Stratford on Avon District Level 1 Strategic Flood Risk Assessment

Final Report

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Stratford on Avon District Council

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Revision history

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Contract

This report describes work commissioned by Paul Harris on behalf of Stratford on Avon District Council, by a letter dated 3rd June 2020. Alex Clark, Copper Lewis and James Harvey of JBA Consulting carried out this work.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to Stratford on Avon District Council.

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- Stratford on Avon District Council
- Warwickshire County Council, including Highways
- Environment Agency
- Canals and River Trust
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Executive summary

Introduction

The Level 1 Strategic Flood Risk Assessment (SFRA) 2020 document was created with the purpose of supporting the production of the District Council's Site Allocations Plan (SAP). This will provide an understanding of the risk from all types of flooding across the Stratford on Avon District and present clear and robust evidence. It will also provide useful information to inform future Infrastructure Planning and Neighbourhood Plans.

Strategic Flood Risk Assessment Objectives

The key objectives of the Level 1 Strategic Flood Risk Assessment are:

- Inform Stratford on Avon District Council's SAP by assessing flood risk from all sources, current and future.
- Produce a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the SAP.
- Assess the cumulative impact that development will have on flood risk.
- To inform decisions in the emerging Local Plan, including 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's preparation of the Local Plan.
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as evidence base for use in the emerging Local Plan.
- To provide advice for applicants carrying out site-specific Flood Risk Assessments and outline specific measures or objectives that are required to manage flood risk.

Summary of flood risk in Stratford on Avon District

Parts of Stratford on Avon District are at risk of flooding from the following sources: fluvial, surface water, groundwater, sewers, reservoir inundation and canal overtopping/breaches. This study has shown that the most significant sources of flood risk in Stratford on Avon District are fluvial and surface water.

- *Fluvial flooding*: The primary fluvial flood risk is along the River Avon and its main tributaries. These present fluvial flood risk to rural communities as well as to the main urban centre of Stratford upon Avon. The floodplains of the watercourses are fairly well confined in the majority of the District, with wider extents along the River Avon due to lower lying, flat topography, notably through Stratford upon Avon and downstream of Bidford on Avon.
- *Surface water:* The Risk of Flooding from Surface Water map shows a number of prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas.
- *Sewer*: The majority of sewers in Stratford on Avon District are managed by Severn Trent Water, with Thames Water and Anglian Water managing sewers in some limited areas. Thames Water provided their list of historical sewer flooding records which show 3 properties with historic incidents of sewer flooding. Severn Trent Water provided their 'At Risk Register' which denotes 143 properties at risk from sewer flooding.
- *Groundwater:* The Areas Susceptible to Groundwater Flooding map shows that in general, the majority of Stratford on Avon District. The majority of the

District is shown to be within the "No risk" classification. Areas with higher susceptibilities and more likely to flood from groundwater are found in the centre of the district along the River Avon and River Stour, in the north east along the River Itchen, in the southern tip of the district and in the west of the district along the River Arrow.

- *Canals*: There are three canals in Stratford on Avon District: the Stratford-upon-Avon Canal, the Grand Union Canal, and the Oxford Canal. These have the potential to interact with other watercourses and become flow paths during flood events or in a breach scenario. There have been no recorded incidents of breach or overtopping in the District on any of the canals.
- *Reservoirs:* There is a potential risk of flooding from reservoirs both within the District and those outside. 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 Flood Risk Assessments (where relevant).

Defences

The main flood defences in the District are located in Alcester, Broom, Long Itchington, Wellesbourne, Wootton Wawen, Henley-in-Arden, Barton and Marcliff which are comprised of flood walls and embankments. The condition of these defences varies from poor to very good, with the Standard of Protection for all the defences being 100 year, apart from a 50-year defence in Wootton Wawen.

Development and flood risk

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

When necessary, development and redevelopment within Stratford on Avon District will require a Flood Risk Assessment appropriate to the scale of the development and to the scope as agreed with the Lead Local Flood Authority and/or Environment Agency. Flood Risk Assessments should consider flood risk from all sources including residual risk, along with promotion of Sustainable Drainage Systems to create a conceptual drainage strategy and safe access/egress at the development in the event of a flood. Latest climate change guidance (published in February 2016) should also be taken into account, for the lifetime of developments. The UK Climate Impacts Programme published new predictions for climate change in November 2018. The Environment Agency will, in due course, use this information to update their climate change guidance for planners. Planners and developers must ensure that modelling in line with the most up to date Environment Agency climate change guidance has been run.

How to use this report

Planners

The SFRA provides recommendations regarding all sources of flood risk in Stratford on Avon District, which can be used to inform policy on flood risk within the Local Plan. 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 and provides guidance on how to apply the Exception Test. The Council can use this information

to apply the Sequential Test to strategic allocations and identify where the Exception Test will also be needed.

The SFRA provides guidance for developers, which can be used by development management staff to assess whether site-specific Flood Risk Assessments meet the required quality standard.

Developers

For sites that are not strategic allocations, developers will need to use this SFRA to help apply the Sequential Test. For all sites, whether strategic allocations or windfall sites, developers will need to apply the Exception Test and use information in a site-specific Flood Risk Assessment to inform this test at planning application stage.

When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as providing evidence to show that they have adequately considered other reasonably available sites.

This SFRA provides guidance for the application of the Sequential and Exception Tests at a site level and for detailed site-specific Flood Risk Assessments.

This is a strategic assessment and does not replace the need for site-specific Flood Risk Assessments where a development is either within Flood Zones 2 or 3 or greater than a hectare in Flood Zone 1. In addition, a surface water drainage strategy will be needed for all major developments in any Flood Zone to satisfy Warwickshire County Council, the Lead Local Flood Authority (LLFA).

Developers can use the information in this SFRA, alongside site-specific research to help to scope out what additional work will be needed in a detailed Flood Risk Assessment. To do this, they should refer to Chapter 5, Chapter 6 and Appendix A (Interactive PDF mapping). At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances, due to be updated by the Environment Agency in 2019), inform master planning and prove, if required, whether the Exception Test can be passed. As part of the Environment Agency's updated guidance on climate change, which must be considered for all new developments and planning applications, developers will need to undertake a detailed assessment of climate change as part of the planning application process when preparing FRAs.

Developers need to ensure that new development does not increase surface water runoff from a site. Chapter 9 provides information on the surface water drainage requirements of the LLFA. Sustainable Drainage Systems should be considered at the earliest stages that a site is developed which will help to minimise costs and overcome any site-specific constraints.

Flood Risk Assessments will need to identify how flood risk will be mitigated to ensure the development is safe from flooding. In high risk areas the Flood Risk Assessment will also need to consider emergency arrangements, including how there will be safe access and egress from the site.

Any developments located within an area protected by flood defences and where the standard of protection is not of the required standard (either now or in the future) should be identified and the use of developer contributions considered to fund improvements.

Neighbourhood plans

The SFRA provides information on the sources of flooding and the variation in the risk across the district, which organisations are involved in flood risk management and their latest strategic plans, current plans for major flood defences, the requirements for detailed Flood Risk Assessments and to inform the site selection process.

Neighbourhood planners can use this information to assess the risk of flooding to sites within their community, using Chapter 6, the sources of flooding in Stratford on Avon District and the flood mapping in the appendices. The SFRA will also be helpful for developing community level flood risk policies in high flood risk areas.

These maps highlight on a broadscale where flood risk from fluvial, surface water, groundwater and the effects of climate change are most likely. These 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 model small scale changes in flood risk. Local knowledge of flood mechanisms will need to be included to complement this broadscale mapping. Similarly, all known recorded historical flood events for the district are listed in Section 6.1 and this can be used to supplement local knowledge regarding areas worst hit by flooding. Ongoing and proposed flood alleviation schemes planned by Stratford District Council are outlined in Section 7.6 and Section 9.7 discusses mitigations, resistance and resilience measures which can be applied to alleviate flood risk to an area.

A cumulative impact assessment has been carried out which has identified which catchments in Stratford District are more sensitive to the cumulative impact of development and where more stringent policy regarding flood risk is recommended. Any development in these areas should seek to contribute to work that reduces wider flood risk in those catchments.

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Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability – The probability (expressed as a percentage) of a flood event occurring in any given year.
AStGWf	Areas Susceptible to Groundwater flooding
Brownfield	Previously developed parcel of land
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CDA	Critical Drainage Area - A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, Main River and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan- A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association
Cumecs	The cumec is a measure of flow rate. One cumec is shorthand for cubic metre per second; also m^3/s.
Defra	Department for Environment, Food and Rural Affairs

Design flood	This is 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; tidal flooding with a 0.5% annual probability (1 in 200 chance each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union
Exception Test	Set out in the NPPF, the Exception Test is a method used to demonstrate that flood risk to people and property will be managed appropriately, where alternative sites at a lower flood risk are not available. The Exception Test is applied following the Sequential Test.
FCERM	Flood and Coastal Erosion Risk Management
FEH	Flood Estimation Handbook
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Map for Planning	The Environment Agency Flood Map for Planning (Rivers and Sea) is an online mapping portal which shows the Flood Zones in England. The Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences and do not account for the possible impacts of climate change.
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
FWA	Flood Warning Area
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a River
FRA	Flood Risk Assessment - A site-specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
FSA	Flood Storage Area
FWMA	Flood and Water Management Act
FWS	Flood Warning System
GI	Green Infrastructure – a network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and urban fringe
Greenfield	Undeveloped parcel of land
Ha	Hectare
IDB	Internal Drainage Board

Indicative Flood Risk Area	Nationally identified flood risk areas based on the definition of 'significant' flood risk described by Defra and WAG.
JBA	Jeremy Benn Associates
LFRMS	Local Food Risk Management Strategy
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
m AOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NRD	National Receptor Database
NRIM	National Reservoir Inundation Mapping
NVZs	Nitrate Vulnerability Zones
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity.
RBMP	River Basin Management Plan
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Riparian owner	A riparian landowner, in a water context, owns land or property, next to a river, stream or ditch.
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.
Risk Management Authority (RMA)	Operating authorities who's remit and responsibilities concern flood and/or coastal risk management.
RoFfSW	Risk of Flooding from Surface Water (formerly known as the Updated Flood Map for Surface Water (uFMfSW)

Sequential Test	Set out in the NPPF, the Sequential Test is a method used to steer new development to areas with the lowest probability of flooding.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
SPD	Supplementary Planning Document
SPZ	(Groundwater) Source Protection Zone
Stakeholder	A person or organisation affected by the problem or solution or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
WFD	Water Framework Directive – Under the WFD, all waterbodies have a target to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline. River Basin Management Plans (RBMPs) set out the ecological objectives for each water body and give deadlines by when objectives need to be met.

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

> ***"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.".***
>
> (National Planning Policy Framework, paragraph 156)

JBA Consulting were commissioned by Stratford on Avon District Council to prepare a Level 1 Strategic Flood Risk Assessment (SFRA). This study provides a comprehensive and robust evidence base to inform the preparation of the Site Allocations Plan (SAP) and for future Development Plan documents. This SFRA replaces the "Stratford-on-Avon DC, Warwickshire CC, North Warwickshire BC & Rugby BC Level 1 SFRA Report", prepared by URS for the sub-regional group in September 2013.

The 2020 SFRA will be used in decision-making and to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

1.2 Levels of SFRA

The Planning Practice Guidance (PPG) identifies the following two levels of SFRA:

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

This is a Level 1 SFRA assessment. Should the Council be unable to place all development outside of Flood Zones 2 and 3, a Level 2 assessment may be required in the future.

1.3 SFRA outputs

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

- Identification of policy and technical updates.
- Identification of any strategic flooding issues which may have cross boundary implications.
- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, sewers, groundwater, reservoirs and canals.
- Mapping showing distribution of flood risk across all flood zones from all sources of flooding including climate change allowances.
- Review of historic flooding incidents.
- Identification of any specific locations within Stratford on Avon District at risk of sewer flooding.

- Reporting on the standard of protection provided by existing flood risk management infrastructure.
- Assessment of the potential increase in flood risk due to climate change.
- Assessment of surface water management issues, how these can be addressed through development management policies and the application of Sustainable Drainage Systems.
- Flood Risk Assessment guidance for developers.
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.
- Assessment of strategic flood risk solutions that can be implemented to reduce risks.
- Assessment of cumulative impacts of development on flood risk

1.4 SFRA Study Area

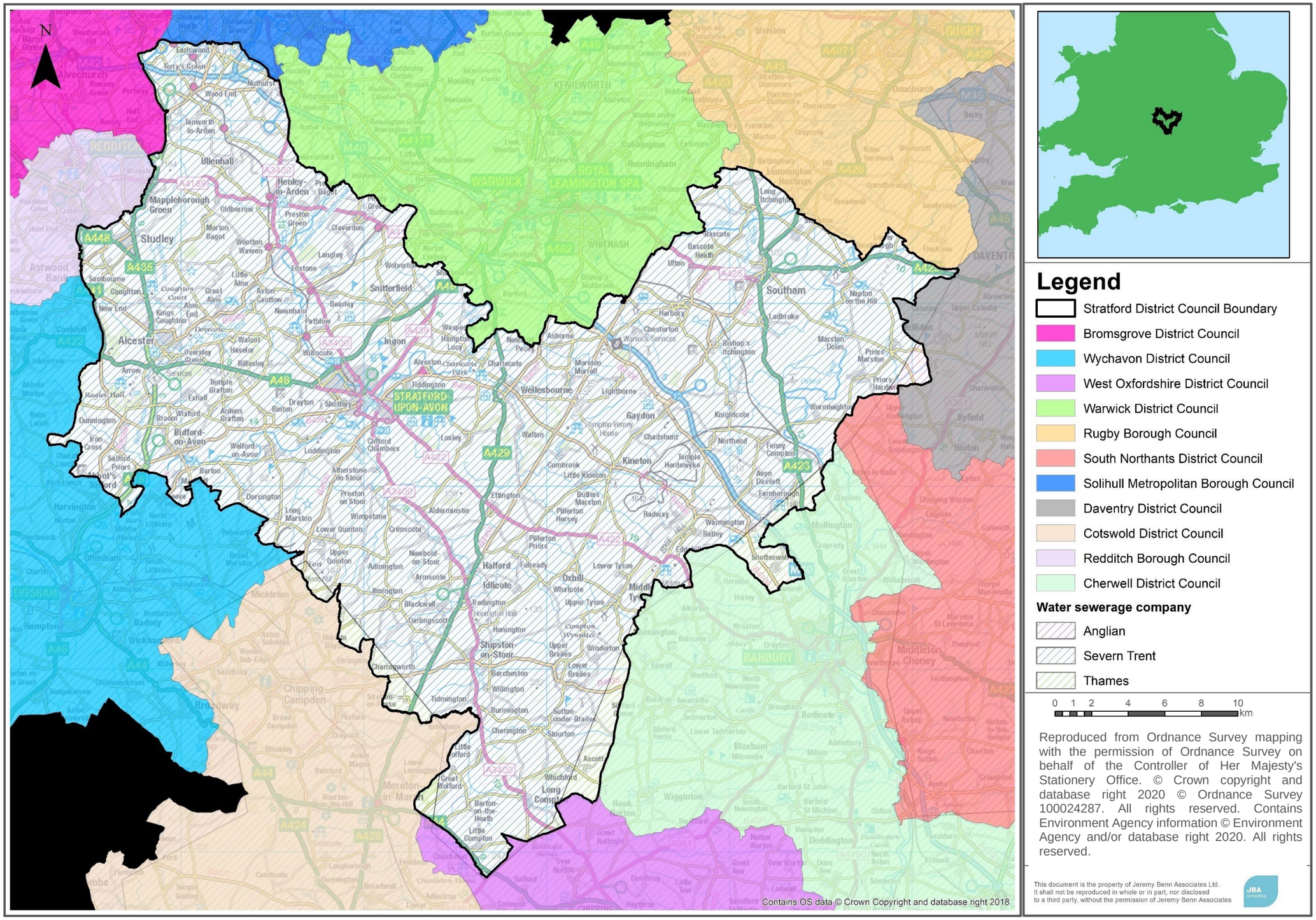
Stratford on Avon District lies within the county of Warwickshire and covers an area of approximately 977.9km^2 with a population of approximately 120,485 (2011 Census). The main urban centre within the District is Stratford upon Avon which has a population of around 26,000. Other main urban areas in the District include Alcester, Henley in Arden, Bidford on Avon, Southam, Shipston on Stour and Wellesbourne.

The main rivers in the District are the River Avon, River Arrow, River Alne, River Stour, River Itchen and the River Dene, with the Avon being the principal watercourse in the District.

The District is bounded by 11 other authorities; Bromsgrove District Council, Redditch Borough Council, Wychavon District Council, West Oxfordshire District Council, Warwick District Council, Rugby Borough Council, South Northants District Council, Solihull Metropolitan Borough Council, Daventry District Council, Cotswold District Council and Cherwell District Council.

An overview of the study area showing the neighbouring authorities and the areas covered by Severn Trent, Thames and Anglian Water is shown in Figure 1-1.

Figure 1-1 Study Area



1.5 Consultation

SFRAs should be prepared in consultation with other risk management authorities. The following parties (external to Stratford on Avon District Council) have been consulted during the preparation of this version of the SFRA:

- Environment Agency
- Warwickshire County Council (LLFA)
- Canal and River Trust
- Warwickshire Highways
- Warwickshire Fire and Rescue
- Severn Trent Water, Thames Water and Anglian Water
- Neighbouring authorities including:
    - Bromsgrove District Council
    - Redditch Borough Council
    - Wychavon District Council
    - West Oxfordshire District Council
    - Warwick District Council
    - Rugby Borough Council
    - South Northants District Council
    - Solihull Metropolitan Borough Council
    - Daventry District Council
    - Cotswold District Council
    - Cherwell District Council

1.6 Use of SFRA data

It is important to recognise that Level 1 SFRAs are high-level strategic documents and, as such, do not go into detail on an individual site-specific basis. The primary purpose of this SFRA data is to provide an evidence base to inform Stratford on Avon District Council's Development Plan, including its Site Allocations Plan and any future flood risk policies, as detailed in the objectives listed in Section 1.2. This SFRA is intended to aid Stratford on Avon District Council in applying the Sequential Test for their site allocations and identify where the application of the Exception Test may be required via a Level 2 SFRA.

The data contained in this SFRA also has several other uses, in addition to that which is noted above. Table 1-1 sets out the structure and content of the SFRA report and associated mapping, alongside how the data can be used, primarily by Stratford on Avon District Council or private developers.

Hyperlinks to external guidance documents/websites are provided in **green** throughout the SFRA.

Advice to users has been highlighted in **amber boxes** throughout the document.

Appendix C presents a SFRA User Guide, further explaining how SFRA data should be used, including reference to relevant sections of the SFRA, how to consider different sources of flood risk and recommendations and advice for Sequential and Exception Tests.

On the date of publication, the SFRA contains the latest flood risk information. Over time, new information will become available to inform planning decisions, such as updated hydraulic models (which then update the Flood Map for Planning), flood event information, new defence schemes and updates to policy and legislation. Developers should check the online **Flood Map for Planning** in the first instance to identify any major changes to the Flood Zones.

Table 1-1 SFRA report contents

Section	Contents	How to use
Executive Summary	Focuses on how the SFRA can be used by planners, developers and neighbourhood planners	Summarises the Level 1 findings and recommendations.
1. Introduction	Provides a background to the study, the Local Plan stage the SFRA informs, the study area, the roles and responsibilities for the organisations involved in flood management and how they were involved in the SFRA Provides a short introduction to how flood risk is assessed and the importance of considering all sources Includes this table of the contents of the SFRA	For users to understand the purpose, objectives and outputs of the study.
2. The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.	Users should refer to this section for any relevant policy which may underpin strategic or site-specific assessments.
3. The sequential, risk-based approach	Provides an overview of both national and existing Local Plan policy on flood risk management This includes the Flood Zones, application of the Sequential Approach and Sequential/Exception Test process. 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. The impact of climate change	Outlines the latest climate change guidance published by the Environment Agency and how this was	This section should be used to understand the climate change

	applied to the SFRA Sets out how developers should apply the guidance to inform site specific Flood Risk Assessments	allowances for a range of epochs and conditions, linked to the vulnerability of a development.
5. Summary of SFRA mapping for all sources of flood risk and methodology	Outlines what information has been used in the preparation of the SFRA including any data gaps.	The methodology will provide users with an understanding of where broad-scale or detailed models have been used to identify the fluvial flood risk. Any data gaps identified may help to shape future strategic flood risk studies or indicate where studies need to be undertaken at a site-specific level.
6. Understanding flood risk in Stratford on Avon District	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting Stratford on Avon District including historical flooding incidents, flood risk from canals and reservoirs and flood warning arrangements.	The outputs (including mapping) will identify communities in the study area at flood risk and the potential sources. This will be used to help the Council apply the Sequential Test and if necessary, the Exception Test to site allocations proposed in the Development Plan. Private developers should consider the findings of this SFRA, particularly in relation to site-specific FRAs, the application of the Sequential and Exception Test, and/or drainage strategies. The Council should also review the findings in relation to any strategic flood emergency plans.
7. Flood defences and assets, residual risk	Provides a summary of current flood defences and asset management and future planned schemes. Introduces actual and residual flood risk.	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.
8. Cumulative impact of development and cross boundary issues	Broadscale assessment of areas where the cumulative impact of development may be detrimental to flood risk. An assessment of potential cross boundary flood risk issues as a result	The Council and neighbouring authorities should use this section to help develop policy recommendations for

	of future large-scale developments.	the cumulative impact of development.
9. Flood Risk Assessment and Surface Water Drainage Strategy requirements and guidance for developers	Guidance for developers on Flood Risk Assessments, considering flood risk from all sources	Developers should use this section to understand requirements for FRAs and what conditions/ guidance documents should be followed, as well as mitigation options.
10. Surface water management and SuDS	An overview of Sustainable Drainage Systems, Guidance for developers on Surface Water Drainage Strategies, considering any specific local standards and guidance for Sustainable Drainage Systems (SuDS) from the Lead Local Flood Authority.	Developers should use this section to understand what national, regional and local SuDS standards are applicable. Hyperlinks are provided.
11. Strategic Flood Risk Solutions	Summary of Strategic Flood Risk Solutions.	The potential strategic flood risk solutions that could be considered by the Council and other flood management authority partners.
12. Summary and recommendations	Summarises sources of flood risk in the study area and outlines key planning policy recommendations	Developers and planners should use this section to provide an overview of the Level 2 assessment. Planners should use this section to identify which potential site allocations have the least risk of flooding. Developers should refer to the Level 1 SFRA recommendations when considering requirements for site-specific assessments.

Appendix A: Level 1 SFRA mapping - GeoPDFs Appendix B: Cumulative Impact Maps Appendix C: SFRA User Guide Appendix D: Groundwater Mapping Appendix E: Surface Water Climate Change Mapping	The appendices are intended to map the sources of flood risk in Stratford on Avon District and to help users identify whether a site is at flood risk and from what source. The appendices are intended to complement EA datasets and do not seek to replace these. Developers should refer to both the SFRA and EA datasets (where relevant). The SFRA outputs do not remove requirements for site-specific FRAs, drainage strategies or further detailed modelling at a site-specific level.

1.7 Understanding flood risk

This section provides useful background information on how flooding arises and how flood risk is determined.

1.7.1 Sources of Flooding

Flooding is a natural process and can happen at any time in a wide variety of locations. It constitutes a temporary covering of land not normally covered by water and presents a risk when people and human or environmental assets are present in the area that floods. Assets at risk from flooding can include housing, transport and public service infrastructure, commercial and industrial enterprises, agricultural land and environmental and cultural heritage. Flooding can occur from many different and combined sources and in many different ways, as illustrated in Figure 1-2. Major sources of flooding include:

- Fluvial (rivers) - inundation of floodplains from rivers and watercourses; inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels; overtopping or breaching of defences; blockages of culverts; blockages of flood channels/corridors.
- Surface water - surface water flooding covers two main sources including direct run-off from adjacent land (pluvial) and surcharging of piped drainage systems (public sewers, highway drains, etc.)
- Groundwater - water table rising after prolonged rainfall to emerge above ground level remote from a watercourse; most likely to occur in low-lying areas underlain by permeable rock (aquifers); groundwater recovery after pumping for mining or industry has ceased.
- Infrastructure failure - reservoirs; canals; industrial processes; burst water mains; blocked sewers or failed pumping stations.

Different types and forms of flooding present a range of different risks and the flood hazards of speed of inundation, depth and duration of flooding can vary greatly. With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging.

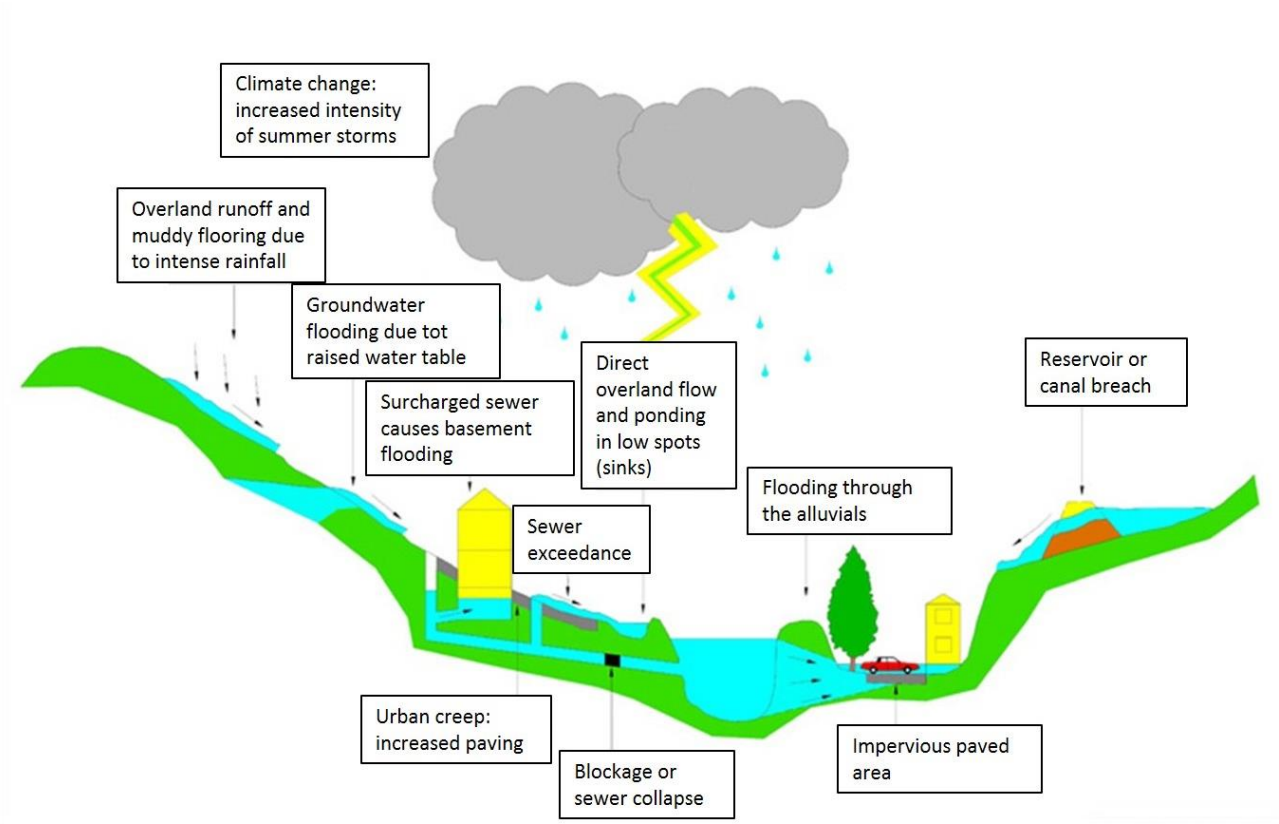


Figure 1-2: Flooding from all sources

1.8 Likelihood and Consequence

Flood risk is a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the source – pathway – receptor model as shown in Figure 1-3 below. This is a standard environmental risk model common to many hazards and should be the starting point of any assessment of flood risk. However, it should be remembered that flooding could occur from many different sources and pathways, and not simply those shown in the illustration below.

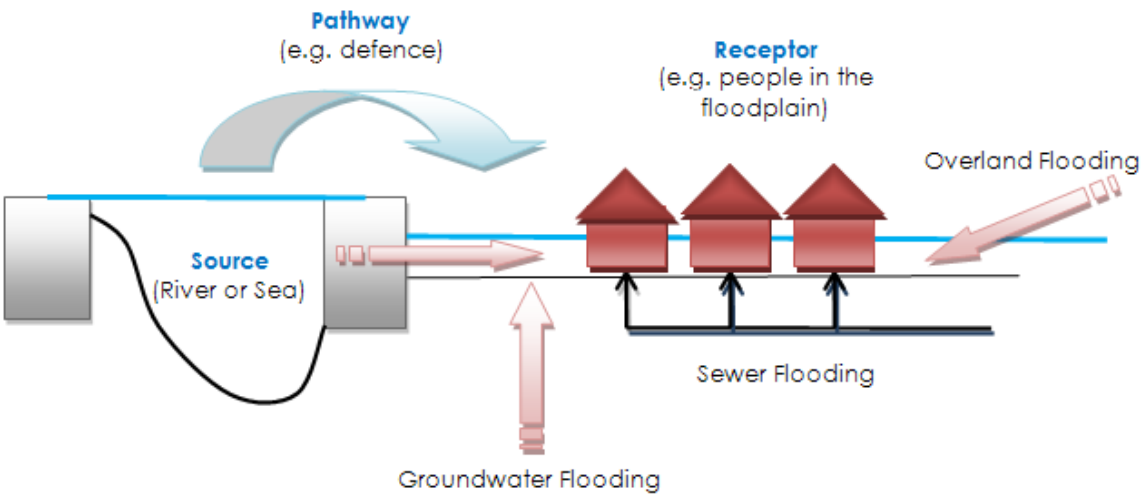


Figure 1-3: Source-Pathway-Receptor Model

The principal sources are rainfall; the most common pathways are rivers, drains, sewers, overland flow and river floodplains; their defence assets; and the receptors can include people, their property and the environment. All these elements must

be present for flood risk to arise. Mitigation measures have little or no effect on sources of flooding, but they can block or impede pathways or remove receptors.

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 in order to apply this guidance in a consistent manner.

1.9 Likelihood

Likelihood of flooding is expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1% probability 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 once every hundred years.

Considered over the lifetime of development, such an apparently low frequency or rare flood has a significant probability of occurring. For example:

- A 1% flood has a 26% (1 in 4) chance of occurring at least once in a 30-year period - the period of a typical residential mortgage
- And a 49% (1 in 2) chance of occurring in a 70-year period - a typical human lifetime

1.10 Consequence

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) and the vulnerability of receptors (type of development, nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc). Flood risk is then expressed in terms of the following relationship:

Flood risk = Probability of flooding x Consequences of flooding

1.11 Risk

Flood risk is not static; it cannot be described simply as a fixed water level that will occur if a river overtops its banks or from a high spring tide that coincides with a storm surge. It is therefore important to consider the continuum of risk carefully. Risk varies depending on the severity of the event, the source of the water, the pathways of flooding (such as the condition of flood defences) and the vulnerability of receptors as mentioned above.

2 Flood Risk policy and strategy

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 for Flood Risk Management in Stratford on Avon District

There are different organisations in and around Stratford on Avon District that have responsibilities for flood risk management, known as Risk Management Authorities (RMAs). These are shown on Table 2.1, with a summary of their responsibilities.

It is important to note that land and property owners are responsible for the maintenance of watercourses either on or next to their properties. Property 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 in the Environment Agency publication **Owning a watercourse** (2018).

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

Table 2-1 Roles and responsibilities for Risk Management Authorities

Risk Management Authority	Strategic Level	Operational Level	Planning role
Environment Agency	• Strategic overview for all sources of flooding • National Strategy • Reporting and general supervision	• Main rivers • Reservoirs	• Statutory consultee for development in Flood Zones 2 and 3
Warwickshire County Council as Lead Local Flood Authority (LLFA)	• Develop, maintain, apply and monitor a Local Flood Risk Management Strategy. • Co-ordinate partnership working between relevant organisations. • Represent Warwickshire on the English Severn and Wye Regional Flood and Coastal Committee. • To comply with the European Floods	• Investigate flooding incidents and set out who has responsibilities and what actions can be taken. • Hold a register of significant drainage/flood alleviation assets. • Power to designate third party assets acting as flood defences so they cannot be altered or removed. • Powers to enforce land drainage legislation to ensure ordinary watercourses flow	• Statutory consultee for major developments

	Directive, produce a Preliminary Flood Risk Assessment and for nationally significant Flood Risk Areas, surface water mapping and a Flood Risk Management Plan (on a six-year cycle).	properly and a duty to consent to certain works on these watercourses. • Powers to build new flood alleviation schemes for local sources of flooding. • Statutory Consultee for Planning Applications for surface water drainage on major developments	
Stratford on Avon District Council as Local Planning Authority	• Local Plans as Local Planning Authorities	• Determination of Planning Applications as Local Planning Authorities • Local Plan/ Development Plan Document preparation	• As left
Water Companies *Severn Trent Water* *Thames Water* *Anglian Water*	• Asset Management Plans supported by Periodic Reviews (business cases) • Develop Drainage and Wastewater management plans	• Public sewers	• Non-statutory consultee
Highways Authorities *Highways England (motorways and trunk roads)* *Warwickshire County Council (other adopted roads)*	• Highway drainage policy and planning	• Highway drainage	• Internal planning consultee regarding highways design standards and adoptions

2.2 Relevant legislation

The following legislation is relevant to development and flood risk in Stratford on Avon District:

- **Flood Risk Regulations (2009)** - these transpose the European Floods Directive (2000) into law and require the Environment Agency and LLFAs to produce Preliminary Flood Risk Assessments and identify where there are nationally significant Flood Risk Areas. For the Flood Risk Areas, detailed flood maps and a Flood Risk Management Plan is produced; this is done in a six-year cycle.
- **Town and Country Planning Act (1990), Water Industry Act (1991), Land Drainage Act (1991), Environment Act (1995), Flood and Water**

Management Act (2010) – as amended and implanted via secondary legislation. These set out the roles and responsibilities for organisations that have a role in FRM.

