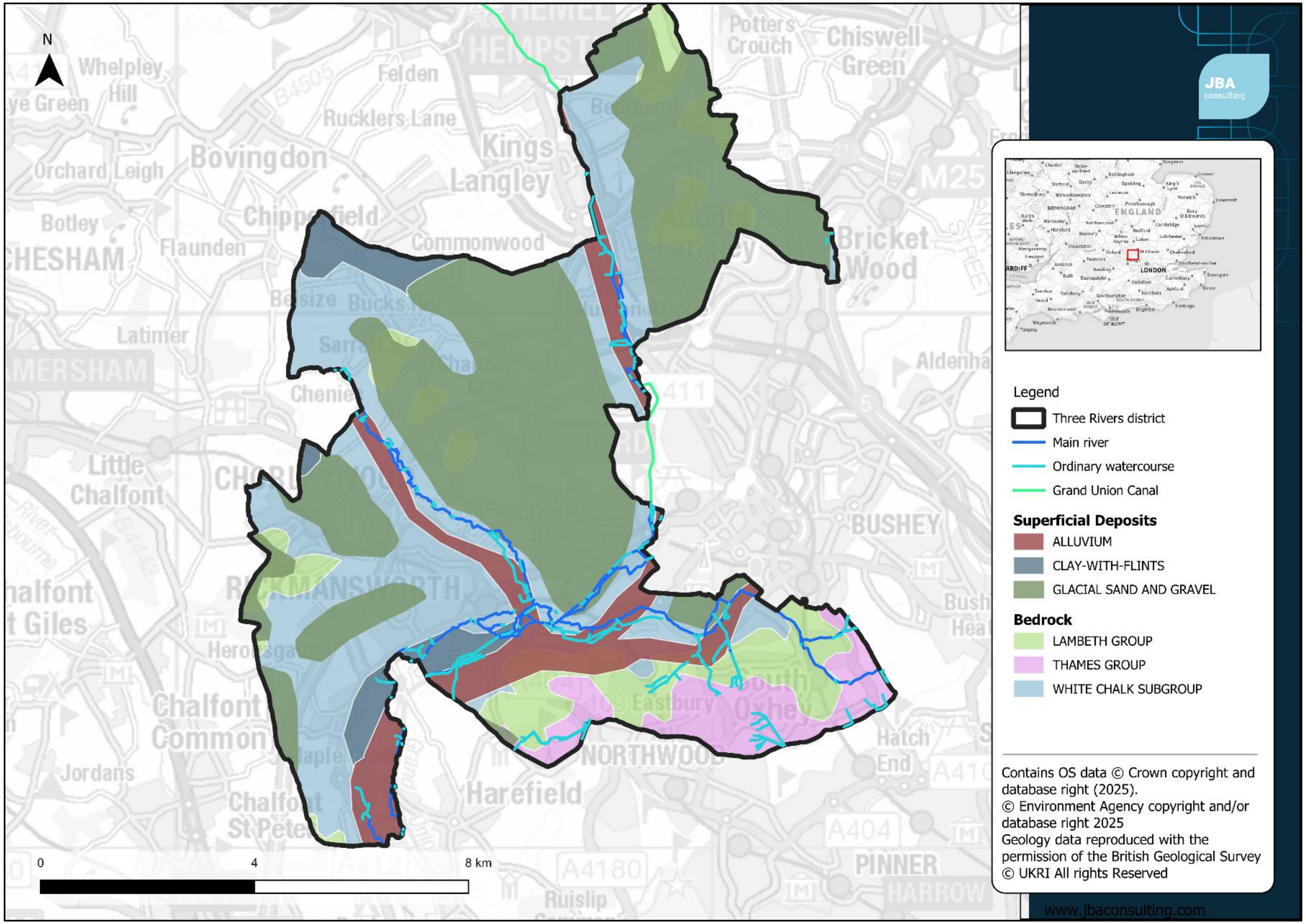


Figure 4-4: Bedrock geology across the district.

4.3 Historical flooding

Several flood incidents have been recorded in the district in recent years, with the greatest number occurring in Rickmansworth. The sources of flooding reflect the diverse and complex flood risks in the district, ranging from surface water flooding caused by overland flows and exceeded sewer systems, to groundwater flooding and overtopping of the River Colne.

Historic flood records provided by Hertfordshire County Council identify the flood events known to have occurred between 2004 and 2016. Since the publication of the previous Level 1 SFRA for Southwest Hertfordshire in 2018, no major flood events have been recorded with the majority of recorded incidents being associated with road flooding due to inundated sewers. The flood incident records are presented at a 1 km^2 scale in Appendix D.

Based on information from the Environment Agency, Thames Water and Hertfordshire County Council, a listing of known recorded events in the district and sources of information is provided in Table 4-1.

Table 4-1: Recorded flood incidents in Three Rivers District

Date	Settlement / location	Source of flooding / description of incident
February 2004	Church Street, Batchworth, Rickmansworth	Groundwater flooding
November 2006	Kewferry Road, Rickmansworth	Groundwater flooding
2007	Uxbridge Road, Rickmansworth	Surface water drainage exceedance as a result of River Colne rising. Properties flooded.
2007	High Street. Rickmansworth	Surface water drainage exceedance during flood event, causing flooding to commercial properties.
1988	South Oxhey	112 properties flooded in the area, 42 by a mixture of foul and surface water, 70 by surface water only.
1988	Uxbridge Road, Rickmansworth	15 properties experienced flooding from foul sewerage system, 12 were flooded from surface water and 14 experienced rear gardens being flooded.
2013 and 2014	Green Street, Chorleywood	Overland surface water flows onto Green Street which led to prolonged flooding of the highway. Dangerous flood level depths meant road closure.
7 February 2014	Harefield Road & Juniper Dell, Rickmansworth	19 properties flooded from surface water flowing down road due to ‘failed culverts'
February 2014	Drayton Ford Cottages, Rickmansworth	Two properties flooded from overtopping of defences from the Colne.

Date	Settlement / location	Source of flooding / description of incident
23 June 2016	Batchwood Lane, Northwood	Intense rainfall formed a surface water flow path which caused internal flooding to 15 properties and external flooding to 9 properties. Also reports of surcharging sewer and highway drainage networks due to high water levels in the Moor Park Stream.
23 June 2016	By The Wood and The Courtway, Carpenders Park	Intense rainfall formed several surface water flow paths which caused internal flooding to four properties and external flooding to one property. Several roads in the area also experienced flooding.
16 September 2016	Church Street, Chorleywood Bottom, Lower Road & Links way, Moor Lane; Rickmansworth	High intensity rainfall event produced surface water runoff, which followed the natural topography and exceeded the capacity of the highway drainage system. Affected 11 properties, including internal flooding of three properties on Church Street and Lower Road.
January 2024	Aquadrome, underpass between Uxbridge Road and Rectory Road, Rickmansworth	Heavy rainfall caused surface water flooding and high groundwater levels. Flooding to the underpass was reportedly linked to failure of a pump which controlled flows from an underground spring.
23 September 2024	Various, road closures included A404 Chorleywood to Rickmansworth	Heavy rainfall caused widespread surface water flooding. 260 reports of flooding across Hertfordshire, as well as closure of road and rail routes.

4.4 Fluvial flood risk

Within Three Rivers District, the main fluvial flooding sources are from the River Chess in the west of the district, the River Colne in the south-east and the River Gade in the north-east. The confluence of the three rivers is in the town of Rickmansworth in the south of the district, and they then continue flowing south as the River Colne, a tributary of the River Thames.

4.4.1 Flood Zones

Fluvial flood risk across the district is assessed based on Flood Zones. The definition of the Flood Zones is provided below. The Flood Zones do not consider defences, except when considering the functional floodplain. This is important for planning long term developments as long-term policy and funding for maintaining flood defences over the lifetime of a development may change over time.

The Flood Zones are:

- Flood Zone 1: Low risk: land having less than a 0.1% chance of flooding from rivers in any given year.
- Flood Zone 2: Medium risk: land having between a 1% and 0.1% chance of flooding from rivers in any given year.
- Flood Zone 3a: High risk: land having between a 3.3% and 1% chance of flooding from rivers in any given year.
- Flood Zone 3b: Functional Floodplain: land where water has to flow or be stored in times of flood (greater than a 3.3% chance of flooding from rivers in any given year). 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. Annex 3 of the NPPF (gov.uk) provides information on flood risk vulnerability.

Since the publication of the 2018 Level 1 SFRA, the EA's Flood Map for Planning (FMfP) (gov.uk) was updated (on 25 March 2025) as part of the new National Flood Risk Assessment (NaFRA2). The Upper Colne (2025) model also was made available through the Environment Agency in October 2025. Updated flood zones included as part of these model outputs have been used in this Level 1 SFRA and at the time of writing this is more up to date. Although, it should be note that over time the online Flood Map for Planning is likely to be updated more often than the SFRA.

Hydraulic models have been used as the evidence base to inform the Environment Agency's fluvial flood mapping. Flood defences should be considered when delineating the functional floodplain. The Flood Map for Planning does not explicitly map the outer boundary of the extent of Flood Zone 3b. The Rivers and Sea 3.33% defended flood extents available as part of the NaFRA2 release is not considered suitable for defining the functional floodplain unless there is an absence of detailed modelling. Therefore, where suitable model outputs were available, these were used to define Flood Zone 3b (see **Error! Not a valid bookmark self-reference.**). Flood Storage Areas, as identified in the Flood Map for Planning dataset, have also been incorporated. The Hartsbourne Flood Storage Area (FSA) lies within the Three Rivers District. The FSA was created by impounding the Hartsbourne Stream with an earth bund, immediately above Oxhey Lane. The FSA only comes into operation during high flows, with normal stream flows passing on their natural course under Oxhey Lane and through Carpenders Park. However, Three Rivers District Council has decided to designate Hartsbourne Flood Storage Area (FSA) as Flood Zone 3b, to safeguard this key flood risk asset from development.

For areas outside of the detailed model coverage, Flood Zone 3a has been used as a conservative proxy for Flood Zone 3b to identify the presence or absence of floodplain. Further work should be undertaken as part of a detailed site-specific FRA to define and refine the extent of Flood Zone 3b where no detailed modelling exists. Caution should also be applied where the conservative Flood Zone 3b extent encompasses existing urban areas which would not otherwise be "designed to flood". Additionally, if existing development or infrastructure is shown in Flood Zone 3b, additional consideration should be given to whether the specific location is appropriate for designation as ‘functional’ with respect to the storage or flow of water in time of flood.

Table 4-2 provides a summary of models available for the district. Detailed modelling was requested from the Environment Agency for all models available for the district. The current FMfP, incorporates the outputs from the now superseded Upper Colne model developed as part of a Strategic Flood Risk Management study undertaken from 2008 to 2010, with the final model completed during 2010. A comparison of these extents to the updated model shows small increase in predicted flood extent across the district, particularly at the River Chess in Rickmansworth and Hartsbourne Stream in Oxhey Hall. Table 4-2 shows a comparison of flood extents in the Upper Colne catchment. Outside of this catchment, Flood Zones 2 and 3a within this SFRA show the same extent as the online FMfP, which incorporates the latest modelled data. It should be noted that the EA Flood Zone 2 also incorporates accepted recorded flood outlines.

Table 4-2 Flood Zone comparison for the Upper Colne catchment within the Three Rivers District

	Upper Colne (2010) model	Upper Colne (2025) model
Flood Zone 2 (%)	9.4	14
Flood Zone 3 (%)	6.8	11.7

It should be noted that the EA Flood Zones do not cover all catchments or ordinary watercourses with areas less than 3km². As a result, whilst the EA Flood Zones may show an area is in Flood Zone 1, there may be a flood risk from a smaller watercourse(s) not shown in the Flood Zones.

Flood defences should be considered when delineating the functional floodplain. The Flood Map for Planning does not explicitly map the outer boundary of the extent of Flood Zone 3b. The Rivers and Sea 3.33% defended flood extents available as part of the NaFRA2 release is not considered suitable for defining the functional floodplain unless there is an absence of detailed modelling. Therefore, where suitable model outputs were available, these were used to define Flood Zone 3b (see **Error! Not a valid bookmark self-reference.**). Flood Storage Areas, as identified in the Flood Map for Planning dataset, have also been incorporated. The Hartsbourne Flood Storage Area (FSA) lies within the Three Rivers District. The FSA was created by impounding the Hartsbourne Stream with an earth bund, immediately above Oxhey Lane. The FSA only comes into operation during high flows, with normal stream flows passing on their natural course under Oxhey Lane and through Carpenders Park. However, Three Rivers District Council has decided to designate Hartsbourne Flood Storage Area (FSA) as Flood Zone 3b, to safeguard this key flood risk asset from development.