- The **Land Drainage Act (1991, as amended)** and **Environmental Permitting Regulations (2018)** also set out where developers will need to apply for additional permission (as well as planning permission) to undertake works to an **Ordinary Watercourse** or **Main River**.
- The **Water Environment Regulations (2017)** – these transpose the European Water Framework Directive (2000) into law and require the Environment Agency to produce River Basin Management Plans (RBMPs). These aim to ensure that the water quality of aquatic ecosystems, riparian ecosystems and wetlands reaches 'good' status.
- Other environmental legislation such as the Habitats Directive (1992), Environmental Impact Assessment Directive (2014) and Strategic Environmental Assessment Directive (2001) also apply as appropriate to strategic and site-specific developments to guard against environmental damage.

2.3 Relevant flood risk policy and strategy documents

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 Flood Risk Assessments within the local area.
- Set the strategic policy and direction for Flood Risk Management (FRM) 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 FRM and drainage in the district.
- Provide guidance and/or standards that informs how a developer should assess flood risk and/or design flood mitigation and SuDS.

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

	Document, lead author and date	Information	Policy and measures	Development design requirements	Next update due
National	**Flood and Coastal Management Strategy** (Environment Agency) 2020	No	Yes	No	Due to be reviewed in 2026
	National Planning Policy Framework and Guidance (MHCLG) 2018/2015)	No	No	Yes	2019 updates to PPG
	Building Regulations Part H (MHCLG) 2010	No	No	Yes	-
Regional	**River Severn Catchment Flood Management Plan** (Environment Agency) 2009	Yes	Yes	No	-
	Severn River Basin Management Plan (Environment Agency) 2016	No	Yes	No	2021
	Climate Change guidance for development and flood risk (Environment Agency) 2019	No	No	Yes	2020 for fluvial and rainfall allowances
Local	**Supplementary Planning Document for Sustainable Drainage Systems** (WCC) (2020)	No	No	Yes	-
	Local Flood Risk Management Strategy (WCC) 2016	Yes	Yes	No	2021
	Stratford-on-Avon DC Water Cycle Study 2014	Yes	No	Yes	-

2.4 Relevant legislation for flood and water management

This section summarises relevant national and local flood risk and water management documents and policies. Some of these are required by EU legislation. The UK is due to leave the EU in March 2019. However, both the Floods Directive and Water Framework Directive have been applied into English law using secondary legislation. Until this secondary legislation is reviewed, these requirements will remain.

2.4.1 Flood Risk Regulations (2009)

The **Flood Risk Regulations (2009)** translate the EU Floods Directive into UK law. The EU requires Member States to complete an assessment of flood risk (known as a Preliminary Flood Risk Assessment (PFRA)) and then use this information to identify areas where there is a significant risk of flooding. For these Flood Risk Areas, States must then undertake Flood Risk and Hazard Mapping and produce Flood Risk Management Plans.

The Flood Risk Regulations direct the Environment Agency to do this work for river, sea and reservoir flooding. LLFAs must do this work for surface water, Ordinary Watercourse and Groundwater flooding. This is a six-year cycle of work and the second cycle started in 2017.

The **Warwickshire County Council PFRA** (2011) provides information on significant past and future flood risk from localised flooding in Warwickshire. This was **updated in 2017**, and no nationally significant Flood Risk Areas for localised flooding have been identified in within the Stratford on Avon District.

The Environment Agency PFRA (2018) for river, sea and reservoir flooding identifies nationally significant Flood Risk Areas for these sources. They exercised an exemption clause for the first six-year cycle and so there are no current FRAs from these sources in Stratford on Avon District. However, the **Severn Flood Risk Management Plan** does provide information on flood risk management work in the District.

2.4.2 Flood and Water Management Act (2010)

The Flood and Water Management Act (2010) (FWMA) aims to create a simpler and more effective means of managing flood risk and implements Sir Michael Pitt's recommendations following his review of the 2007 floods. The responsibilities for Warwickshire County Council as LLFA are covered in Table 2-2. Below is a summary of some of the work Warwickshire County Council has undertaken to date as a LLFA.

- **Warwickshire County Council's Local Flood Risk Management Strategy** was published in April 2016.
- Formal flood investigations have been undertaken for Drayton Avenue, Stratford upon Avon (draft stage) and Long Itchington (draft stage). These can be requested from Warwickshire County Council.
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion are likely to have a significant effect on flood risk in the LLFA area. A Flood Asset Register has been prepared for Stratford on Avon District (see Section 7.4).

2.4.3 The Water Framework Directive & Water Environment Regulations

The EU Water Framework Directive (WFD) seeks to integrate and enhance the way in which water bodies are managed throughout Europe by the preservation,

restoration and improvement of the water environment. In England, the Environment Agency is responsible for the delivery of the WFD objectives.

The purpose of the Water Framework Directive (WFD), which was transposed into English Law by the Water Environment Regulations (2003), is to deliver improvements across Europe in the management of water quality and water resources through a series of plans called River Basin Management Plans (RBMP), which were last published in 2015 and are currently being updated.

Stratford on Avon District is made up of two catchments: the Avon Rural Rivers and Lakes and Avon Urban Rivers and Lakes. Of these catchments, there are several waterbodies within Stratford on Avon District which are not achieving 'good status' for the Water Framework Directive, including parts of the River Avon, River Dene, River Itchen, River Stour, River Stowe, River Alne and River Arrow. The Environment Agency is working with its partners, businesses and the community to investigate improvements to the ecological status of these water bodies and techniques. Further information on the ecological status of waterbodies in Stratford on Avon District is available on the Environment Agency's **Catchment Data Explorer**.

2.5 Key national, regional and local policy documents and strategies

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

The **National Flood and Coastal Erosion Risk Management Strategy** (FCERM) for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. The new Strategy has been in preparation since 2018. The Environment Agency brought together a wide range of stakeholders to develop the strategy collaboratively. The Strategy is much more ambitious than the previous one from 2011 and looks ahead to 2100 and the action needed to address the challenge of climate change.

The Strategy has been split into 3 high level ambitions: climate resilient places, today's growth and infrastructure resilient in tomorrow's climate and a nation ready to respond and adapt to flooding and coastal change. Measures include updating the national river, coastal and surface water flood risk mapping and the understanding of long term investment needs for flood and coastal infrastructure, trialling new and innovative funding models, flood resilience pilot studies, developing an adaptive approach to the impacts of climate change, seeking nature based solutions towards flooding and erosion issues, integrating natural flood management into the new Environmental Land Management scheme, considering long term adaptive approaches in Local Plans, maximising the opportunities for flood and coastal resilience as part of contributing to environmental net gain for development proposals, investing in flood risk infrastructure that supports sustainable growth, aligning long term strategic planning cycles for flood and coastal work between stakeholders, mainstreaming property flood resilience measures and 'building back better' after flooding, consistent approaches to asset management and record keeping, updating guidance on managing high risk reservoirs in light of climate change, critical infrastructure resilience, education, skills and capacity building, research, innovation and sharing of best practise, supporting communities to plan for flood events, develop world leading ways of reducing the carbon and environmental impact from the construction and operation of flood and coastal defences, development of digital tools to communicate flood risk and transforming the flood warning service and increasing flood response and recovery support.

The Strategy was laid before parliament in July 2020 for formal adoption and published alongside a New **National Policy Statement for Flood and Coastal Erosion Risk Management**. The statement sets out five key commitments which will accelerate progress to better protect and better prepare the country for the coming years:

1. Upgrading and expanding flood defences and infrastructure across the country,
2. Managing the flow of water to both reduce flood risk and manage drought,
3. Harnessing the power of nature to not only reduce flood risk, but deliver benefits for the environment, nature, and communities,
4. Better preparing communities for when flooding and erosion does occur, and
5. Ensuring every area of England has a comprehensive local plan for dealing with flooding and coastal erosion.

2.5.2 Updated Strategic Flood Risk Assessment guidance

There was an update to the **'How to prepare a Strategic Flood Risk Assessment guidance'** in August 2019, which had some key additions to both Level 1 and Level 2 assessments. The Level 1 assessment is undertaken in accordance with this guidance.

2.6 Catchment Flood Management Plans

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

The **River Severn Catchment Flood Management Plan** is the one that is most relevant to Stratford on Avon District. The actions of this were brought forward into the 2015 Flood Risk Management Plan for the Severn.

2.6.1 River Basin Management Plans

The WFD requires the production of Management Plans for each River Basin District. River Basin Management Plans (RBMPs) aim to ensure that all aquatic ecosystems, riparian ecosystems and wetlands reach 'good status'. To achieve 'good status', a waterbody must be observed to be at a level of ecological and chemical quality.

Stratford on Avon District primarily falls within the Severn River Basin District, but in the north of the District its footprint reaches into the Humber River Basin District, and into the Thames River Basin District in the south of the District. The River Basin Districts management plans highlight a number of actions to a number of issues raised either within the District as a whole or in sub Districts. Further information can be found in the RBMP and the **Catchment Based Approach (CaBA) website**.

2.6.2 Warwickshire County Council Local Flood Risk Management Strategy (LFRMS) 2016

Warwickshire County Council is responsible for developing, maintaining, applying and monitoring a LFRMS. The **most recent Strategy** was published in April 2016 and is used as a means by which the LLFA co-ordinates Flood Risk Management on a day-to-day basis. The five high-level objectives proposed in the Strategy for managing flood risk include:

- Develop a better understanding of local flood risk in Warwickshire to better manage flood risk to people, property, infrastructure and the natural environment
- Seek to reduce local flood risk in Warwickshire in an economically, socially and environmentally sustainable way
- Adopt a collaborative approach to local flood risk management
- Promote community preparedness and resilience to local flood risk
- Enable planning decisions to take full account of local flood risk and seek to reduce local flood risk through development

The Action Plan in **Appendix D** of the Strategy sets out how the objectives will be delivered and by whom. The actions are monitored by a strategic Flood Risk Management Board.

2.6.3 LLFAs, surface water and SuDS

The revised 2018 NPPF states that: 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (Para 165). When considering planning applications, local planning authorities should consult the LLFA on the management of surface water in order to satisfy that:

- The proposed minimum standards of operation are appropriate
- Through the use of planning conditions or planning obligations there are clear arrangements for on-going maintenance over the development's lifetime

Warwickshire County Council's requirements for new developers on SuDS are set out on their **website**, alongside supporting documents. At the time of writing this SFRA, documents and policies relevant to SuDS and surface water are:

- **Standing Advice on Flood Risk and Drainage**
- **Ordinary Watercourse Land Drainage Consents in Warwickshire Advice Note**
- **Surface Water Management Plan**
- **Stratford on Avon District Council Core Strategy** Policy CS.4 Water Environment and Flood Risk

2.7 Water Cycle Studies

Water Cycle Studies assist local authorities to select and develop growth proposals that minimise impacts on the environment, water quality, water resources, infrastructure and flood risk and help to identify ways of mitigating such impacts.

Stratford on Avon DC Water Cycle Study Update was completed in 2015 and highlighted the following:

- *Water resources*: The study area mainly falls within Severn Trent Water's Strategic Grid water resource zone, with Thames Water and Anglian Water covering minor areas of the District. The sources are supplied by a mixture of river abstraction, groundwater boreholes/wells and from surface water reservoirs. The study concluded that there would be adequate water supply for the planned growth in the District to 2031, however long-term limitations on further abstraction from raw water resources were identified and the

importance of achieving sustainability of water resources in Stratford on Avon District was outlined.

- *Wastewater and sewerage*: Public sewerage is mainly provided by Severn Trent Water. The report identified that two Wastewater Treatment Works (WwTWs) within the District did not have the capacity to accept the wastewater flow from the entirety of the proposed growth in Stratford on Avon District and a series of recommendations were put forward.
- *Water Quality*: With the predicted growth in the District, water quality can become an issue. Where it is predicted to be an issue, discharge to the watercourses should be limited to achieve no deterioration of water quality, as well as to demonstrate if growth will make it more difficult to achieve the requirements of the Water Framework Directive. The report identified and conducted water quality modelling on the WwTWs where permitted headroom would be exceeded after the proposed levels of growth.
- *Flood risk and drainage*: Surface and ground water sources are noted to be of flood risk across the Water Cycle Area. The report recommends a series of varying recommendations that are site-specific.

2.8 Surface Water Management Plans

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

3 Planning policy for flood risk management

This section summaries national planning policy for development and flood risk.

3.1 National Planning Policy Framework and Guidance

The revised National Planning Policy Framework (**NPPF**) was published in July 2019, replacing the 2012 version. The NPPF sets out Government's planning policies for England. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions. The NPPF defines Flood Zones, how these should be used to allocate land and flood risk assessment 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"

Planning Practice Guidance on flood risk was published in March 2014 and sets out how the policy should be implemented. **Diagram 1 in the NPPG** sets out how flood risk should be considered in the preparation of Local Plans.

3.2 The risk-based approach

The NPPF takes a risk-based approach to development in flood risk areas.

3.2.1 The Flood Zones

The definition of the Flood Zones is provided below. The Flood Zones do not take into account defences. 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 do not take into account surface water, sewer or groundwater flooding or the impacts of canal or reservoir failure. They do not consider climate change. Hence there could still be a risk of flooding from other sources and that the level of flood risk will change over time during the lifetime of a development.

The Flood Zones are:

- **Flood Zone 1: Low probability**: less than a 0.1% chance of river and sea flooding in any given year
- **Flood Zone 2: Medium probability**: between a 1% and 0.1% chance of river flooding in any given year or 0.5% and 0.1% chance of sea flooding in any given year
- **Flood Zone 3a: High probability**: greater or equal to a 1% chance of river flooding in any given year or greater than a 0.5% chance of sea flooding in any given year. Excludes Flood Zone 3b.
- **Flood Zone 3b: Functional Floodplain**: land where water has to flow or be stored in times of flood. SFRAs identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain takes account of local circumstances. Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes.

Important note on Flood Zone information in this SFRA

The Flood Zones presented in Appendix A Geo-PDFs are the same as those shown on the Environment Agency's 'Flood Map for Planning'.
The Environment Agency Flood Zones do not cover all catchments or ordinary watercourses. As a result, whilst the Environment Agency Flood Zones may show an area is in Flood Zone 1, it may be that there is actually a degree of flood risk from smaller watercourses not shown in the Flood Zones.
At the time of writing this SFRA, the Environment Agency's Flood Map for Planning did not incorporate all the latest modelling results in Stratford upon Avon, along the Racecourse and Shottery Brooks. Therefore, in this area, the 100-year and 1,000-year modelled flood extents were used to represent Flood Zones 3a and 2 respectively.
Functional floodplain (Flood Zone 3b) is identified as land which would flood with an annual probability of 1 in 20 years; where detailed hydraulic modelling exists. The 1 in 20-year flood extent has been used to represent Flood Zone 3b (or 1 in 25-year in the absence of 1 in 20-year), provided by the Environment Agency. For areas outside of the detailed model coverage, or where no outputs were available (River Dene and Bell Brook), this is represented by Flood Zone 3a as a conservative indication. Further work should be undertaken as part of a detailed site-specific Flood Risk Assessment to define the extent of Flood Zone 3b where no detailed modelling exists.

3.2.2 The Sequential Test

Firstly, land at the lowest risk of flooding and 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, developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test.

The LPA should work with the Environment Agency to define a suitable area of search for the consideration of alternative sides 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 or Employment Land Availability Assessments.

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 NPPG** defines the vulnerability of different development types to flooding. **Table 3 of the NPPG** shows whether, having applied the Sequential Test first, that vulnerability of development is suitable for that Flood Zone and where further work is needed.

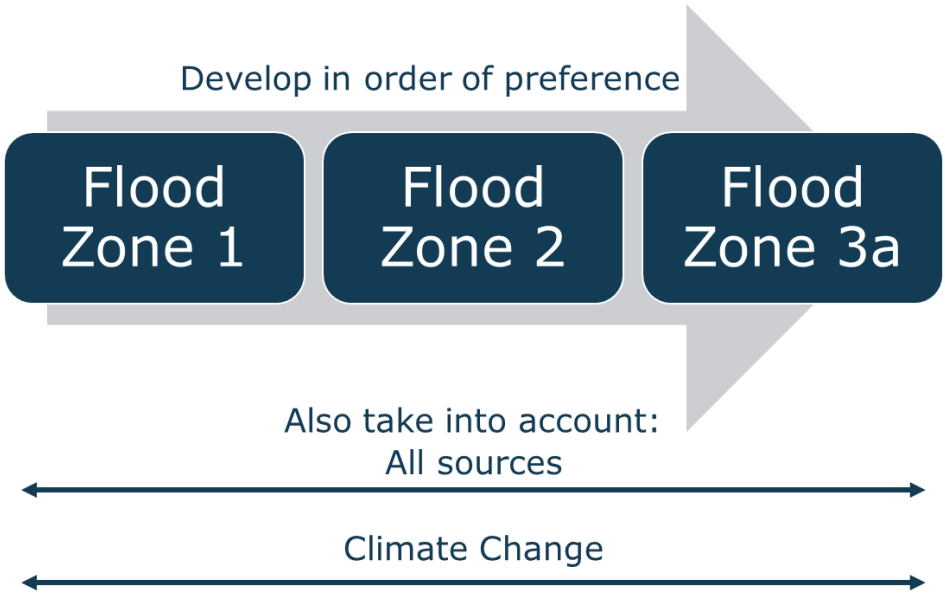


Figure 3-1 The Sequential Test

Figure 3-2 illustrates the Sequential and Exception Tests as a process flow diagram using the information contained in this SFRA to assess potential development sites against the EA's Flood Map for Planning flood zones and development vulnerability compatibilities.

This is a stepwise process, but a challenging one, as a number 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 outer sources and the impact of climate change must be considered when considering which sites are suitable to allocate. The SFRA User Guide in Appendix C shows where the Sequential and Exception Test may be required for the datasets assessed in the SFRA, and how to interpret different levels of concern with the datasets, recommending what development might be appropriate in what situations.

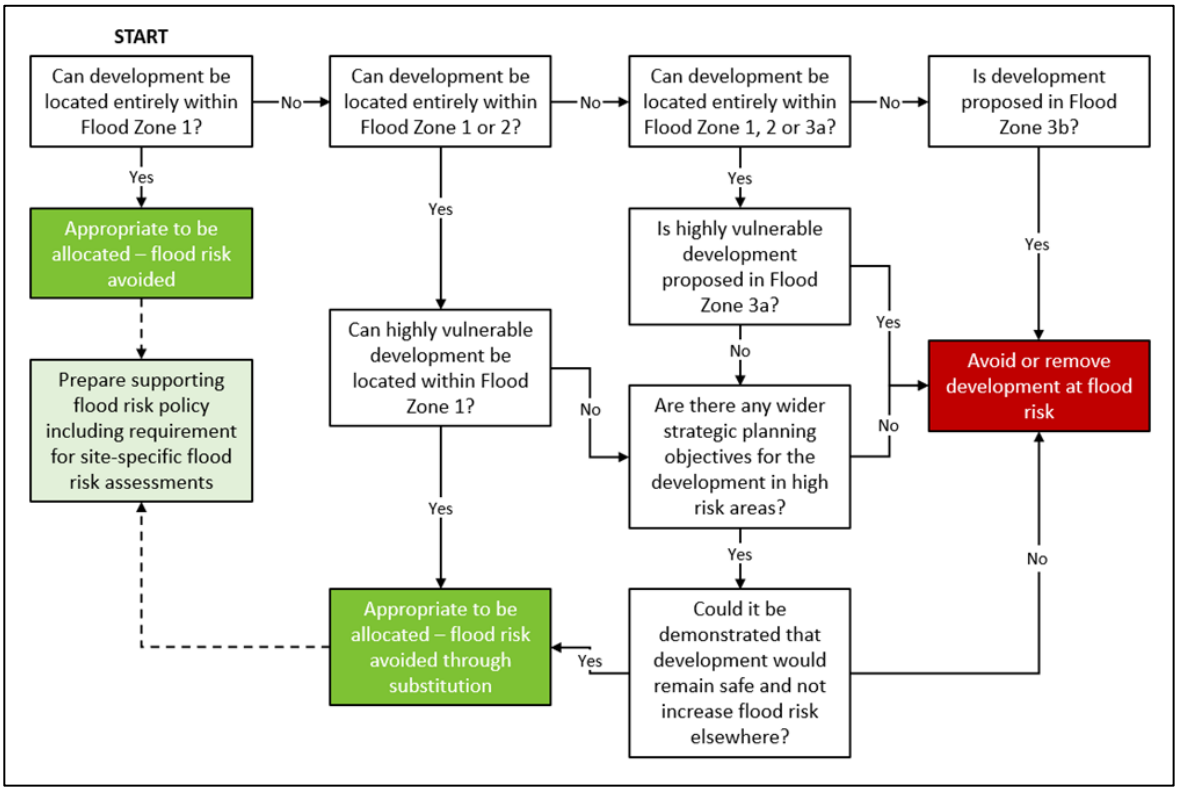


Figure 3-2: Local Plan sequential approach to site allocation

3.2.3 The Exception Test

It will not always be possible for all new development to be allocated 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.

The Exception Test should only be applied following the application of the Sequential Test. It applies in the following instances:

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

Figure 3-3 summarises the Exception Test. An LPA should apply the Exception Test to strategic allocations. For all developments, developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test. This is because when a site-specific Flood Risk Assessment is done, more information on the exact measures that can manage the risk is available.

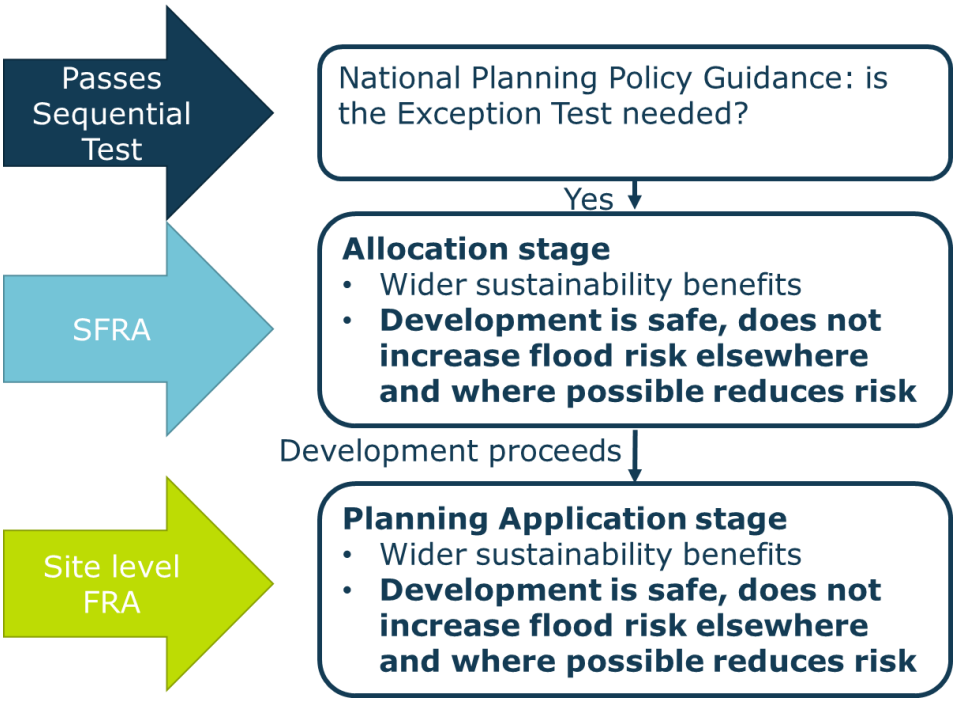


Figure 3-3 The Exception Test

There are two parts to demonstrating a development passes the Exception Test:

1 *Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk*

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

2 *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.*

A Level 2 SFRA is likely to be needed to inform the Exception Test in these circumstances for strategic allocations. At Planning Application stage, a site-specific Flood Risk assessment will be needed. Both would need to consider the actual and residual risk and how this will be managed over the lifetime of the development.

3.2.4 Making a site safe from flood risk over its lifetime

Local Planning Authorities will need to consider the actual and residual risk of flooding and how this will be managed over the lifetime of the development:

- The actual risk is the risk to the site considering existing flood mitigation measures. The fluvial 1% chance flood in any year event is a key event to consider because the National Planning Policy Guidance refers to this as the 'design flood' against which the suitability of a proposed development should be assessed and mitigation measures, if any, are designed.

- Safe access and egress should be available during the design flood event. Firstly, this should seek to avoid areas of a site at flood risk. If that is not possible then access routes should be located above the design flood event levels. Where that is not possible, access through shallow and slow flowing water that poses a low flood hazard may be acceptable.
- Residual risk is the risk that remains after the effects of flood defences have been taken into account and/ or from a more severe flood event than the design event. The residual risk can be:
- The effects of an extreme 0.1% chance flood in any year event. Where there are defences this could cause them to overtop, which may lead to failure if this causes them to erode, and/ or
- Structural failure of any flood defences, such as breaches in embankments or walls.

Flood resistance and resilience measures should be considered to manage any residual flood risk by keeping water out of properties and seeking to reduce the damage it does, should water enter a property. Emergency plans should also account for residual risk, e.g. through the provision of flood warnings and a flood evacuation plan where appropriate.

In line with the NPPF, the impacts of climate change over the lifetime of the development should be taken into account when considering actual and residual flood risk.

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

3.3.1 Sequential Test

Stratford-on-Avon District Council, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied.

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, or
- A change of use (except to a more vulnerable use), or
- A minor development (householder development, small non-residential extensions with a footprint of less than 250m^2), or
- A development in flood zone 1 unless there are other flooding issues in the area of the development (i.e. surface water, ground water, sewer flooding).

The SFRA contains information on all sources of flooding and taking into account 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.

Local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear 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:

- Site allocations in Local Plans
- Site 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.

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

3.3.2 The Exception Test

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding the Exception Test must then be applied if required (as set out in Table 3 of the NPPG). Developers are required to apply the Exception Test to all applicable sites (including strategic allocations).

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

- Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk.

  Applicants should refer to wider sustainability objectives in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.

  Applicants should detail the suitability issues the development will address and how doing out will outweigh the flood risk concerns for the site e.g. by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.

- 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.

  The site-specific Flood Risk Assessment should demonstrate that the site will be safe, and the people will not be exposed to hazardous flooding from any source. The FRA should consider actual and residual risk and how this will be managed over the lifetime of the development, including:

  - The design of any flood defence infrastructure;
  - Access and egress;
  - Operation and maintenance;
  - Design of the development to manage and reduce flood risk wherever possible;
  - Resident awareness;
  - Flood warning and evacuation procedures, including whether the developer would increase the pressure on emergency services to rescue people during a flood event; and
  - Any funding arrangements required for implementing measures.

4 Impact of Climate Change

Climate change projections show an increased chance of warmer, wetter winters and hotter, drier summers with a higher likelihood of more frequent and intense rainfall. This is likely to make severe flooding happen more often.

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.

4.1 Revised Climate Change Guidance

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050.

The Environment Agency published **updated climate change guidance** in 2019 on how allowances for climate change should be included in both strategic and site specific FRAs. The guidance adopts a risk-based approach considering the vulnerability of the development. Whilst the guidance was updated in 2019, fluvial allowances are still to be updated from those in the original 2016 guidance.

In 2018, the government published new UK Climate Projections (UKCP18). The Environment Agency are currently using these to update their climate change guidance for new developments with regards to updated fluvial and rainfall allowances. Developers should check on the government website for the latest guidance before undertaking a detailed Flood Risk Assessment. At the time of writing this report, this was reported to be due in late 2020, but is not yet released.

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

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

- Total potential change anticipated for '2020s' (2015 to 2039)
- Total potential change anticipated for '2050s' (2040 to 2069)
- Total potential change anticipated for '2080s' (2070 to 2115)

One or two of the percentiles are provided for each combination of vulnerability and flood zone, which in the latter case provides a 'range' of allowances. The peak river flow allowances show the anticipated changes to peak flow by river basin district, for three future epochs and percentiles, as shown in Table 4-1. The majority of the district lies within the Severn river basin district.

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

River basin district	Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Severn	Upper end	25%	40%	70%
	Higher central	15%	25%	35%
	Central	10%	20%	25%

4.1.1 High ++ allowances

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

4.1.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. The guidance states the information in the tables below. Note that developments should consider the range of allowances identified for each vulnerability classification.

Flood Zone 2

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

Flood Zone 3a

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

Flood Zone 3b

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

4.2 Peak rainfall intensity allowance

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

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

Table 4-2 Peak rainfall intensity allowance in small and urban catchments

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

4.3 Using climate chance allowances

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

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

4.4 Impact of climate change in Stratford on Avon District

This section explores which areas of the District are most sensitive to increases in flood risk due to climate change. It should be noted that areas that are already at high risk will also become at increasing risk in future and the frequency of flooding will increase in such areas.

It is recommended that the Council works with other Risk Management Authorities to review the long-term sustainability of existing and new development in these areas when developing climate change plans and strategies for the District.

4.4.1 Impact of climate change on fluvial flood risk

Climate change modelled flood extents can be compared to the 100-year flood extent (Flood Zone 3a), and where no detailed modelling exists, compared against Flood Zone 2, for an indication of areas most sensitive to climate change.

Areas in the district most sensitive to fluvial impacts of climate change are:

- Stratford-upon-Avon close to watercourses such as Shottery Brook and the River Avon, passing through the town centre and due to the low-lying topography
- Alveston and Tiddington to the northeast of Stratford-upon-Avon
- Henley-in-Arden
- Walcote and Alne End; and
- Areas along the banks of the River Alne from Studley to Alcester

4.4.2 Impact of climate change on surface water flood risk

In the absence of modelling surface water risk with climate change uplifts, the 1,000-year surface water flood extent can be used as an indication of climate change (as well as for smaller watercourses; some of which are not included in the Flood Zones).

Areas in the district most sensitive to changes between the 1,00-year and 1,000-year surface water extents are typically in areas of low-lying topography on the floodplains of the main watercourses. In particular the following areas are sensitive to increased surface water flooding due to climate change:

- Areas surrounding the River Stour along the reach from Newbold-on-Stour to Wimpstone
- The floodplain to the north east of Shipston-on-Stour
- The floodplain of the River Alne to the southeast of Alcester, close to the confluence with the River Arrow
- Stratford-upon-Avon, particularly at low elevations close to the River Avon

4.4.3 Impact of climate change on groundwater flood risk

There is no technical modelling data available to assess climate change impacts on groundwater. It would depend on the flooding mechanism, historic evidence of known flooding and geological characteristics, for example prolonged rainfall in a chalk catchment. Flood risk could increase when groundwater is already high or emerged, causing additional overland flow paths or areas of still ponding.

A high likelihood of groundwater flooding may mean infiltration SuDS are not appropriate and groundwater monitoring may be recommended.

4.4.4 Adapting to climate change

The **NPPG Climate Change guidance** contains information and guidance for how to identify suitable mitigation and adaptation measure in the planning process to address the impacts of climate change. Examples of adapting to climate change include:

- Considering future climate risks when allocating development sites to ensure risks are understood over the development's lifetime;
- Considering the impact of and promoting design responses to flood risk and coastal change for the lifetime of the development;

- Considering availability of water and water infrastructure for the lifetime of the development and design responses to promote water efficiency and protect water quality;
- Promoting adaptation approaches in design policies for developments and the public realm for example by building in flexibility to allow future adaptation if needed, such as setting new development back from watercourses; and
- Identifying no or low-cost responses to climate risks that also deliver other benefits, such as green infrastructure that improves adaptation, biodiversity and amenity, for example by leaving areas shown to be at risk of flooding as public open space.

It is recommended that the differences in flood extents from climate change are compared by the Council when allocating sites, to understand how much additional risk there could be, where this risk is in the site, whether the increase is marginal or activates new flow paths, whether it affects access/ egress and how much land could still be developable overall. Recommendations for development are made for the levels of risk in the SFRA User Guide in Appendix C.

Important note on Climate Change mapping in this SFRA

For this L1 SFRA, the existing hydraulic models provided by the Environment Agency (River Arrow and Alne, River Leam, Bell Brook, River Stour, Middle Avon Tributaries, Racecourse and Shottery Brooks, River Dene and River Avon) were re-run for climate change scenarios to account for the new climate change guidance.

It should be noted that different mapping techniques have been applied, depending on the type of hydraulic model (e.g. 1D-2D or 1D-only). LIDAR ground levels will have updated in some places along with newer model software versions since some of the much older models were originally run, and hence mapped outputs may differ slightly in some areas compared against the original studies.

Three scenarios were modelled to reflect the three climate change allowances for the '2080s' timeframe in the Severn River Basin District, therefore the 100-year plus 25%, 35% and 70%. The climate change mapping reflects the defended scenario. Where no detailed hydraulic models are present, or where existing hydraulic models failed to run (Bell Brook), Flood Zone 2 has been used as a proxy. More detailed hydraulic modelling in these areas may be required at site-specific Flood Risk Assessment stage to confirm flood risk and climate change impacts.

This modelling was undertaken to assist the Council with the preparation of their Local Plan. Developers will need to undertake a more detailed assessment of climate change as part of the planning application process when preparing FRAs.

Climate change mapping has been provided in Appendix A: Geo-PDFs. The Indicative Flood Zone 2 layer provided under the climate change sub-heading should be viewed in conjunction with the modelled climate change outlines. The Indicative FZ2 extent has been provided where climate change models are not available or could not be run, to serve as an indication of possible extents.

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

5 Sources of information used in preparing the SFRA

5.1 Data used to inform the SFRA

Table 5-1 provides an overview of the supplied data, used to inform the appraisal of flood risk for Stratford on Avon District.

Table 5-1 Overview of supplied data for Stratford on Avon District SFRA

Source of flood risk	Data used to inform the assessment	Data supplied by
Historic (all sources)	Historic Flood Map and Recorded Outlines Hydraulic Modelling Reports	Environment Agency
	2013 SFRA	Warwickshire County Council
	Historic flood incidents/records	Warwickshire County Council Stratford on Avon District Council Canals and River Trust Highways
	Historic sewer flooding records	Thames Water
Fluvial (including climate change)	Rivers Arrow and Alne (2009, Halcrow Group Ltd) River Leam (2010, JBA) River Avon (2010, Halcrow Group Ltd, JBA) Middle Avon Tributaries (2015, Capita, AECOM) Racecourse and Shottery Brook (2019, AECOM) Wellesbourne (2008, JBA) Bell Brook (2016, *model not used*) River Stour (2010, Capita)	Environment Agency
Surface Water	Risk of Flooding from Surface Water dataset	Environment Agency
Groundwater	Areas Susceptible to Groundwater Flooding dataset Bedrock geology/superficial deposits dataset JBA Groundwater Mapping Dataset	Environment Agency JBA Consulting
Sewer	At Risk Register Historic flooding records	Severn Trent Water Thames Water
Reservoir	National Inundation Reservoir Mapping	Environment Agency
Canal	Description of flood incidences	Canal and River Trust

Mapping of surface water flood risk in Stratford on Avon District has been taken from the Environment Agency's Risk of Flooding from Surface Water (RoFfSW)

mapping, which is a slightly more detailed resolution than that published online by the Environment Agency. Surface water flood risk is subdivided into the following four categories:

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

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater Flooding (AStGWF) dataset and a range of Groundwater Flood Map products produced by JBA at the national scale. The 5m resolution JBA Groundwater map has been used within the SFRA. The modelling involves simulating groundwater levels for a range of return periods (including 75, 100 and 200-years). Groundwater levels are then compared to ground surface levels to determine the head difference in metres. The JBA Groundwater Map categorises the head difference (m) into five feature classes based on the 100-year model outputs which are outlined in Table 5-2.

Table 5-2: JBA Groundwater flood risk map categories

Flood depth range during a 1% AEP flood event	Groundwater flood 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 is important to note that the modelled groundwater levels are not predictions of typical groundwater levels. Rather they are flood levels i.e. groundwater levels that might be expected after a winter recharge season with 1% AEP, so would represent an extreme scenario.

It should be noted that the JBA Groundwater Flood Map is suitable for general broad-scale assessment of the groundwater flood hazard in an area but is not explicitly designed for the assessment of flood hazard at the scale of a single property. In high risk areas a site-specific risk assessment for groundwater flooding is recommended to fully inform the likelihood of flooding.

The JBA Groundwater Map for the Local Plan areas can be found in Appendix D. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix C.

The AStGWF dataset is a strategic-scale map showing groundwater flood areas on a 1km square grid. It shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring and does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

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

Historical incidents of sewer flooding are detailed by Thames Water in Table 6-2 and properties at risk from sewer flooding provided by Severn Trent Water are detailed in Table 6-3. For confidentiality reasons this data has been supplied on a postcode basis.

Note on the Environment Agency Flood Map for Planning

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

All of the mapping can be found in the appendices to this SFRA. More details of the mapping structure can be found in Table 1-1.

5.1.1 Other relevant flood risk information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. The Planning Framework and Flood Risk Policy chapter includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to this study.

5.2 Use of Strategic Flood Risk Assessment data

It is important to recognise that Level 1 Strategic Flood Risk Assessments are high-level strategic documents and, as such, do not go into detail on an individual

site-specific basis. The primary purpose of this Strategic Flood Risk Assessment data is to provide an evidence base to inform Stratford on Avon District's Site Allocations Plan and any future flood risk policies. This SFRA is intended to help Stratford on Avon District Council in applying the Sequential Test for their site allocations and identify where the application of the Exception Test may be required via a Level 2 SFRA. The SFRA can also be used by private developers, as a starting point, to help appraise the flood risk to their proposed development or re-development site.

This SFRA should be a 'living document' and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. At the time of writing, this report was developed using the best available information but should be updated when new information on flood risk, new planning guidance or legislation becomes available.

It is recommended that the SFRA is reviewed internally on a quarterly basis, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with Stratford on Avon District Council, Warwickshire County Council, the Highways Authority, Severn Trent Water, Thames Water, Anglian Water and the Environment Agency for any new information.

6 Understanding flood risk in Stratford on Avon District

This chapter explores the key sources of flooding in the district and the factors that affect flooding including topography, soils and geology. The main sources of flooding are from watercourses, surface water and sewers.

6.1 Historical flooding

Stratford on Avon District has a history of documented flood events with the main source being from fluvial and surface water sources. Significant historic flood events are highlighted in Table 6-1.

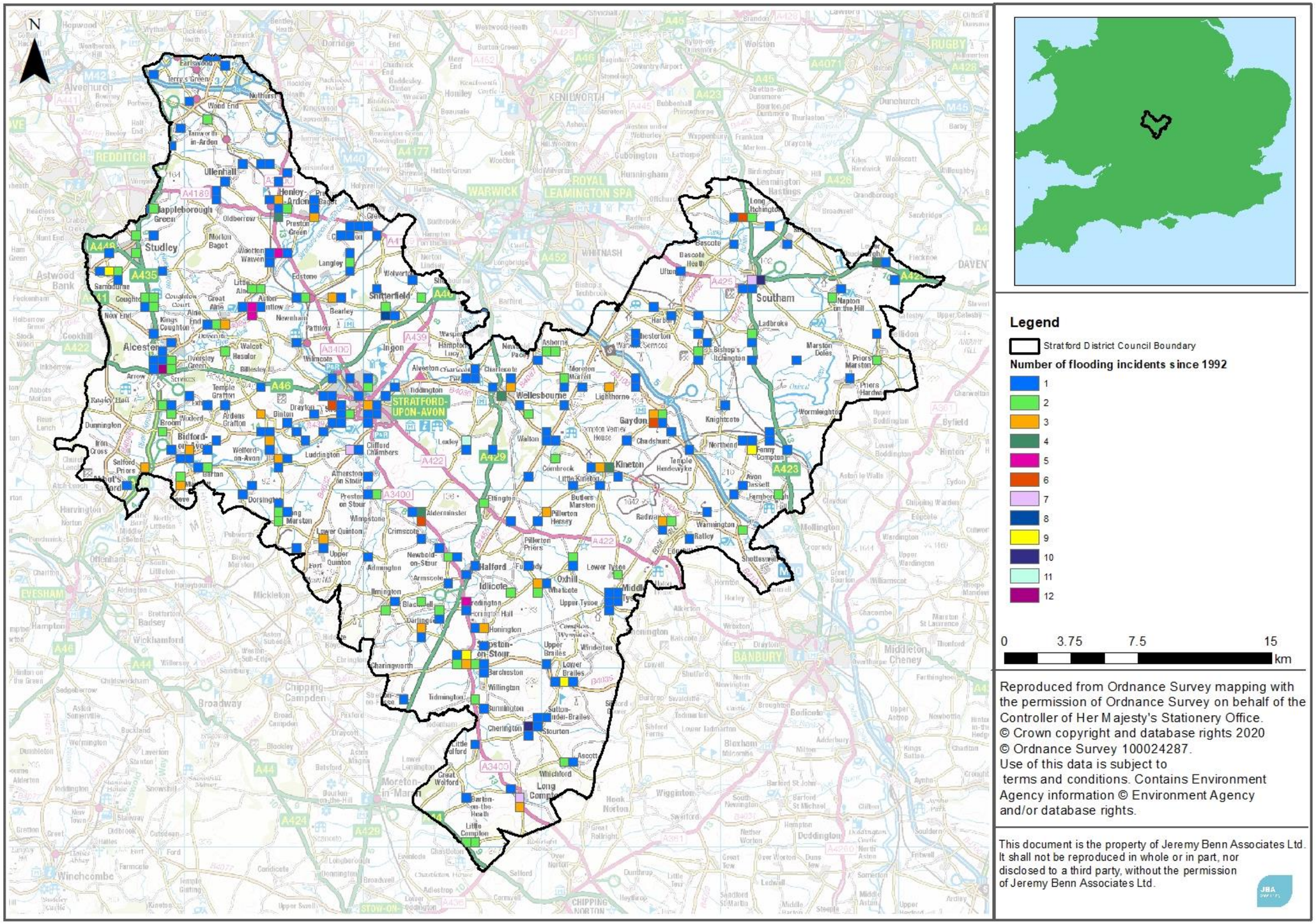
Table 6-1 Documented Historic Flood Records in Stratford on Avon District

Location	Date	Record Source	Additional Information
Stratford upon Avon	March 1947	Recorded flood outlines	Fluvial flooding from the Avon
Alcester	1960	Recorded flood outlines	Fluvial flooding from the Rivers Alne and Arrow
River Avon	July 1968	Recorded flood outlines	Fluvial flooding from the River Avon affecting Stratford upon Avon, Bidford on Avon, Wellesbourne, Tiddington, Alveston and Welford on Avon
Hampton Lucy	February 1979	Recorded flood outlines	Fluvial flooding from the River Avon
District wide along the River Avon and River Itchen	January 1985	Recorded flood outlines	Fluvial flooding along the River Avon and River Itchen
Stratford upon Avon	January 1992	Recorded flood outlines Warwickshire CC historic flood records	Fluvial and surface water flooding
District wide	Easter 1998	Recorded flood outlines Warwickshire CC historic flood records **Met Office**	Fluvial and surface water flooding. Heavy rainfall causing District wide flooding, seriously affecting Stratford upon Avon and along the River Avon
District wide	July 2007	Recorded flood outlines **Flooding in Stratford on Avon District Recovery Plan**	Heavy rain on the 9th July caused the River Avon to rise flooding 33 homes Heavy rain caused pluvial flooding on 20th July leading to fluvial flooding from the River Avon, River Stour, River Alne and

			River Arrow until the 23rd of July. More than 60 roads were closed during the flooding, and the settlements most severely affected included Alcester, Southam, Welford on Avon, Bidford on Avon, Shipston on Stour and Wellesbourne
District wide	December 2008	Warwickshire CC historic flood records	
Stratford on Avon	November 2012	**BBC News**	Fluvial flooding from the River Avon and surface water flooding due to heavy rainfall
District wide	March 2016	Warwickshire CC historic flood records **Warwickshire CC website**	Flooding due to heavy rainfall causing the River Avon to reach its highest level since monitoring equipment was installed in 1973 on the 9th March.
District wide	June 2016	Warwickshire CC historic flood records **Warwickshire CC website**	Flooding District wide due to heavy rainfall.
District wide	November 2019	Environment Agency	Widespread flooding due to regular severe storms. Areas impacted include Loxley, Long Compton, Snitterfield, Stratford-on-Avon, Kineton, Lower Brailes, Stourton, Fenny Compton, Bidford-on-Avon, Welford-on-Avon, Clifford Chambers, Walcote and Wixford.

Flooding records relating to flooding incidents since January 1992, provided by Warwickshire County Council are shown in Figure 6-1. The records do not specify the source of flooding. The flooding incidents are widespread throughout the District; however, there are notable clusters of flooding history in the main urban areas in the District: Stratford upon Avon, Southam, Alcester, Long Itchington and Shipston on Stour. There are notable dates which have a high frequency of recorded incidents; Easter 1998 (104 incidents), June/July 2007 (133 incidents), 2012 (75 incidents) and 9th March 2016 (34 incidents).

Figure 6-1 Historic flooding incidents in Stratford on Avon District



6.2 Topography, geology, soils and hydrology

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

6.2.1 Topography

The topography of Stratford on Avon District is mainly characterised by lower elevations in centre of the District, around the town of Stratford upon Avon and in the areas surrounding the river valleys of the River Avon, River Alne, River Arrow and the River Stour. From these valleys, elevations increase to the east of the District where the edge of the Cotswold Hills fall into the District boundary, and to the north-west. The topography of the study area is shown in Figure 6-2.

6.2.2 Geology and Soils

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

Figure 6-3 shows the bedrock (solid permeable) formations in Stratford on Avon District and Figure 6-4 shows the superficial (permeable, unconsolidated (loose) deposits. These are classified as the following:

The eastern and southern parts of the District are mainly comprised of secondary undifferentiated bedrock, which is unattributable to either permeable or lower permeability layers. The central and northern parts of the District are comprised mainly of Secondary B bedrock formations, largely lower permeability which store limited amounts of groundwater, interspersed with Secondary A formations where storage is possible at local levels. There are a few small areas, primarily on the southern border of the District where the bedrock is formations are highly permeable principal layers where high levels of water can be stored, surrounded by lower permeability unproductive layers.

The majority of the study area is not overlain by superficial deposits, those areas which have superficial deposits tend to be in river valleys. The superficial deposits that are present in the District are mainly higher permeability Secondary A deposits, with some areas of undifferentiated deposits.

Figure 6-2 Topography of Stratford on Avon District

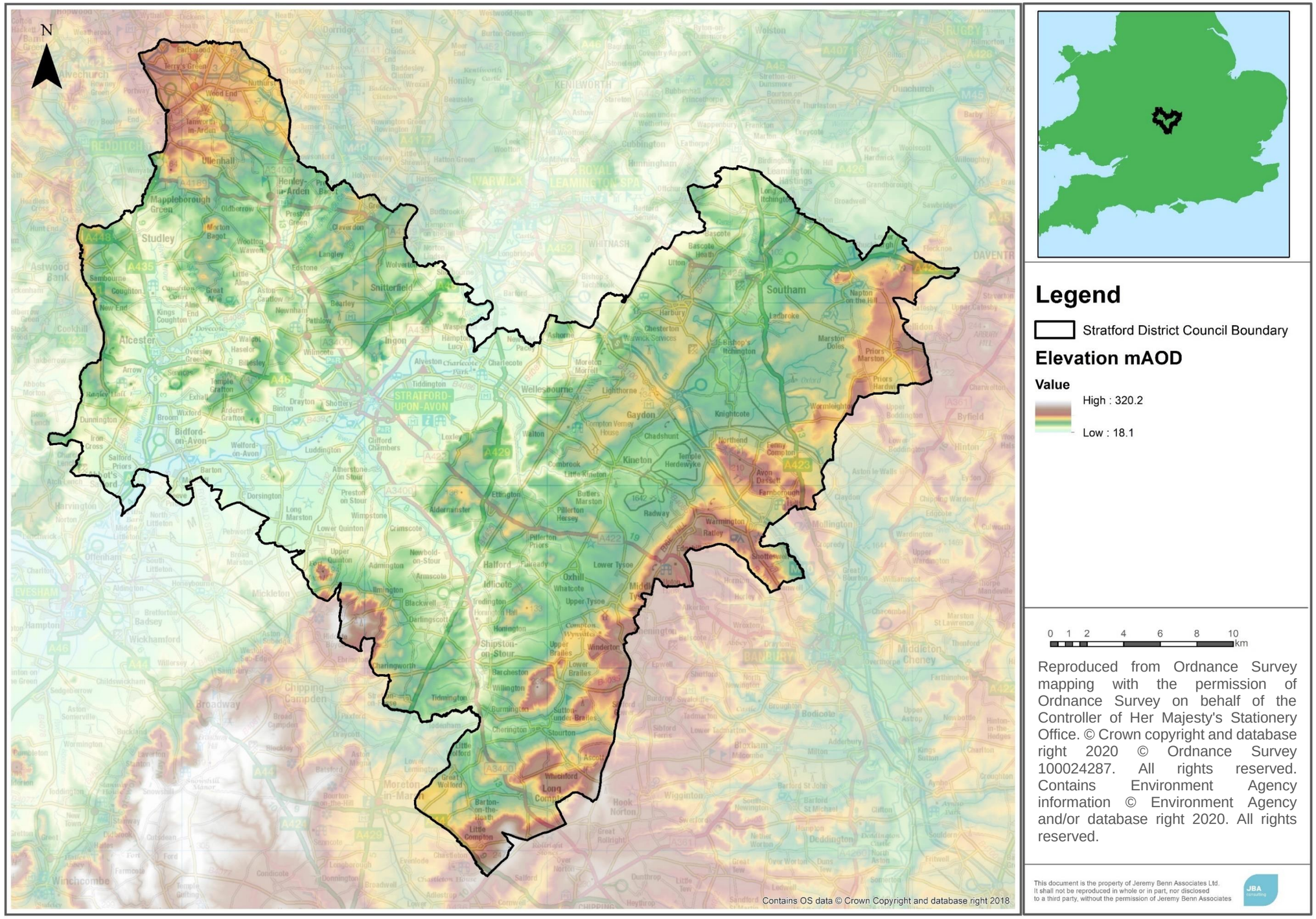


Figure 6-3 Bedrock formations in Stratford on Avon District

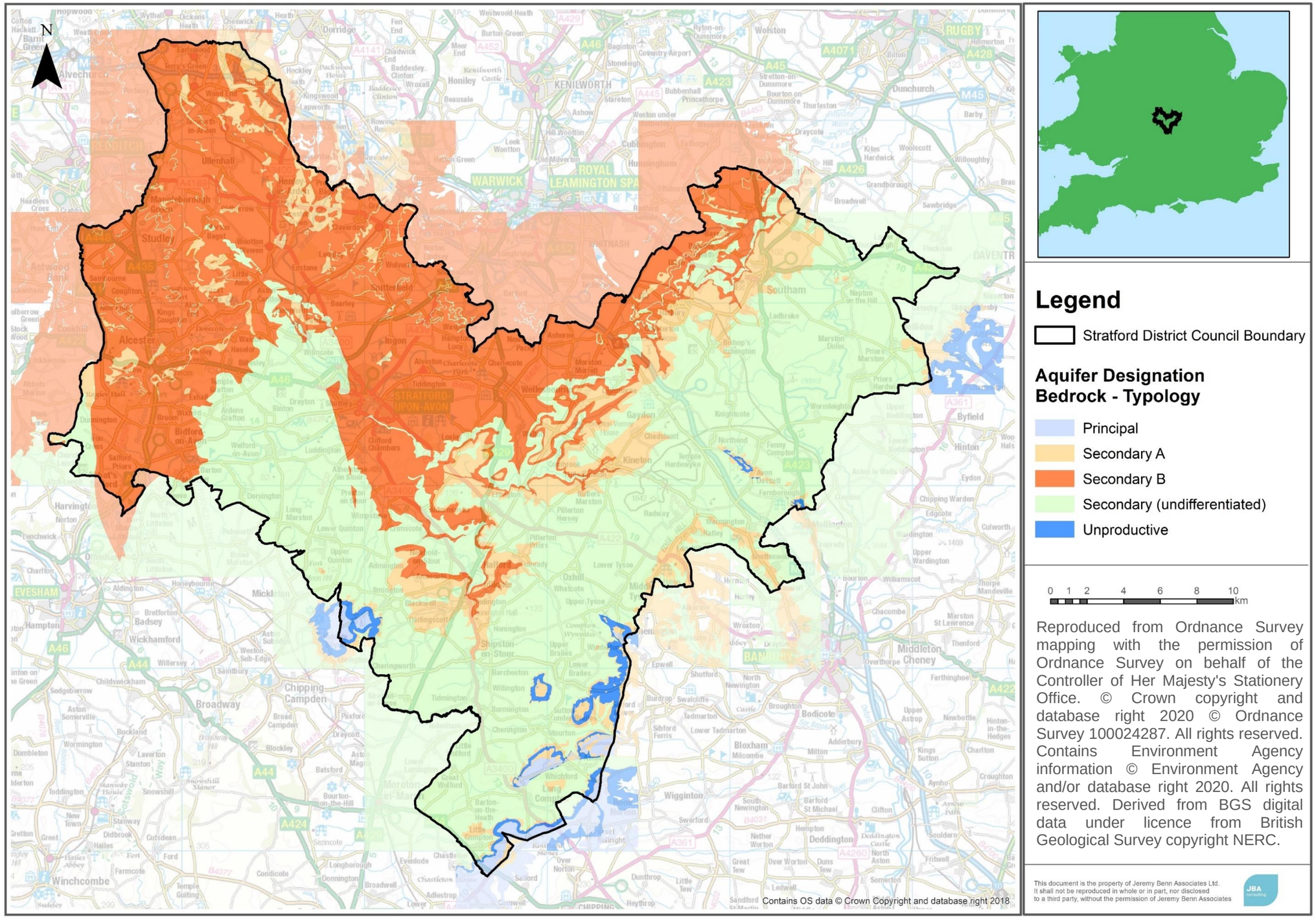
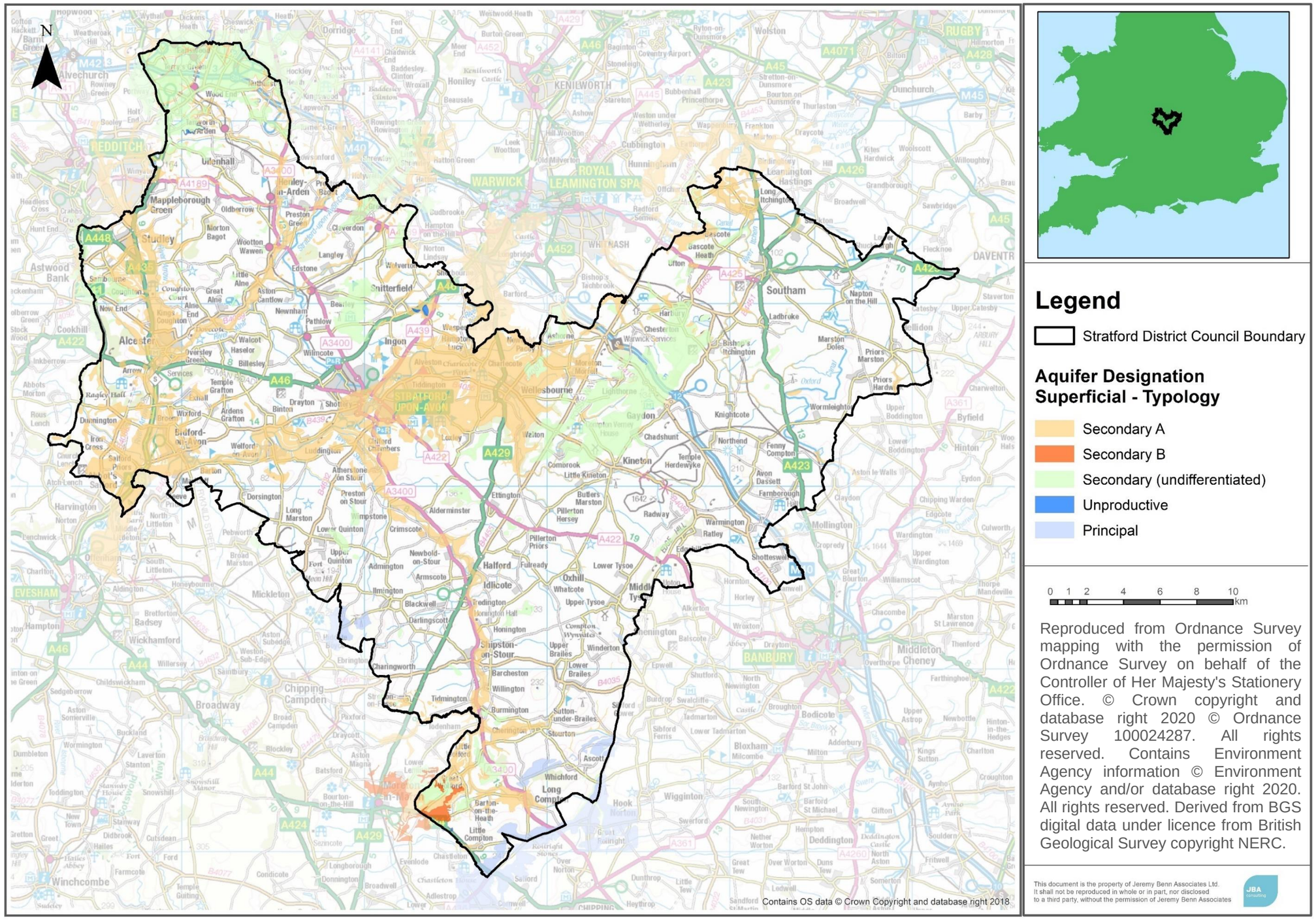


Figure 6-4 Superficial deposits in Stratford on Avon District



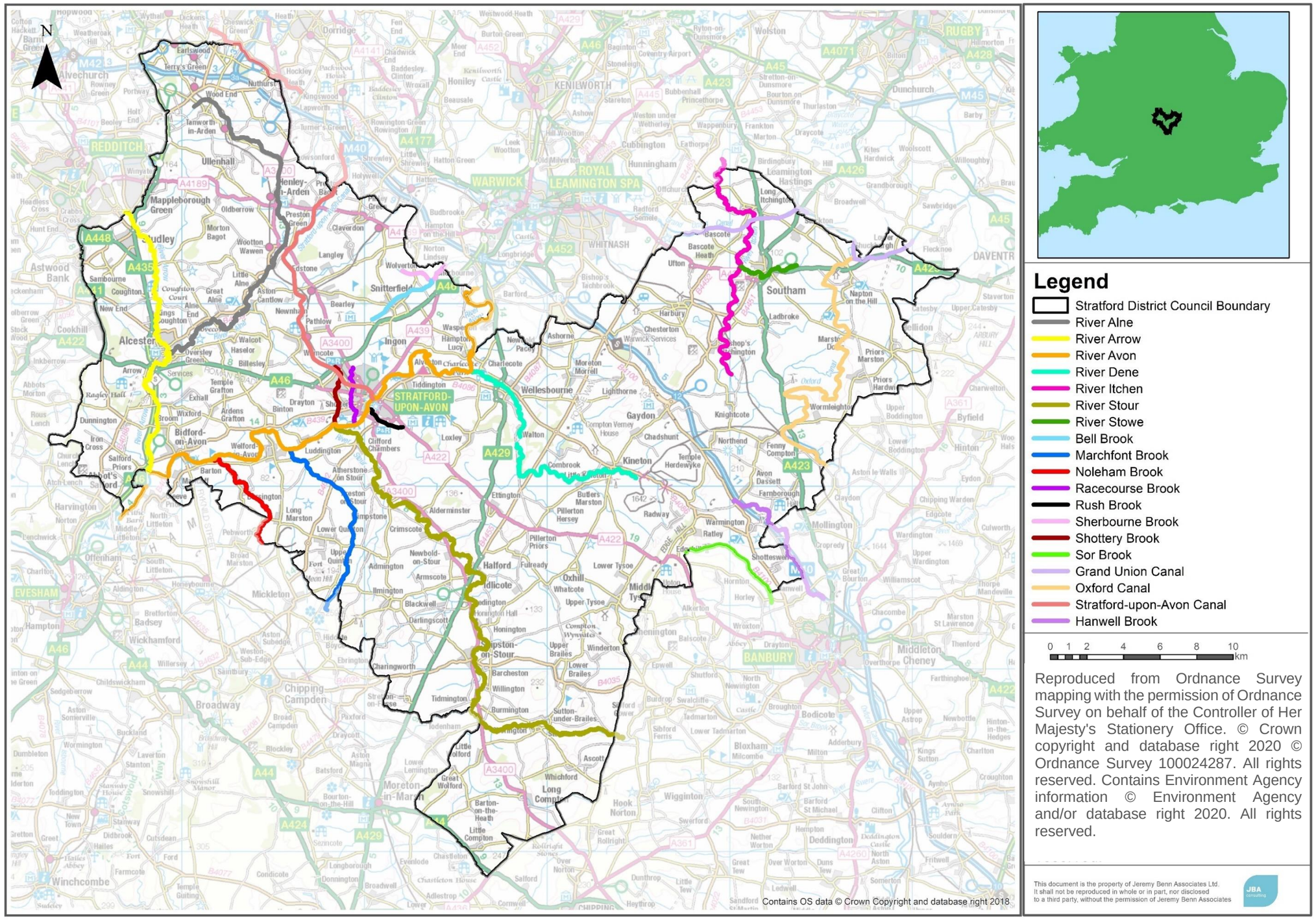
6.2.3 Hydrology

The principal watercourses flowing through the SFRA study area are:

- River Avon
- River Alne
- River Arrow
- River Stour
- River Stowe
- River Itchen
- River Dene
- Shottery Brook
- Marchfont Brook
- Noleham Brook
- Racecourse Brook
- Rush Brook
- Bell Brook
- Sherbourne Brook
- Hanwell Brook
- Sor Brook

Tributaries of these watercourses include smaller ordinary watercourses and numerous unnamed drains. There are also a number of ponds and lakes within the study area. A summary of the key watercourses in the SFRA are provided in Figure 6-5. Mapping indicating the location of the key watercourses can be found in Appendix A.

Figure 6-5 Key watercourses in Stratford on Avon District



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6.3 Fluvial flood risk

The primary fluvial flood risk is along the River Avon and its main tributaries. These present fluvial flood risk to rural communities as well as some of the main urban centres including, but not exclusively, Alveston, Tiddington, Stratford upon Avon, Welford on Avon, Bidford on Avon, Alcester and Henley in Arden. The fluvial flood extents are fairly well confined in the majority of the District, with wider extents along the River Avon due to lower lying, flat topography, notably through Stratford upon Avon and downstream of Bidford on Avon.

The Flood Zone maps for Stratford on Avon District are provided in Appendix A: Geo-PDFs, split into Flood Zones 2, 3a and 3b (including an 'indicative 3b' where FZ3a acts as FZ3b in the absence of detailed model data). The flood risk associated with the major locations in Stratford on Avon District are detailed in Table 6-5. *Please note that this table does not cover all locations at risk and the reader should refer to the mapping for further information on other locations.*

6.4 Surface water flooding

Surface water runoff (or 'pluvial' flooding) 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 Risk of Flooding from Surface Water mapping (RoFfSW) provided by the Environment Agency via Stratford on Avon District Council shows that a number of communities are at risk of surface water flooding, as discussed in Table 6-5. In general, the RoFfSW shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low-lying areas. Whilst in the majority of cases the risk is confined to roads, there are notable prominent run-off flow routes around properties, e.g. properties situated at the foot of surrounding hills. The RoFfSW mapping for Stratford on Avon District can be found in Appendix A.

6.4.1 Surface water flood risk with climate change uplifts

Additional modelling has been carried out to account for the impact of climate change on surface water flood risk in the SFRA study area. The Environment Agency 2016 climate change guidance shows that increases in the peak rainfall intensity in small and urban catchments should be considered when preparing FRAs.

The recommended uplifts for the central and upper end allowances are 20% and 40% respectively. The peak rainfall intensities for the RoFSW 1% AEP event have been uplifted by 40% to assess the impact of climate change on surface water flood risk in the Stratford District in this SFRA.

Mapping showing the extents of the 1% AEP plus 40% climate change scenarios can be found in Appendix E. Guidance on how this information should be used to inform the Sequential and Exception Tests can be found in Appendix C.

6.5 Groundwater flooding

In general, less is known about groundwater flooding than other sources. 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

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 groundwater flood mapping of Stratford on Avon District has been provided in Appendix D. The majority of the District is shown to be within the "No risk" classification. Areas with higher susceptibilities and more likely to flood from groundwater are found in the centre of the district along the River Avon and River Stour, in the north east along the River Itchen, in the southern tip of the district and in the west of the district along the River Arrow.

6.6 Flooding from sewers

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

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

Further, sewer flooding is more likely to occur along the routes of main trunk sewers and in particular, if these sewers interact with fluvial systems.

The majority of sewers in Stratford on Avon District are managed by Severn Trent Water, with Thames Water and Anglian Water also managing sewers in some areas.

Historical incidents of flooding recorded by Thames Water are shown in Table 6-2. Severn Trent's DG5 register of historic sewer flooding incidents has recently been replaced by the 'At Risk Register', which gives properties a risk based on incident likelihood and impact on customer. Settlements with properties at risk on Severn Trent's 'At Risk Register' are set out in

Table 6-3.

For confidentiality reasons this data has been supplied on a postcode basis. The datasets were supplied on the 05/10/2018 and 03/10/2018 respectively. While Anglian Water also manage sewers in the District, they only cover a very small, rural area (approximately 0.5km^2) to the east of Priors Marston in the north-east

of the District, therefore they were not contacted to provide sewer flooding history. Developers should contact Severn Trent Water for any proposed development in that area.

Table 6-2 Recorded sewer flooding incidents (Thames Water)

Post Code	Recorded flood incidents
CV47 2	1
OX17 1	2
	Total=3

Table 6-3 Properties at risk from sewer flooding (Severn Trent Water)

Post code	Locality associated with post code	Number of properties at risk
CV36 4	Ilmington, Tredington, Blackwell	28
CV35 0	Lighthorne, Gaydon, Butlers Marston, Oxhill, Upper Tysoe, Middle Tysoe, Kineton	22
CV37 8	Armscote, Newbold on Stour, Lower Quinton, Broad Marston, Wilmcote, Long Marston	15
CV37 6	Stratford upon Avon	14
CV37 9	Stratford upon Avon, Binton, Wilmcote	14
CV36 5	Long Compton, Cherington, Great Wolford	12
CV37 0	Snitterfield, Stratford upon Avon	11
CV47 9	Long Itchington, Southam	10
CV47 2	Southam, Fenny Compton, Bishops Itchington	8
CV35 9	Wellesbourne, Moreton Morrell, Loxley	7
CV47 1	Southam	7
CV47 8	Stockton, Napton on the Hill	6
CV35 8	Claverdon	5
CV37 7	Loxley, Stratford upon Avon	2
CV47 7	Priors Hardwick	1
CV47 0	Southam	1
		Total=163

A total of 163 properties are at risk from sewer flooding within the District, the highest risk localities include Stratford upon Avon, Southam, Ilmington, Tredington and Blackwell.

6.7 Flooding from canals

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

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

- Culvert collapse
- Overtopping
- Animal burrowing

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

There are three canals in Stratford on Avon District: the Stratford on Avon Canal, the Oxford Canal and the Grand Union Canal. The Canal and River Trust were consulted to identify any instances of breaches and overtopping of each of the canals.

- The **Stratford on Avon Canal** comes into the District at Preston Bagot, just to the east of Henley-in-Arden. It travels in a southerly direction through the District to Stratford on Avon, where it joins the River Avon. There are no instances of breach or overtopping on the Stratford upon Avon Canal within the District.
- The **Oxford Canal** enters Stratford and converges with the Grand Union Canal on the north-eastern corner at Lower Shuckburgh. Just inside the District boundary just north of Napton on the Hill, the canal splits again. The Oxford Canal then travels in a southerly direction to leave the District at Claydon. There are no instances of breach or overtopping on the Oxford Canal within the District.
- The **Grand Union Canal** after splitting from the Oxford Canal travels north and back out of the District boundary at Napton Reservoirs. Approximately 3km further along the canal it re-enters Stratford on Avon District, just north of Stockton, where it travels west for approximately 5.5km, leaving Stratford on Avon District at Welsh Road, north-west of Southam. There are no instances of breach or overtopping on the Grand Union Canal within the District.

Whilst there have been no instances of breach or overtopping from the canals within the Stratford on Avon District, the canals have the potential to interact with other watercourses in the study area, including the River Itchen, River Alne, River Avon, Shottery Brook and Racecourse Brook. These have the potential to become flow paths if these canals were overtopped or breached. Any development proposed adjacent to a canal should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific Flood Risk Assessment. Guidance on development near canals is available from the **Canal and River Trust.**

6.8 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the **Reservoir Act 1975** and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is very low. Recent changes to legislation under the Flood and Water Management Act require the Environment Agency to designate the risk of flooding from reservoirs over 25,000 cubic metres.