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Table 4-3 Hydraulic model data used in the Level 1 SFRA

Model	Year of publication	Model Type	Definition of Flood Zone 3b	Comments
River Chess	2010	1D only	Flood Zone 3a	1D only model
Hartsbourne Stream	2010	1D only	Flood Zone 3a	1D only model
Upper Colne	2025	1D-2D	3.33% AEP defended	Includes both defended and undefended scenarios for the 3.33%, 1% AEP (with 35% and 72% climate change) and the 0.1% AEP. The undefended flood extents have not yet been incorporated in the FMfP.
River Gade	2019	1D-2D	2% AEP defended	Undefended flood extents are included in the FMfP.

The Flood Zone maps for the district are provided in Appendix C.

4.4.2 Summary of fluvial flood risk across the district

Fluvial flood risk in Three Rivers District is concentrated in the floodplains of the three major watercourses:

- The River Colne, which flows from the southeast to the south of the district
- The River Gade, which crosses the district from the northwestern boundary to the eastern boundary, before meeting the Rivers Colne and Chess at Rickmansworth

- The River Chess, which flows from the western boundary to form a confluence with the Rivers Colne and Gade at Rickmansworth

The area of most extensive fluvial flood risk in the district is the low-lying valley of the River Colne, which affects Rickmansworth and Batchworth. Elsewhere in the district, the steeper topography results in fluvial flood risk being closely confined to the river valleys. The floodplain of the River Chess extends into southern Loudwater, and becomes more extensive upstream of the M25, where the river becomes braided. The floodplain of the River Gade at is very confined, and does not extend into adjacent settlements, such as Chorleywood. The southern tributaries of the Colne, Moor Park Stream, Hartsbourne Stream, and Oxhey Brook, pass through residential areas in the southeast of the district, with the most extensive fluvial flood risk predicted from the Hartsbourne Stream at Carpenders Park, upstream of the railway line.

The impacts of climate change on fluvial flooding are discussed in Section 5.2.

4.5 Surface water flood risk

Surface water runoff is most likely to be caused by intense downpours e.g. thunderstorms. At times the amount of water falling can completely overwhelm the drainage network, which is not designed to cope with extreme storms. The flooding can also be complicated by blockages to drainage networks, sewers being at capacity and/or high-water levels in watercourses that cause local drainage networks to back up.

The EA's Risk of Flooding from Surface Water mapping (RoFSW) (gov.uk) has been used to assess surface water risk within this SFRA. These maps are intended to provide a consistent standard of assessment for surface water flood risk across England and Wales in order to help LLFAs, the EA, and any potential developers to focus their management of surface water flood risk.

Revised RoFSW data was released as part of NaFRA2 data in March 2025. The data supersedes previously available data used in the prior Level 1 SFRA. This mapping adopts latest improvement in data (including local modelling from LLFAs), technology and modelling. In comparison with the superseded RoFSW, the NaFRA2 mapping shows significantly reduced flood extents near fluvial flood plains which suggests a refinement in the modelling of surface water flood risk in the district. As such it is considered the most appropriate dataset to use to assess surface water flood risk in this SFRA.

The RoFSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water. The RoFSW should not be used to understand flood risk for individual properties but is suitable for high level assessments such as SFRAs for local authorities.

4.5.1 Summary of surface water flood risk across the district

The EA RoFSW highlights several communities in the district at risk from surface water flooding.

Surface water flood risk is largely confined to the urban areas of Three Rivers District. Flow paths form on the steep slopes and in river valleys and follow the natural topography through the residential areas including Eastbury, South Oxhey, Carpenders Park and Rickmansworth, before entering the River Colne. To the north, at Croxley Green, overland flows are routed in two directions, eastwards to the River Gade and southwards into the Colne. A further flow path in the west of the district follows the route of a dry valley from Chorleywood to Rickmansworth, with areas of ponding forming where the valley is intersected by a railway embankment.

Large areas of surface water ponding occur where the topography flattens on the floodplain of the River Colne, at Rickmansworth, Carpenders Park and Croxley Green. In addition, the railway embankment crossing Eastbury, Moor Park, Rickmansworth and Chorleywood results in some backing up of surface water against the steeper topography.

The RoFSW mapping for the district can be found in Appendix C.

The impacts of climate change on surface water flooding are discussed in Section 5.3.

4.6 Sewer flood risk

Sewer flooding occurs when intense rainfall/river flooding overloads sewer capacity (surface water, foul or combined), and/or when sewers cannot discharge to watercourses due to high water levels. Sewer flooding can also be caused by blockages, collapses, equipment failure or groundwater leaking into sewer pipes.

Since 1980, the Sewers for Adoption guidelines mean that new surface water sewers have been designed to have capacity for a 3.3% AEP rainfall event, although until recently this did not apply to smaller private systems. This means that sewers can be overwhelmed in larger rainfall and flood events.

New developments should not cause additional pressures on existing sewers due to the requirements to maintain greenfield runoff rates. However, increases in rainfall as a result of climate change can lead to existing sewers becoming overloaded, although this can be reduced through the use of well-designed SuDS to reduce surface water runoff.

Thames Water is the water company responsible for the management of the sewerage networks across the district.

Thames Water provided their sewer flooding register for Three Rivers, which is detailed below in **Error! Not a valid bookmark self-reference.**, which shows the total number of incidents between 2015 and 2025. The largest number of incidents within a single postcode area is recorded in WD3, which includes the settlements of Rickmansworth, Chorleywood and Croxley Green. A further area with many incidents is WD19, which covers the areas of Oxhey and Carpenders Park.

Table 4-4 Thames Water sewer flooding register for Three Rivers

Postcode sector	Number of incidents
HA6 2	22
HA6 3	18
HP3 8	1
WD18 8	4
WD19 4	19
WD19 5	46
WD19 6	20
WD19 7	15
WD25 7	1
WD25 7	1
WD25 9	7
WD3 1	30
WD3 4	19
WD3 6	15
WD3 7	23
WD3 8	32
WD3 9	27
WD4 8	16
WD4 9	3
WD5 0	66

The mechanism of flooding is not specified in the register. However, the presence of fluvial, surface water and groundwater flood risk in these areas suggests an interaction with the sewer network, such as ingress or restricted outfalls due to high river levels.

4.7 Groundwater flood risk

In general, less is known about groundwater flooding than other sources of flooding and availability of data is limited. Groundwater flooding can be caused by:

- High water tables, influenced by the type of bedrock and superficial geology.
- Seasonal flows in dry valleys, which are particularly common in areas of chalk geology.
- Rebounding groundwater levels, where these have been historically lowered for industrial or mining purposes.
- Where there are long culverts that prevent water easily getting into watercourses.

- Perched aquifers underlain by impermeable geology, particularly in low lying areas.

Groundwater flooding is different to other types of flooding. It can last for days, weeks, or even months and is much harder to predict and warn for. Monitoring does occur in certain areas, for example where there are major aquifers or when mining stops. The potential impacts of high groundwater levels are not limited to the observable above-ground or basement-level flooding. Shallow groundwater levels can also exacerbate poor drainage and groundwater ingress can damage below-ground infrastructure.

Groundwater flooding can also interact with and exacerbate other sources of flooding. Groundwater emerging at the surface may be conveyed overland and drain into surface water networks, exacerbating surface water. High groundwater levels can also occur in tandem with high river levels. Rising groundwater levels can be caused by high river level due to increased recharge. Conversely, higher baseflow contributions from groundwater may also motivate fluvial flooding in permeable catchments. Elevated ground water levels can surcharge drainage outfalls and reducing a river's capacity during a fluvial flood event due to saturation of the ground that can retain flood water. As such, it is often difficult to distinguish historic incidents of groundwater flooding from other sources of flooding, or discern the contribution of high groundwater levels to flooding.

The JBA Groundwater Emergence map shows the likelihood of groundwater emergence posing a risk to both surface and subsurface assets, based on predicted groundwater levels during a 1% AEP event. This divides groundwater emergence into five categories (Table 4-5).

Table 4-5: JBA Groundwater Emergence Map category descriptions.

Category	Potential risk
Groundwater levels are either at or very near (within 0.025m of) the ground surface.	Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
Groundwater levels are between 0.025m and 0.5m below the ground surface.	Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
Groundwater levels are between 0.5m and 5m below the ground surface.	There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
Groundwater levels are at least 5m below the ground surface.	Flooding from groundwater is not likely.
No risk.	This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.

It should be noted that this dataset only identifies areas likely to be at risk of groundwater emergence and does not allow prediction of the likelihood of groundwater flooding or quantification of the volumes of groundwater that might be expected to emerge in a given area.

4.7.1 Summary of groundwater emergence risk across the district

In this SFRA, the risk of emergence mapping has been combined with 1 in 1000-year Risk of Flooding from Surface Water mapping to provide an indication of the likely flow paths as the generalised modelling is based on the topography of the area. Where a surface water flow path insects and is downstream of, a higher risk groundwater emergence zone (groundwater <5m below the ground surface) this can be considered as an area potentially at-risk from groundwater flooding. In Three Rivers flow path are mostly associated with the floodplains of the Rivers Colne, Chess and Gade. Here, the chalk geology and gravel surface deposits can result in heightened groundwater levels at, or just below, the ground surface. The settlements identified as at highest risk of groundwater flooding (such as Rickmansworth, eastern Croxley Green, western Loudwater and Oxhey) are coincident with the fluvial flood zones. As such, groundwater would be considered in the base flow of the watercourses and therefore fluvial flooding.

However, there are a few notable areas that are away from fluvial flood zones. For instance, there is a westward surface water flow path from Rickmansworth towards Chorleywood, where groundwater levels are predicted to be between 0.5m and 5m. Additional notable areas with surface water risk and shallow groundwater levels, include flow paths from Maple Cross to Heronsgate (west of the M25) and north to south of Bucknalls Lane (east of the A405 in Waterdale).

If a site is identified as being potentially at risk from groundwater flooding a more detailed assessment will be undertaken within the Level 2 SFRA which should consider local conditions on a site-by-site basis using available historic, borehole, geological and LIDAR data.

This JBA Groundwater Emergence map is shown in Appendix C.

4.8 Residual risk

Residual risk comes in two main forms (PPG: Flood Risk and Coastal Change Paragraph: 041):

- Residual risk from flood risk management infrastructure.
- Residual risk to a development once any site-specific flood mitigation measures are taken into account.

Examples of residual flood risk from flood risk management infrastructure include:

- A breach of a raised flood defence, blockage of a surface water conveyance system or failure of a pumped drainage system;
- Failure of a reservoir; and

- A flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot accommodate.

This SFRA does not assess the probability of failure. However, in accordance with the NPPF, all sources of flooding need to be considered. If a breach or overtopping event were to occur, then the consequences to people and property could be high. It is the responsibility of the developer to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks can be safely managed.

Examples of residual flood risk to a development include:

- The depth of internal flooding predicted after any raising of land or floor levels;
- The flood hazard to which people would be exposed on access or escape routes after they have been raised; and
- A failure of flood forecasting or flood warning and the risks associated with people not receiving warnings or acting upon them.

4.8.1 Canal flood risk

Canals are regulated waterbodies and are unlikely to flood unless there is a sudden failure of an embankment or a sudden ingress of water from a river in areas where they interact closely. Embankment failure can be caused by:

- Culvert collapse.
- Overtopping.
- Animal burrowing.
- Subsidence/sudden failure e.g., collapse of former mine workings.
- Utility or development works close or encroaching onto the footings of a canal embankment.

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 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. The Canal and River Trust monitor embankments at the highest risk of failure.

There is a risk of flooding from the Grand Union Canal, where it interacts with the River Colne at Rickmansworth and further downstream. Data received from the Canal and Rivers Trust indicates that there have been several incidents of canal overtopping between Rickmansworth and West Hyde, in response to heavy rainfall and raised levels or overtopping of the River Colne. The incidents occurred in April 2013 and February 2014, largely affecting the canal towpath between Coppermill Lane and Coppermill Lock, with no damage to property reported.

The canals have the potential to interact with other watercourses in the district. These have the potential to become flow paths if these canals were overtopped or breached. Interactions between the Grand Union Canal and adjacent watercourses may not be represented in full within the Flood Map for Planning. Any development proposed adjacent to a canal should include a detailed assessment of how a canal breach or overtopping would impact the site, as part of a site-specific Flood Risk Assessment (FRA). Guidance on development near canals is available from the Canal and River Trust (canalrivertrust.org.uk).

To address a future shortfall in water resources, Affinity Water (in collaboration with multiple stakeholders, including the Canal and River Trust) is currently investigating plans to transfer water from the Midlands to the South via the Grand Union Canal network. This will require raising of the canal banks, new pipelines and pumps, as well as a new water recycling plant at Minworth to treat water. The project is also expected to provide flood alleviation, as well as biodiversity and public access enhancements. The project is due to be completed by late 2032.