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 rivers or surface water. It may not be possible to seek refuge upstairs from floodwater as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure.

The risk of inundation to Stratford on Avon District as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Mapping (NIRIM) study. There are 22 reservoirs shown to affect Stratford on Avon District; this includes reservoirs located within the District and a number of reservoirs outside of the area whose inundation mapping is shown to affect Stratford on Avon District. The reservoirs inundation extents provided by the Environment Agency can be found on the Environment Agency's **Long term flood risk map for England**.

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

Table 6-4 Reservoirs that may potentially affect Stratford on Avon District in the event of a breach

Reservoir	Location (grid reference)	Reservoir owner	Is the reservoir located within the study area?	Local Authority Area
Walton Hall Lake	428540, 252728	The Hotel Collection	Yes	Warwickshire County Council
Upper Compton Verney	431036, 252617	Cariss	Yes	
Lower Compton Verney	430695, 251934	Cariss	Yes	
Ventnor Marina – Sunrise Basin	446101, 263753	Castle Marina	No – Rugby Borough	
Napton	446513, 262930	Canal & River Trust	Yes	
Earlswood Lakes – Terry's Pool	410910, 274030	Canal & River Trust	Yes	
Earlswood Lakes – Windmill Pool	411531, 274147	Canal & River Trust	Yes	
Earlswood Lakes – Engine Pool	411399, 274291	Canal & River Trust	Yes	
Ragley Hall Lake	407835, 255205	Hertford	Yes	
New Waters, Warwick Castle	428538, 263427	C & S Taylor LLP	No – Warwick District	
Warren Chase Water	416910, 256944	King	Yes	
Coombe Pool	438310, 279216	Coventry City Council	No – Rugby Borough	
Edstone Lake	417589, 261657	Slater	Yes	
Wormleighton	444952, 251509	Canal & River Trust	Yes	
Draycote Water	445110, 270060	Severn Trent Water	No – Rugby Borough	
Ingot Manor Reservoir	420624, 258403	Cantella Farms Limited	Yes	

Wootton Pool	415647, 263720	Haimes	Yes	
Cofton	400675, 275621	Canal & River Trust	No – Bromsgrove District	Worcestershire County Council
Bittell Upper	401778, 274937	Canal & River Trust	No – Bromsgrove District	
Bittell Lower	402019, 273969	Canal & River Trust	No – Bromsgrove District	
Lodge Pool	404942, 266646	Severn Trent Water	No – Redditch District	
Naseby	466673, 277975	Canal & River Trust	No – Daventry District	Northampton-shire County Council

As above, the risk of reservoir flooding is extremely low. However, there remains a residual risk to development from reservoirs which developers should consider during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include:
  - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
  - operation: discharge rates/maximum discharge;
  - discharge during emergency drawdown; and
  - inspection/maintenance regime.
- Developers should apply the sequential approach to locating development within the site.
- Consult with relevant authorities regarding emergency plans in case of reservoir breach.
- The reservoir owners are contacted to confirm the Reservoir Risk Designation (if determined) and the inspection and maintenance regime of the reservoir.
- Consider the impact of a breach and overtopping, particularly for sites proposed to be located immediately downstream of a reservoir. This should consider whether there is sufficient time to respond.
- The EA and NRW online Reservoir Flood Maps contain information on the extents, depths and velocities following a reservoir breach (note: only for those reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975). For proposed sites located within the extents, consideration should be given to the extent, depths and velocities shown in these online maps.
- In addition to the risk of inundation, those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

6.9 Flood warning and emergency planning

6.9.1 Emergency planning

Emergency planning enables Emergency Responders to respond effectively before, during and after a flood. Emergency Planners also work with local businesses to increase their resilience to flooding through business continuity and local communities on Community Emergency Plans.

The **Warwickshire Local Resilience Forum** brings Emergency Responders together in Warwickshire to plan for flooding. A Multi Agency Flood Plan has previously been produced for Warwickshire by the Coventry, Solihull and Warwickshire Resilience Team and was reviewed in September 2018. It is recommended that the information in this SFRA is used to inform any further reviews to the document. **The Warwickshire Community Flood Resilience Pathfinder Project Final Report** was published in 2015 and aims to assist communities in helping themselves to become more resilient to flooding.

Safety is a key consideration for any new development, and this includes the residual risk of flooding i.e. behind flood defences, the availability of flood warnings, safe access and egress routes and evacuation procedures. There are currently 11 Flood Alert Areas (FAA) and 25 Flood Warning Areas (FWAs) covering significant parts of the Stratford on Avon District. These are shown in Appendix A. Flood Warnings are supplied by the Environment Agency for river flooding via the Flood Warning System service, to homes and businesses within Flood Zones 2 and 3.

The 2018 NPPF requires that LPAs assess Planning Applications to ensure 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.

There are circumstances where a flood warning and evacuation plan is required and/or advised:

- Camping and caravan sites, holiday accommodation and where there are transient occupants e.g. hostels
- Buildings that will be occupied below a design flood level i.e. basements

In addition to the flood warning and evacuation plan considerations in the NPPG, developers should also consider:

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided e.g. managing the residual risk of a flood defence breach or failure.
- That proposed new development that places additional burden on the existing response capacity of the Council will not normally be considered appropriate.
- Encouraging those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.
- The vulnerability of site occupants.
- Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and/or move to a higher floor or safe refuge area (e.g. developments located immediately behind a defence and at risk of a breach).

Table 6-5 Summary of Flood Risks in Stratford on Avon District

Settlement	Fluvial flood risk	Existing or proposed defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risks	Historic, recorded flood events
				<25%	>=25% <50%	>=50% <75%	>=75%		
Alcester	The confluence of the Rivers Arrow and Alne is located in Alcester and the Spittle Brook flows south on the western edge of the town. Given the low, flat topography of the land surrounding the rivers, Alcester is likely to flood from fluvial sources. Some properties in the town are located within Flood Zone 3, to the west of the River Arrow and to the north of the River Alne. Properties located within the bounds of School Road, Priory Road and High Street lie almost entirely within Flood Zone 2 and partially within Flood Zone 3.	Wall/embankment along right bank of the River Arrow, ~380m behind houses on School Road, ~275m behind Gas House Lane and Stratford Road and ~665m adjacent to Bleachfield Street and Newport Drive	The surface water risk in the town is largely confined to overland flow routes via local roads. There are some properties at risk of flooding in the 30-year event, along the B4089, Adams Way, Meadow Road and Seymour Road. The majority of roads in the town are flow routes in the 1,000-year event affecting a large number of properties.		✓	✓	✓	Alcester is partially located within the reservoir inundation extents of Bittell Upper, Bitell Lower, Edstone Lake, Cofton, Lodge Pool and Wootton Pool reservoirs.	Fluvial events: 1960, 2007, 2019
Alveston	The River Avon flows past the eastern boundary of Alveston, before meandering around the north of the village and back past the west of it. A large area of flat fields lies between Alveston and the River Avon to the north and the west, which is almost entirely within the Flood Zone 2 and 3 extents. Only a few properties are located in Flood Zone 3, along Mill Lane and Ferry Lane. More properties are located within Flood Zone 2, along Alveston Lane, Church Lane and The Rookery. Given the location and topography of the village, Alveston is likely to flood from fluvial sources.	None	The 30-year surface water flood risk is largely confined to the river channel and rural parts of the village, with no properties affected. The 100-year flood extents affect some roads in the village; however, only a small number of properties may be affected, along the Rookery and Church Close. In the 1,000-year surface water event, Church Lane, Alveston Lane, The Rookery and Kissing Tree Way become flow routes affecting a small number of properties.			✓		Alveston is partially located within the reservoir inundation extents of Walton Hall Lake, Upper Compton Verney, Lower Compton Verney, Naseby, Draycote Water and Ingon Manor reservoirs.	Fluvial events: 1985, 1998, 2007
Bidford-on-Avon	The southern edge of Bidford on Avon lies along the River Avon, and the Small Brook bounds the north and west of the village. The majority of Bidford on Avon lies on higher ground within Flood Zone 1, and only a small number of properties lie within Flood Zones 2 and 3, along High Street, Grange Road, the B4085 and The Pleck on the River Avon, and Victoria Road, Steppes Piece and Burnell Close which lies along the Small Brook.	None	Given the high topography of Bidford on Avon north of the River Avon, a large number of roads in the village become overland flow routes in the 1,000-year event. The 30-year surface water flood extent is largely confined to the channels and the B439, with small pockets of surface water extents spread elsewhere in the village.		✓	✓	✓	Bidford on Avon is partially located within the reservoir inundation extents of Draycote Water, Ragley Hall Lake and Bittell Upper reservoirs.	Fluvial events: 1968, 1998, 2007, 2012, 2016, 2019
Henley-in-Arden	The River Alne flows through the centre of Henley-in-Arden and an unnamed watercourse flows south of Henley-in-Arden to join the River Alne. The topography of the town is low-lying and flat, therefore it is more likely to flood from fluvial sources. East of the A3400, west of Arden Road, the A4189 and Glenhurst Road are largely located within Flood Zone 2 with a number of properties located within it. Properties along Glenhurst Road, the A4189, Brook End Drive, Prince Harry Road, Riverside Gardens, Beaudesert Lane, Alne Close and the A4300 lie within the extent of Flood Zone 3.	~140m of wall/embankment along the right bank of the River Alne past William James Way	The A3400, A4189 and Glenhurst Road are major flow routes for the 30-year surface water event with small isolated pockets elsewhere in the town. A large extent lies in the fields north of Beaudesert Lane. A small number of properties are affected by the 30-year and 100-year events, with a significant number of properties east of the A3400 affected in the 1,000-year event.	✓	✓	✓		None	Fluvial events: 2007, 2019, 2020
Kineton	Kineton lies along the River Dene, which flows west past the southern edge of the village. The village lies on high ground relative to the River Dene, therefore almost all of the village is located in Flood Zone 1. Small parts of the B4086 in the east of the village are located within Flood Zones 2 and 3.	None	The 30-year surface water extents are largely confined to the River Dene and the unnamed watercourse on the western edge of the village, with isolated pockets of flooding elsewhere in the village, and a major flow route over low ground on the northern edge of the village. A small number of properties are at risk of surface water flooding from the 30-year and 100-	✓				None	Fluvial events: 2019

			year events, including along Brookhampton Lane, Geden Close, Mill Street and Gardiner Road. The B4086, Southam Street, Green Farm End, Greenacres and St Peters Road become flow routes in the 1,000-year event.						
Long Itchington	Long Itchington lies along the River Itchen which poses a large fluvial flood risk to the village due to its relatively low, flat topography. Parts of Bascote Road, Stonebridge Lane, Church Road and Thorn Way lie within Flood Zone 3, with Flood Zone 2 also extending to Galanos and Leamington Road. Given the lower elevations of the village, it is more likely to flood from fluvial sources.	~370m of wall/embankment along the right bank of the River Itchen, adjacent to Church Road passing past Bascote Road	Parts of Church Road and the A423 become major surface water flow routes in the 30-year and 100-year events, with large pockets of flooding in the fields to the north of the village and areas around Marton Road Farm. The 1,000-year surface water flood extent entirely covers Church Road and a number of properties in the village are at risk from flooding.	✓	✓	✓		Long Itchington is partially located within the reservoir inundation extents of Ventor Marina and Napton reservoirs.	Fluvial events: 1985
Shipston on Stour	The River Stour flows through the eastern edge of Shipston on Stour and the town notably slopes from higher ground in the west, to lower ground in the east, meaning that the majority of Shipston on Stour lies outside of Flood Zones 2 and 3. Properties along the A3400, B4035 and Mill Court are located within Flood Zone 3, with Flood Zone 2 extents also reaching Telegraph Street, Market Place and Sheep Street.	None	Due to the topography of the town, the majority of surface water flood risk in Shipston on Stour is runoff from the higher ground in the west towards the River Stour. The B4035, Telegraph Street, Station Road and surrounding roads are notable flow routes in the 30-year and 100-year events with a number of isolated pockets of flooding elsewhere in the town. The majority of roads in the town become flow routes in the 1,000-year event putting a number of properties at risk from flooding.	✓	✓			None	Fluvial events: 2007, 2019
Snitterfield	Snitterfield lies on the Bell Brook which flows East-West through the centre of the village and is joined bv several small tributaries and drains. The Green road and School Road, and properties along them, are modelled within Flood zone 3 putting them at immediate risk. Flood Zone extends further into the village, reaching the village hall and primary school. The brook passes through a culvert downstream of the village which modelling shows as a potential cause of impounding.	None	Similar to the fluvial flood risk, surface water flood risk is centred around the Bell Brook and its tributaries, as well as the main roads through the village. Modelled data shows 100 and 1000-year extents covering residential dwellings along The Green, as well as along White Horse Hill.	✓				None	Fluvial events: 2007, 2019
Southam	The majority of Southam lies on much higher ground relative to the River Stowe, therefore the majority of the town lies within Flood Zone 1. The extent of Flood Zone 3 reaches properties along Banbury Road, Tattle Bank, Brown's Bridge Road, Stowe Drive, Spire Bank and Welsh Road East with Flood Zone 2 also reaching properties on Abbey Lane, Pound Way and Warwick Street. The proposed HS2 route will cross the River Itchen to the south-west of the town. Any works to the river will be undertaken in accordance with technical standards and consent will be needed from the appropriate land drainage authority. Hence HS2 should not have an adverse effect on flood risk.	None currently. HS2 is primarily a scheme for a rail line and not a flood defence scheme. However, the EA and WCC are working with HS2 and the various designers to look at opportunities for betterment.	The surface water flood extents in the 30-year and 100-year events are largely isolated pockets of flooding, affecting a small number of properties along Parkfields, Stowe Drive, Abbey Lane, Flying Fields Road, the industrial estate on Kineton Road and nursery on St James Road. Many roads in the town become flow routes in the 1,000-year event as water runs off from the higher ground towards the River Stowe.	✓				Southam is partially located within the reservoir inundation extents of Ventor Marina and Napton reservoirs.	Fluvial events: 2007, 2019
Stratford upon Avon	A number of watercourses flow through Stratford, posing a fluvial flood risk: the River Avon, Rush Brook, Racecourse Brook and the Shottery Brook. Along the A3400 and the surrounding roads from Maybrook Road to Ash Grove are located within the Flood Zones of the	None	The 30-year surface water flood extents are mainly isolated small pockets of flooding affecting a small number of properties. Along the Racecourse Brook from Rye Close to Park Road along the A3400, a number	✓	✓	✓	✓	Stratford upon Avon is partially located within the reservoir inundation extents of Walton Hall Lake, Naseby, Warren Chase Water, Draycote	Fluvial events: 1947, 1968, 1985, 1992, 2007, 2012, 2016, 2019

	Racecourse Brook and properties in close proximity to the Shottery Brook also lie within the Flood Zones. The extents of the Flood Zones of the River Avon through Stratford are very wide, which largely cover adjacent fields and car park areas; however, a large number of properties also lie within the Flood Zones. The topography of Stratford is relatively low and flat, and as there are several watercourses flowing through the town, this makes Stratford more likely to flood from fluvial sources.		of properties are affected by the 30-year event. A large area upstream of Stratford Parkway train station is covered by the 30-year surface water extent. A large number of roads become overland flow routes in the 1,000-year surface water event.					Water and Ingon Manor reservoirs.	
Studley	West of the B4093 and A435 in Studley is located on higher ground, which slopes away east of these roads towards the River Arrow. The topography of the town means that the majority of Studley is located in Flood Zone 1. Only a small number of properties in Studley are located within Flood Zones 2 or 3, along Wickham Road, Riverside, Thane Close and Castle Road.	None	The 30-year surface water extent in the town is largely isolated pockets of flooding with Castle Road being a notable flow route. The 100-year surface water extent is largely similar with Toms Town Lane, Bell Lane, Crooks Lane and Littlewoods Green also becoming flow routes. Many roads in the town become flow routes in the 1,000-year event as water runs off from the higher ground towards the River Arrow.	✓	✓	✓		Studley is partially located within the reservoir inundation extents of Cofton, Bittell Upper, Bittell Lower and Lodge Pool reservoirs.	Fluvial events: 2007, 2019
Tiddington	As the majority of Tiddington is located on higher ground, the majority of the village is located in Flood Zone 1. Small parts of School Lane, Dark Lane and Carters Lane lie within the Flood Zone 2 extent. The Riverside Caravan park is almost entirely located in Flood Zone 3.	None	The surface water flood extents in Tiddington are largely isolated pockets of flooding in the 30 and 100-year events, with very few affected properties. The 1,000-year extent is more widespread, notably at the Riverside Caravan park and the major roads in the village.				✓	Tiddington is partially located within the reservoir inundation extents of Walton Hall Lake, Upper Compton Verney, Lower Compton Verney, Naseby, Draycote Water and Ingon Manor reservoirs.	Fluvial events: 1968, 1998, 2007
Welford on Avon and Weston on Avon	Welford on Avon is largely located on higher ground, which slopes to the north, west and east towards the River Avon, therefore the majority of the village is located in Flood Zone 1. Properties located within Flood Zone 3 are situated along Binton Road, Boat Lane and Mill Lane, with Flood Zone 2 also reaching properties on Duck Lane and Church Lane. Some properties in neighbouring Weston-on-Avon are also located within Flood Zones 2 and 3.	None	The 30 and 100-year surface water extents are largely isolated pockets of flooding within the villages including potential flooding to properties on High Street, Headland Road, Barton Road, Cress Hill Meadow and Chapel Street. Chapel Street, Duck Lane, Boat Lane and Church Street see notable flow routes in the 1,000-year event.		✓	✓		Welford on Avon and Weston on Avon are partially located within the reservoir inundation extents of Warren Chase Water and Draycote Water reservoirs.	Fluvial events: 1968, 1985, 1998, 2007, 2016
Wellesbourne	The River Dene flows north-west through the centre of Wellesbourne, with higher ground to the north east and south west of the river. An unnamed watercourse flows parallel to the Dene on the northern edge of Wellesbourne also providing a fluvial flood risk to the B4087, Mountford Close, Hopkins Way, Whitehead Drive, Mordaunt Road, St Peter's Road and Lawrence Mackie Gardens. The River Dene poses a fluvial risk to properties on Lowes Lane, Chapel Street, Bridge Street, Church Walk and Willow Drive.	~590m of wall/embankment along the left bank of the River Dene from behind Chapel Street to behind Church Walk and ~81m of wall along the right bank behind Willow Drive	The 30-year surface water extent is mainly isolated pockets of flooding, affecting a small number of properties in the village. Notable areas of surface water flooding in the 30-year event are Wellesbourne Distribution Park, roads surrounding Walton Road and Copeland Avenue. A significant area south of the unnamed watercourse is also largely covered by surface water flood extents.				✓	Wellesbourne is partially located within the reservoir inundation extents of Walton Hall Lake, Upper Compton Verney, Lower Compton Verne and Draycote Water reservoirs.	Fluvial events: 1968, 1998, 2007, 2016, 2019

7 Flood alleviation schemes and assets

This section provides a summary of existing flood alleviation schemes and assets in the Stratford on Avon District. Planners should note the areas that are protected by defences where further work to understand the actual 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 Flood Risk Assessment.

7.1 Asset management

Risk Management Authorities hold databases of flood risk management and drainage assets:

- The Environment Agency 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 Flood and Water Management Act (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.

Developers should collect the available asset information and undertake further survey as necessary to present an understanding of current flood risk and the existing drainage network in a site-specific Flood Risk Assessment.

7.2 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 100-year 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 Environment Agency's on-going hydraulic modelling programme may revise flood risk datasets and as a consequence, the standard of protection offered by flood defences in the area may differ from those discussed in this report.

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

7.3 Maintenance

The Environment Agency and Local Authorities have permissive powers to maintain and improve Main Rivers and Ordinary Watercourses, respectively. There is no legal duty to maintain watercourses, defences or assets and maintenance and improvements are prioritised based on flood risk. The ultimate responsibility for maintaining watercourses rests with the landowner.

Highways Authorities have a duty to maintain public roads, making sure they are safe, passable and the impacts of severe weather have been considered. Water Companies have a duty to effectually drainage their area. What this means in practice 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 highways or sewer flooding.

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 defences 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 ensure future users of the development are aware of their obligations to maintain watercourses.

The Environment Agency endeavour to ensure that as many flood defence assets as possible are at the required condition and keep a record of those assets which fall below the required condition. As of January 2019, within Stratford on Avon District the Environment Agency are aware that there are below required condition assets within Stratford upon Avon and Wootton Wawen. However, all planning applicants should contact the Environment Agency to check if there are any below required condition assets on or within close vicinity of the application of the site as the Environment Agency would like to discuss the potential requirement for works to be undertaken to repair, replace or remove any such asset as part of any proposed development.

Formal structural defences are given a rating based on a grading system for their condition. A summary of the grading system used by the Environment Agency for condition is provided in Table 7-1. A broadscale overview of formal flood defences is provided using AIMS data from the Environment Agency, provided in Table 7-2.

Table 7-1 Grading system used by the Environment Agency 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 – Environment Agency 2006

7.4 Major flood risk management assets in the district

The Flood Map for Planning contains information on 'Areas Benefiting from Defences' (ABD). This shows areas that benefit from the defences that provide a SoP of at least a 100-year river flood event. It does not show areas that benefit from protection for more frequent events. The following are areas shown on the ABD map in Stratford on Avon District.

Table 7-2 Formal Flood Defences in Stratford on Avon District

Watercourse	Location	NGR	Type	Design SoP (year)	Approximate Length (m)	Condition rating	Comments
River Arrow	Alcester	408931, 257749	Wall/ embankment	100	382	Poor to good	Right bank, behind houses on School Road
River Arrow	Alcester	409126, 257245	Wall/ embankment	100	277	Fair to good	Right bank only, behind Gas House Lane and Stratford Road
River Arrow	Alcester	408836, 256831	Wall/ embankment	100	664	Fair to good	Right bank, adjacent to Bleachfield Street and Newport Drive
River Arrow	Broom	408721, 253451	Wall/ embankment	100	572	Very good	Left bank
River Itchen	Long Itchington	441095, 265107	Wall/ embankment	100	373	Fair to good	Right bank only, adjacent to Church Road passing Bascote Road
River Dene	Wellesbourne	427903, 255199	Wall/ embankment	100	591	Fair to good	Left bank
River Dene	Wellesbourne	427952, 255223	Wall	100	80.5	Very good	Right bank
River Alne	Wootton Wawen	415748, 263698	Embankment	50	1000	Poor to fair	Right bank
River Alne	Henley-in-Arden	415281, 266567	Wall/ embankment	100	138	Good	Right bank
River Avon	Barton	410824, 251269	Wall / embankment	100	810	Fair	Left bank
River Avon	Marcliff	409501, 250647	Wall	100	309	Good to very good	Left bank

Source: AIMS dataset, Environment Agency

7.5 Actual and residual flood risk

A Level 2 SFRA (for strategic allocations) or developer site-specific Flood Risk Assessment will need to consider the actual and residual flood risk due to the presence of flood and drainage assets in greater detail.

7.5.1 Actual flood risk

This is the risk to the site considering existing flood mitigation measures and any planned to be provided through new development. Note that it is not likely to be acceptable to allocate developments in existing undefended areas on the basis that they will be protected by developer works, unless there is a wider community benefit that can be demonstrated.

The assessment of the actual risk should take into account that:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for this to be reviewed.
- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change will erode the present-day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present-day levels of protection are to be maintained and where necessary, land secured and safe-guarded that is required for affordable future flood risk management measures.
- By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources.

7.5.2 Residual risk

Residual risk is the risk that remains after the effects of flood risk infrastructure have been taken into account. It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be:

- The effects of a larger flood than defences were designed to alleviate (the 'design flood'). This can cause overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming amount of water.
- Failure of the defences or flood risk management measures, such as breaches in embankments or walls, failure of flood gates to open or close or failure of pumping stations.

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.

This SFRA does not assess the probability of failure other than noting that such events are very rare. However, in accordance with 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. Developers should be aware that any site that is at or below defence level may be subject to flooding if an event occurs that exceeds the design capacity of the defences, or the defences fail, and this should be considered in a detailed Flood Risk Assessment.

The assessment of residual risk should take into account:

- The flood hazard, depth and velocity that would result from overtopping or breach of defences. Flood gate or pumping station failure and/ or culvert blockage (as appropriate). The Environment Agency can provide advice at site-specific development level for advice on breach/ overtopping parameters for flood models.
- The design of the development to take account of the highest risk parts of the site e.g. allowing for flood storage on parts of the site and considering the design of the development to keep people safe e.g. sleeping accommodation above the flood level.
- A system of warning and a safe means of access and egress from the site in the event of a flood for users of the site and emergency services.

7.5.3 Overtopping

The risk from overtopping of defences 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 Environment Agency **Flood Risks to People** guidance document provides standard flood hazard ratings based on the distance from the defence and the level of overtopping.

Any sites located next to defences or perched ponds/reservoirs, may need overtopping modelling or assessments at the site-specific FRA stage.

The risk of rapid inundation following defence overtopping or breach is limited in Stratford on Avon District to areas of Alcester, Broom, Long Itchington, Wellesbourne, Wootton Wawen, Henley-in-Arden, Marcliff and rural areas protected by minor defences.

7.5.4 Defence breach

A breach of a defence occurs when there is a failure in the structure and a subsequent ingress of flood water.

Where defences are present, risk of breach events should be considered as part of the site-specific flood risk assessment. Flood flows from breach events can be associated with significant depths and flow velocities in the immediate vicinity of the breach location and so FRAs must include assessment of the hazards that might be present so that the safety of people and structural stability of properties and infrastructure can be appropriately taken into account. Whilst the area in the immediate vicinity of a breach can be subject to high flows, the whole flood risk area associated with a breach must also be considered as there may be areas remote from the breach that might, due to topography, involve increased depth hazards.

Considerations 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 currently no national standards for breach assessments and there are various ways of assessing breaches using hydraulic modelling. Work is currently being undertaken by the Environment Agency to collate and standardise these methodologies. It is recommended that the Environment Agency are 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.

7.6 Flood alleviation schemes

More information on the current programme of Flood Alleviation Schemes can be found in Chapter 11.2. The Environment Agency have made recent amendments to the Stratford Flood alleviation scheme in light of flooding events in 2019/2020.

7.7 LLFA Asset Register

Warwickshire County Council has compiled a Flood Risk Asset Register for the County under Section 21 of the FWMA (2010).

Figure 7-1 and Figure 7-2 show the assets listed on the Warwickshire County Council Asset Register located within Stratford on Avon District. Warwickshire County Council should be contacted for further information on these assets.

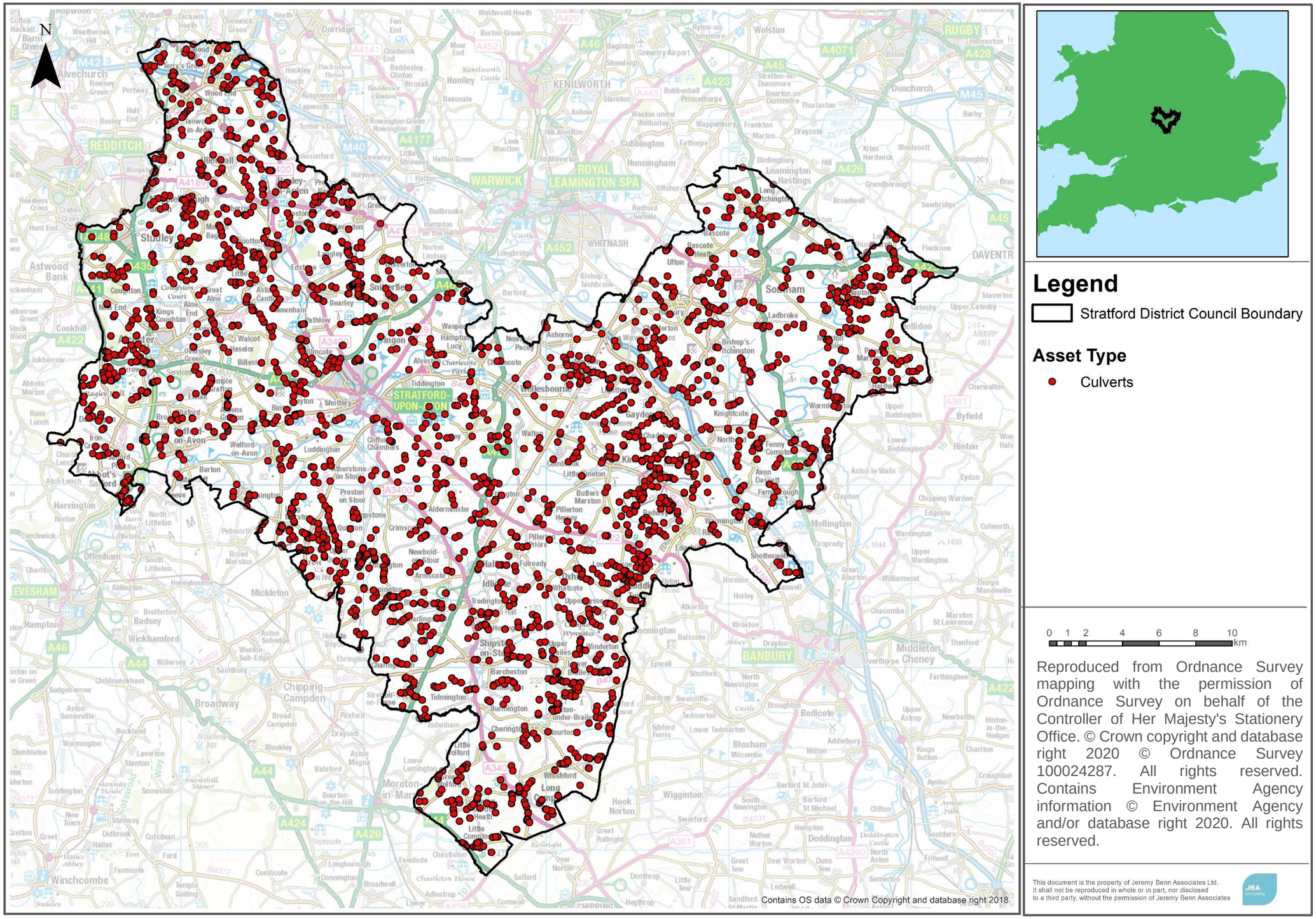
When culverts fail - Snitterfield case study

There are 35 properties at risk of flooding in Snitterfield. Flooding occurs from watercourses and surface water following heavy rainfall. The Bell Brook flows through the village and was culverted for the majority of its length beneath properties along The Green. Part of the 150-year old culvert collapsed in January 2015, causing property flooding, partial blocking of the Bell Brook and a large hole in a residential garden. The culvert had been heavily modified over time on an ad-hoc basis, leading to numerous sections being culverted to varying dimensions, construction methods and standards, most of which had deteriorated over time.

Following this, a new culvert was constructed along the field at the rear of the properties on The Green to cross open land. The existing culvert along the Green was also stabilised and additional gullies were installed to improve the drainage of surface water runoff from the road. The scheme was formally opened in July 2017.

A significant issue with the development of the scheme was that no single authority had sufficient funding to meet the expected cost of the proposed culvert diversion, which was nearly £3 million. A collaborative approach from the Environment Agency, Warwickshire County Council, Stratford District Council and the Local Parish Council was required to cover the cost of the proposed works and external funds for emergency works were secured from national Flood Defence Grant in Aid.

Figure 7-1 Map of LLFA Asset Register within Stratford on Avon District



8 Cumulative impact of development and cross-boundary issues

This section provides a summary of the catchments with the highest flood risk and development pressures and then makes recommendations for local planning policy based on these.

8.1 Cumulative impact of development

Under the revised 2019 NPPF, strategic policies and their supporting Strategic Flood Risk Assessments (SFRAs), are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para. 156).

To understand the impact of future development on flood risk in Stratford on Avon District, the potential change in developed area and the communities at risk from the 1 in 100-year surface water flooding event within each river catchment have been identified. This identifies the catchments where development may have the greatest impact on flood risk, and further assessment may be required within a Level 2 Strategic Flood Risk Assessment (SFRA) or site-specific Flood Risk Assessment (FRA).

The information will also be useful for the LLFA and other Risk Management Authorities, who may wish to use this information, alongside the high priority flood hotspot information in the Local FRM Strategy, to inform a long-term pipeline of flood alleviation studies.

Where catchments have been identified as sensitive to the cumulative impact of development, the assessment concludes with recommended strategic planning policy suggestions to manage the risk.

8.1.1 Method of assessing cumulative impact

To assess the cumulative impact within Stratford on Avon District, the surface water flood risk and number of historic flooding events in each catchment was assessed along with the potential change in developed area of each river catchment to identify the catchments at greatest risk. Figure 8-1 shows the methodology used and Table 8-1 summarises the datasets used within the Stratford on Avon District cumulative development scenario.

Figure 8-1 Overview of the method used within the Cumulative Impact Assessment

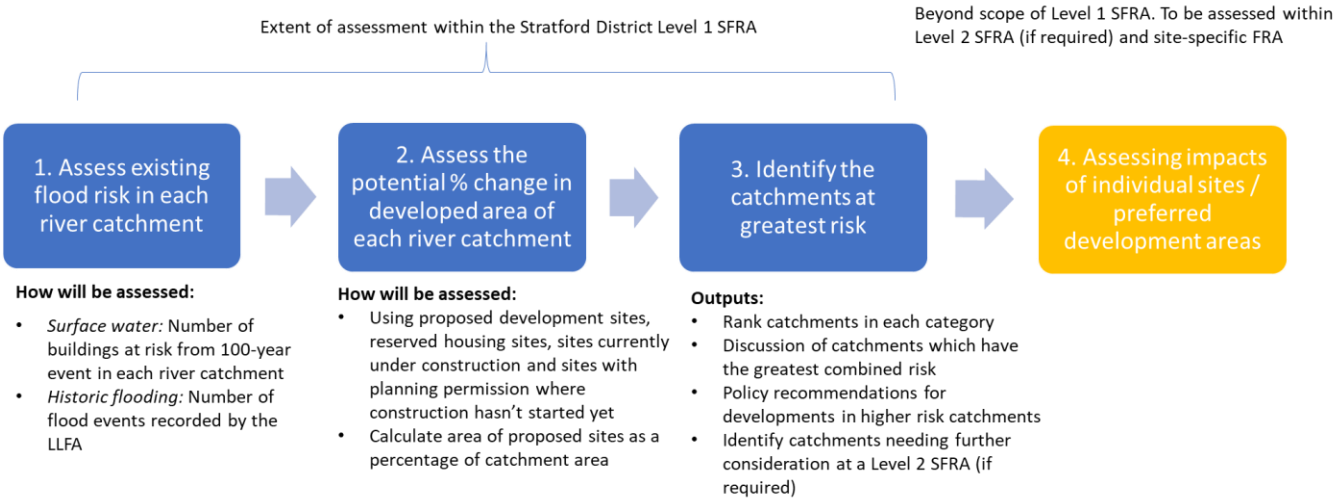


Table 8-1 Summary of datasets used within the Cumulative Impact Assessment

Dataset	Coverage	Source of data	Use of data
Catchment boundaries	Stratford on Avon District study area	Water Framework Directive (WFD) catchments	Defining catchment boundaries
Sub-catchment boundaries	Stratford on Avon District study area	FEH CD-ROM	Defining catchment boundaries
Stratford on Avon District potential development sites, reserved housing sites and sites with planning permission granted	Stratford on Avon District study area	Stratford on Avon District Council	Determining % area of catchment where development has been proposed
Historic flooding incidents	Stratford on Avon District study area	Warwickshire County Council	Assessing the number of historic flooding records in each catchment
OS MasterMap	Stratford on Avon District study area	Ordnance Survey supplied by Stratford on Avon District Council	Location of buildings in the District for assessing those at risk from surface water flooding
Risk of flooding from surface water map (RoFSW) 100-year extent	Stratford on Avon District study area	Environment Agency	Assessing the number of properties within the 100-year surface water flooding extent

8.1.2 Assessing existing surface water flood risk

To understand the surface water flood risk in each catchment, the OS MasterMap data was used to locate building outlines within the District, these outlines were then taken intersected with the 100-year surface water flood extent to determine how many buildings were at risk from surface water flooding in each catchment.

8.1.3 Assessing historic flood risk

Historic flooding records provided by Warwickshire County Council were used to determine the number of flooding incidents within each catchment in Stratford on Avon District. The historic incidents data was provided as the number of flooding incidents per 500 x 500m grid square.

8.1.4 Assessing potential future development

Stratford on Avon District Council provided GIS data of potential reserve housing sites and potential site-specific proposals. GIS data of sites currently under development and those with planning permission granted was also supplied. This

data was used to determine the area of potential development within each river catchment, as a percentage of the total area of the catchment.

8.1.5 Assessment assumptions and limitations

The study has been undertaken using the best available data. The assumptions made in assessing and ranking the impacts of cumulative development on catchments within Stratford on Avon District are summarised in Table 8-2.

Table 8-2 Assumptions and limitations of the assessment

Assessment aspect	Assumption made	Details of limitation in method	Justification of method used
Development scenarios	Inclusion of all potential reserve housing sites and potential site-specific proposals and all sites with planning permission.	The study assessed the impact of potential reserved housing sites and potential site-specific development proposals in addition to sites under development at the time the report was written and sites with planning permission granted. It is possible that not all of the sites identified here will need to be released for development. On that basis, it presents a 'worst case' assessment of the scale of development and is likely to overestimate the risk within each catchment.	Although the method was a very conservative estimate, it identified settlements and catchments with the greatest potential for growth.
	Assumption of housing density and impermeable areas	As potential development densities were not known for all of the sites, it was assumed that the entire area of the site would contribute surface water runoff to the wider catchment. In reality, landscaping and requirements for SuDS within sites lessen the impacts of new development.	The assessment considered the 'worst case' development scenario, if surface water runoff was not controlled from new developments. With housing densities and proportions of undeveloped areas not known, the approach was conservative.
Surface water flood risk	Buildings	Assumption that all properties have been included in the in the OS MasterMap. It may not include all new build properties.	This was the most up to date and accurate data available updated in July 2018
Historic flood events	Location of flooding incidents	The number of flooding incidents was provided on 500 x 500m grid squares. This meant that in some places one	It was considered most conservative to take the number of flooding incidents per

		historic flooding incident square would fall into multiple catchments. As the exact locations of the flooding events were unknown, the total number of flooding incidents per grid square was used in the sum for each individual catchment, regardless of the number of catchments the square covered. This may lead to an overestimate of historic food risk.	grid square and add that to the sum for each individual catchment, regardless of the number of catchments the square covered. For example, if one 500 x 500m square denoting 4 historic flooding incidents covered 3 separate catchments, 4 historic incidents would be added to the total number of historic events for each of the catchments the square covered.

8.1.6 Outcomes

The assessment was initially conducted on the WFD River Catchments as described above; however, some of the catchments seen as 'high risk' were large catchments along the River Avon where any site development would be unlikely to have a significant effect on such a large river. Following the initial assessment, two of the high-risk catchments (River Avon – Stratford upon Avon to Evesham and River Avon – Warwick to Stratford upon Avon) were split into smaller sub-catchments using the FEH CD-ROM to produce more locally specific results for the cumulative impact of development.

Catchments were ranked based on the three factors: historic flood risk, surface water flood risk and proposed development. The Top 10 ranked catchments for each of these assessments are shown in Table 8-3, Table 8-4 and Table 8-5. These rankings were then combined to provide an overall ranking of the Top 10 at risk catchments in the District as shown in Table 8-6. Catchments where greater than 15% of the catchment area is proposed for development are also considered to be high risk and has been included in this table. An overview of the highest ranked catchments in Stratford on Avon District by policy recommendations is shown in Figure 8 2 and Figure 8 3. Detailed maps of each high-risk catchment are shown in Appendix B.

Table 8-3 Top 10 ranked catchments for proposed development

Catchment	% of catchment covered by proposed development
Rush Brook, draining towards Stratford upon Avon*	18.5
Marchfont Brook, including Lower and Upper Quinton	9.5
Charlecote, unnamed watercourse draining towards the River Avon at Wellesbourne	8.4
Small Brook, Bidford on Avon*	6.4
Shottery Brook, draining towards Stratford upon Avon*	4.3
Abbots Salford, unnamed watercourse draining towards the River Avon at Cleeve Hill	2.9
River Stowe, draining towards Southam	2.8
River Arrow, south of Alcester, draining towards Salford Priors	1.4
Racecourse Brook, draining towards Stratford upon Avon*	1.3
River Dene, draining towards Wellesbourne	1.1

*Catchment is sub-catchment originally part of larger WFD catchment

Table 8-4 Top 10 ranked catchments for historic flood events

Catchment	Number of historic flooding events
River Stour, draining towards Shipston on Stour and Tredington	49
River Stour, including Upper and Lower Brailes	39
River Dene, draining towards Wellesbourne	33
River Dene, draining towards Butlers Marston	32
River Stour, draining towards Clifford Chambers	31
River Itchen, draining towards Southam	28
River Alne, draining from Little Alne to Alcester	26
River Arrow, south of Alcester, draining towards Salford Priors	25
River Alne, draining towards Henley in Arden	23
River Stowe, draining towards Southam	22

Table 8-5 Top 10 ranked catchments for surface water flood risk

Catchment	Number of properties located in the 100-year surface water flood extent
Racecourse Brook, draining towards Stratford upon Avon*	639
River Stour, draining towards Shipston on Stour and Tredington	586
River Dene, draining towards Butlers Marston	479
River Alne, draining towards Henley in Arden	476
River Itchen, draining towards Southam	455
River Dene, draining towards Wellesbourne	436
Marchfont Brook, including Lower and Upper Quinton	357
River Stour, including Upper and Lower Brailes	349
Shottery Brook, draining towards Stratford upon Avon*	292
River Itchen, Southam and Long Itchington	287

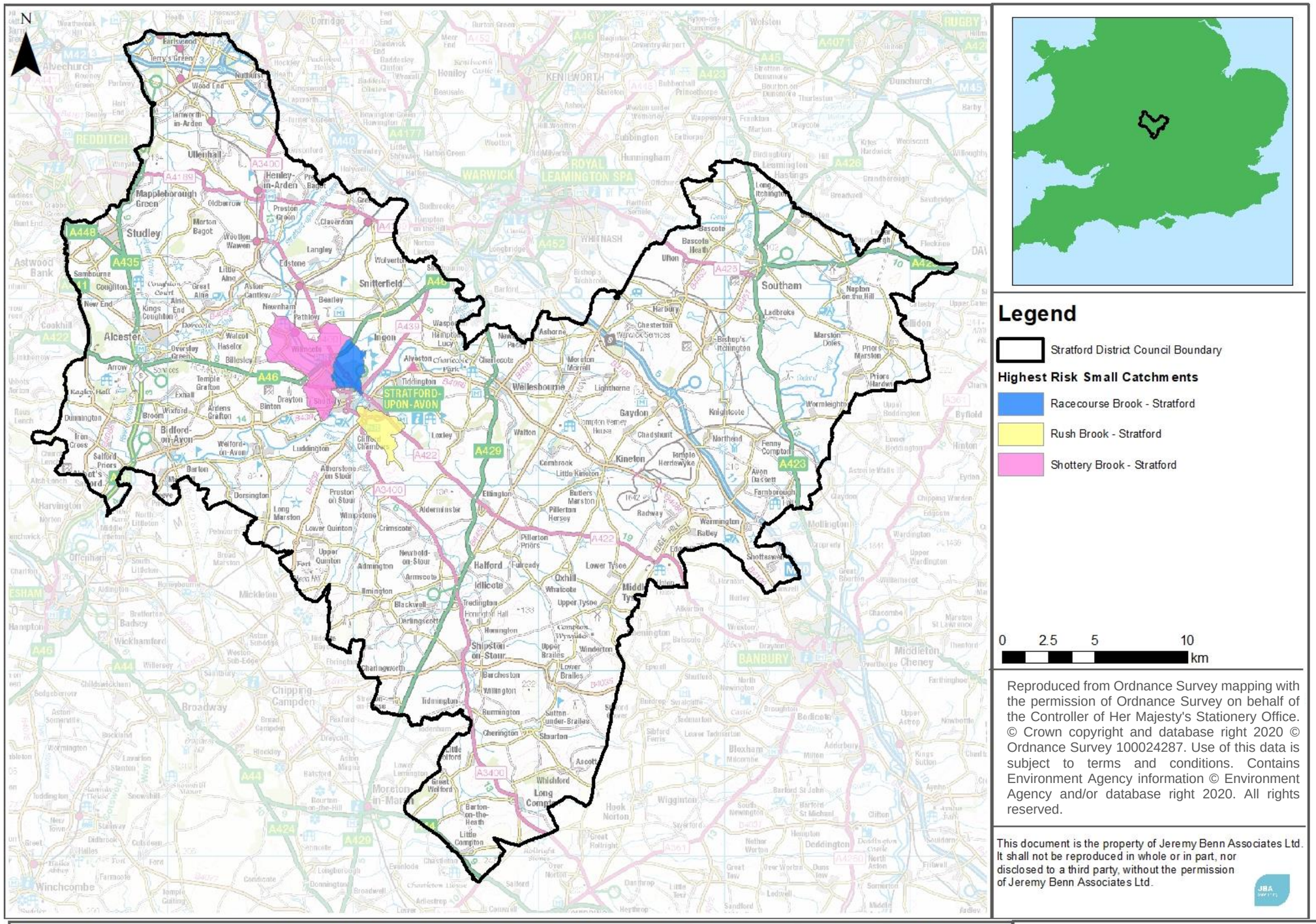
Table 8-6 Overall ranked high-risk catchments

Catchment	Final ranking
River Stour, draining towards Shipston on Stour and Tredington	1
River Dene, draining towards Wellesbourne	2
River Itchen, draining towards Southam	3
River Dene, draining towards Butlers Marston	4
River Stowe, draining towards Southam	5
Shottery Brook, draining towards Stratford upon Avon	6
Marchfont Brook, including Lower and Upper Quinton	7
River Alne, draining towards Henley in Arden†	8
River Stour, draining towards Clifford Chambers†	9
Racecourse Brook, draining towards Stratford upon Avon	10
Rush Brook, draining towards Stratford upon Avon**	25

**Catchment considered to be high risk as >15% of the catchment area is covered by proposed development.

† Catchments that have been newly identified as high risk in the updated cumulative impact assessment compared to the original assessment undertaken for the Level 1 SFRA in 2019. Catchments of the River Itchen, including Southam and Long Itchington, and the River Arrow, draining towards Alcester, are no longer considered within the ten highest risk catchments. Additionally, the inclusion of updated historical flooding incident data and proposed developments have changed the final order of the highest risk catchments.

Figure 8-2 Map of highest risk catchments in Stratford on Avon District – Small catchments draining into settlements with known flood risk issues



8.1.7 Planning Policy Considerations for Catchments

The following Planning Policy recommendations have been made for the catchments where cumulative development is likely to have the greatest impact on flood risk.

8.1.8 Small catchments draining into settlements with known flood risk issues

- Catchments of the Rush Brook, Shottery Brook and Racecourse Brook draining towards Stratford upon Avon.

In these areas the recommended policy is to:

- Undertake more detailed drainage strategy work as part of a Level 2 SFRA[1] or detailed local area Strategic Drainage Study to consider further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions/enforcement through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online/offline flood storage, and where land should be safeguarded within proposed site allocations to fulfil this purpose. *
- Incorporate SuDS and provide details of adoption, ongoing maintenance and management on all development sites. Proposals will be required to provide reasoned justification for not using SuDS techniques, where ground conditions and other key factors show them to be technically feasible. Preference will be given to systems that contribute to the conservation and enhancement of biodiversity and green infrastructure in the District where practicable.
- Seek to provide wider betterment by demonstrating in site-specific Flood Risk Assessments and Surface Water Drainage Strategies what measures can be put in place to contribute to a reduction in flood risk downstream. This may either be by provision of additional storage on site e.g. through oversized SuDS, natural flood management techniques, green infrastructure and green-blue corridors and/or by providing a Partnership Funding contribution towards any flood alleviation schemes. Consultation on the site-specific requirements should be undertaken with Stratford on Avon District Council and the Environment Agency at the earliest opportunity.

It is also recommended that the Environment Agency, in consultation with Stratford on Avon District Council and Warwickshire County Council, should consider whether to formally designate these catchments as Critical Drainage areas. This would mean that a detailed Flood Risk Assessment would be required for all developments that are proposed, regardless of their size.

Warwickshire County Council as LLFA will review Surface Water Drainage Strategies in accordance with their local requirements for major developments. These should take into account all sources of flooding to ensure that future development is resilient to flood risk and does not increase flood risk elsewhere.

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[1] A Level 2 SFRA will be required should sites require the Exception Test. A Level 2 SFRA could also contain more detailed local area Strategic Drainage Strategy work.

* This recommendation is more applicable to smaller catchments, because the proportion of new development to catchment area is likely to be greater and therefore the potential impact of development on flood risk greater. More detailed drainage strategy planning would entail building a small hydrological model of the catchment to provide a more specific information on the likely impact of those new developments. Doing this to cover a small catchment is more affordable and would yield more meaningful results than modelling much larger catchments, where in proportion to overall catchment size, new development would not have as much of an effect on flood risk elsewhere in those larger catchments.

8.1.9 Larger rural catchments with some localised flood risk issues

- Catchments of the River Dene draining towards Butlers Marston and Wellesbourne
- Catchments of the River Stowe and River Itchen draining towards Southam and Long Itchington
- Catchments of the River Stour draining towards Shipston on Stour and Tredington and draining towards Clifford Chambers
- Marchfont Brook, including Lower and Upper Quinton
- A catchment of the River Alne draining towards Henley in Arden

In these areas the recommended policy is:

- To incorporate SuDS and provide details of adoption, ongoing maintenance and management on all development sites. Proposals will be required to provide reasoned justification for not using SuDS techniques, where ground conditions and other key factors show them to be technically feasible. Preference will be given to systems that contribute to the conservation and enhancement of biodiversity and green infrastructure in the District where practicable.
- To seek to provide wider betterment by demonstrating in site-specific Flood Risk Assessments and Surface Water Drainage Strategies what measures can be put in place to contribute to a reduction in flood risk downstream. This may either be by provision of additional storage on site e.g. through oversized SuDS, natural flood management techniques, green infrastructure and green-blue corridors and/or by providing a Partnership Funding contribution towards any flood alleviation schemes. Consultation on the site-specific requirements should be undertaken with Stratford on Avon District Council and the Environment Agency at the earliest opportunity.
- For the LPA to work closely with the Environment Agency and Warwickshire County Council as LLFA to identify areas of land that should be safeguarded for the future use of natural flood management features.

Warwickshire County Council as LLFA will review Surface Water Drainage Strategies in accordance with their local requirements for major developments. These should take into account all sources of flooding to ensure that future development is resilient to flood risk and does not increase flood risk elsewhere.

8.2 Cross-boundary issues

Future large-scale development, both within and outside Stratford on Avon District, can have the potential to affect the flood risk to existing development and

surrounding areas. Stratford on Avon District has boundaries with the following local authorities:

- Bromsgrove District Council
- Wychavon District Council
- West Oxfordshire District Council
- Warwick District Council
- Rugby Borough Council
- South Northants District Council
- Solihull Metropolitan Borough Council
- Daventry District Council
- Cotswold District Council
- Redditch Borough Council
- Cherwell District Council

There are catchments within Stratford district that drain downstream into other neighbouring authorities including Warwick District, Rugby Borough and Wychavon District. Any development within Stratford must consider the potential downstream impacts on catchments within these neighbouring authorities.

Wychavon District Council supplied GIS data regarding proposed development sites across the district. A sensitivity test was carried out where these sites were included within the cumulative impact assessment. However, the inclusion of these development sites had minimal impact on the identification of high-risk catchments across the Stratford on Avon study area. No additional high-risk catchments were identified as a result of considering development sites proposed within Wychavon district.

It is recommended that Stratford on Avon District Council consults neighbouring authorities, particularly during the consultation phases of their respective Local Plans, to identify and review potential cross-boundary issues. In the vast majority of cases, if appropriate flood risk and drainage policies and SuDS are adopted to ensure compliance with the NPPF, development in these neighbouring authorities is unlikely to affect flood risk in Stratford on Avon District and development in Stratford on Avon District is unlikely to affect flood risk in downstream catchments.

8.3 Water quality considerations

In addition to cross-boundary issues regarding flood risk, there are also cross-boundary issues relating to water quality. Development or changes to land management practices in the upper catchments of watercourses that flow across boundaries into Stratford on Avon District can potentially impact on the quality of watercourses within the study area. Development should consider the quality of the water that is released from sites and the impact it may have on the water quality on any receiving waterbodies. Future development should ensure there is no adverse impact on the quality of watercourses within the District administrative area. Any impacts identified should then be considered in relation to the WFD Ecological, Hydromorphological and Chemical Status of the waterbody and the status objectives. Opportunities to improve the status of watercourses should also be considered. This is particularly important for Stratford on Avon District as there are several watercourses within the area which have not achieved a good status,

primarily due to diffuse pollution and phosphate levels mainly from agriculture and rural land management, the water industry and transport and urban activities.

9 Flood Risk Assessment requirements for developers

This section provides guidance on site-specific Flood Risk Assessments (FRAs). These are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with Planning Applications and should demonstrate how flood risk will be managed over the development's lifetime, considering climate change and vulnerability of users.

9.1 Introduction

The report provides a strategic assessment of flood risk within the Stratford District. Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk and any defences at a site are considered in more detail. Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), to inform the sequential approach within the site and prove, if required, whether the Exception Test can be satisfied.

A detailed Flood Risk Assessment (FRA) may show that a site is not appropriate for development of a particular vulnerability, or even at all. However, a detailed Flood Risk Assessment undertaken for a windfall site[2] may find that the site is entirely inappropriate for development.

9.2 Principles for new developments

9.2.1 Apply the Sequential and Exception Tests

Developers should refer to Section 3 for more information on how to consider the Sequential and Exception Tests. For allocated sites, Stratford District Council should use the information in this SFRA to apply the Sequential Test. For windfall sites a developer must undertake the Sequential Test, which includes considering reasonable alternative sites at lower flood risk. Only if it passes the Sequential Test should the Exception Test then be applied if required. The Sequential and Exception Tests in the NPPF apply to all developments and an FRA should not be seen as an alternative to proving these tests have been met.

Developers should also apply the sequential approach to locating development within the site. The following questions should be considered:

- can risk be avoided through substituting less vulnerable uses or by amending the site layout?
- can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? And
- can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?

9.2.2 Consult with statutory consultees at an early stage to understand their

[2] 'Windfall sites' is used to refer to those sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan.

requirements

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

9.2.3 Consider the risk from all sources of flooding and that they are using the most up to date flood risk data and guidance

The SFRA can be used by developers to scope out what further detailed work is likely to be needed to inform a site-specific Flood Risk Assessment. At a site level, Developers will need to check before commencing on a more detailed Flood Risk Assessment that they are using the latest available datasets. Developers should apply the 2019 Environment Agency climate change guidance and ensure the development has taken into account climate change adaptation measures.

9.2.4 Ensure that the development does not increase flood risk elsewhere

Chapter 10 sets out these requirements for taking a sustainable approach to surface water management. Developers should also ensure mitigation measures do not increase flood risk elsewhere and that floodplain compensation is provided where necessary.

9.2.5 Ensure the development is safe for future users

Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered. Developers should consider both the actual and residual risk of flooding to the site, as discussed in section 3.

Further flood mitigation measures may be needed for any developments in an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard.

9.2.6 Enhance the natural river corridor and floodplain environment through new development

Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted. Where possible, developers should identify and work with partners to explore all avenues for improving the wider river corridor environment. Developers should open up existing culverts and should not construct new culverts on site except for short lengths to allow essential infrastructure crossings.

9.2.7 Consider and contribute to wider flood mitigation strategy and measures in the district and apply the relevant local planning policy

Wherever possible, developments should seek to help reduce flood risk in the wider area e.g. by contributing to a wider community scheme or strategy for strategic measures, such as defences or natural flood management or by contributing in kind by mitigating wider flood risk on a development site. More information on the contribution developers are expected to make towards achieving the wider vision for FRM and sustainable drainage in the district can be found in Chapter 7.3.

Developers must demonstrate in an FRA how they are contributing towards this vision.

9.3 Planning consultees

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

- Stratford on Avon District Council decides all planning matters, including those related to flood risk, in their decision whether or not to grant planning permission.
- Warwickshire County Council are a statutory consultee on surface water drainage proposals for all major development. As the Lead Local Flood Authority, they provide technical advice on surface water drainage strategies and designs put forward for 'major' developments.
- The Environment Agency is a statutory consultee for applications in Flood Zones 2 and 3 and any development within 20m of a Main River.

9.4 Requirements for site-specific Flood Risk Assessments

9.4.1 When is a FRA required?

Site-specific FRAs are required in the following circumstances:

- Proposals of 1 hectare or greater in Flood Zone 1.
- Proposals for new development (including minor development such as non-residential extensions, alterations which do not increase the size of the building or householder developments and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

An FRA may also be required for some specific situations:

- If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1)
- Where evidence of historical or recent flood events have been passed to the LPA
- In an area of significant surface water flood risk.

9.4.2 Objectives of site-specific FRAs

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

- whether a proposed development will be at risk of flooding, from all sources, both now and in the future, taking into account climate change;
- whether a proposed development will increase flood risk elsewhere;
- whether the measures proposed to deal with the effects and risks are appropriate;

- the evidence, if necessary, for the local planning authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Stratford on Avon District Council. Guidance and advice for developers on the preparation of site-specific FRAs include:

- Standing Advice on Flood Risk (Environment Agency);
- Flood Risk Assessment for Planning Applications (Environment Agency);
- Warwickshire Council flood risk advice to developers; and
- Site-specific Flood Risk Assessment: CHECKLIST (NPPF PPG, Defra)

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

9.5 Flood risk management guidance - Mitigation measures

9.5.1 Site layout and design

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

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from flood zones, to higher ground, while more flood-compatible development (e.g. recreational space) can be located in higher risk areas. Whether parking in floodplains is appropriate will be based on the likely flood depths and hazard, evacuation procedures and availability of flood warning.

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

9.5.2 Modification of ground levels

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

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken as raising land above the floodplain 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 analyses 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 (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary (unless the site is strategically allocated). Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C62430.

Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment.

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

9.5.3 Raised floor levels

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

The Environment Agency advises that minimum finished floor levels should be set 600mm above the 100-year plus climate change peak flood level, where the new climate change allowances have been used (see Chapter 4 for the climate change allowances). 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.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels. Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route.

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

9.5.4 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain.

Where development is located behind, or in an area benefitting from defences, the residual risk of flooding must be considered.

9.5.5 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).

9.6 Buffer strips

The provision of a buffer strip to 'make space for water', allows additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes. It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult.

Appendix A shows the buffer areas for different watercourses within Stratford District, which should be consulted when allocating new development.

9.7 Making space for water

The PPG sets out a clear aim in Flood Zone 3 to create space for flooding by restoring functional floodplain and generally development should be directed away from these areas.

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

9.8 Resistance and resilience measures

The consideration of resistance and resilience measures should not be used to justify development in inappropriate locations.

Having applied planning policy, there will be instances where developments, such as those that are water compatible and essential infrastructure are permitted in high flood risk areas. The above measures should be considered before resistance and resilience measures are replied on. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system and the use of back up pumping to evacuate water from a property as quickly as possible. The proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate. Available resistance and resilience measures are shown in

Table 9-1.

Table 9-1: Available temporary measures

Measures	Description
Permanent barriers	Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers
Temporary barriers	Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale, temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.
Community resistance measures	These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.
Flood resilience measures	These measures aim to ensure no permanent damage is caused, the structural integrity of the building is not compromised and the clean up after the flood is easier. Interior design measures to reduce damage caused by flooding can include electrical circuitry installed at a higher level and water-resistant materials for floors, walls and fixtures.

9.9 Reducing flood risk from other sources

9.9.1 Groundwater

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

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk on or off of the site. For features like swales and pond, high groundwater can affect the capacity to receive surface water inflows. Developers should provide evidence and ensure that this will not be a significant risk. When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an acceptable solution.

All new sites should undertake ground investigation as early in the planning process as possible to inform the design in relation to groundwater and SuDS design.

9.9.2 Surface water and sewer flooding

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

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

When redeveloping existing buildings, the installation of some permanent or temporary floodproofing and resilience measures could protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained.

Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut. This should be demonstrated with suitable modelling techniques.

Developers should refer to **Warwickshire County Council's Standing Advice on Flood Risk and Drainage** for guidance on how to design new developments to take surface water flood risk into account.

9.9.3 Reservoirs

As discussed in Section 6.8 the risk of reservoir flooding is extremely low. However, there remains a residual risk to development from reservoirs which developers should consider during the planning stage:

- Developers should contact the reservoir owner for information on:
  - the Reservoir Risk Designation
  - reservoir characteristics: type, dam height at outlet, area/volume, overflow location
  - operation: discharge rates / maximum discharge
  - discharge during emergency drawdown; and
  - inspection / maintenance regime.
- The EA online Reservoir Flood Maps contain information on the extents, depths and velocities following a reservoir breach (note: only for those reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975). Consideration should be given to the extent, depths and velocities shown in these online maps.
- The GOV.UK website on **Reservoirs: owner and operator requirements** provides information on how to register reservoirs, appoint a panel engineer, produce a flood plan and report and incident.

Developers should use the above information to:

- Apply the sequential approach to locating development within the site.
- Consider the impact of a breach and overtopping, 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.

- Assess the potential hydraulic forces imposed by sudden reservoir failure event and check that that the proposed infrastructure fabric could withstand the structural loads.
- Develop site-specific Emergency Plans and/ or Off-site Plans if necessary and ensure the future users of the development are aware of these plans. This may need to consider emergency drawdown and the movement of people beforehand, similar to the response to the Toddbrook Reservoir incident in Whaley Bridge, Derbyshire, 2019.

9.10 Key considerations for developers

Stratford on Avon District Council, Warwickshire County Council, the Environment Agency and Severn Trent Water have highlighted common challenges that can arise for site-specific developments. Table 9-2 sets these out and outlines how developers should address these issues:

Table 9-2 Key considerations for developers

Common challenge	Consideration for developers
Sites in Flood Zone 1 are at risk of flooding from other sources	Developers should use the information in the SFRA, the national surface water mapping and WCC SWMP to identify if sites are subject to other sources of flooding. If Ordinary Watercourses run through, or along the boundary of a site, these will require modelling and an independent review (if requested) to be submitted to the LLFA to demonstrate the level of flood risk present.
Overland flow paths and SuDS features are not considered at an early enough stage of design. This leads to a lack of space for well-designed features and large amounts of open space being taken up by SuDS areas in developments, affecting the amount of genuine open space being secured.	Flow paths and SuDS should be considered at pre-application stage. SuDS should be incorporated into the landscaping as an integral part of a masterplan for the development site. A holistic approach to working with water should be taken to gain multiple benefits rather than "hiding" it below ground to save space. WCC as LLFA do not consider below ground tanks or oversized pipes in isolation as SuDS.
Large amounts of open space are being taken up by SuDS in developments. They are nearly always dry-balancing ponds which still end up being fenced off as a result of safety assessments. This is having impacts on the amount of publicly accessible open space being provided on developments.	Flow paths and SuDS should be considered at pre-application stage and designed with best practices in mind. SuDS should be incorporated into the landscaping as an integral part of a masterplan for the development site.
The SuDS management train is often not used effectively, and large, single features are proposed instead of dealing with	The C753 CIRIA SuDS manual should be used to incorporate all stages of the SuDS management train and design features in line with best practice.

flows at the source using multiple features to maximise surface water treatment.	
Planning applications are submitted without an adequate level of detail on flood risk and drainage e.g. FRA or Drainage Strategy, a viable outfall, site run-off calculations, suitably detailed drawings, exceedance routes, section drawings, maintenance information and infiltration testing.	Developers should ensure that these are provided as appropriate. Depending on the type of application and stage of development, the LLFA and LPA will need satisfactory information that a site can be drained and will not be at unacceptable risk of flooding or increase flood risk elsewhere. It will not always be acceptable to condition this information being provided at a later stage. For example, to prove a drainage system is workable, ground investigations will be needed at outline stage where infiltration methods are proposed. The **WCC Standing Advice** provides further guidance.
Proposed downstream outfalls are in poor condition.	All proposed outfalls should be fully investigated to ensure connectivity with a downstream waterbody and ensure that they are in a sufficient condition to convey flows.
Culverts on site or taking flows from the site are in poor condition.	Re-naturalisation and de-culverting of watercourses that flow through redevelopment schemes should be considered at pre-application stage. The requirement and cost of such work should be reflected in the price of acquiring land to ensure that such works are financially viable.
New development can have a significant impact on the ability for STW/Thames Water/Anglian Water to maintain assets and continue to provide their services where there are intersections between water mains and sewers.	Where existing infrastructure is protected by easements, they should not be built over or located in private gardens where access is restricted and existing sewer/water mains should be located in highways or public open space. Early consultation with Severn Trent/Thames Water/Anglian Water by planners and developers will ensure that intersections between water mains and sewers are accounted for, minimising delays and associated abortive costs.
The drainage discharge hierarchy for disposing of surface water discharge is not being followed.	The developer should provide evidence that they have considered discharging water in order of preference to: Groundwater via infiltration Watercourse (including an offsite watercourse) Surface water sewer Combined sewer
Development is proposed that encroaches on the watercourse banks.	Developer to ensure that the following easements are used to ensure there is access for maintenance: Main River 8m Ordinary Watercourse 6m (minimum, see **WCC Standing Advice** for further guidance)
Sewers on new developments do not always meet the required standards.	If developers are looking for STW/Thames Water/Anglian Water to adopt responsibility for a new sewer it will need to be approved in advance of it being built and adopted post an inspection to ensure that it meets standards.

	Any new sewers and pumping stations should be constructed in accordance with the Sewers for Adoption standards by following the process and application forms for **Severn Trent Water**, **Thames Water**, **Anglian Water** as appropriate.
During the construction of sites, runoff is not being adequately managed, causing local surface water and siltation issues.	Measures should be put in place to prevent siltation washing into watercourses/culverts/sewers/gullies during construction, caused by increased run-off after top-soil strip. On completion of construction works, wet features are to be desilted and if applicable culverts/sewers are to be CCTV surveyed.

10 Surface water management and SuDS

This chapter provides guidance and advice on managing surface water runoff and flooding.

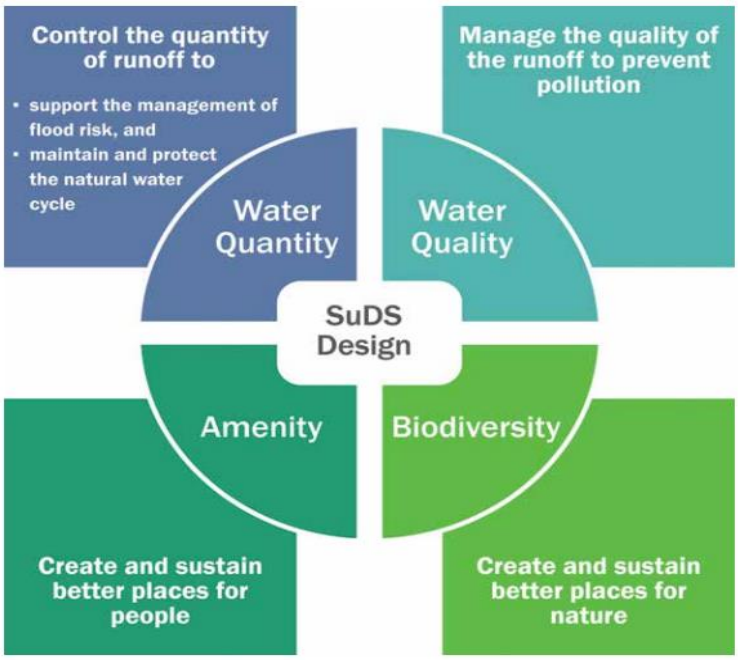
10.1 Role of the LLFA and Local Planning Authority in surface water management

In April 2015 Warwickshire County Council was made a statutory consultee on the management of surface water and, as a result, provides technical advice on surface water drainage strategies and designs put forward for major development proposals to ensure that onsite drainage systems are designed in accordance with the current legislation and guidance.

When considering planning applications, Warwickshire County Council as LLFA will provide advice to the Planning Department on the management of surface water. As LPA, Stratford on Avon District Council should satisfy themselves that the development's proposed minimum standards of operation are appropriate and ensure through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the lifetime of the development.

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These four principles are shown in Figure 10-1.