4.8.2 Reservoir flood risk

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoirs Act 1975 (gov.uk) and are on a register held by the EA. The level and standard of inspection and maintenance required by a Supervising Panel of Engineers under the Act means that the risk of flooding from reservoirs is very low.

Reservoirs have a designated "risk category" set by the potential damage and loss of life in circumstances where there is a breach or an extreme flood event. Reservoirs designated as high risk are subject to increased inspection and maintenance requirements. However, this designation does not mean they are at a high risk of flooding. Allocation of new development downstream of an existing reservoir could potentially change the risk category and result in a legal requirement to improve the structural and hydraulic capacity of the dam. As the cost of implementing such works can be substantial, consideration should be given to whether it would be more appropriate to place development in alternative locations not associated with such risk.

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 is extremely low compared to flooding from other sources. 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 EA hold mapping showing what might happen if reservoirs fail. Developers and planners should check the Long-Term Risk of Flooding (gov.uk) before using the reservoir data shown in this SFRA to make sure they are using the most up to date mapping.

The EA provide two flooding scenarios for the reservoir flood maps: a 'dry-day' and a 'wet-day'. The 'dry day' scenario shows the predicted flooding which would occur if the dam or reservoir fails when rivers are at normal levels. The 'wet day' scenario shows the predicted worsening of the flooding which would be expected if a river is already experiencing an extreme natural flood. It should be noted that these datasets give no indication of the likelihood or probability of reservoir flooding. The EA 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.

4.8.2.1 Summary of reservoir flood risk across the district

The current mapping shows that there are three reservoirs located within the district (Hartsbourne Flood Storage Area, Heronsgate No.3, Oxhey Woods) and a further four reservoirs located outside the district which pose a risk within the district (detailed in Table 4-6). The reservoir flood mapping is shown in Appendix C.

A considerable area of Three Rivers District is identified as having a residual risk of flooding, in the unlikely event of a reservoir breach. Narrow river valleys and dry valleys are predicted to convey flows from the reservoirs located within the District, through South Oxhey, Carpenders Park, Chorleywood Bottom and Mill End. Elsewhere, flows from reservoirs outside the District, including Hilfield Park and Latimer Lakes, are conveyed through the floodplains of the Rivers Chess, Colne and Gade.

Table 4-6: Reservoirs with flood extents that impact the district.

Reservoir	Easting and Northing	Reservoir owner	Risk Category	Local Authority	Does reservoir impact district in 'dry day' scenario?
Bushey Heath No.5	515232, 194040	Affinity Water Limited	High	Hertfordshire	Yes
Harefield No.3	506800, 191500	Affinity Water Limited	High	Hillingdon	Yes
Hartsbourne Flood Storage Area	513000, 193200	Environment Agency	High	Hertfordshire	Yes
Heronsgate Reservoir No.3	502393, 195278	Affinity Water Limited	High	Hertfordshire	Yes
Hilfield Park	515700, 196000	Affinity Water Limited	High	Hertfordshire	Yes
Latimer Lakes (Great Water)	499720, 198712	Restore Hope	High	Buckinghamshire	Yes
Oxhey Woods Reservoir	510662, 191764	Affinity Water Limited	High	Hertfordshire	Yes

4.9 Combined sources of flood risk

Several areas of the district are at risk from combined sources of flooding. This is particularly the case in urban areas, where surface water drainage systems discharging into watercourses can be restricted by high river levels, or surface water runoff and groundwater ingress can impact the capacity of sewage.

As part of the Three Rivers SWMP (2021), surface water flooding and its interactions with sewage and drainage systems was assessed, and a series of flooding hotspot areas were identified in the district. The settlements identified in the longlist of hotspots included Batchworth, Eastbury, Oxhey, Rickmansworth, Chorleywood, South Oxhey, Nash Mills and Kings Langley, Moor Park.

5 Impact of climate change

The NPPF sets out that flood risk should be managed over the lifetime of a development, taking climate change into account. This section sets out how the impact of climate change should be considered.

5.1 Climate change guidance

The Climate Change Act 2008 (legislation.gov.uk) 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. This was updated in June 2019 under the Climate Change Act 2008 (2050 Target Amendment) Order (legislation.gov.uk) to a 100% reduction (or net zero) by 2050.

In 2018, the Met Office published new UK Climate Projections (UKCP18) (gov.uk). The EA used these projections to update their guidance on climate change allowances for new developments for river flow (July 2021) and rainfall intensity (May 2022). This includes information on how these allowances should be included in both SFRAs and FRAs. The guidance adopts a risk-based approach considering the vulnerability of the development and considers risk allowances on a management catchment level, rather than a river basin level. The management catchments for the district are shown in **Error! Reference source not found.**.

Developers should check Flood risk assessments: climate change allowances (gov.uk) for the most recent guidance before undertaking a detailed FRA.

5.2 Peak river flows

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

The peak river flow allowances (gov.uk) provided in the guidance show the anticipated changes to peak flow for the management catchment within which the subject watercourse is located. The range of allowances are based on percentiles which describe the proportion of possible scenarios that fall below an allowance level:

- The central allowance is based on the 50th percentile (exceeded by 50% of the projections in the range).
- The higher central allowance is based on the 70th percentile (exceeded by 30% of the projections in the range).
- The upper end allowance is based on the 95th percentile (exceeded by 5% of the projections in the range).

These allowances (increases) are provided in the form of figures for the total potential change anticipated, for three climate change periods:

- The '2020s' (2015 to 2039).
- The '2050s' (2040 to 2069).
- The '2080s' (2070 to 2125).

The time period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years, whilst the lifetime of a non-residential development depends upon the characteristics of that development, but a period of at least 75 years is likely to form a starting point for assessment. Further information on what is considered to be the lifetime of development is provided in the PPG (gov.uk).

5.2.1 Peak river flow allowances

The district is located within the Colne Management Catchment for peak river flow allowances. Table 5-1 displays the peak river flow allowances that apply to the district.

Table 5-1: Peak river flow allowances for the Colne Management Catchment.

Allowance category	Total potential change (%) anticipated for '2020s' (2015 to 2039)	Total potential change (%) anticipated for '2050s' (2040 to 2069)	Total potential change (%) anticipated for '2080s' (2070 to 2125)
Upper	30%	38%	72%
Higher	16%	16%	35%
Central	10%	8%	21%

5.2.2 Which peak river flow allowance to use?

The EA guidance states that both the central and higher central allowances should be assessed in SFRAs.

The Flood Zone and flood risk vulnerability classification (gov.uk) should be considered when deciding which allowances apply to the development or the plan. Specific guidance for which climate change allowance estimates should be applied can be found in the EA climate change guidance (gov.uk).

5.2.3 Representation of fluvial climate change within the Level 1 SFRA

The following model outputs were available for the assessment of climate change impacts:

- Upper Colne model (2025) - 1% AEP defended scenario (+35%, +72%)
- River Gade and Bulbourne (2019) - 3.3% and 1% AEP defended scenario (+25%, +35%)

The FMfP released as part of NAFRA2 also includes a 'Rivers and Sea undefended flood risk extents - climate change' dataset, which applies the central uplift for the 2080s epoch. However, this does not include depth, velocity and hazard information. These are provided for the 1% AEP, and 0.1% AEP events which are suitable for considering future flood risk to all development types other than essential infrastructure. Climate change modelling was available for the Upper Colne (2025) and the Gade and Bulbourne (2019) defended models.

Care should be taken when interpreting how Flood Zone 3b is predicted to change as a consequence of climate change. It is possible that the assessment performed to estimate the frequency of inundation (3.33% AEP for Flood Zone 3b) will not include an allowance for the potential increase in standard of protection provided by flood risk management features. In these circumstances more detailed assessments should be performed when considering whether development is appropriate to understand the commitment required to improve the standard of protection and how this affects the extent of Flood Zone 3b.

5.2.4 Implications of climate change for fluvial risk across the district

In assessing the impact on flood risk, the effect of climate change tends to be an increase in the mapped flood extent. However, it should be noted that even where flood extents are not predicted to significantly increase, flooding is likely to become more frequent under a climate change scenario.

The River Gade and River Chess flow through areas of steep upload, where the floodplains are well defined. However, the FMfP Central climate change allowance for the '2080s' epoch (20170 to 2125) shows that the total area of Flood Zone 2 and 3 in the district increases from 6.9% in the present day to 8.3% with climate change. The most significant increases in flood extent associated with these watercourses, particularly on the River Gade at Kings Langley and Croxley, and the River Chess from Loudwater to Rickmansworth.

In contrast, climate change is predicted to result a minor increase in flood extent on the floodplain of the River Colne itself, although a greater increase is predicted the tributary watercourses of Hartsbourne Stream and Oxhey Brook, particularly west of Oxhey Lane in Carpenders Park and South Oxhey. A larger increase in flood extent is predicted on the lower reaches of the Hartsbourne Stream, in residential areas between Brookdene Avenue and Brookside Road.

To a lesser extent this trend is also predicted in the Upper Colne defended model, but this modelling also shows a localised increase in flood extents from the Colne at Maple Cross. The Gade defended model similarly shows a more modest increase in flood extents, a small area of increase is only predicted at Croxley Green.

5.3 Peak rainfall intensities

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems. The EA have developed a peak rainfall allowances map (gov.uk) which shows anticipated changes in peak rainfall intensity which can be used for site-scale applications (like urban drainage design) and surface water flood mapping in small catchments (<5km^2).

The guidance suggests that direct rainfall modelling may not be suited to larger (>5km^2) catchments with rural land use. In these instances, the guidance states that the fluvial flood risk affected by climate change should be assessed using uplifts from peak river flow allowances (Section 5.2).

5.3.1 Peak rainfall intensity allowances for the district

The district is located within the Colne Management Catchment for peak rainfall allowances. Table 5-2 shows the peak rainfall allowances that apply to the district.

Table 5-2: Peak rainfall intensity allowances for small and urban catchments for Colne Management Catchment.

Allowance category	Total potential change (%) anticipated for '2050s' (2022 to 2060) 3.3% AEP	Total potential change (%) anticipated for '2050s' (2022 to 2060) 1% AEP	Total potential change (%) anticipated for '2070s' (2061 to 2125) 3.3% AEP	Total potential change (%) anticipated for '2070s' (2061 to 2125) 1% AEP
Upper end	35%	40%	35%	40%
Central	20%	20%	25%	25%

5.3.2 Which peak rainfall intensity allowance to use?

Rainfall intensity climate change uplifts should be applied to both the 3.3% and 1% AEP events. The recommended epoch and use of either the central or upper end allowances should be based on the design lifetime of the proposed development. Further details are provided within the EA climate change guidance (gov.uk). For FRAs and SFRAs the upper end allowance should be used. The EA guidance recommends that the upper end allowance is considered for both the 3.3% and 1% AEPs for the 2070's epoch (2061 to 2125), unless the allowance for the 2050's epoch (2022 to 2060) is higher, in which case this should be used. This is appropriate for development with a lifetime beyond 2100. For development with a shorter lifetime the central allowance can be used.

5.3.3 Representation of surface water climate change within the Level 1 SFRA

The Environment Agency's Risk of Flooding from Surface Water (RoFSW) with Climate Change dataset has been used to assess the impacts of climate change on surface water flood risk. This data includes depth, hazard and velocity information. However, this dataset only provides the central allowance up to the 2050s epoch, which is insufficient for development with longer lifetimes. As such, the 0.1% AEP extent has also been used as a indicative extent for the 1% plus Upper End Climate Change event.

5.3.4 Implications of climate change for surface water risk across the district

The climate change uplift extends and connects existing surface water flow paths generated during a 1 in 100-year event. There are a few expanded areas of surface water ponding on low-lying ground, particularly against railway embankments and on the fluvial floodplain.

5.4 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is much more uncertain than other types of flooding. The limitations of datasets available for present day risk are more prominent when considering the impacts of climate change.

It is understood that 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. Climate change is also predicted increase the probability and magnitude of high river flows. Where river and ground water levels are hydraulically linked, increased peak river flows brought about by climate change will directly impact local groundwater levels. This may extend the influence of a fluvial flood event to affect below-ground infrastructure and development beyond the floodplain.

The effect of climate change on groundwater levels for sites in areas where groundwater is known to be an issue should be considered at the planning application stage.

5.5 Adapting to climate change

PPG: Climate Change (gov.uk) Paragraph 003 (Reference ID: 6-003-20140612) contains information and guidance for how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change. Paragraph 005 (Reference

ID: 6-005-20140306) also provides considerations for the LPA on dealing with the uncertainty of climate risks and accounting for climate change in a realistic way within developments.

Climate change projections predict that Three Rivers District will experience the following changes over the next few decades:

- A 2°C increase in average annual temperatures
- Hotter, drier summers with up to 25% less rainfall
- Warmer, wetter winters with up to 22% more rainfall
- Higher frequency and more intense extreme weather events, such as heatwaves and severe flooding

6 Flood risk infrastructure

This section provides a summary of existing flood alleviation schemes and assets in the district. Planners should note the areas that are protected by defences where further work to understand the undefended and residual flood risk through a Level 2 SFRA may be beneficial. Developers should consider the benefit they provide over the lifetime of a development in a site-specific FRA.

6.1 Asset management

RMAs hold databases of flood risk management and drainage assets according to their jurisdiction as follows:

- The EA holds a national database that is updated by local teams.
- The LLFA holds a database of significant local flood risk assets, required under Section 21 of the FWMA (2010).
- Highways Authorities hold databases of highways drainage assets, such as gullies and connecting pipes.
- Water Companies hold records of public surface water, foul and combined sewers, the records may also include information on culverted watercourses.

The databases include assets RMAs directly maintain and third-party assets. The drainage network is extensive and will have been modified over time. It is unlikely that any RMA contains full information on the location, condition, and ownership of all the assets in their area. They take a prioritised approach to collecting asset information, which will continue to refine the understanding of flood risk over time.

6.2 Standards of Protection

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

Over time the actual SoP provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to climate change. The understanding of SoP may also change over time as RMAs undertake more detailed surveys and flood modelling studies.

It should be noted that the EA's on-going hydraulic modelling programme may revise flood risk datasets and, therefore, the SoP offered by flood defences in the area may differ from those discussed in this report.

6.3 Maintenance

Different authorities have responsibilities relating to maintenance of flood risk assets, set out in Table 6-1. It is important that the authorities work in partnership to maintain flood risk assets and manage flood risk across the district.

Table 6-1: Flood risk asset maintenance responsibilities based on the FWMA (2010).

Authority	Asset maintenance responsibilities
EA	Permissive powers to maintain and improve main rivers, ultimate responsibility for maintaining watercourses rests with the landowner.
Local Authorities	Permissive powers to maintain and improve ordinary watercourses, ultimate responsibility for maintaining watercourses rests with the landowner.
LLFA	Permissive powers, limited resources are prioritised and targeted to where they can have the greatest effect
Highways Authorities	Duty to maintain public roads, making sure they are safe, passable, and the impacts of severe weather have been considered. Responsible for maintaining sections of watercourses where they are crossed by highways.
Water Companies	Duty to effectually drain their area. What this means in practise is that assets are maintained to common standards and improvements are prioritised for the parts of the network that do not meet this standard e.g., where there is frequent sewer flooding.
Riparian Owners	Responsible for the protection of their properties from flooding as well as other management activities, for example by maintaining riverbeds/banks, controlling invasive species, and allowing the flow of water to pass without obstruction.

There is potential for the risk of flooding to increase in areas where flood alleviation measures are not maintained regularly. Breaches in raised flood defences are most likely to occur where the condition of a flood defence has degraded over time. Drainage networks in urban areas can also frequently become blocked with debris and this can lead to blockages at culverts or bridges.

Developers should not assume that any defence, asset, or watercourse is being or will continue to be maintained throughout the lifetime of a development. They should contact the relevant RMA about current and likely future maintenance arrangements and make future users of the development aware of their obligations to maintain watercourses.

Formal structural defences are given a rating based on a grading system for their condition. A summary of the grading system used by the EA for condition is provided in Table 6-2.

Table 6-2: Grading system used by the EA to assess flood defence condition.

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

Source: Condition Assessment Manual – EA 2006

6.4 Major flood risk management assets in the district

The EA retired the Flood Map for Planning 'Areas Benefiting from Defences' (ABD) dataset in December 2022. The ABD was replaced with the Reduction in Risk of Flooding from Rivers and Sea due to Defences dataset (RRDD), which was created to support spatial planning, incident response, and determining flood risk activity permits. The dataset was designed to act as a prompt to find out more about the flood defences in a particular area of interest. This dataset has been temporarily discontinued and is due to be superseded by new information following updates to some of the national flood risk products.

The EA 'AIMS' (Asset Information Management System) flood defence dataset gives further information on flood defence assets within the district. Table 6-3 details the locations which benefit from formal flood defences within the 'AIMS' dataset. Developers should refer to the AIMS Spatial Flood Defences dataset (gov.uk) for further information on specific flood defences. The EA 'AIMS' dataset is shown in Appendix C.

Table 6-3: Locations shown in the EA 'AIMS' data set.

Watercourse	Location	Type	Design SoP (AEP)	Actual SoP (AEP)	Target Condition Rating (1-5)	Actual Condition Rating (1-5)	Ownership
Grand Union Canal	Batchworth - Frogmore Lane (TQ 05951 93895)	Flood wall	1%	Not specified in data	3 (Fair)	3 (Fair)	Unknown
Hartsbourne Stream	Carpenders Park - Oxhey Lane (TQ 12970 93281)	Flood Storage Area embankments	1%	1%	2 (Good)	Not specified	Environment Agency
Hartsbourne Stream	Upstream of Hampermill Lane, Oxhey (TQ 10833 94665)	Reinforced concrete flood wall and clay core earth embankment	1.43%	Not specified in data	3 (Fair)	3 (Fair)	Environment Agency

Watercourse	Location	Type	Design SoP (AEP)	Actual SoP (AEP)	Target Condition Rating (1-5)	Actual Condition Rating (1-5)	Ownership
River Chess	Rickmansworth - Norfolk Road to Ebury Way footpath (TQ 06340 94245)	Raised concrete wall	5%, 20% - Norfolk Road section 1% - Skidmore Way section 0.5% - Church Wharf section	Not specified in data	3 (Fair)	4 (Poor) - Church Wharf section 3 (Fair) - all other sections	Environment Agency
River Colne	Lower Colne Improvement Scheme - Rickmansworth to Maple Cross (TQ 03996 91124)	Reinforced walls and embankments	20% - sections of flood wall at Springwell and Pynesfield Lakes 1%	Not specified in data	2 (Good) - embankment section at Pynesfield Lake 3 (Fair) - all other sections	3 (Fair)	Environment Agency

6.5 Existing and future flood alleviation schemes

6.5.1 Hartsbourne Flood Storage Area

The Hartsbourne Flood Storage Area was constructed in response to frequent flooding of properties and disruption to the road network in the Carpenders Park area. The scheme comprises of a Flood Storage Area, created by impounding the Hartsbourne Stream with an earth bund, immediately above Oxhey Lane. The scheme only comes into effect during high flows, with normal stream flows passing on their natural course under Oxhey Lane and through Carpenders Park.

The earth dam is 280m long, with a crest height 4.1m above the valley floor, and is designed to hold 42,000m^3 of water[1]. During storm events, river flows enter the storage area, and are slowly discharged downstream via a small pipe in the earth dam. Excess water spills into the adjacent field, allowing temporary flood storage over a period of a few hours.

Following further investment between April 2025 and March 2026, capital maintenance work will be undertaken to address recommendations from a Matters in the Interest of Safety flood study for the scheme.

1 National Rivers Authority Thames Region (1996) Hartsbourne Stream Proposed Flood Alleviation Scheme. Available at: http://www.environmentdata.org/archive/ealit:3257.

7 Flood risk management requirements for developers

This section provides guidance on site-specific FRAs and other principles for managing flood risk in new development.

7.1 Early consultation with statutory and non-statutory consultees

Developers should consult with the EA, the LLFA and Thames Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling and foul and surface water drainage assessment and design. Where a site is located near to a canal, the Canal and River Trust should be consulted at the earliest opportunity, as additional assessments such as hydraulic modelling of breach or overtopping events, may be required. It should be noted that some of these consultees may need to charge for data and/or advice requested by developers or landowners.

7.2 Site-specific FRAs

7.2.1 What is a site-specific FRA?

A site-specific FRA is carried out by (or on behalf of) a developer to assess the flood risk to and from a development site and should accompany a planning application where required (see Section 0). It is recommended that the assessment is undertaken by a suitably qualified person. The assessment should demonstrate how flood risk will be managed now and over the development's lifetime, taking both climate change and the vulnerability of users into account.

The developer should check whether they are required to apply the Sequential Test prior to commencing with a site-specific FRA.

The objectives of a site-specific FRA are to 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 these effects and risks are adequate and appropriate.
- The nature of residual risk and whether this can be safely managed.
- The evidence, if necessary, for the LPA to apply the Sequential Test.
- The evidence, if applicable, to show whether the development will be safe and pass the Exception Test.

7.2.2 When is an FRA required?

As set out in Flood risk assessments: applying for planning permission (gov.uk), a site-specific FRA is required for all development (including minor development and changes of use) proposed:

- In Flood Zones 2, 3, or 3b.
- Within Flood Zone 1 with a site are of 1 hectare or more.
- Within the 'Flood Zones plus Climate Change' extent shown on the EA Flood Map for Planning.
- Within Flood Zone 1 and the EA Flood Map for Planning shows it is at risk of flooding from surface water.
- In areas with critical drainage problems.
- Within Flood Zone 1 where this SFRA shows it will be at increased risk of flooding during its lifetime.
- That increases the vulnerability classification and may be subject to sources of flooding other than rivers or sea.

7.2.3 What level of detail is needed in a site-specific FRA?

Site-specific FRAs should be proportionate to the degree of flood risk and the scale, nature, and location of the development. The SFRA can be used by developers as a starting point to identify the initial flood risk to a site however a pre-application consultation is key to define the scope of the FRA and identify data requirements, making sure that latest available datasets are used.

7.2.4 Guidance for FRAs

FRAs should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the EA and the LLFA. Guidance and advice for developers on the preparation of site-specific FRAs is available from the following websites with hyperlinks provided:

- Standing Advice on Flood Risk (gov.uk)
- Flood Risk Assessment for Planning Applications (gov.uk); and
- Site-specific Flood Risk Assessment: Checklist (gov.uk)

Guidance should be sought from the EA and the Council at the earliest possible stage, and opportunities should be taken to incorporate environmental enhancements and reduce flooding from all sources both to and from the site through development proposals. Developers should seek to go beyond managing the flood risk and support opportunities to reduce the causes and impacts of flooding, whilst enhancing and conserving the natural environment. PPG: Flood risk and coastal change (gov.uk) Paragraphs 062 - 067 provide further information. Potential strategic solutions to consider are detailed in Section 0.

7.3 Emergency planning

Safe access and escape routes from the site should be provided. The developer should seek to incorporate an emergency plan and a safe refuge point if the development site has been identified to be at risk of flooding. The local authority and Emergency Services should be consulted when designing an emergency plan. For further details on emergency planning, see Section 10.

8 Principles for site design and master planning

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 uses away from high-risk areas to higher ground and lower flood risk areas, while more flood-compatible development (e.g., vehicular parking, recreational space) can be located in higher risk areas. Higher risk areas can also be retained and enhanced as natural green space. Whether parking in floodplains is appropriate will be based on the likely flood depths and hazard, evacuation procedures and availability of flood warning. The nature of risk to water quality also needs to be considered and mitigated to ensure that accumulated hydrocarbons and other vehicle related pollutants are not released to the aquatic environment.

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

8.1 Modification of ground levels

Modifying ground levels to raise the land above the design 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 as raising land above the flood level could reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land. Raising ground levels can also deflect flood flows, so analysis should be performed to demonstrate that there are no adverse effects on third party land or property.

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 (for it to fill and drain by gravity). 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). Appendix A3 of the CIRIA Publication C624 (ciria.org) provides guidance on how to address floodplain compensation.

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 check that it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels within areas of flood risk will need to be discussed at an early stage with the EA and its impacts assessed as part of a detailed FRA.

8.2 Raised floor levels

If raised floor levels are proposed, these should be agreed with the Council and the EA. The minimum Finished Floor Level (FFL) may change dependent upon the vulnerability and flood risk to the development.

Developers should refer to the Preparing a flood risk assessment: standing advice (gov.uk) for the latest guidance on FFLs but generally the EA advises the minimum finished floor levels should be set 600mm above the 1% AEP fluvial plus climate change peak flood level, where the appropriate climate change allowances have been used. An additional allowance may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA. Lowering existing FFLs below the existing levels within the 1% AEP plus climate change floodplain would not be acceptable and should be discouraged. New development offers opportunities to improve the resilience of buildings.

Building design and raised floor levels is the only way to fully reduce groundwater flood risk, through ensuring FFLs are raised above predicted groundwater levels considering known groundwater issues.

Allocating the ground floor of a building for less vulnerable, non-residential, or non-habitable 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 of flood defences). This risk can be reduced by use of multiple storey construction and raised areas that provide a point of refuge. However, access and escape routes may still be an issue, particularly when flood duration covers many days.

Similarly, the use of basements should be avoided in areas of flood risk. Habitable uses of basements within Flood Zone 3 and areas at high risk of surface water flooding should not be permitted, whilst basement dwellings (classed as 'highly vulnerable') in Flood Zone 2 will be required to pass the Exception Test.