Figure 10-1 Four pillars of SuDS design



Source: The SuDS Manual (C753)

10.2 Sustainable Drainage Systems (SuDS)

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

SuDS provide a means of dealing with the quantity and quality of surface water and can also provide amenity and biodiversity benefits. 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 for all new major development proposals to ensure that sustainable drainage systems for management of runoff are put in place. Likewise, minor developments should also ensure sustainable systems for runoff management are provided. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and current drainage arrangements is essential.

10.3 Sources of SuDS guidance

10.3.1 Warwickshire County Council Flood Risk and Drainage Standing Advice

Warwickshire County Council's **Flood Risk and Drainage Standing Advice** was updated in August 2017 and gives advice on SuDS and flood risk for new developments.

10.3.2 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015) 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.

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

Non-Statutory Technical guidance provides non-statutory standards on the design and performance of SuDS. It outlines peak flow control, volume control, structural integrity, flood risk management and maintenance and construction considerations.

10.3.4 Non-statutory Technical Guidance for Sustainable Drainage Practice Guidance, LASOO (2016)

The Local Authority SuDS Officer Organisation produced their **practice guidance** in 2016 to give further detail to the Non-statutory technical guidance.

10.4 Other surface water considerations

10.4.1 Groundwater Vulnerability Zones

The Environment Agency published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise of the underlying bedrock. The map shows the vulnerability of groundwater at a location based on the hydrological, hydro-ecological and soil propertied 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.**

10.4.2 Groundwater Source Protection Zones (GSPZ)

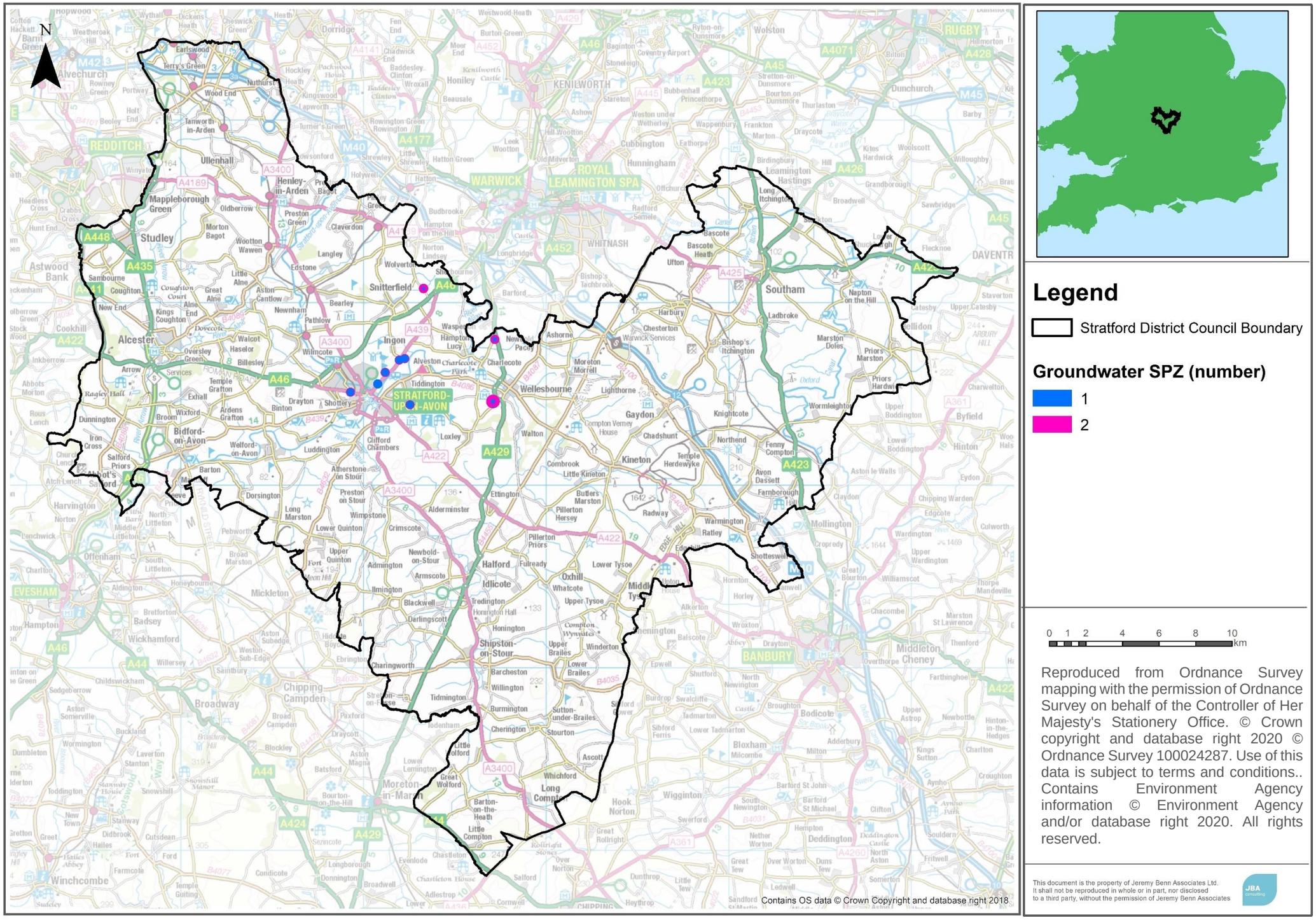
The Environment Agency also defines Groundwater Source Protection Zones (GSPZs) near groundwater abstraction points. These protect areas of groundwater that are used for drinking water. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination. GSPZs can be viewed on **DEFRA's Magic Map.**

The location of the Groundwater SPZs in relation to Stratford on Avon District are shown in Figure 10-2.

The vast majority of Stratford on Avon District is not located within a Groundwater SPZ. Areas within a Groundwater SPZ are predominantly located in Stratford upon Avon, with other SPZ areas in Wellesbourne and Snitterfield.

Due to the permeable nature of the bedrock classified as Principal, infiltration may not be a suitable SuDS technique in areas underlain by this bedrock. For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough and a site-specific infiltration test is conducted early on as part of the design of the development. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to Groundwater Source Protection Zones (GSPZs) or aquifers or near areas of contaminated land/areas of former mining works, further restrictions may be applicable, and guidance should be sought from the LLFA.

Figure 10-2 Groundwater Source Protection Zones



10.5 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.

Stratford on Avon District is located entirely within a surface water NVZ. A small amount of the District is located within a Groundwater NVZ, predominantly on the eastern border of the District around Farnborough and Warmington and to the south of Long Compton.

The NVZ coverage can be viewed on the **Environment Agency's online maps**.

11 Strategic flood risk solutions

11.1 Introduction

Stratford-on-Avon District Council have a vision for the future management of flood risk and drainage in the district. This concerns flood risk management, alongside wider environmental and water quality enhancements. Strategic solutions may include upstream flood storage, integrated major infrastructure/ FRM schemes, new defences and watercourse improvements as part of regeneration and enhancing green infrastructure, with opportunities for natural flood management and retrofitting sustainable drainage systems.

Chapter 2 sets out the strategic plans that exist for the District. The list below summarises the key outcomes these are seeking to achieve. This vision needs to be delivered by new development alongside retrofitting and enhancing green infrastructure and flood defence schemes in the existing developed area.

The strategic policy vision from the CFMP and RBMP focuses on re-naturalising watercourses, safeguarding the floodplains and the encouraging collaboration and creating new partnerships to reduce the risk of flooding and to enhance the natural environment. Within Stratford on Avon District, strategic solutions encourage development to:

- Use sustainable flood storage and mitigation schemes to store water and manage surface water runoff in locations that provide overall flood risk reduction as well as environmental benefits.
- In areas where flood risk is being managed effectively, there will be a need in the future to keep pace with increasing flood risk as a result of climate change.
- Promote partnership working with all relevant stakeholders in the Severn River Basin. This includes working with land managers and farmers to reduce soil erosion from intensively farmed land.
- Assess long-term opportunities to move development away from the floodplain and create green river corridors through the District.
- Identify opportunities to use areas of the floodplain to store water during high flows, to reduce long term dependence on engineered flood defences located both within the district and outside the district.
- Safeguard the natural floodplain from inappropriate development.
- Where possible, land management change should be used to reduce run-off rates from the development whilst maintaining or enhancing the capacity of the natural floodplain to retain water. Land management and uses that reduce runoff rates in upland areas should be supported.
- Development should maintain conveyance of watercourses through hamlets and villages, to help reduce the impact of the more frequently experienced floods and to improve the natural environment.
- Use SFRAs to inform future development and minimise flood risk from all sources.
- Implement upstream catchment management e.g. slow the flow and flood storage schemes could be implemented in upper catchments to reduce flooding downstream and across neighbouring authority boundaries; and
- Promote and consider SUDS at the earliest stage of the development of a site.

11.2 Current programme of Flood Alleviation Schemes

Figure 11-1 shows a map of the current and potential future schemes lead by the Environment Agency, Warwickshire County Council and Severn Trent Water. Some of these schemes are outlined in more detail below.

There is more certainty over some schemes than others. This is due to the level of investigation that has gone into a scheme so far and the availability of funding. In particular, all Severn Trent Water schemes, and WCC schemes for Clifford Chambers, Gaydon, Coughton, Long Itchington and Shottery, should be considered as indicative at this time. The organisation leading the scheme should be contacted for up to date information on scheme progression. Due to severe flooding events in November 2019, schemes in the following areas may be in development: Loxley, Long Compton, Snitterfield, Stratford-on-Avon, Kineton, Lower Brailes, Stourton, Fenny Compton, Bidford-on-Avon, Welford-on-Avon , Clifford Chambers, Walcote and Wixford.

11.2.1 Fenny Compton

Warwickshire County Council are looking to develop a scheme based on upstream storage. Geotechnical investigations have been undertaken to understand the best ways to maximise the benefit of the existing storage feature.

11.2.2 Cherington

Cherington is located in a steep-sided catchment and is therefore at high risk of surface water flooding. Property Level Resilience (PLR) including flood doors and flood defender barriers were installed at a number of properties in the village in 2018.

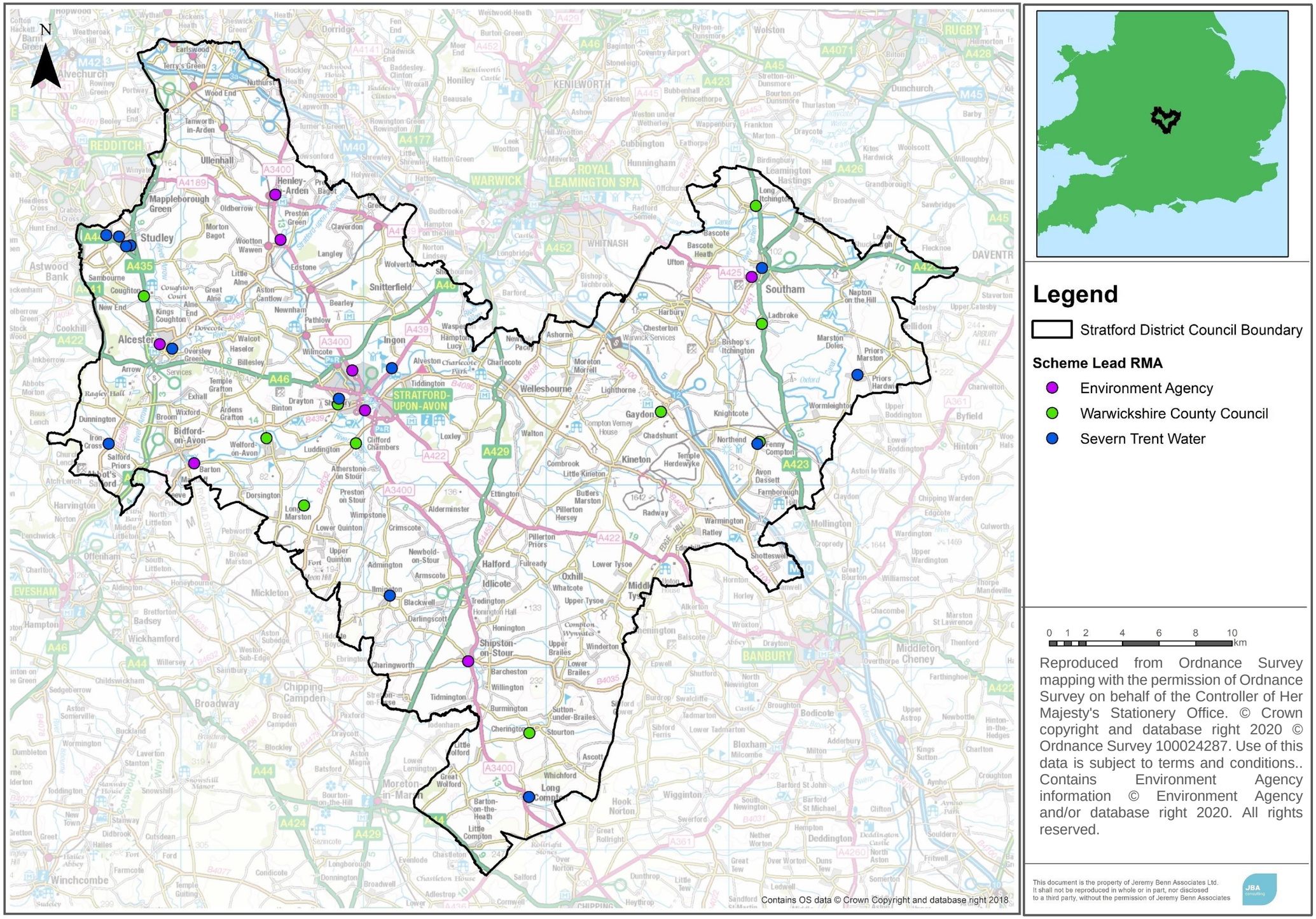
11.2.3 Ladbroke

PLR including flood defender barriers and waterproof external walls were installed in a number of properties in the village in 2018.

11.2.4 Racecourse Brook

An Environment Agency Flood Risk Management Scheme along the Racecourse Brook in Stratford on Avon has been proposed, which plans to better protect 47 homes from flooding by scheme completion in 2021.

Figure 11-1 Current and future flood alleviation schemes



11.3 Natural flood management (NFM)

NFM is used to protect, restore and re-naturalise the function of catchments and rivers to reduce flood risk. A wide range of techniques can be used that aim to reduce flooding by working with natural features and processes in order to store or slow down flood waters before they can damage flood risk receptors (e.g. people, property, infrastructure, etc.). Techniques and measures, which could be applied in Stratford on Avon 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
- Restoration of rivers and removal of redundant structures i.e. weirs and sluices no longer used or needed
- Installation or retainment of large woody material in river channels
- Improvements in management of soil and land use
- Creation of rural and urban SuDS

In 2017, the Environment Agency published an **online evidence base** to support the implementation of NFM and 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.

There are areas within Stratford on Avon District whereby removing existing defences and reconnecting the floodplain could create areas for potential without causing risk to properties. Areas where such opportunities could potentially be considered includes along the Rivers Avon, Stour, Alne and Arrow. Areas in Stratford on Avon District where tree planting could potentially be considered as an NFM measure are most notably along the River Avon and River Alne.

Natural flood management measures have been implemented in the Stour catchment in 2017 and 2018, along the Knee Brook and its tributaries, by the Shipston Area Flood Action Group (SAFAG). 'Slow the flow' measures such as ponds, bunds and woody dams have been installed, mainly on upstream farmland, to reduce flood risk to Shipston on Stour and surrounding villages during flooding events. Warwickshire County Council are currently working with SAFAG and the National Flood Forum on the Stour Catchment Partnership to obtain further funding to implement NFM features in the wider Stour catchment, to benefit villages including Brailes, Cherington and Long Compton.

11.4 Culverts

Culverted watercourses were often constructed to enable the efficient drainage of an area and allow land to become developable. However, culverted watercourses require regular maintenance to ensure that they function correctly. In most cases they also require trash screens at their entrance to ensure they do not become blocked by large debris, further adding to the maintenance requirements.

Where practical, the de-culverting and re-naturalisation of watercourses restoring to open channel should be encouraged. De-culverting can bring many benefits including reducing the need for regular maintenance and trash screens, reducing blockages and enhancing the river environment by providing a more varied habitat.

In some cases, small sections of open channel can be beneficial for flood risk management allowing for flood water to disperse naturally and thus slowing the movement of flood water downstream.

Works to alter culverts on Ordinary Watercourses would require an **Ordinary Watercourse Land Drainage Consent** from Warwickshire County Council as LLFA.

Further information is provided in the '**Trash and Security Screen Guide 2009**', published by the Environment Agency/Defra, which should be used as evidence for any culvert assessment, improvement or structure retention. The reader should refer to the CIRIA website, as this document is currently being updated.

12 Summary and Recommendations

12.1 Sources of flood risk

Parts of Stratford on Avon District are at risk from the following sources: fluvial, surface water, groundwater, sewers, reservoir inundation and canal overtopping/breaches. This study has shown that the most significant sources of flood risk in Stratford on Avon District are fluvial and surface water.

- *Fluvial flooding*: The primary fluvial flood risk is along the River Avon and its main tributaries. These present fluvial flood risk to rural communities as well as to the main urban centres of the District. The floodplains of the watercourses are fairly well confined in the majority of the District, with wider extents along the River Avon due to lower lying, flat topography, notably through Stratford upon Avon and downstream of Bidford on Avon.
- *Surface water:* The Risk of Flooding from Surface Water map shows a number of prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas.
- *Sewer*: The majority of sewers in Stratford on Avon District are managed by Severn Trent Water, with Thames Water and Anglian Water managing sewers in some areas. Thames Water provided their list of historical sewer flooding records which show 3 properties with historic incidents of sewer flooding. Severn Trent Water provided their 'At Risk' Register which denotes 143 properties at risk from sewer flooding.
- *Groundwater:* The Areas Susceptible to Groundwater Flooding map shows that, in general, the majority of Stratford on Avon District is within the <25% susceptible classification, therefore it is at a lower risk of groundwater flooding. Parts of the centre of the District along the River Avon, and the west of the District along the River Arrow, fall within higher susceptibility classifications and are therefore at higher risk from groundwater flooding.
- *Canals*: There are three canals in Stratford on Avon District: the Stratford-upon-Avon Canal, the Grand Union Canal, and the Oxford Canal. These have the potential to interact with other watercourses and become flow paths during flood events or in a breach scenario. There have been no recorded incidents of breach or overtopping in the District on any of the canals.
- *Reservoirs:* There is a potential risk of flooding from reservoirs both within the District and those outside. There are no records of flooding from reservoirs in the study area. The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However, there is a residual risk of a reservoir breach and this risk should be considered in any site-specific Flood Risk Assessments (where relevant).

12.2 Planning policy recommendations

Reduction of flood risk through site allocations and appropriate site design

- To locate new development in areas of lowest risk, in line with the Sequential Test, by steering sites to Flood Zone 1. If a Sequential Test is undertaken and a site at flood risk is identified as the only appropriate site for the development, the Exception Test shall be undertaken.
- After application of the Exception Test, a sequential approach to site design will be used to reduce risk. Any re-development within areas of flood risk

which provide other wider sustainability benefits, will need to provide flood risk betterment and be made resilient to flooding.

- Identification of long-term opportunities to remove development from the floodplain and to make space for water.
- Ordinary watercourses not currently afforded flood maps should be modelled to an appropriate level of detail to enable a sequential approach to the layout of the development.
- Ensure development is 'safe', dry pedestrian egress from the floodplain and emergency vehicular access should be possible for all residential development. If at risk, then as assessment should be made to detail the flood duration, depth, velocity and flood hazard rating in the 1 in 100-year plus climate change flood event, in line with FD2320.
- Raise residential and commercial finished floor levels 600mm above the 1 in 100-year plus climate change flood level. Protect and promote areas for future flood alleviation schemes.
- Safeguard functional floodplain from future development.
- Identify opportunities for brownfield sites in functional floodplain to reduce risk and provide flood risk betterment.
- Identify opportunities to help fund future flood risk management through developer contributions to reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

Contribute to wider infrastructure improvements

- Assess the condition of existing drainage assets and upgrade, if required, to ensure that the infrastructure can accommodate pressures/flows for the lifetime of the development.
- Contribute to reducing flood risk off site wherever feasible.
- Ensure the whole life costs and maintenance of any engineering works to reduce the flood risk to the site have been accounted for.

Protect and promote areas for future flood alleviation schemes

- Safeguard functional floodplain from future development.
- Develop appropriate policies for brownfield sites which lie in functional floodplain to reduce risk and to provide flood risk betterment.
- Positively contribute towards the wider vision for flood risk management and drainage in the District, as set out in the Warwickshire Local Flood Risk Management Strategy and supporting Surface Water Management Plan, Severn Flood Risk Management Plan and emerging Severn Trent and Thames Water Drainage and Wastewater Management Plans.
- Identify opportunities to help fund future flood risk management through developer contributions to reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

Promote SuDS to mimic natural drainage routes to improve water quality

- 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.
- 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.
- Use of the SuDS management train to prevent and control pollutants to prevent the 'first flush' polluting the receiving waterbody.
- SuDS are to 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.

Reduce Surface Water Runoff from New Developments and Agricultural Land

- Space should be provided for the inclusion of SuDS on all allocated sites and outline proposals
- Promote biodiversity, habitat improvements and **Countryside Stewardship schemes** to help prevent soil loss and to reduce runoff from agricultural land

Enhance and Restore River Corridors and Habitat

- Assess condition of existing assets and upgrade, if required, to ensure that the infrastructure can accommodate pressures/flows for the lifetime of the development.
- Natural drainage features should be maintained and enhanced.
- Identify opportunities for river restoration/enhancement to make space for water.
- A presumption against culverting of open watercourses 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.
- 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.

Mitigate Against Risk, Improved Emergency Planning and Flood Awareness

- Work with emergency planning colleagues and stakeholders to identify areas at highest risk and locate most vulnerable receptors.
- Exceedance flows, both within and outside of the site, should be appropriately designed to minimise risks to both people and property.
- For a partial or completely pumped drainage system, an assessment should be undertaken to assess the risk of flooding due to any failure of the pumps to be assessed. The design flood level should be determined if the pumps were to fail; if the attenuation storage was full, and if a design storm occurred.
- An emergency overflow should be provided for piped and storage features above the predicted water level arising from a 100-year rainfall event, inclusive of climate change and urban creep.

- Consideration and incorporation of flood resilience measures up to the 1 in 1,000-year event.
- Ensure robust emergency (evacuation) plans are produced and implemented for major developments.
- Increase awareness and promote sign-up to the Environment Agency Flood Warnings Direct (FWD) within the Stratford District.

12.2.1 Recommendations from the cumulative impact analysis

The following planning policy recommendations have been made for the catchments where cumulative development is likely to have the greatest impact on flood risk:

1. That a Level 2 SFRA or detailed local area Strategic Drainage Study considers further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions/enforcement through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online/offline flood storage, and where land should be safeguarded within proposed site allocations to fulfil this purpose.
2. Incorporate SuDS and provide details of adoption, ongoing maintenance and management on all development sites. Proposals will be required to provide reasoned justification for not using SuDS techniques, where ground conditions and other key factors show them to be technically feasible. Preference will be given to systems that contribute to the conservation and enhancement of biodiversity and green infrastructure in the District where practicable.
3. Seek to provide wider betterment by demonstrating in site-specific Flood Risk Assessments and Surface Water Drainage Strategies what measures can be put in place to contribute to a reduction in flood risk downstream. This may either be by provision of additional storage on site e.g. through oversized SuDS, natural flood management techniques, green infrastructure and green-blue corridors and/or by providing a Partnership Funding contribution towards any flood alleviation schemes. Consultation on the site-specific requirements should be undertaken with Stratford on Avon District Council and the Environment Agency at the earliest opportunity.
4. That the Environment Agency consult with Stratford on Avon District Council and Warwickshire County Council and consider whether to formally designate small catchments draining into settlements with known flood risk issues as Critical Drainage areas. This would mean that a detailed Flood Risk Assessment would be required for all developments that are proposed, regardless of their size.
5. Warwickshire County Council as LLFA will review Surface Water Drainage Strategies in accordance with their local requirements for major developments. These should take into account all sources of flooding to ensure that future development is resilient to flood risk and does not increase flood risk elsewhere.
6. For the LPA to work closely with the Environment Agency and Warwickshire County Council as LLFA to identify areas of land that should be safeguarded for the future use of natural flood management features.
7. That Stratford on Avon District Council consult neighbouring authorities, particularly during the consultation phases of their respective Local Plans, to identify and review potential cross-boundary issues. In the vast majority of

cases, if appropriate flood risk and drainage policies and SuDS are adopted to ensure compliance with the NPPF, development in these neighbouring authorities is unlikely to affect flood risk in Stratford on Avon District and development in Stratford on Avon District is unlikely to affect flood risk in downstream catchments.

8 Where cross-boundary issues need to be considered, Stratford District Council should work closely with Warwickshire County Council to ensure that runoff is attenuated through the upper catchment through SuDS implementation to minimise and mitigate flood risk downstream. This could include opportunities for Natural Flood Management techniques in the upper catchment and the installation of storage areas.

Appendices

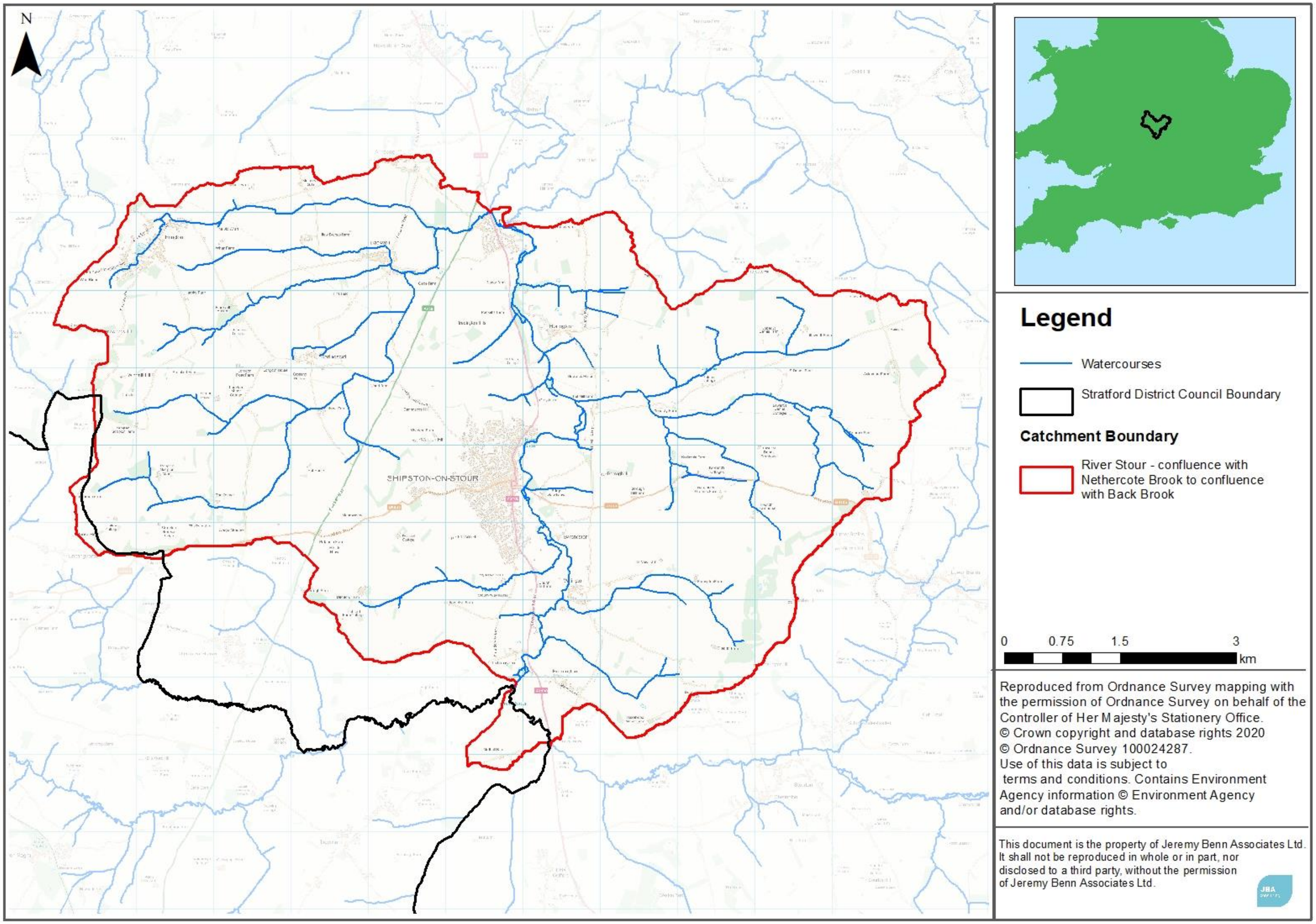
A Stratford on Avon District Council Level 1 SFRA Geo-PDF mapping

Important note on Flood Zone information in the Geo-PDFs

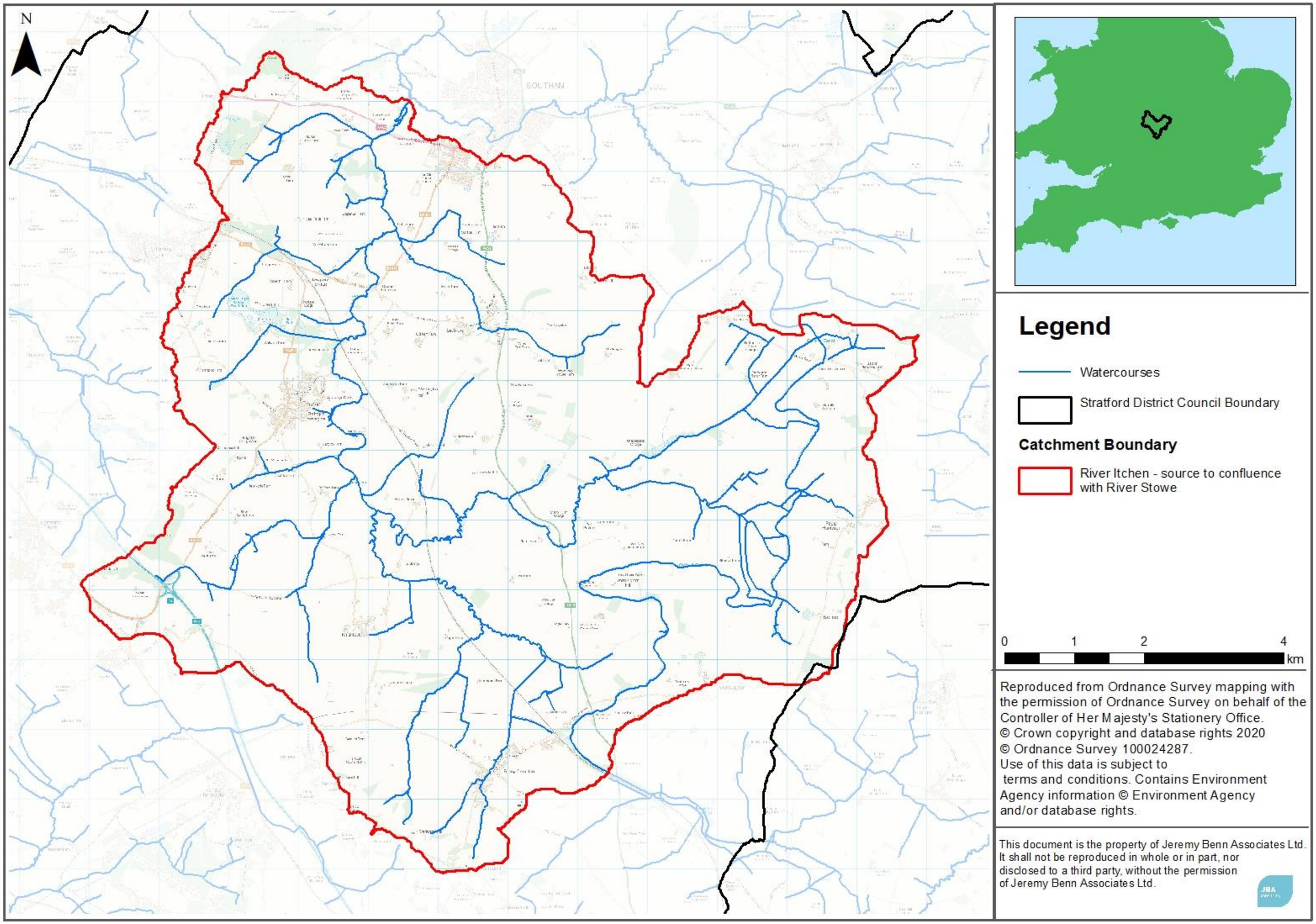
The Environment Agency's Flood Map for Planning does not incorporate latest modelling results in Stratford upon Avon, along the Racecourse and Shottery Brooks. Therefore, in this area the 2019 latest 100-year and 1,000-year model results were used to represent Flood Zones 3a and 2 respectively. Developers should contact the Environment Agency to ensure the most up to date data is being used.