Where the ground level of a site is below the ground level at the point where the drainage connects to the public sewer, care must be taken to ensure that the proposed development is not at an increased risk of sewer surcharge. It is good practice for the finished floor levels and manhole cover levels (including those that serve private drainage runs) to be higher than the manhole cover level at the point of connection to the receiving sewer. Alternatively, mitigation measures may need to be incorporated into the proposals to protect against sewer surcharge.

8.3 Development and raised defences

8.3.1 Undefended and residual risk

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.

Where development is located behind, or in an area benefitting from defences, both the undefended risk and residual risk of flooding must be considered by the developer and demonstrated that they can be safely managed. The assessment of the risk should consider:

- Improvements required to the level of protection afforded by existing defences for future development.
- The future commitment to maintain the current standard of protection of any existing defences.
- Any disparities between the proposed level of commitment to maintain the current standard of protection and the level of protection required to support future development.
- The effects of climate change on the future SoP afforded by the defences and the associated maintenance and upgrade commitments required.
- Any land required to be safeguarded for affordable future flood risk management measures.

8.3.2 Breach assessment

The assessment of the residual risk from a breach event should consider an assessment of the hazards that might be present from flood flows from a breach event, considering depth and flow velocities, so that the safety of people and structural stability of properties and infrastructure can be appropriately considered.

Considerations should include the location of a breach, when it would occur and for how long, the depth of the breach (toe level), the loadings on the defence, and the potential for multiple breaches.

There are various ways of assessing breaches using hydraulic modelling. EA LIT56413 Breach of Defences Guidance (2021) provides some guidance for breach assessment. It is recommended that the EA is consulted if a development site is located near to a flood defence, to understand the level of assessment required and to agree the approach for the breach assessment.

The residual risk to development from reservoirs should be considered during the planning stage. The impact of a breach and overtopping should be considered, particularly for sites proposed to be located immediately downstream of a reservoir. This should consider whether there is sufficient time to respond, and whether in fact it is appropriate to place development immediately on the downstream side of a reservoir. The potential risk should be assessed in both the pre- and post-development scenarios, to determine any increase in risk to the site.

8.3.3 Overtopping assessment

The assessment of the residual risk from overtopping of defences should consider the risk which is based on the relative heights of property or defence, the distance from the defence level, and the height of water above the crest level of the defence. The Defra and EA Flood

Risks to People guidance document (gov.uk) provides standard flood hazard ratings based on the distance from the defence and the level of overtopping. Overtopping modelling or assessments should be undertaken for any sites located next to defences or perched ponds/reservoirs, accounting for climate change.

Where sites are located near to a canal, the residual risk of canal breach or overtopping must be considered. Within this SFRA, a buffer distance of 100m around raised canal embankments has been used as an indication of areas where the impact of canal breach may be greatest. However, the Canal and River Trust considers canal flood risk on an individual site basis, and therefore the Trust should be consulted at the earliest opportunity, where a site is located near to a canal.

8.3.4 Developer contributions

In some cases, and following the application of the Sequential Test, it may be appropriate for the developer to contribute 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).

8.4 Buffer strips

The provision of a buffer strip allows additional capacity to accommodate climate change and means 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. A buffer strip of 8m is required from any main river. Where flood defences are present, these distances should be taken from the landward toe of the defence.

Building adjacent to riverbanks can cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult. Flood Risk Activity Permits (gov.uk) from the EA are likely to be required for development in these areas alongside any planning permission. There should be no built development within these distances from main rivers/flood defences (where present).

8.5 Property Flood Resilience (PFR)

PFR includes a range of measures that can be installed around the perimeter of a building to reduce the risk of internal flooding. PFR can also be used within a building, to minimise the damage done if internal flooding still occurs. PFR aims to help households and businesses reduce the damage caused by flooding, helping to speed up recovery and reoccupation.

PFR encompasses two main elements:

- Resistance - Resistance measures are installed around the perimeter of a building. These measures aim to reduce the amount of water entering the

building, reducing the damage caused internally. Examples include flood doors/barriers, automatic airbricks, and non-return valves.
- Resilient Adaptation (Recoverability) - Adaptions made within a property, which aim to reduce the damage caused if internal flooding still occurs.

The consideration of resistance measures and resilient adaptation should not be used to justify development in inappropriate locations. However, having applied planning policy there may be some instances where development is permitted in high flood risk areas where application of resistance and resilience measures may be required.

There may also be opportunities for 'change of use' developments to be used to improve the flood resistance and resilience of existing development, which may not have been informed by a site-specific FRA when it was first constructed.

Further information and guidance on best practice can be found in the following locations:

- Department for Communities and Local Government - Improving the Flood Performance of New Buildings: Flood Resilient Construction (gov.uk)
- CIRIA Property Flood Resilience Code of Practice (ciria.org)
- EA Flood resilience construction of new buildings (gov.uk)

9 Surface water management and SuDS

9.1 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner and to mimic the local natural drainage. The inclusion of SuDS within developments is an opportunity to enhance ecological and amenity value, and promote green infrastructure, incorporating above ground features into the development landscape strategy.

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the pre-application or master-planning stage. To further inform development proposals at the master-planning stage, pre-application submissions are accepted by the Council. This will assist with the delivery of well designed, appropriate, and effective SuDS. Applicants are also encouraged to engage with Thames Water to discuss their surface water proposals, especially where adoption is proposed.

9.2 Sources of SuDS guidance

9.2.1 C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015) (ciria.sharefile.com) provides guidance on planning, design, construction, and maintenance of SuDS. 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.

9.2.2 National standards for SuDS

Previously SuDS guidance was developed to sit alongside the PPG and provide non-statutory standards as to the expected design and performance for SuDS.

As of June 2025, the Defra National standards for sustainable drainage systems (SuDS) (gov.uk) were brought in to comply with principles laid out in Section **Error! Reference source not found.**. Whilst remaining as a non-statutory specification, these now form a material consideration for LPAs when assessing planning applications. These standards aim to reflect and reinforce good practice and use of SuDS as detailed in Section **Error! Reference source not found.**, reflecting the four pillars of SuDS design.

The national standards contain two sets of standards. The first type (Standard 1) is known as the hierarchy standard and gives criteria for the prioritisation of final runoff destinations. The other standards (Standards 2-7) detail the minimum requirements of design criteria that surface water drainage systems should satisfy alongside how they are to be appropriately built, maintained, and operated.

9.2.3 Design and Construction Guidance (DCG)

The Design and Construction Guidance (DCG) (water.org.uk), part of a new Codes for Adoption covering the adoption of new water and wastewater infrastructure by water companies, contains details of the water sector's approach to the adoption of SuDS.

9.2.4 Local SuDS guidance

Policies for managing surface water runoff and drainage in Hertfordshire are detailed within the Hertfordshire LFRMS and are to be considered alongside the national standards for SuDS. SuDS policies for Hertfordshire include designing SuDS with wider benefits, at or near the surface, managing existing natural flow routes and existing flooding issues, as well as managing and maintaining SuDS features throughout the lifetime of the development.

9.3 Roles of the LLFA and LPA

Hertfordshire County Council as the LLFA are a statutory planning consultee. They provide technical advice on surface water drainage strategies and designs put forward for major development proposals, to confirm that onsite drainage systems are designed in accordance with the current legislation and guidance.

When considering planning applications, the drainage/flood risk engineering team will provide advice to the LPA on the management of surface water. The LPA should satisfy themselves that the development's proposed minimum standards of operation are appropriate and, using planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the lifetime of the development.

In their respective roles as LLFA and LPA, Hertfordshire County Council and Three Rivers District Council should:

- Promote the use of SuDS for the management of run off;
- Ensure their policies and decisions on applications support and compliment the building regulations on sustainable rainwater drainage, giving priority to infiltration over watercourses and then sewer conveyance;
- Incorporate favourable policies within development plans;
- Adopt policies for incorporating SuDS requirements into the Local Plan; and
- Encourage developers to utilise SuDS whenever practical, if necessary, through the use of appropriate planning conditions.

9.3.1 Schedule 3 of the Flood and Water Management Act (2010)

Currently the implementation of SuDS is driven through planning policy. Schedule 3 of the FWMA 2010 will provide a framework for the approval and adoption of drainage systems, a SuDS Approving Body (SAB) within Unitary and County Councils, and national standards on the design, construction, operation, and maintenance of SuDS for the lifetime of the development. Timescales for enactment of Schedule 3 by the Government are unknown.

9.4 Considerations for SuDS design

9.4.1 Four pillars of SuDS design

SuDS are designed to maximise the opportunities and benefits that can be secured from surface water management practices. SuDS design should consider the four pillars of SuDS (Figure 9-1): water quantity, water quality, amenity, and biodiversity.

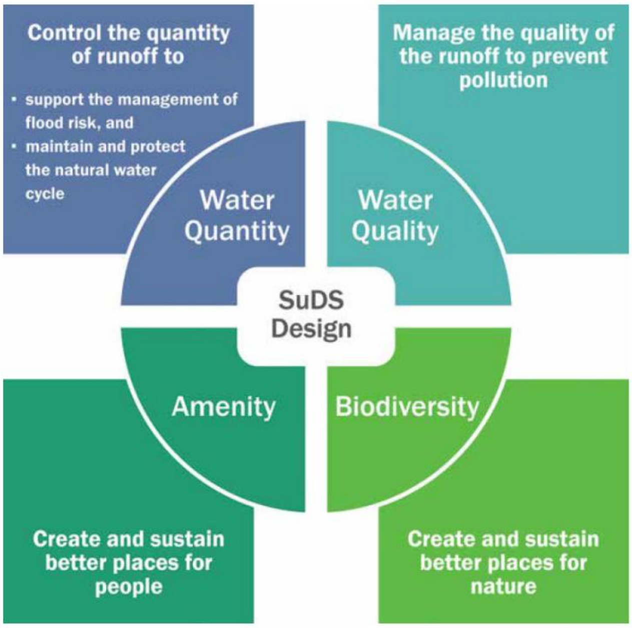

Figure 9-1: Four pillars of SuDS design (The SuDS Manual C753, 2015).

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

It is a requirement that 'applications which could affect drainage on or around the site should incorporate sustainable drainage systems to control flow rates and reduce volumes of runoff, and which are proportionate to the nature and scale of the proposal. These should provide multifunctional benefits wherever possible, through facilitating improvements in water quality and biodiversity, as well as benefits for amenity' (NPPF Paragraph 182).

It is important that SuDS are maintained for the lifetime for the development so that features can function as designed. Consideration should be given to enhancing SuDS to achieve biodiversity net gain.

9.4.2 Types of SuDS System

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage. Techniques can include soakaways, infiltration trenches, permeable pavements, grassed swales, green roofs, ponds and wetlands. Many of which do not necessarily need to take up a lot of space. 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 EA and the Construction Industry Research and Information Association (CIRIA) e.g. the CIRIA SuDS Manual C753 (2015).

9.4.3 SuDS management train

SuDS should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to a discharge location. Collectively this concept is described as a SuDS Management Train (see Figure 9-2).

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.

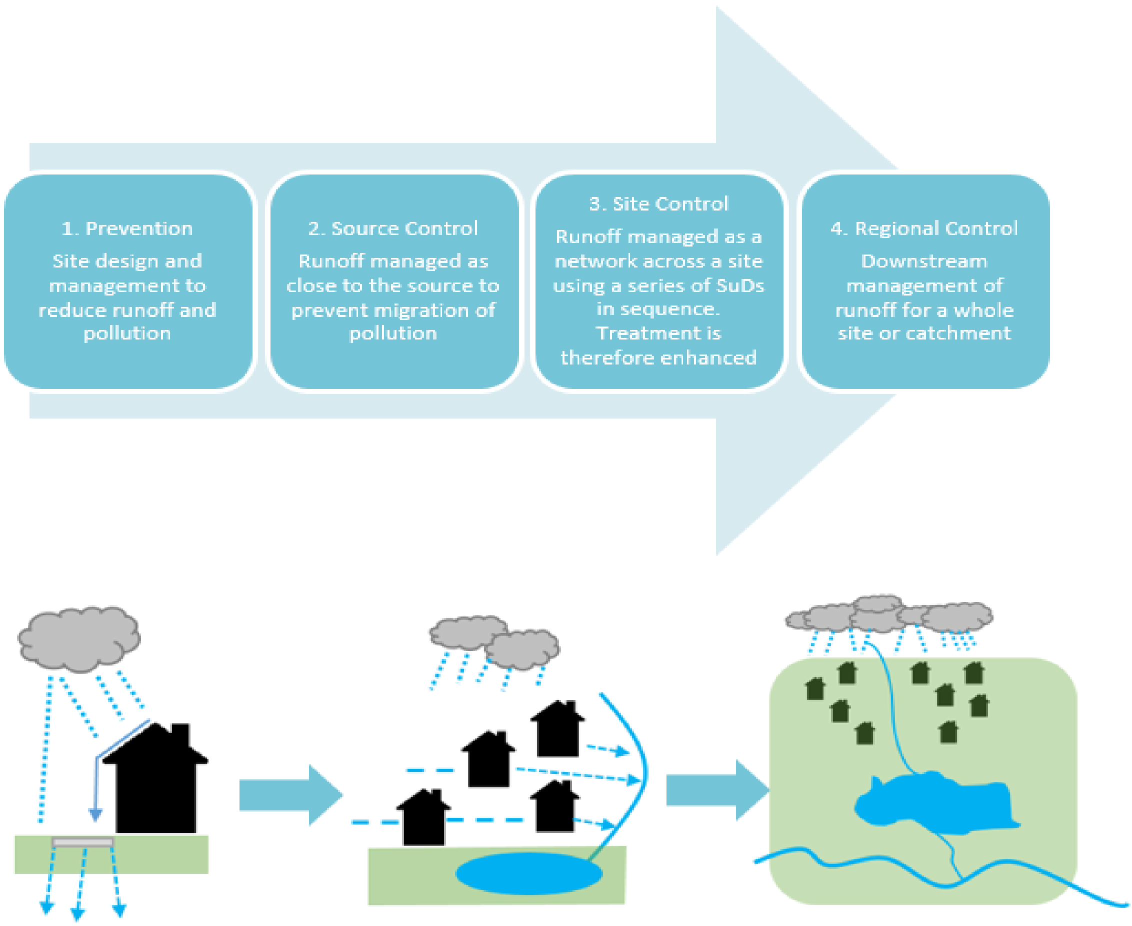

Figure 9-2: SuDS Management Train.

9.4.4 SuDS 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. Table 9-1 details some possible constraints and how they may be overcome.

Drainage from new development sites or redeveloped sites should be designed in line with the drainage hierarchy (PPG: Flood Risk and Coastal Change Paragraph: 056 Reference ID: 7-056-20220825) which initially promotes the use of infiltration prior to considering alternative drainage. For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough to receive surface run-off waters. Most types of SuDS will be suitable in areas with permeable bedrock including features such as soakaways and infiltration basins. In areas with more impermeable geology, off-site discharge in accordance with the drainage hierarchy may be required to discharge surface water runoff from the site. In some cases, above-ground features such as attenuation ponds may be practical with a managed outlet or discharge point. Infiltration should be considered with caution within areas of possible subsidence or sinkholes.

A site-specific infiltration test will need to be conducted early on as part of the design of the development in order to determine the impact of groundwater levels on the effectiveness of the drainage system. Groundwater monitoring is also encouraged and may be required in some locations.

Where sites lie within or close to Groundwater Source Protection Zones (GSPZs) (Section 9.5.2) or aquifers (Section 4.2.2), further restrictions may be applicable, and guidance should be sought from the LLFA and the EA.

Table 9-1: Example SuDS design constraints and possible solutions

Constraints	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

Constraints	Solution
	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	The LPA should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

9.5 Other surface water considerations

9.5.1 Groundwater Vulnerability Zones

The 2015 EA published groundwater vulnerability maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise of the underlying bedrock. The map shows the vulnerability of groundwater at a location based on the hydrological, hydro-ecological, and soil properties within a one-kilometre grid square.

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. Groundwater vulnerability maps can be found on Defra's interactive mapping (defra.gov.uk).

9.5.2 Groundwater Source Protection Zones (GSPZ)

The EA also defines Groundwater Source Protection Zones (GSPZs) near groundwater abstraction points. These protect areas of groundwater used for drinking water. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination. GSPZs can be viewed on Defra's interactive mapping (defra.gov.uk). Three main zones are defined as follows:

- Inner protection zone (Zone 1) - areas from where pollution can travel to the groundwater source within 50 days or is at least a 50m radius.
- Outer protection zone (Zone 2) - areas from where pollution can travel to the groundwater source within 400 days or lies within the nearest 25% of the total catchment area (whichever is largest).
- Total catchment (Zone 3) - the total area needed to support removal/discharge of water from the groundwater source.

Online mapping shows that the entire District is covered by GSPZs, which reflects the presence of an underlying chalk aquifer. Large areas are covered by Zones 1 and 2, notably the valleys of the Rivers Colne, Chess and Gade, as well as the Hartsbourne and Moor Park Streams.

Where a site is located in a GSPZ used for public water supply, applicants should engage with the EA to understand any concerns and any necessary mitigating measures to manage the risk of development to public water supply.

9.5.3 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 potentially influence the choice of SuDS and should be assessed as part of the design process.

NVZs can be viewed on the EA's interactive mapping (data.gov.uk). There are currently no NVZs designated in Three Rivers District.

9.5.4 Critical Drainage Areas

Local Authorities can also choose to designate Critical Drainage Areas (CDAs) within their authority area; however, there are no CDAs currently designated within the district.

10 Flood warning and emergency planning

10.1 NPPF requirements

The NPPF Flood Risk Vulnerability and Flood Zone "incompatibility" table seek 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 upon by flood water, or that such infrastructure is resistant to the effects of flooding such that it remains serviceable/operational during ‘upper end’ events, as defined in the Environment Agency’s Climate Change allowances.

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

10.2 Emergency planning

The Civil Contingencies Act 2004 lists Local Authorities, the EA and emergency services as Category 1 responders, responsible for reducing, controlling, and mitigating the effects of emergencies in both response and recovery phases.

The 2024 NPPF (Paragraph 181) requires site-level FRAs to demonstrate that “any residual risk can be safely managed; and safe access and escape routes are included where appropriate, as part of an agreed emergency plan.”

In accordance with the NPPF, SFRAs, PFRAs and SWMPs can be used in the preparation and execution of a flood emergency plan as they can indicate areas that may be at risk of flooding. These can be provided as part of an FRA or as a separate document. Decisions regarding whether an Emergency Plan is required sits with the LPA, with advice from their Emergency Planning Teams, the EA and LLFA.

According to the PPG flood risk and coastal change guidance, an emergency plan is needed wherever emergency flood response is an important component of making a development safe; this includes the free movement of people during a ‘design flood’ and potential evacuation during an extreme flood.

Emergency plans are essential for any site with transient occupancy in areas at risk of flooding, such as holiday accommodation, hotels, caravan, and camping sites (PPG: Flood risk and coastal change paragraph 043).

Emergency Plans should consider:

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

- The vulnerability of site occupants.
- The impact of the flooding on essential services e.g., electricity, gas, telecommunications, water supply and sewerage.
- Safe access and escape routes for users and emergency services (Section 10.2.1).

Further information is available from the following documents/websites with hyperlinks provided:

- The National Planning Policy Guidance (gov.uk)
- 2004 Civil Contingencies Act (legislation.gov.uk)
- Defra (2014) National Flood Emergency Framework for England (gov.uk)
- FloodRe (floodre.co.uk)
- The EA and Defra's Standing Advice for FRAs (gov.uk)
- EA's 'How to plan ahead for flooding' (gov.uk)
- Sign up for Flood Warnings with the EA (gov.uk)
- The National Flood Forum (nationalfloodforum.org.uk)
- 'Prepare for flooding' (gov.uk)
- ADEPT Flood Risk Plans for new development (adeptnet.org.uk)
- Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups
- Environment Agency Personal flood plans (2017)

10.2.1 Safe access and escape routes

Safe access and escape routes will need to be demonstrated during the design flood event. Access requirements are set out in the PPG: Flood Risk and Coastal Change (gov.uk) Paragraph: 047 Reference ID: 7-047-20220825.

As part of an FRA, the developer should review the acceptability of the proposed access in consultation with the LLFA and the EA. Site and plot specific velocity and depth of flows should be assessed against standard hazard criteria to ensure safe access and escape routes can be achieved.

10.3 Local arrangements for managing flood risk

The Hertfordshire Local Resilience Forum (LRF) is a multi-agency partnership of over 60 organisations, including emergency services, local councils, and utility companies, which plans and trains to provide effective response to incidents and emergencies. The LRF uses the Hertfordshire Risk Register and National Risk Register to identify the risks most likely to affect communities in Hertfordshire, of which flooding is a key risk, and guides the response planning process.

10.4 Flood alerts and flood warnings

The EA is the lead organisation for providing warnings of river flooding. Flood Warnings are supplied via the Flood Warning System (FWS) service, to homes and business within Flood

Zones 2 and 3. The EA Sign up for Flood Warnings (gov.uk) page provides information on how to sign up for these warnings.

There are currently four Flood Alert Areas (FAA) and seven Flood Warning Areas (FWAs) covering the district.

Flood Alerts are issued when there is water out of bank for the first time anywhere in the catchment, signalling that ‘flooding is possible’, and therefore FAAs usually cover the majority of main river reaches.

Flood Warnings are issued to designated FWAs (i.e., properties within the extreme flood extent which are at risk of flooding), when the river level hits a certain threshold; this is correlated between the FWA and the gauge, with a lead time to warn that ‘flooding is expected’.

The FAAs and FWAs are included in Appendix C.

11 Cumulative impact assessment

11.1 Introduction

Cumulative impacts are defined as the effects of past, current and future activities on the environment.

Under the NPPF, strategic policies and their supporting SFRAs, are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para. 171). These cumulative impacts may be negative, i.e. development leading to an increase in the existing level of flood risk within the catchment, or positive i.e. surface water management within a development helping to alleviate existing flooding issues within a catchment.

As part of the 2018 South West Hertfordshire Level 1 SFRA, the impact of future development on flood risk in South West Hertfordshire, including Three Rivers District, was assessed. Historic flood risk data was compared with potential change in developed area within each WFD river catchment. This identified the catchments where development may have the greatest impact on flood risk, and further assessment would be required within a Level 2 SFRA or site-specific FRA. The assessment is included in Appendix C.

Where catchments were identified as sensitive to the cumulative impact of development, the assessment concluded with potential strategic planning policy suggestions to manage the risk.

11.2 Results

The highest ranked catchments in South West Hertfordshire for the overall impact of potential development pressure and flood risk were:

- Colne (from Confluence with Ver to Gade) (St. Albans, Three Rivers, Watford)
- Gade (Bulbourne to Chess) (Dacorum, Three Rivers, Watford)
- Upper Colne and Ellen Brooke (St. Albans)
- Ver (Dacorum, St. Albans)

An inspection of flood incidents and SWMP hotspots in the catchments also identified the following catchment as an area with existing flood risk issues, where management of development may help to manage flood risk:

- Thame upstream of Aylesbury (Dacorum)

Figure 11-1 provides an overview of the results from the cumulative impacts assessment.

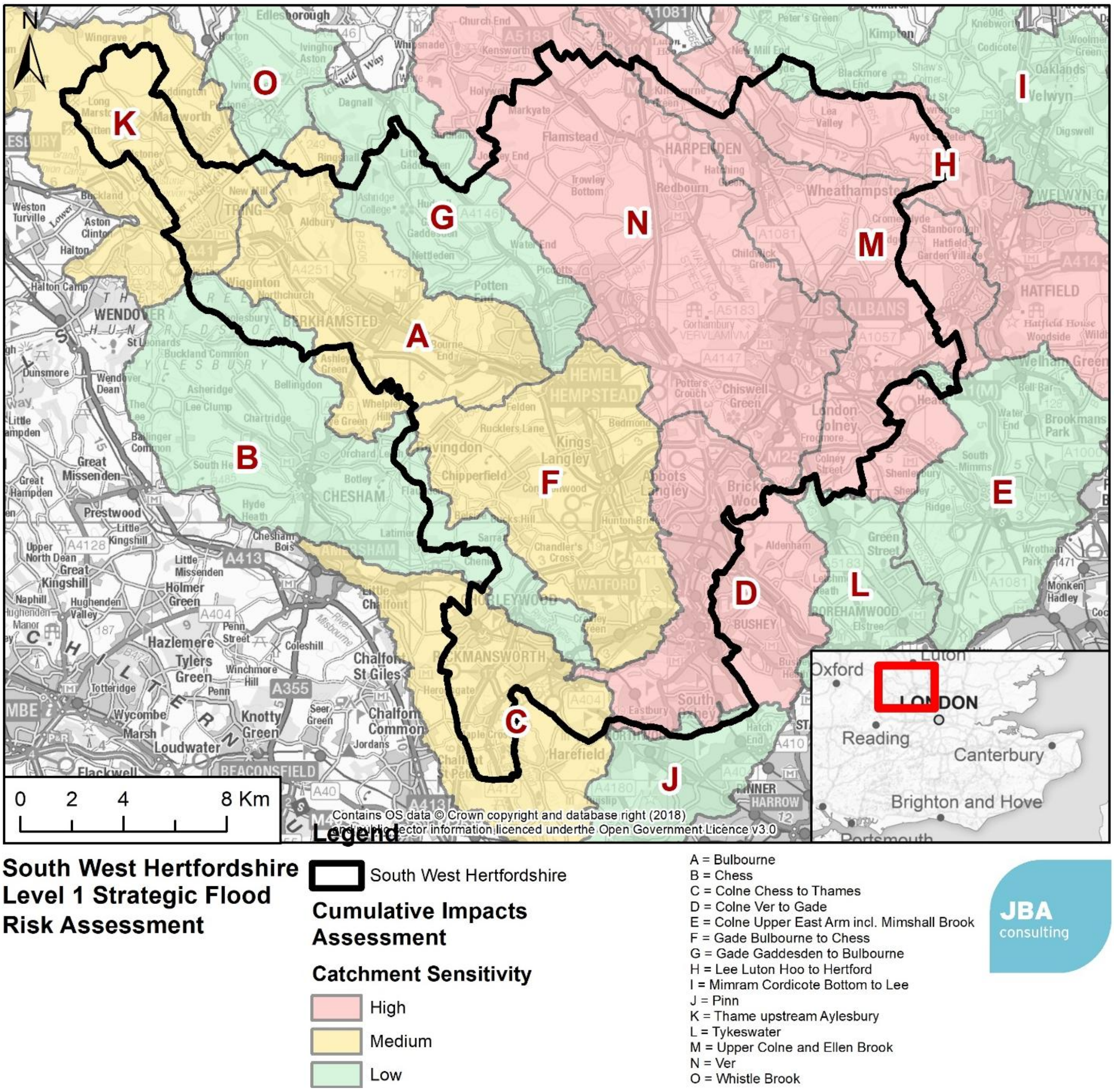

Figure 11-1: Sensitivity to cumulative impacts scoring of catchments within South West Hertfordshire, based on a combined score of potential development pressure and flood risk within each catchment.