B Cumulative Impact Assessment – High Risk Catchments Maps

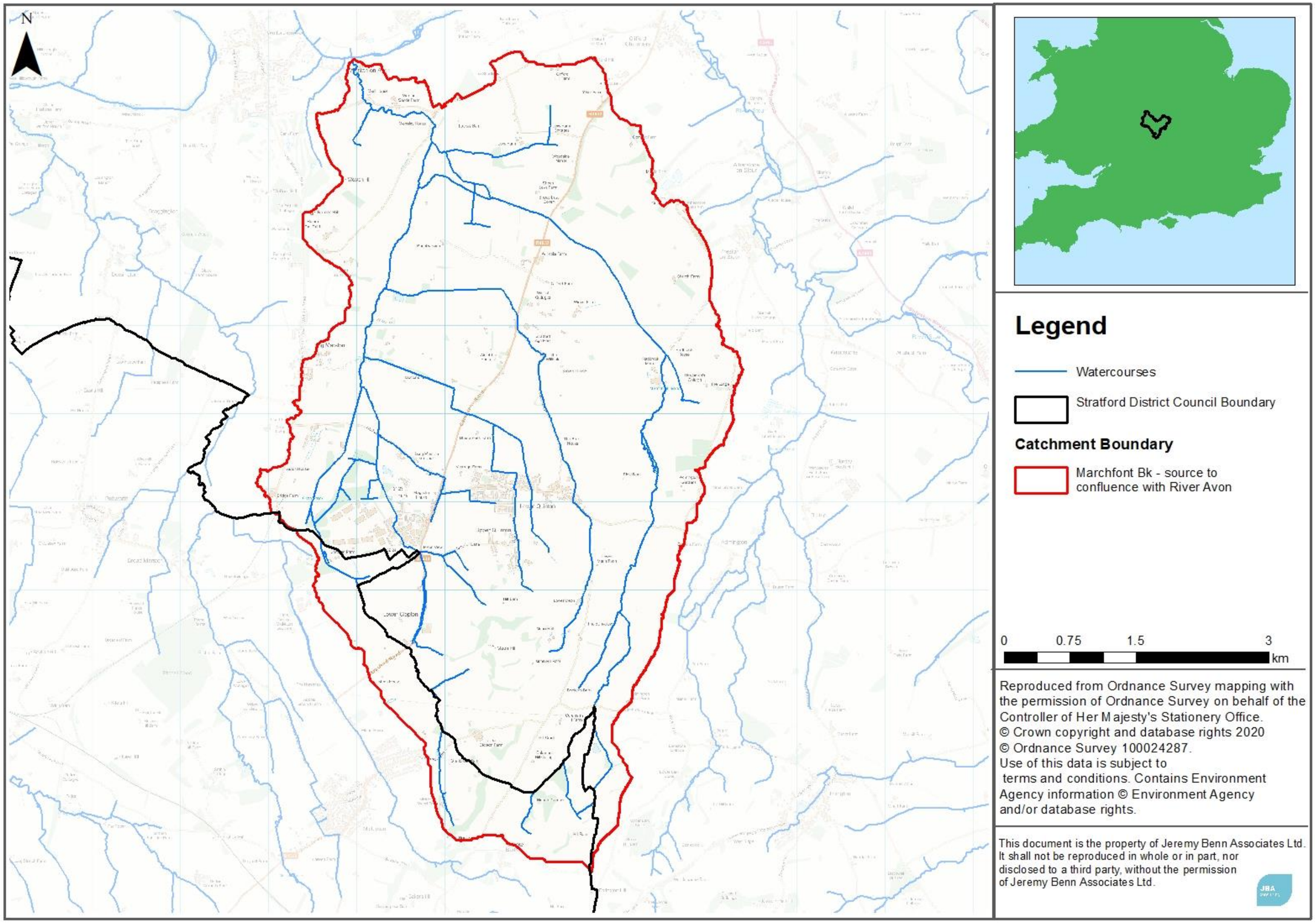
River Stour, draining towards Shipston on Stour and Tredington



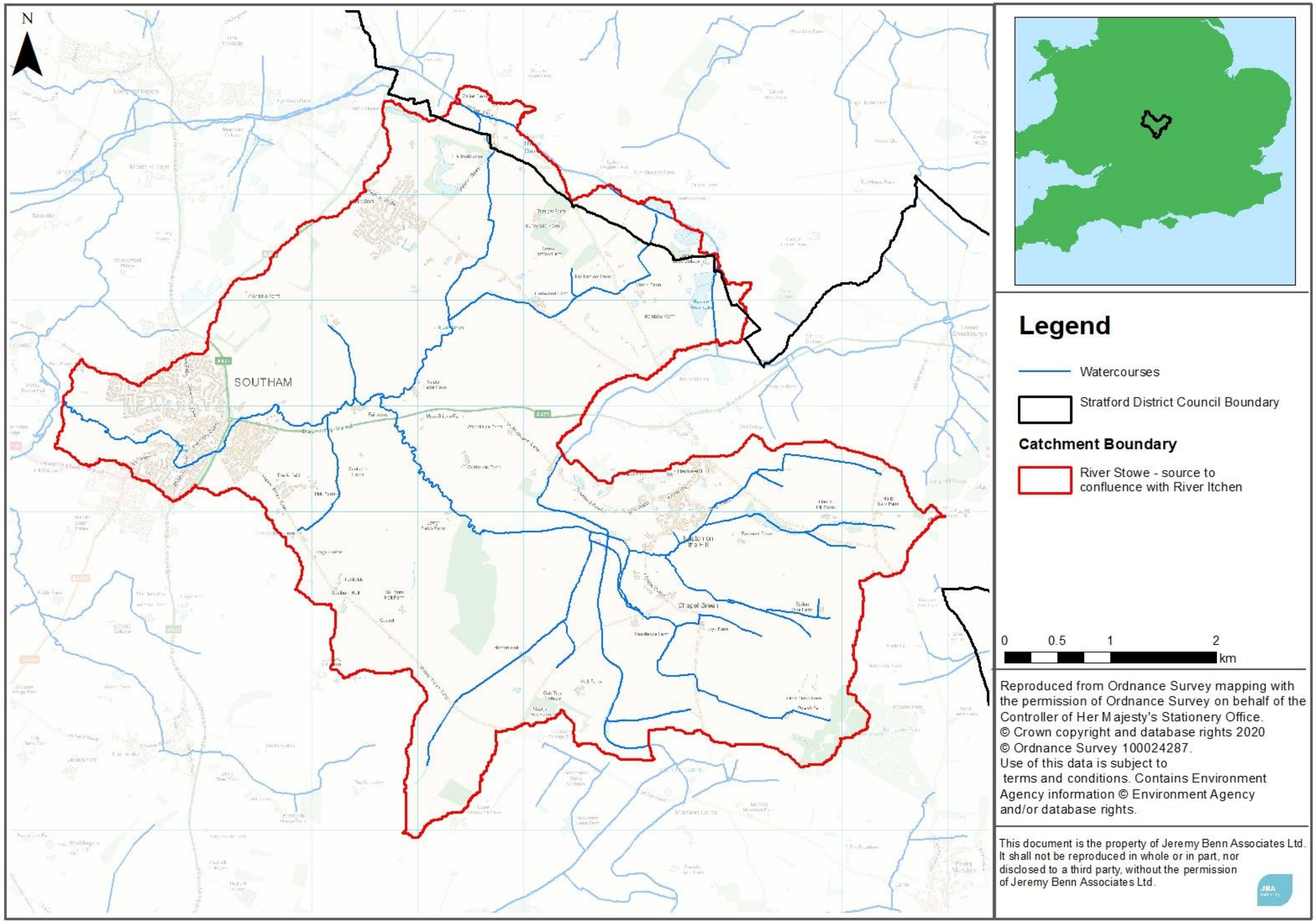
River Itchen, draining towards Southam



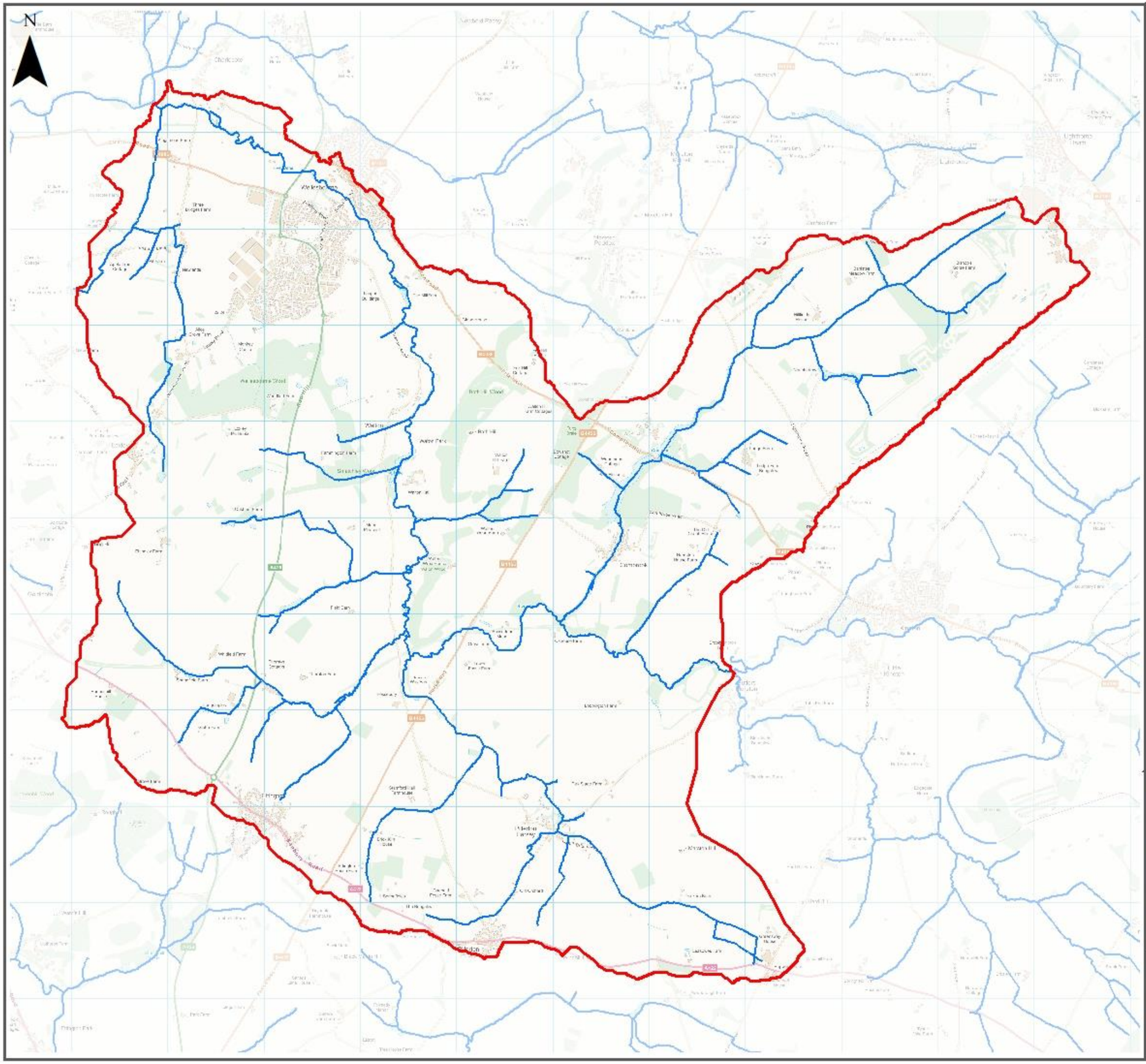
Marchfont Brook, including Lower and Upper Quinton

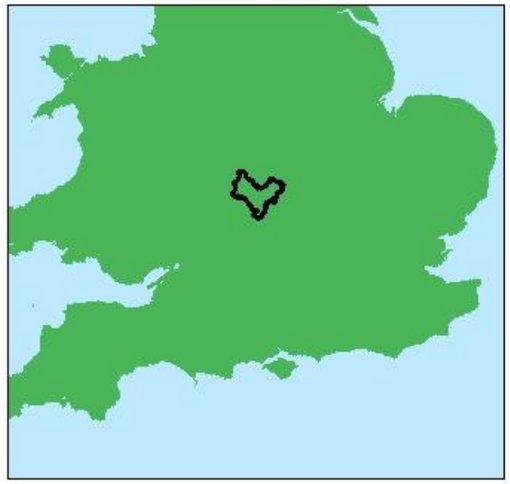


River Stowe, draining towards Southam



River Dene, draining towards Wellesbourne





Legend

Watercourses

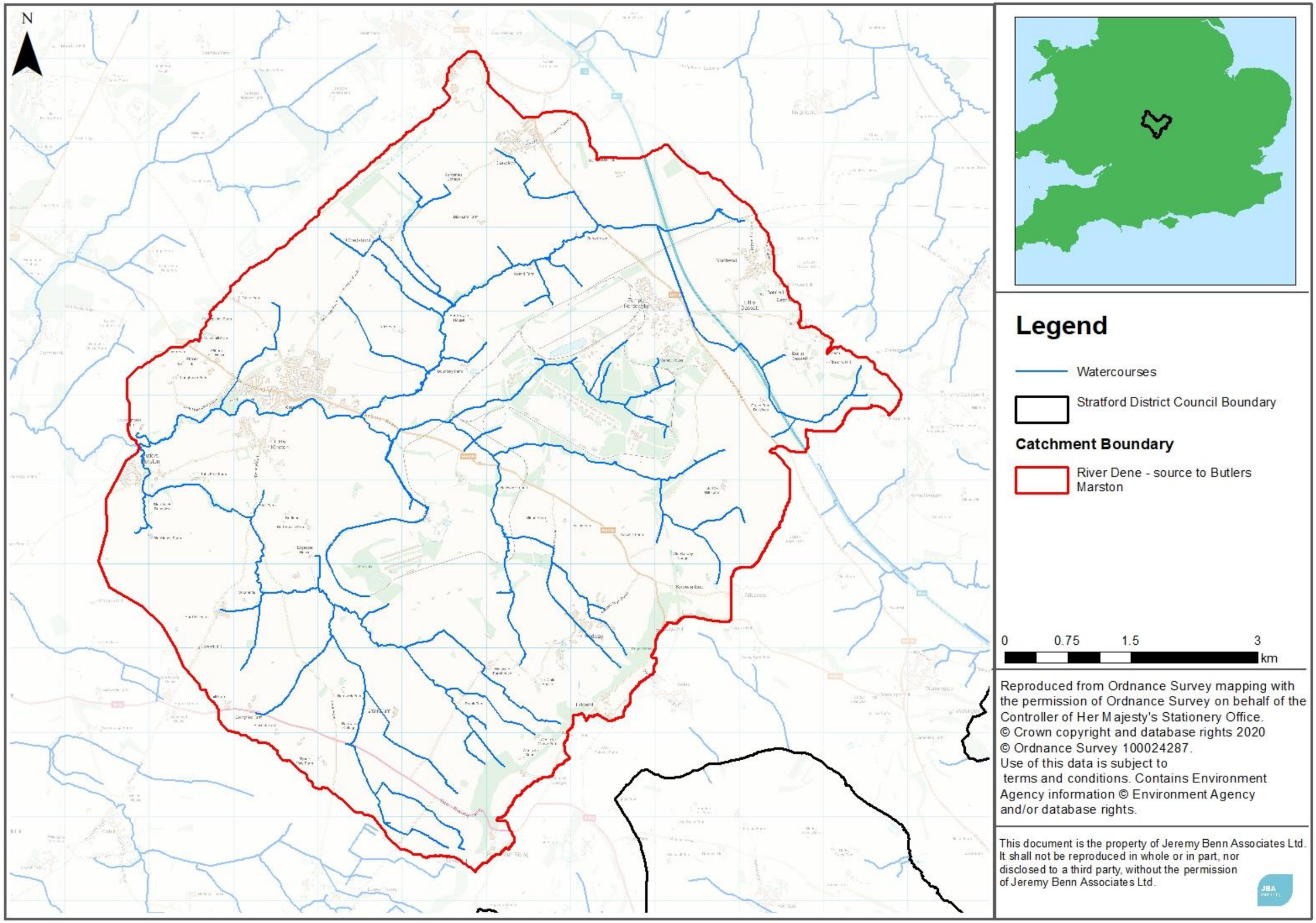
Stratford District Council Boundary

Catchment Boundary

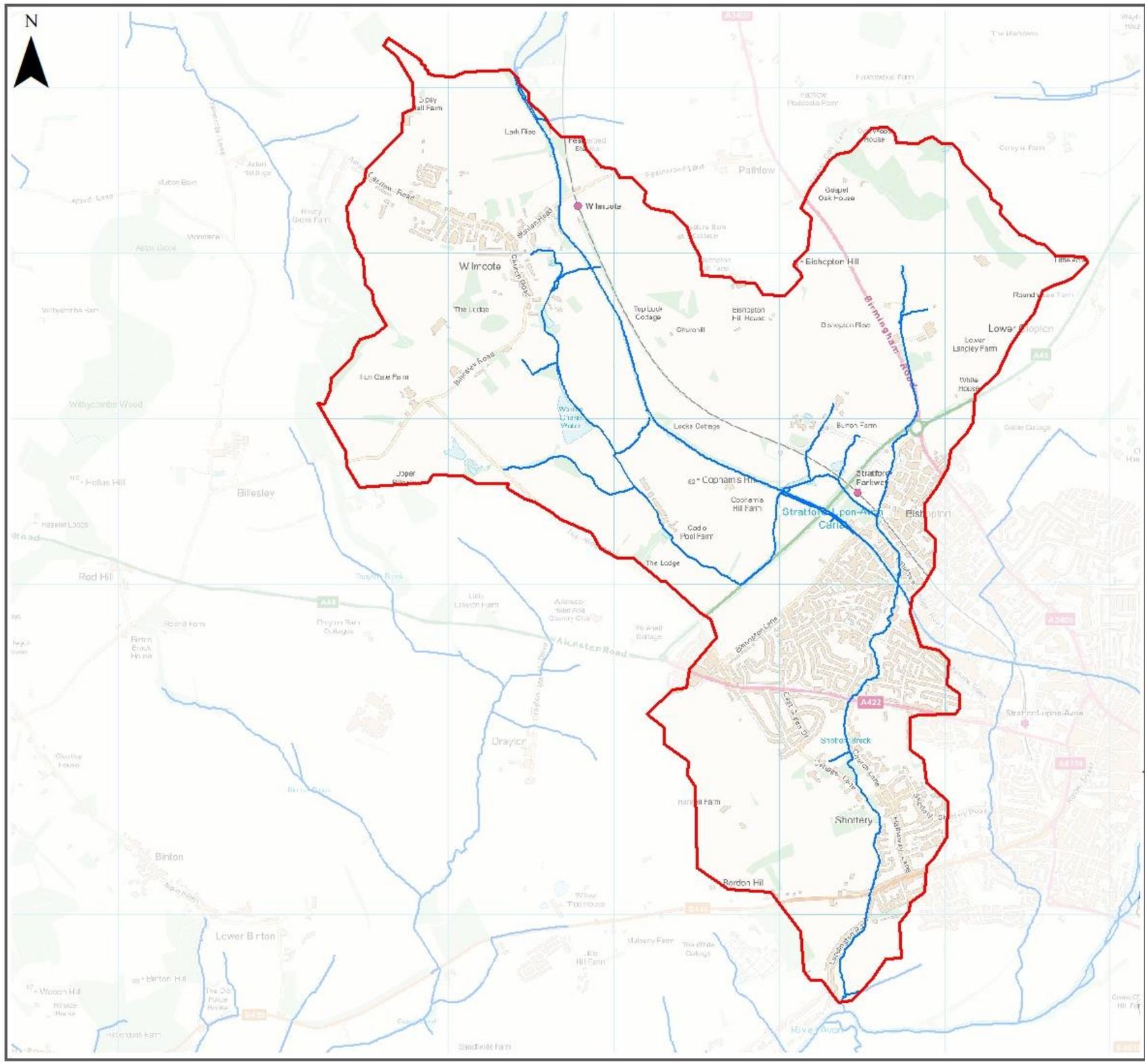
River Dene - Butlers Marston to confluence with River Avon

0 0.75 1.5 3 km

River Dene, draining towards Butlers Marston



Shottery Brook, draining towards Stratford on Avon



Legend

Watercourses

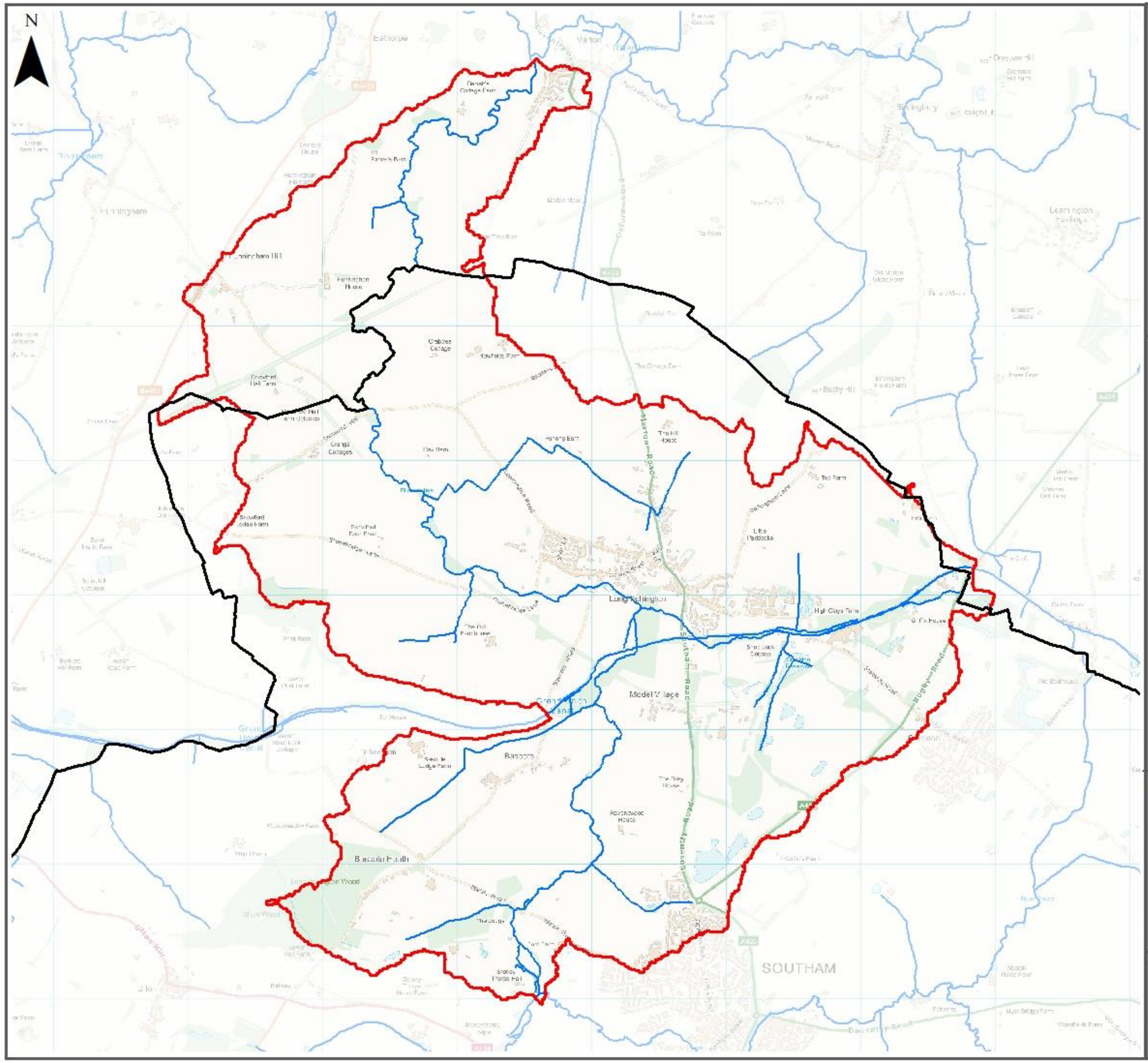
Stratford District Council Boundary

Catchment Boundary

Shottery Brook

0 0.5 1 2 km

River Itchen, Southam and Long Itchington



Legend

Watercourses

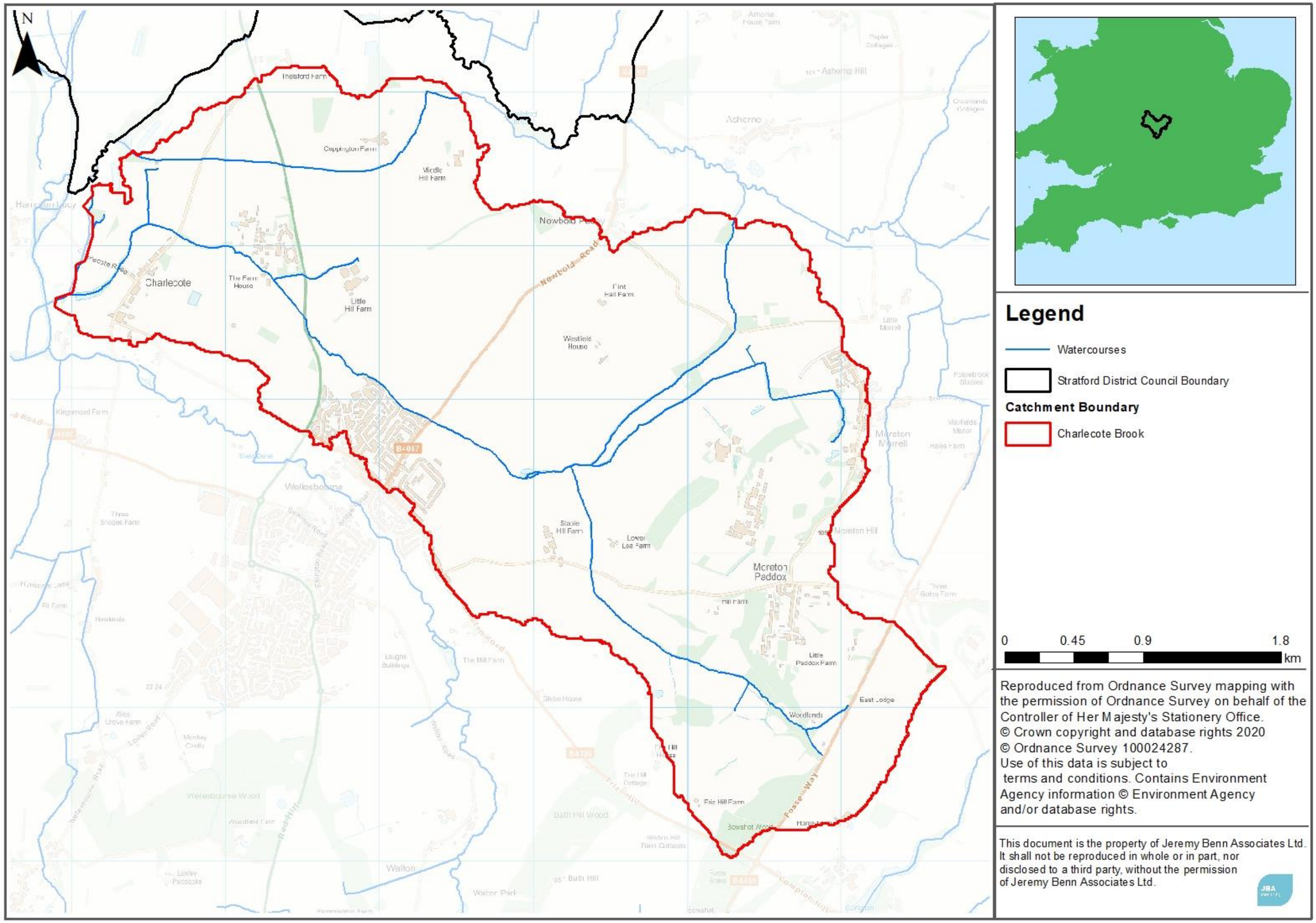
Stratford District Council Boundary

Catchment Boundary

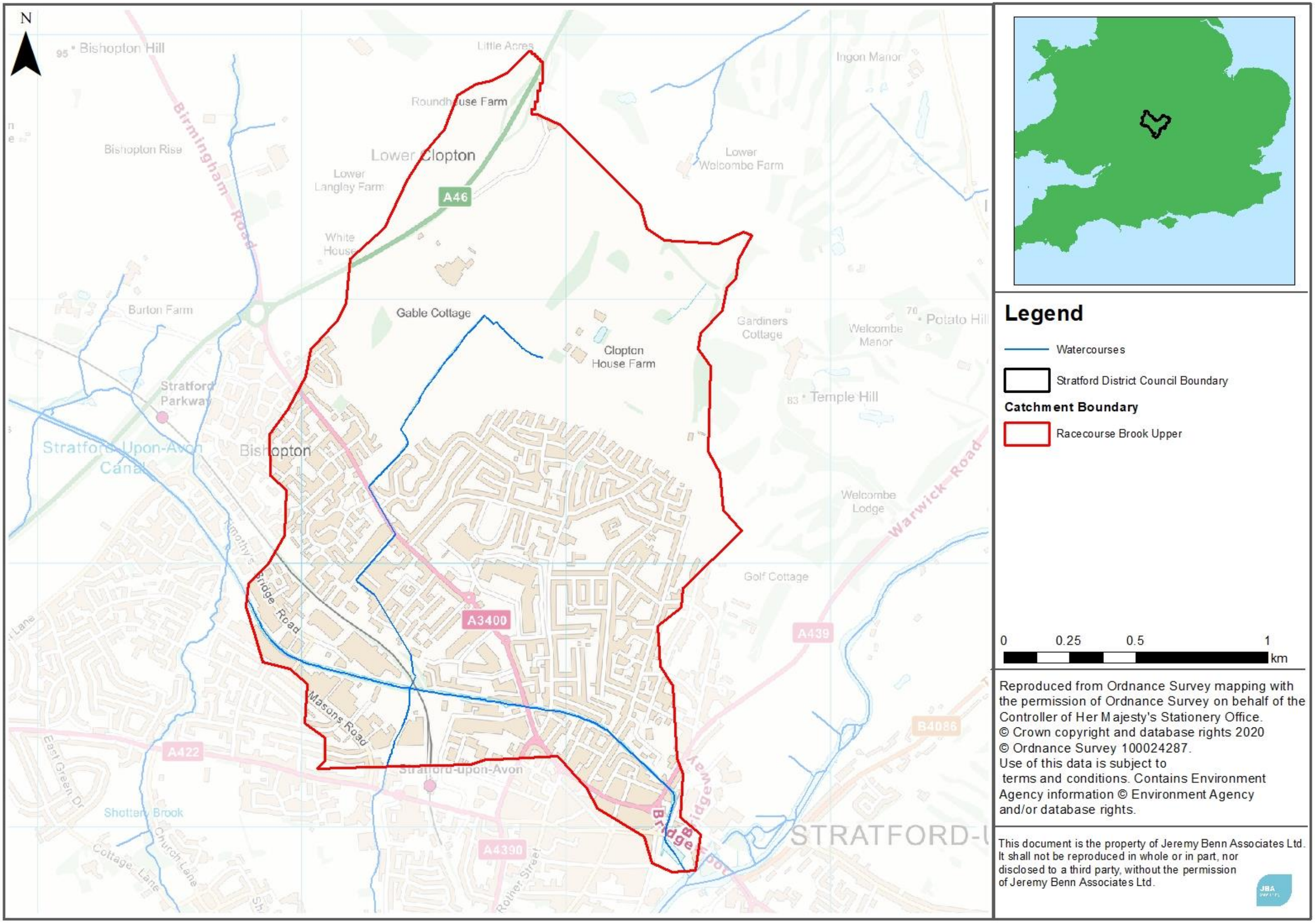
River Itchen - confluence with River Stowe to confluence with River Leam

0 0.5 1 2 km

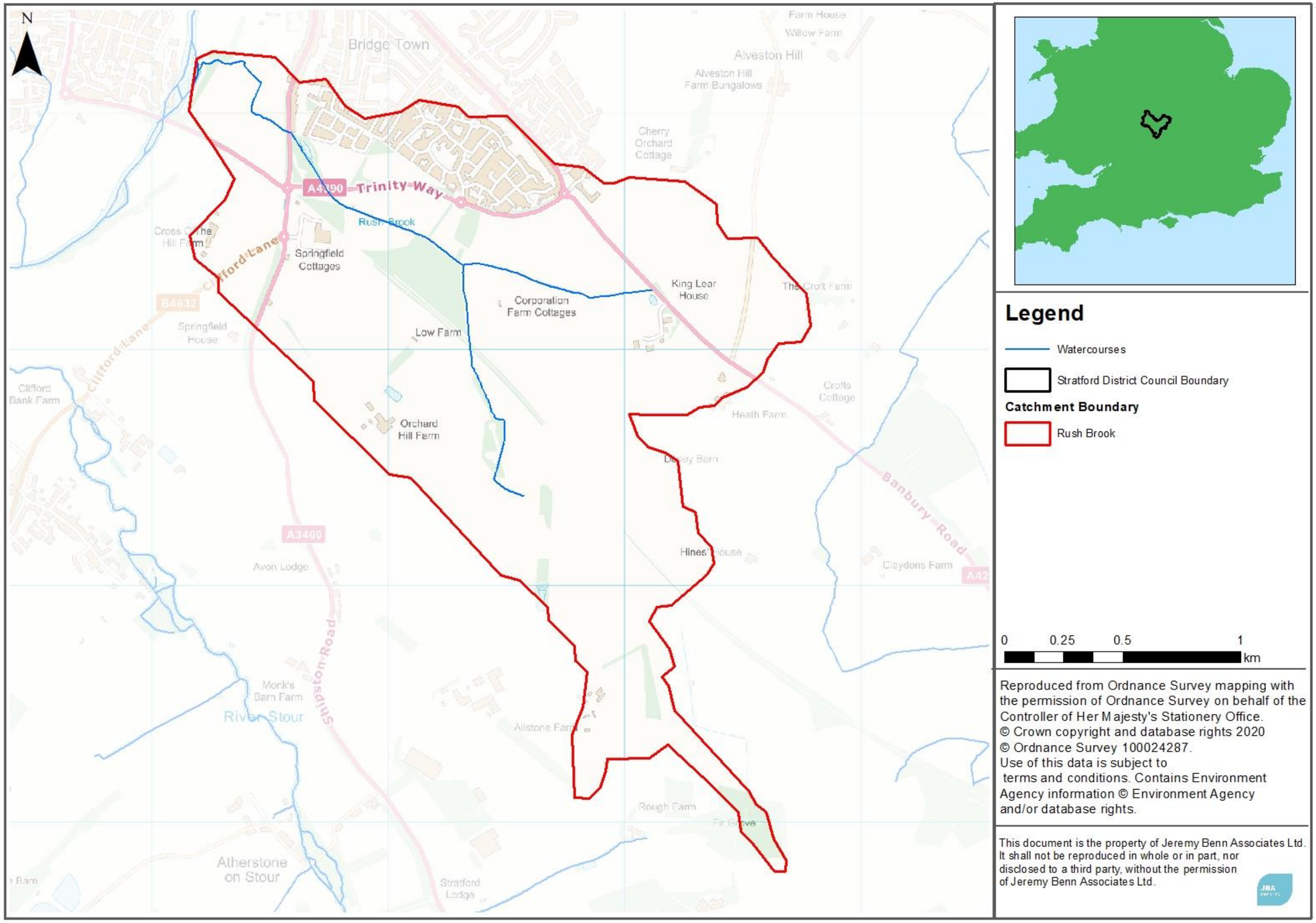
Charlecote Brook, draining towards Charlecote



Racecourse Brook, draining towards Stratford upon Avon



Rush Brook, draining towards Stratford on Avon



C SFRA User Guide

Appendix C - Guide to using technical data

This guide sets out how the data contained within this SFRA should be used to undertake the Sequential and Exception Tests. The different sources of flood risk are divided into three levels of concern: high medium and low. Within these, recommendations and advice for undertaking the Sequential and Exception Tests are provided as well as references to relevant sections of this SFRA.