11.3 Planning policy considerations for catchments in Three Rivers District

11.3.1 Planning Considerations for low to medium risk catchments

As flood risks are present within all the South West Hertfordshire catchments, there are opportunities for development to deliver a positive cumulative impact on flood risk.

Developments should seek betterment of existing flood risks both within the site and in surrounding areas. As a minimum, developments must meet national and local standards for FRAs and surface water drainage strategies. By looking at flood risks beyond the site boundary, developers should be encouraged to implement sustainable solutions which manage flood risk.

In upland and rural areas of the catchments, Natural Flood Management (NFM) techniques, such as woodland planting and earth bunds, can be used to slow down and store flood waters upstream of settlements. In urban and suburban locations, Sustainable Drainage Systems (SuDS) should be integrated into the site design, to manage the existing surface water flow paths on the site and to help mitigate the flood risks to downstream communities.

Successive minor developments have the potential to significantly impact on existing surface water and flood risk issues, particularly as the LLFA is not consulted on these applications. Therefore, planning policy for minor developments should support existing Hertfordshire County Council policy on the reduction of existing runoff rates, through the use of SuDS.

Any development within the floodplain (i.e. Flood Zones 3b, 3a and 2) should provide suitable flood compensation storage, in consultation with the EA, to avoid a net loss in floodplain.

11.3.2 Planning Considerations for highest risk catchments

Catchment-specific planning policy considerations have been identified for the catchments where cumulative development is likely to have the greatest impact on flood risk to communities.

The overall analysis provides a context for further appropriate consideration of catchment-scale flood risk issues. In addition to assessment at a SFRA level, it is recommended that site-specific FRAs are required to include consideration of the cumulative effects of the proposed development. It should be demonstrated that flood risk downstream will not be made worse by the combination of effects from more than one development allocation.

11.3.3 River Gade (Bulbourne to Chess)

The catchment forms the lower extent of the River Gade, extending from the confluence with the River Bulbourne in Hemel Hempstead, to the confluence with the River Chess at Rickmansworth.

The catchment is urbanised to the east and south, covering east Hemel Hempstead, west Watford and Croxley Green, whereas the western area is more rural, with Bovingdon forming the largest settlement.

Significant surface water flow paths flow towards the River Gade, following the natural topography. This is reflected in the high number of surface water flooding incidents reported in Bovingdon, Frogmore End in Hemel Hempstead and Croxley Green, which have been identified, alongside west Watford, as SWMP hotspots.

As rural land fringes the major towns, areas at the edge of these towns will be considered for development within the Gade (Bulbourne to Chess) catchment. Under current legislation, there is greater potential to influence the runoff rates and volumes from these types of development, with opportunities for larger, more strategic surface water management solutions, which could improve surface water flooding issues in the catchment towns, as well as delaying peak river flows from reaching the Lower Gade and the River Colne downstream at Rickmansworth. However, the suitability of larger development areas must be viewed in light of the other objectives for sustainable development.

Opportunities should be taken to implement SuDS schemes which reduce runoff to greenfield runoff rates or less and hold back surface water for longer periods during storm events. A strategic, catchment-based approach to managing surface water should also be taken, particularly in the northwest of the catchment, by interrupting known surface water flow paths and creating ponds or basins to store water.

11.3.4 River Colne (from Confluence with Ver to Gade)

The urbanised catchment extends from Abbots Langley in the north, to eastern Watford, Carpenders Park, Oxhey and South Oxhey. Within the catchment, there is significant flood risk from the River Colne, Hartsbourne Stream and Oxhey Brook, as well as surface water flow paths which follow the topography and are impeded by embankments for major transport infrastructure.

Due to the more urbanised nature of the catchment, development sites are likely to involve redevelopment or infill, on comparatively smaller sites than elsewhere in South West Hertfordshire. Taken individually, these sites may not require an FRA or drainage strategy. However, taken collectively, their cumulative impact could significantly increase the volume of surface water runoff within the catchment, increasing flood risk to existing properties. As the LLFA may not be consulted on minor development sites, planning policy should ensure that these sites limit discharge rates and volumes to greenfield, in line with Hertfordshire County Council policy for major development sites.

To provide wider flood risk benefits to the mid-Colne catchment, development sites in the upper catchment, such as north of Watford and around Abbots Langley, should consider the provision of long-term storage. This would control the release of surface water volumes from the site during and immediately after storm events, help to reduce and delay the peak flows on the River Colne reaching south Watford and Oxhey.

12 Strategic flood risk solutions

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the district. Section 0 considers the cumulative impacts of development across the district and the catchments which are most sensitive to these impacts, and as such where strategic flood risk solutions may be most beneficial.

Where possible developments should seek to help reduce flood risk in the wider area. The following sections outline different options which could be considered for strategic flood risk solutions. Any strategic solutions should ensure they are consistent with wider catchment policy and the local policies.

It is important that the ability to deliver strategic solutions in the future is not compromised by the location of proposed development. When assessing the extent and location of proposed development, consideration should be given to the requirement to secure land for flood risk management measures that provide wider benefits.

12.1 Partnership working

Flood risk to an area or development can often be attributed to multiple different sources, including fluvial, surface water and/or groundwater, which can become intertwined. Where complex flood risk issues are highlighted, it is important that all stakeholders are actively encouraged to work together to identify issues and provide suitable solutions.

12.1.1 Catchment Based Approach

The Catchment Based Approach (CaBA) (catchmentbasedapproach.org) was introduced by the Government to establish catchment partnerships throughout England to jointly deliver improved water quality and reduce flood risk, directly supporting achievement of many of the targets set out within the Government's 25-year Environment Plan. CaBA partnerships are actively working in all 100+ river catchments across England and cross-border with Wales.

The River Colne Catchment Action Network (ColneCAN) operates in the district. ColneCAN has developed a series of action plans and projects for each of the river catchments, with those for the River Chess, Rivers Gade and Bulbourne, Upper River Colne and tributaries and Colne Valley North, being most relevant to Three Rivers District.

12.1.2 River Chess Smarter Water Catchment

The River Chess Smarter Water Catchment project is led by a partnership of water companies, regulators, non-government organisations, academia and local interest groups, working together to protect and enhance the River Chess catchment. Their 10-year project aims to protect landscapes, enhance habitats and improve water quality and flow.

12.2 Biodiversity Net Gain

Biodiversity Net Gain (BNG) is a strategy to develop land and contribute to the recovery of nature. It is making sure the habitat for wildlife is in a better state than it was before development. BNG has been applicable since November 2023 for developments in the Town and Country Planning Act 1990, unless exempt, and has been applicable to small sites since April 2024. Further information is available on the Government BNG webpage (gov.uk). Strategic flood risk solutions can help developments achieve BNG requirements.

12.3 Natural Flood Management

12.3.1 Introduction to NFM

Development can provide opportunities to work with natural processes to help reduce flood and erosion risk, benefit the natural environment and reduce costs of schemes. This is known as Natural Flood Management (NFM), a process whereby action is taken to mitigate flood risk by protecting, restoring and emulating natural processes. This approach aims to reduce flow volumes and delay the arrival of peak flood flow downstream.

Techniques and measures, which could be applied in the district include:

- Creation of offline storage areas.
- Re-meandering streams (creation of new meandering courses or reconnecting cut-off meanders to slow the flow of the river).
- Targeted woodland planting.
- Reconnection and restoration of functional floodplains (Section 12.4).
- De-culverting and naturalising watercourses
- Installation or retainment of large woody material in river channels.
- Improvements in management of soil and land use.
- Creation of rural and urban SuDS.

To maximise the benefits of NFM, it is important that land which is likely to be needed for NFM is protected by safeguarding land for future flood risk management infrastructure. This is particularly important for infrastructure that reduces the risk of flooding to large amounts of existing development, or where options for managing risk in other ways are limited to achieve multiple benefits for flood risk and the environment.

It is important to recognise the value of maintenance or restoration of natural riparian zones, such as grasslands, which protect the soils from erosion and ‘natural’ meadows which can tolerate flood inundation. The use of green infrastructure throughout river corridors can also play a vital role in enhancing the river environment as well as safeguarding land from future development, protecting people and buildings from flooding and reducing flood risk downstream.

12.3.2 Working with natural processes

The EA published their updated evidence base in February 2025 for Working with natural processes to reduce flood risk 2024 (gov.uk) to support the implementation of NFM, with maps showing locations with the potential for NFM measures. These maps are intended to be used alongside the evidence directory to help practitioners think about the types of measure that may work in a catchment and the best places in which to locate them.

Nationally-mapped opportunity areas for NFM measures within Three Rivers District are summarised below. However, it should be noted that opportunities for using NFM techniques are not limited to these areas (consideration should be given on a site-by-site basis when planning applications are determined).

NFM opportunity areas in Three Rivers District identified by the Working with Natural Processes mapping are as follows:

- Floodplain reconnection
    - Confluence of the Rivers Colne, Chess and Gade at Rickmansworth
    - River Colne from Moor Park to Maple Cross (particularly connections between the river and lake network)
    - Hartsbourne Stream at Carpenders Park (west of Oxhey Lane and north of Brookdene Avenue/Prestwick Road)
    - Moor Park Stream at Moor Park Estate
- Woodland Planting
    - Floodplain - River Chess at Loudwater, River Gade at Croxley Common Moor, River Colne from Moor Park to Maple Lodge.
    - Wider Catchment - Oxhey Woods, Carpenders Park, Woodcock Hill, Batchworth Heath.
- Runoff attenuation features
    - River Chess (Loudwater to Rickmansworth)
    - Lower Gade catchment (Croxley Common Moor)
    - River Colne (Hampermill Lake to West Hyde)
    - Upper catchments - Wippendell and Harrocks Woods near Chandler's Cross, Oxhey Woods, Woodcock Hill, Batchworth Heath.

12.3.3 Ongoing NFM schemes

Websites that provide further information about ongoing NFM schemes and community works include The Flood Hub (thefloodhub.co.uk) and the Rivers Trust NFM National Map (theriverstrust.hub.arcgis.com).

Three Rivers District Council primarily promotes the use of Working with natural processes (WWNP) measures through its Nature Recovery Strategy, focusing on enhancing biodiversity, improving habitat connectivity, managing flood risk via natural solutions and restoring waterways (like Taylors Cut). Partnership working is an important of this strategy, including Hertfordshire County Council, Affinity Water, Colne Valley Partnership and the Herts & Middlesex Wildlife Trust.

A notable recent NFM project in the district is the implementation of leaky wooden barriers within watercourses in the South Oxhey Wood. This scheme was completed in April

2025. A hydraulic model was developed to identify the most appropriate scheme to reduce flood risk. This scheme included a maintenance and monitoring plan which is being carried over the winter months and following heavy rainfall events to monitor the benefits of this scheme.

12.4 Catchment and floodplain restoration

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

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

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffering areas around watercourses to provide an opportunity to restore parts of the floodplain.
- Removing redundant structures to reconnect the river and the floodplain.
- Applying the sequential approach to avoid new development within the floodplain.

12.5 Structure removal and/or modification (e.g. weirs)

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

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

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

There is also the potential for negative localised flood risk impacts associated with weir removal or modification. A robust hydraulic assessment, including hydraulic modelling, is likely to be required as part of any planning or Flood Risk Activity Permit application to demonstrate that there is no associated increase in flood risk.

Developers should open up existing culverts where possible and should not construct new culverts on site except for short lengths to allow essential infrastructure crossings.

12.6 Bank stabilisation

Bank erosion should be avoided, and landowners are encouraged to avoid using machinery and vehicles close to or within the watercourse unless in the circumstances where machinery and vehicles are required for watercourse maintenance such as desilting. Care should be taken not to destabilise the banks.

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

12.7 Green infrastructure

Green infrastructure (GI) is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe and consist of:

- Open spaces – parks, woodland, nature reserves, lakes.
- Linkages – river corridors and canals, and pathways, cycle routes and greenways.
- Networks of “urban green” – private gardens, street trees, verges and green roofs.

The identification and planning of GI is critical to achieving sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. GI is also central to climate change action and is a recurring theme in planning policy. 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, particularly in city centres and vulnerable urban regeneration areas. GI can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity.

13 Summary, recommendations, and next steps

13.1 Summary of flood risk across the district

Fluvial: Fluvial flood risk in Three Rivers District is concentrated in the floodplains of the three major watercourses: the Rivers Colne, Chess and Gade. The area of most extensive fluvial flood risk in the district is the low-lying valley of the River Colne, which affects Rickmansworth and Batchworth. The steeper topography of the River Chess and Gade catchments results in fluvial flood risk being closely confined to the river valleys. The heavily urbanised southern tributaries of the Colne, Moor Park Stream, Hartsbourne Stream, and Oxhey Brook, pose a flood risk to the residential areas which they pass through in the southeast of the district.
Fluvial flood risk is discussed in Section 0 and the flood extents are shown in Appendix C.

Surface Water: Surface water flood risk is largely confined to the urban areas of Three Rivers District. Flow paths form on the steep slopes and in river valleys and follow the natural topography through residential areas including Eastbury, South Oxhey, Carpenders Park and Rickmansworth, before entering the River Colne. At Croxley Green, overland flows are routed in two directions, eastwards to the River Gade and southwards into the Colne.
Surface water flood risk is discussed in Section 4.5 and the flood extents are shown in Appendix C.

Climate Change: Areas at risk of flooding today are likely to become at increased risk in the future and the frequency of flooding will also increase in such areas, due to climate change. Flood extents will increase; in some locations this may be minimal, but flood depth, velocity and hazard may have more of an impact due to climate change. This SFRA provides an assessment of the impacts of climate change on fluvial and surface water flood risk. The approach to climate change is discussed in Section 5 and the flood extents are also shown in Appendix C.

Sewer: Thames Water provide water and sewerage services across the district and have provided details of historic sewer flooding across the district. Settlements with the greatest historic risk of sewer flooding include Oxhey, Carpenders Park, Rickmansworth, Chorleywood and Croxley Green.
Sewer flood risk is discussed in Section 4.6.

Groundwater: High groundwater flood risk within the district is concentrated in the floodplains of the Rivers Colne, Chess and Gade, where the chalk geology and gravel surface deposits can result in heightened groundwater levels at, or just below, the ground surface. The settlements identified as at highest risk of groundwater flooding are Rickmansworth, Croxley Green, Loudwater, Carpenders Park and Oxhey.
There is no national risk-based groundwater flood dataset of a suitable resolution to inform the areas at risk from groundwater flooding; however, emergence mapping when considered in conjunction with topography and surface water flow paths can indicate areas where groundwater is likely to emerge, and the flow paths it may take once above the

ground. Groundwater flood risk is discussed in Section 4.7 the JBA emergence map is shown in Appendix C.

Canals: The Grand Union Canal passes through the district from the northeast to southwest, and interacts with the River Gade at Croxley Green, as well as the Rivers Chess and Colne at Rickmansworth. There have been several incidents of canal overtopping between Rickmansworth and West Hyde, in response to heavy rainfall and raised levels or overtopping of the River Colne. However, these incidents largely affected the canal towpath, with no damage to property. Canal flood risk is discussed in Section 4.8.

Reservoirs: There are three reservoirs located within the district, and a further four located outside the district, which present a potential risk of flooding within the district. The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However, there is a residual risk of a reservoir breach, and this risk should be considered in any site-specific FRAs (where relevant) in accordance with the PPG: Flood risk and coastal change. Reservoir flood risk is discussed in Section 4.8.2. The 'Dry Day', 'Wet Day', and 'Fluvial Contribution' flood extents are shown in Appendix C.

Defences

The EA Asset Information Management System (AIMS) dataset provides information on flood defence assets across the district.
There are a series of flood defences in the district, most notably the Hartsbourne Flood Storage Area, an earth bund which impounds the Hartsbourne Stream above Oxhey Lane. It was constructed to alleviate flooding to properties and the road network in the Carpenders Park area. Elsewhere, there are a series of raised or reinforced walls and embankments on the Grand Union Canal at Batchworth, Hartsbourne Stream at Oxhey, the River Chess at Rickmansworth, and the River Colne from Rickmansworth to Maple Cross. Further information on defences across the district is available in Section 6.4 and shown in Appendix C.

13.2 Recommendations from SFRA findings

13.2.1 Drainage strategies and SuDS

Planners should be aware of the conditions set by the LLFA for surface water management. The future enactment of Schedule 3 of the FWMA means that there will be mandatory standards for delivery and adoption of SuDS in new developments, however, this has not yet been enacted.

Space should be provided for the inclusion of SuDS on all allocated sites, outline proposals and full planning applications. SuDS design should demonstrate how constraints have been considered and how the design provides multiple benefits e.g. landscape enhancement, biodiversity, recreation, amenity, leisure, and the enhancement of historical features.

SuDS must be designed appropriately for the area. Parts of the district are underlain by mudstone geology; therefore, infiltration SuDS may not be appropriate in these areas.

Infiltration testing must be undertaken to determine whether infiltration rates are suitable for the use of infiltration SuDS. Where sites lie within or close to GSPZs or aquifers, there may be restrictions on infiltration SuDS and guidance should be sought from the LLFA and the EA.

Planning applications for phased developments should be accompanied by a drainage strategy, which takes a strategic approach to drainage provision across the entire site and incorporates adequate provision for SuDS within each phase. Applicants will need to demonstrate a holistic and co-ordinated approach to both foul and surface water drainage and the management of flood risk.

SuDS should be designed based on the SuDS management train to prevent and control pollutants to prevent the ‘first flush’ polluting the receiving waterbody.

SuDS should be designed so that they are easy to maintain, and it should be set out who will maintain the system, how the maintenance will be funded and should be supported by an appropriately detailed maintenance and operation manual.

13.2.2 Residual risk

Residual risk is the risk that remains after mitigation measures are considered. All residual risks to a site should be considered during the planning stage as part of site-specific FRAs.

There are limited flood defences in the district, however, any development in areas protected by these flood defences should consider the residual risk of overtopping or breach of these defences.

Other residual risks that may be applicable to development sites within the district include potential breaches or overtopping of the reservoirs and canal, and blockages or failure of infrastructure, such as culverts.

13.2.3 Safe access and escape routes

Safe access and escape routes will need to be demonstrated at all development sites.

If raised access routes are required, an assessment must be made to check this will not displace floodwater elsewhere.

Emergency vehicular access should be possible during times of flood. If at risk, then as assessment should be made to detail the flood duration, depth, velocity, and flood hazard rating in the 1% AEP plus climate change flood event, in line with FD2320.

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

13.2.4 River restoration and habitat improvement

Developments should be used as an opportunity to enhance the existing river corridor. Natural drainage features should be maintained, and opportunities identified for river restoration/enhancement to make space for water.

Opportunities should be identified to maintain and enhance permeable surfaces and greenspaces to help reduce surface water runoff whilst promoting other benefits, including biodiversity and wellbeing.

There should be no built development within 8m from the top of a watercourse or main river for the preservation of the watercourse corridor, wildlife habitat, flood flow conveyance and future watercourse maintenance or improvement.

Culverting of open watercourses should be avoided except where essential to allow highways and/or other infrastructure to cross, in line with CIRIA's Culvert design and operation guide (C689) and to restrict development over culverts.

Countryside Stewardship schemes (gov.uk) should be promoted to help prevent soil loss and reduce runoff from agricultural land whilst also providing biodiversity and habitat improvements.

13.2.5 Emergency planning and flood awareness

Improved emergency planning and flood awareness provide an opportunity to mitigate against flood risk. The following recommendations should be considered:

- The Council should work with emergency planning colleagues through the Hertfordshire LRF to identify areas at highest risk and locate most vulnerable receptors. For major developments, robust emergency (evacuation) plans should be produced and implemented.
- Increased flood awareness and sign-up to the EA Flood Warnings (gov.uk) should be promoted across the district.
- Exceedance flows, both within and outside of the site, should be appropriately designed to minimise risks to both people and property.

13.3 Requirements for a Level 2 SFRA

Following the application of the Sequential Test, where sites cannot be appropriately accommodated in low-risk areas, the Council will apply the NPPF's Exception Test. In these circumstances, a Level 2 SFRA may be required, to assess in more detail the nature and implications of the flood characteristics.

13.4 SFRA report recommendations

13.4.1 Updates to SFRA

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

Over time, new information will become available to inform planning decisions. When using the SFRA to prepare FRAs it is important to check that the most up to date information is used.

The EA regularly reviews its hydrology, hydraulic modelling, and flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

The EA published the new national flood risk mapping (NaFRA2) in early 2025 but further updates and additional datasets are expected later in 2026.

Other datasets used to inform this SFRA may also be updated periodically and following the publication of this SFRA, new information on flood risk may be provided by RMAs.

Appendices

A Data Sources used in this SFRA

B Guide for using available flood risk data in applying the Sequential Test

C Cumulative impact assessment

D Mapping

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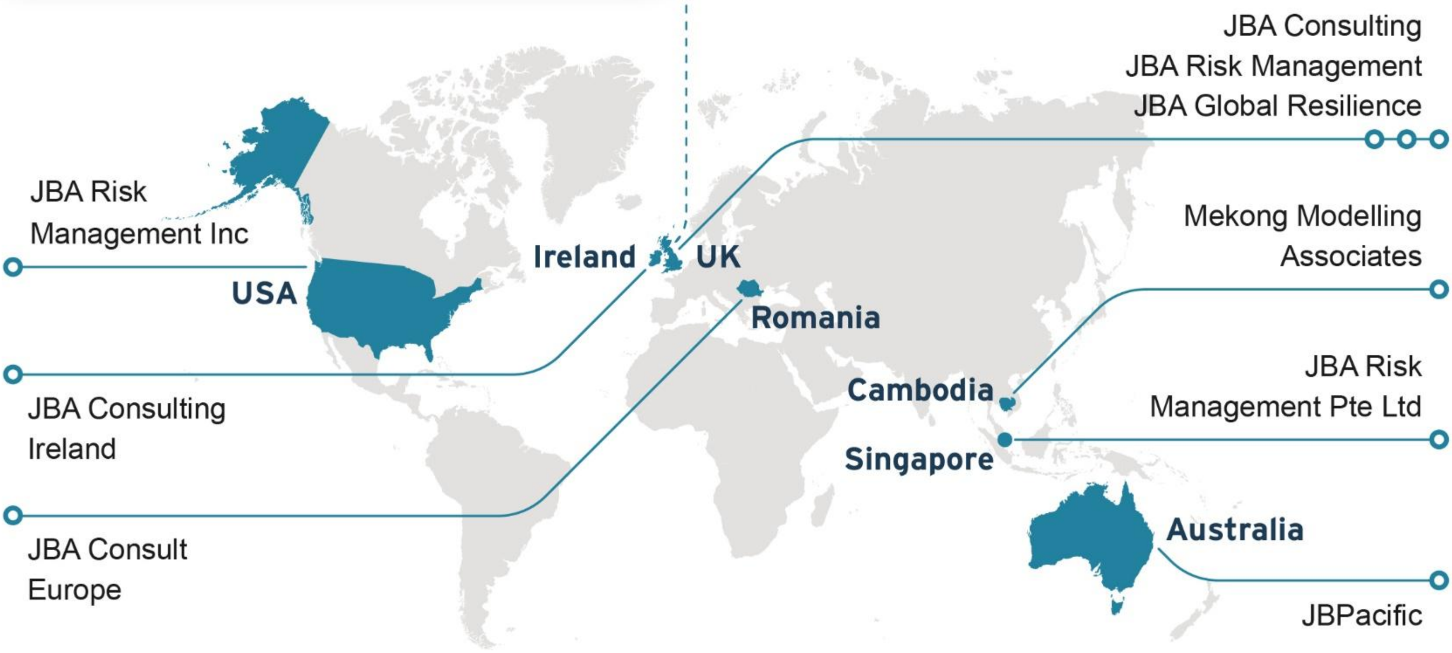

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