Flood risk source / information source: sets out the different sources of flood risk and technical data used within the study, including Flood Zones, surface water, groundwater, climate change, reservoir inundation, historic flood risk and proximity to watercourses.

Relevant sections of this SFRA: cross-references the flood risk and information sources with the relevant sections of this SFRA.

Result: divides the flood risk and information sources into categories based on the extent of impact to a site. The Site Screening process for Stratford on Avon District Council can be used to cross-reference a site against these criteria.

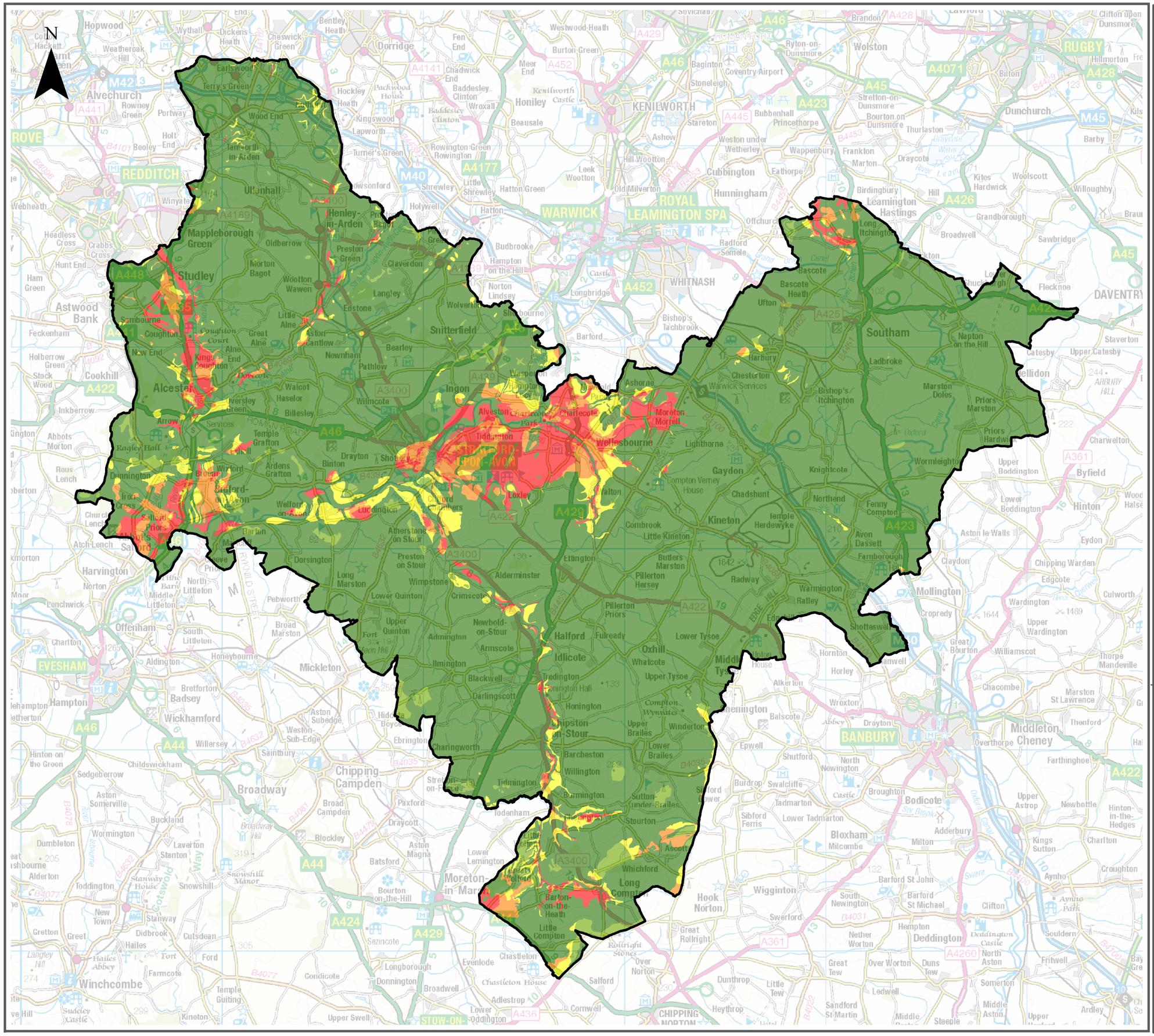
Level of concern: Categorises the flood risk and information sources into three levels of concern (high, medium and low) based on the result column.

Recommendations: Provides recommendations in relation to development suitability, further investigations, additional site-specific FRA considerations and consideration of defences and SuDS, based on the level of concern.

Sequential and Exception Tests: Provides advice on applying the Sequential and Exception Tests, including under what circumstances a Level 2 SFRA may be required, based on the level of concern.

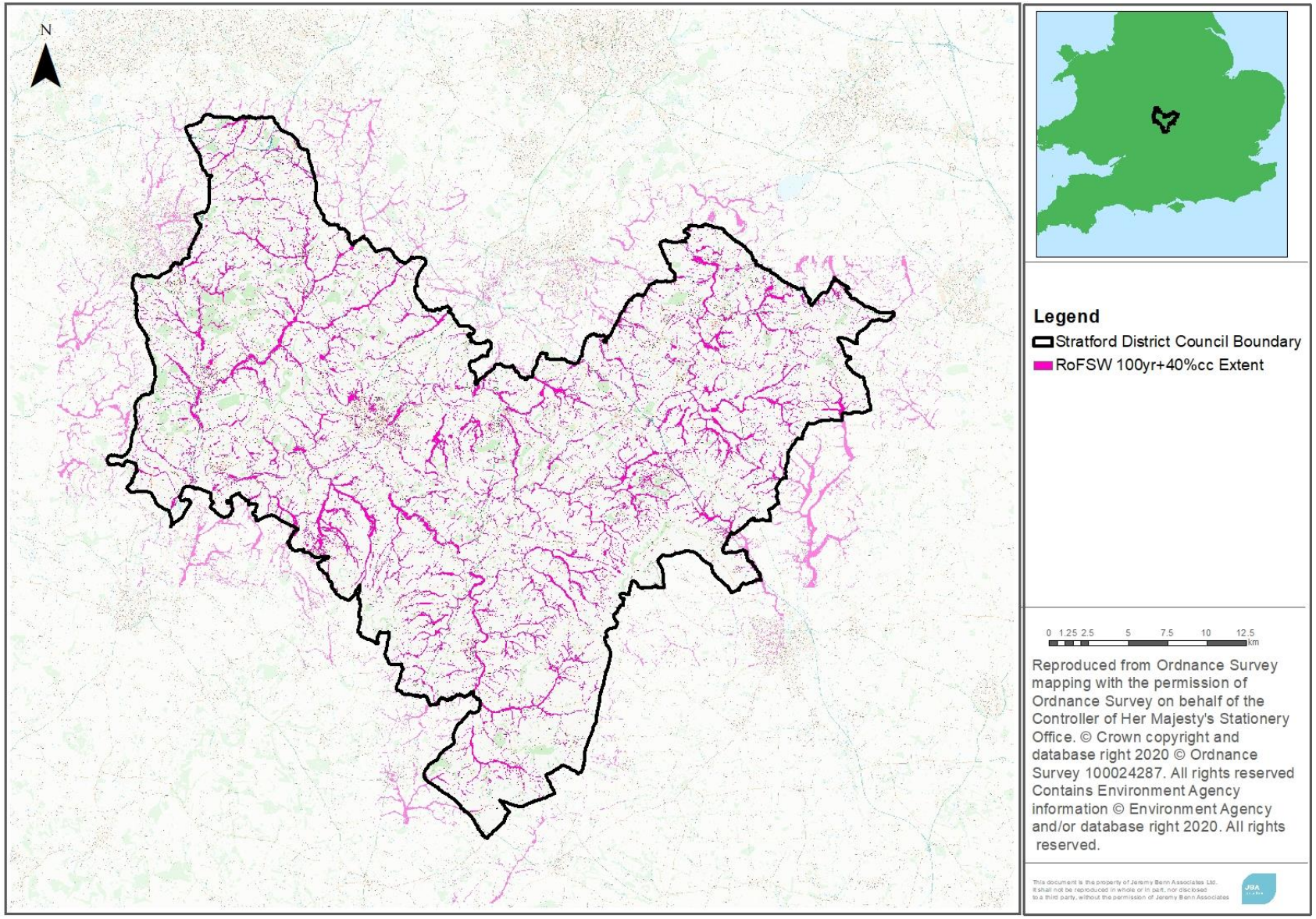
Flood risk source/ information source	Relevant sections of this SFRA	Result	Level of concern	Recommendations	Sequential and Exception Tests
Fluvial (Flood Zones)	5 - Sources of information used in preparing the SFRA 6 - Understanding the risk in the study area	Significant proportion (e.g. greater than 50%) of site in Flood Zones (2 and 3)	High	Residential development on a site in this zone is unlikely to be appropriate unless the site is in an area benefitting from defence and can be made safe for the intended lifespan.	Sites in these categories should be explicitly addressed in a Sequential Test and may require preparation of further evidence to substantiate that Exception Test can be satisfied. Evidence from a Level 2 SFRA is required to demonstrate that the principle of development is supported.
		A proportion (e.g. less than 50%) of site in Flood Zones (2 and 3)	Medium	Residential development may be appropriate, sequential approach should be applied to avoid developing in flood zones as far as reasonable. Parts of the site within flood zone 1 should also be reviewed against the criteria described below.	
		Site located in Flood Zone 1	Medium	Residential development is probably appropriate in this zone, however catchments <3km^2 in area are not covered by the Environment Agency Flood Zones and there may be a risk of flooding from small watercourses and/or other sources. These should be considered in conjunction with the DRN data and data on other sources of flooding. The surface water data in particular often highlights areas at risk of flooding from these smaller watercourses.	
Fluvial - Climate change	4 - Climate change 5 - Sources of information used in preparing the SFRA 6 - Understanding the risk in the study area	Significant proportion (e.g. greater than 50%) of site at risk of flooding from the future 1% AEP event	High	Residential development is unlikely to be appropriate unless the site is in an area benefitting from defence. Consideration should be given to the Standard of Protection of existing defences in relation to future climate change and any other measures necessary to provide appropriate standards of protection to proposed development.	Sites in these categories should be explicitly addressed in a Sequential Test and may require preparation of further evidence to substantiate that Exception Test can be satisfied. Evidence from a Level 2 SFRA is required to demonstrate that the principle of development is supported.
		A proportion (e.g. less than 50%) of site at risk of flooding from the future 1% AEP event	Medium	Residential development may be appropriate, sequential approach should be applied to avoid developing in the areas at risk of flooding as much as reasonable. Consideration should be given to the Standard of Protection of any defences in relation to future climate change and the commitment to deliver the required standards.	
		Site not at risk of flooding from the future 1% AEP event	Medium	Residential development is probably appropriate in this risk area, however this will depend on the present-day fluvial risk - refer to fluvial flood zone recommendations	
Fluvial - Climate change proxy		Significant proportion (e.g. greater than 50%) of site at risk of flooding from the 0.1% AEP event when used as a proxy for climate change	High	Residential development is unlikely to be appropriate unless the site is in an area benefitting from defence. Consideration should be given to the Standard of Protection of existing defences in relation to future climate change and any other measures necessary to provide appropriate standards of protection to proposed development.	Sites in these categories should be explicitly addressed in a Sequential Test and may require preparation of further evidence to substantiate that Exception Test can be satisfied. Evidence from a Level 2 SFRA (including detailed modelling of the impact of climate change) is required to demonstrate that the principle of development is supported.
		A proportion (e.g. less than 50%) of site at risk of flooding from the 0.1% AEP event when used as a proxy for climate change	Medium	Residential development may be appropriate, sequential approach should be applied to avoid developing in the areas at risk of flooding as much as reasonable. Consideration should be given to the Standard of Protection of any defences in relation to future climate change and the commitment to deliver the required standards.	
		Site not at risk of flooding from the 0.1% AEP event when used as a proxy for climate change	Low	Residential development is likely to be appropriate based on this criterion.	
Surface Water	5 - Sources of information used in preparing the SFRA 6 - Understanding the risk in the study area	Significant proportion (e.g. >50%) of site is affected by surface water flooding (across all three surface water events)	High	Development on a site in this risk area is unlikely to be appropriate unless measures (including drainage) are in place to control overland flow.	Evidence may be required from a Level 2 SFRA to demonstrate that the principle of development is supported
		A proportion (e.g. <50%) of site is affected by surface water flooding (across all three surface water events)	Medium	Development may be appropriate and consultations should be held with the Lead Local Flood Authority.	
		No risk of surface water flooding	Low	Development is likely to be appropriate based on this criterion.	
Surface Water - Climate change	4 - Climate change 5 - Sources of information used in preparing the SFRA 6 - Understanding the risk in the study area	Significant proportion (e.g. greater than 50%) of site at risk of surface water flooding from the future 1% AEP event	High	Development on a site in this risk area is unlikely to be appropriate unless measures (including drainage) are in place to control overland flow.	Evidence may be required from a Level 2 SFRA to demonstrate that the principle of development is supported
		A proportion (e.g. less than 50%) of site at risk of surface water flooding from the future 1% AEP event	Medium	Development may be appropriate and consultations should be held with the Lead Local Flood Authority.	
		Site not at risk of surface water flooding from the future 1% AEP event	Low	Development may be appropriate in this risk area, however this will depend on the present-day flood risk - refer to surface water recommendations	
Surface Water - Climate change proxy		Significant proportion (e.g. greater than 50%) of site at risk of surface water flooding from the 0.1% AEP event when used as a proxy for climate change	High	Development on a site in this risk area is unlikely to be appropriate unless measures (including drainage) are in place to control overland flow.	Evidence may be required from a Level 2 SFRA (including detailed modelling of the risk from climate change) to demonstrate that the principle of development is supported
		A proportion (e.g. less than 50%) of site at risk of surface water flooding from the 0.1% AEP event when used as a proxy for climate change	Medium	Development may be appropriate and consultations should be held with the Lead Local Flood Authority.	
		Site not at risk of surface water flooding from the 0.1% AEP event when used as a proxy for climate change	Low	Development is likely to be appropriate in this risk area.	
Groundwater	5 - Sources of information used in preparing the SFRA 6 - Understanding the risk in the Stratford District	Historic records of groundwater flooding within or near a site	Medium	The effect of this will depend on the location and historic evidence of known problems - a site-specific FRA should consider overland flow paths once groundwater has emerged. It is unlikely that infiltration SuDS will be appropriate and groundwater monitoring should be recommended.	
		Risk of flooding from groundwater is not negligible	Medium	Development might be appropriate but a site-specific FRA should consider groundwater risk. A high likelihood may mean infiltration SuDS are not appropriate and groundwater monitoring should be recommended.	
		Negligible risk of flooding from groundwater	Low	Development is likely to be appropriate in this risk area, however as groundwater datasets are generally produced nationally it is recommended that ground investigations are carried out and reported on within a site-specific FRA where this is required (known to be a problem locally).	
Reservoir inundation	5 - Sources of information used in preparing the SFRA 6 - Understanding the risk in the study area	Maximum risk of flooding from reservoir inundation (is greater than 2m depth or 2m/s velocity)	High	Development on a site in this risk area might not be appropriate - this will be heavily dependent on the state of repair of the dam and the long term commitment to its management and maintenance. If development is considered, the local authority Emergency Planning team should be consulted to confirm that proposals can be safely implemented.	Level 2 SFRA required to provide evidence that the principle of development is supported
		Maximum risk of flooding from reservoir inundation (is less than 2 m depth or 2 m/s velocity)	Medium	Risk of flooding from reservoirs should not rule out development as the likelihood of reservoir breach is low, however risk should still be considered by the developer at site specific FRA stage and an emergency plan is likely to be required. The local authority Emergency Planning team should be consulted.	
		No risk of reservoir inundation	Low	Development is likely to be appropriate in this risk area.	
Historic flood map	5 - Sources of information used in preparing the SFRA 6 - Understanding the risk in the study area	Any part of site within historic flood extents	Medium	Sites located in areas that have historically flooded might be appropriate for Development, however further investigation will be required regarding the severity and frequency of the historic flooding and accuracy of the historic flood extent. This should be used alongside other information in the Level 1 SFRA to decide whether the site is appropriate for allocation. Technical work will be required to inform this at the site-specific FRA stage.	
		No risk of historic flooding	Low	Development is likely to be appropriate based on this criterion.	
Canal network		Site within 100m of a Canal	Medium	Development might be appropriate in areas at risk of flooding from canals (unless the flood risk is fluvial and meets the criteria above). However, the risk should be considered by the developer at site-specific FRA stage and an emergency plan may be required. The Canal and Rivers Trust should be contacted to request information on overtopping and breach locations which could affect the site.	
		Site not within 100m of a Canal	Low	Development is likely to be appropriate based on this criterion.	
Detailed River Network		Any part of site within 20m of a watercourse (from the Detailed River Network dataset)	Medium	Sites located within 20m of the DRN line might be appropriate for development. Where the DRN goes through or adjacent to a site, the Flood Zones and surface water map should also be considered to further determine the effect on development. Where the DRN is located away from a site and land slopes down towards the site, development may be less appropriate than a site where land slopes down towards the watercourse and away from the site.	
		Site not within 20m of a watercourse (from the Detailed River Network dataset)	Low / Medium	Development is likely to be appropriate in this risk area, however not all watercourses are mapped on the Detailed River Network dataset, smaller drains may not be mapped and may need to be considered along with flood risk from other sources.	
Areas benefitting from defence	7 - Flood defences	Any part of the site is within an area benefiting from defence	Advisory	Development in this risk area is normally appropriate in principle, however, the performance of formal defences and residual flood risk will need to be considered and consideration given to the commitment and contributions required to maintain the appropriate standard of protection.	Level 2 SFRA required to provide evidence that the principle of development is supported
		The site is not in an area benefiting from defence	Low	Development is likely to be appropriate in this risk area if there is no risk of flooding from other sources on the site. See other recommendations if there is any risk of flooding.	
Cumulative impacts	Cumulative impacts	High - Any part of the site is within a High Cumulative Impact Zone	Medium	Development could be considered as appropriate, however, specific planning policy recommendations may need to be formulated. Drainage and flood risk reduction opportunities will probably need to be considered further within these catchments that may have financial and/or land take implications for the site and allay concerns of existing communities potentially at risk.	Level 2 SFRA may be required to provide evidence that the principle of development is supported
		Medium - Any part of the site is within a Medium Cumulative Impact Zone (unless the site is also within a High Zone)	Low / Medium	Development is likely to be appropriate in these risk areas, however if a Medium score has been identified based on a high amount of development then specific planning policy recommendations may need to be formulated. Drainage and flood risk reduction opportunities may need to be considered further within these catchments that may have financial and/or land take implications for the site.	
		Low - Any site not partially or fully within either High or Medium Cumulative Impact Zones	Low	Development is likely to be appropriate in this risk area.	

D JBA Groundwater Mapping

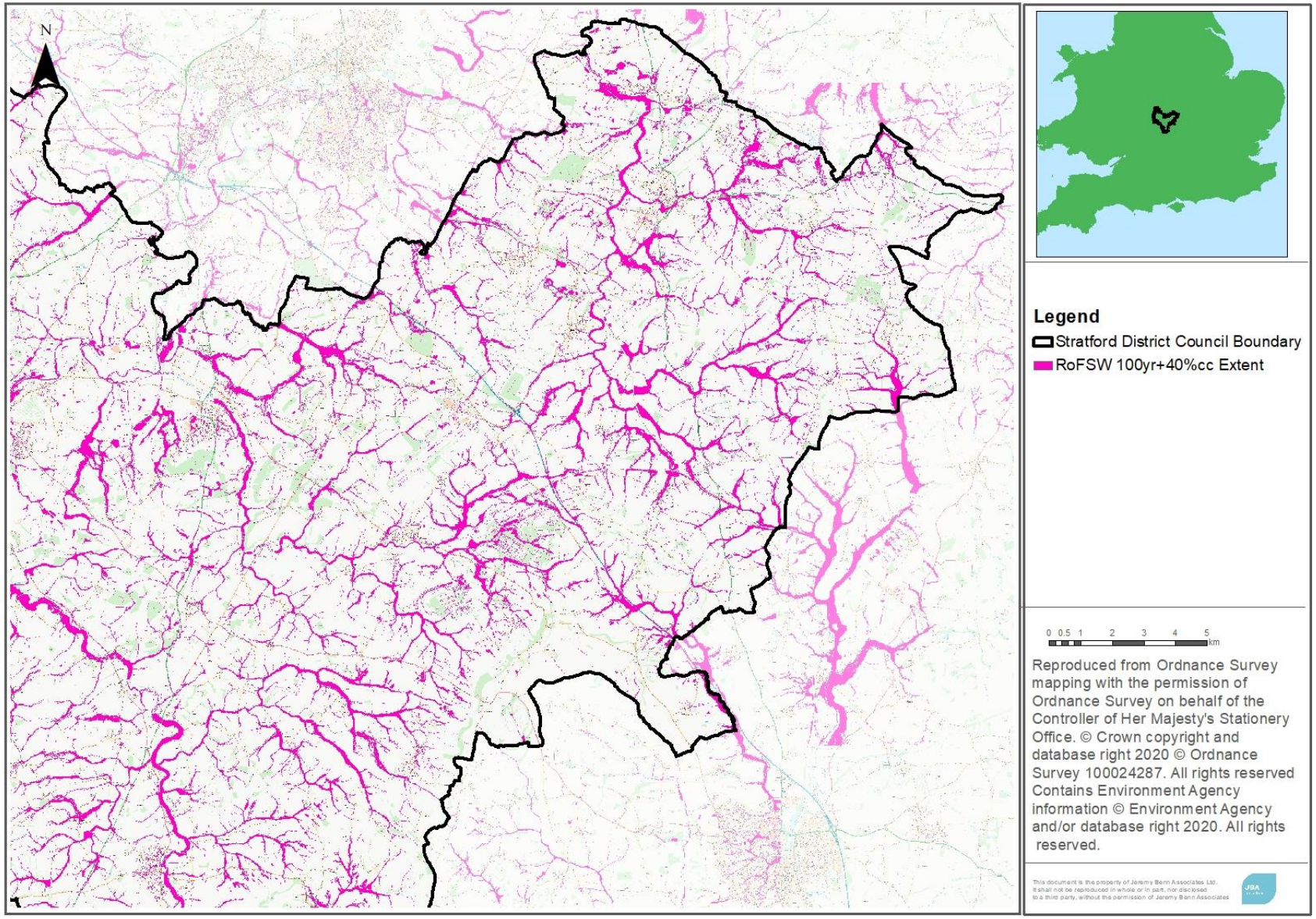


E Surface Water Climate Change Mapping

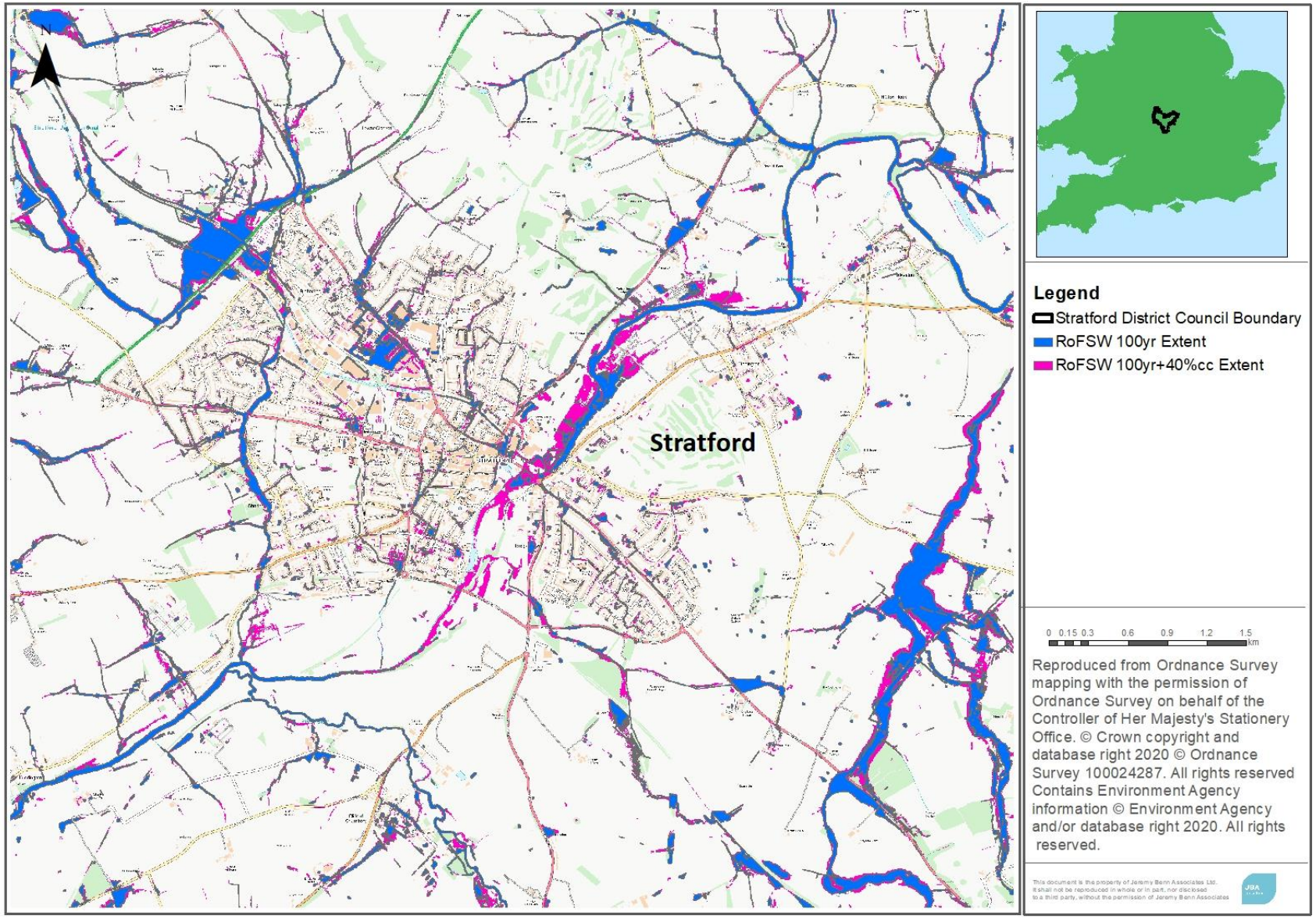
Stratford On Avon District Surface Water flooding 100yr +40% climate change



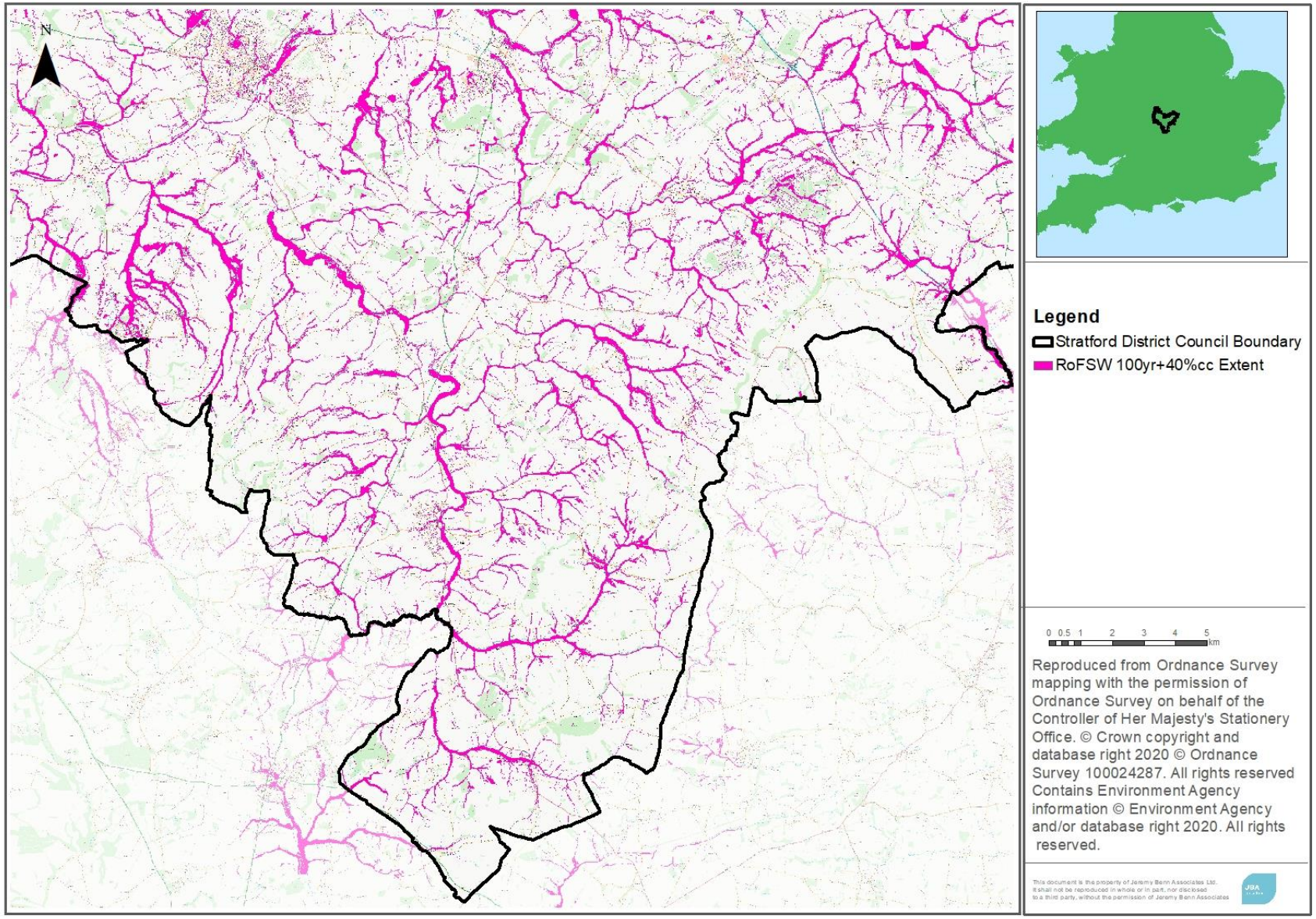
Stratford On Avon District eastern section Surface Water flooding 100yr +40% climate change



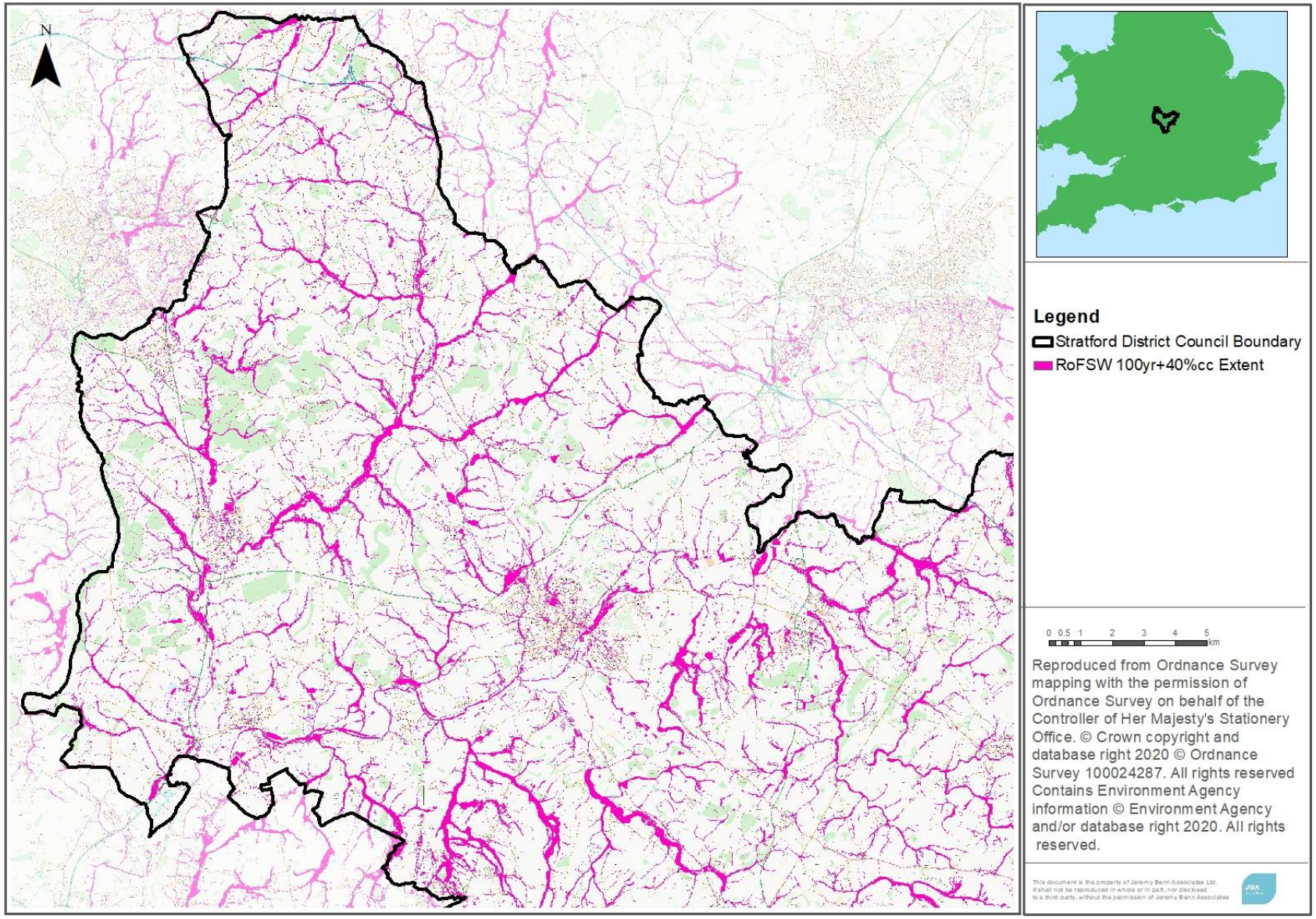
Stratford On Avon Surface Water flooding 100yr +40% climate change



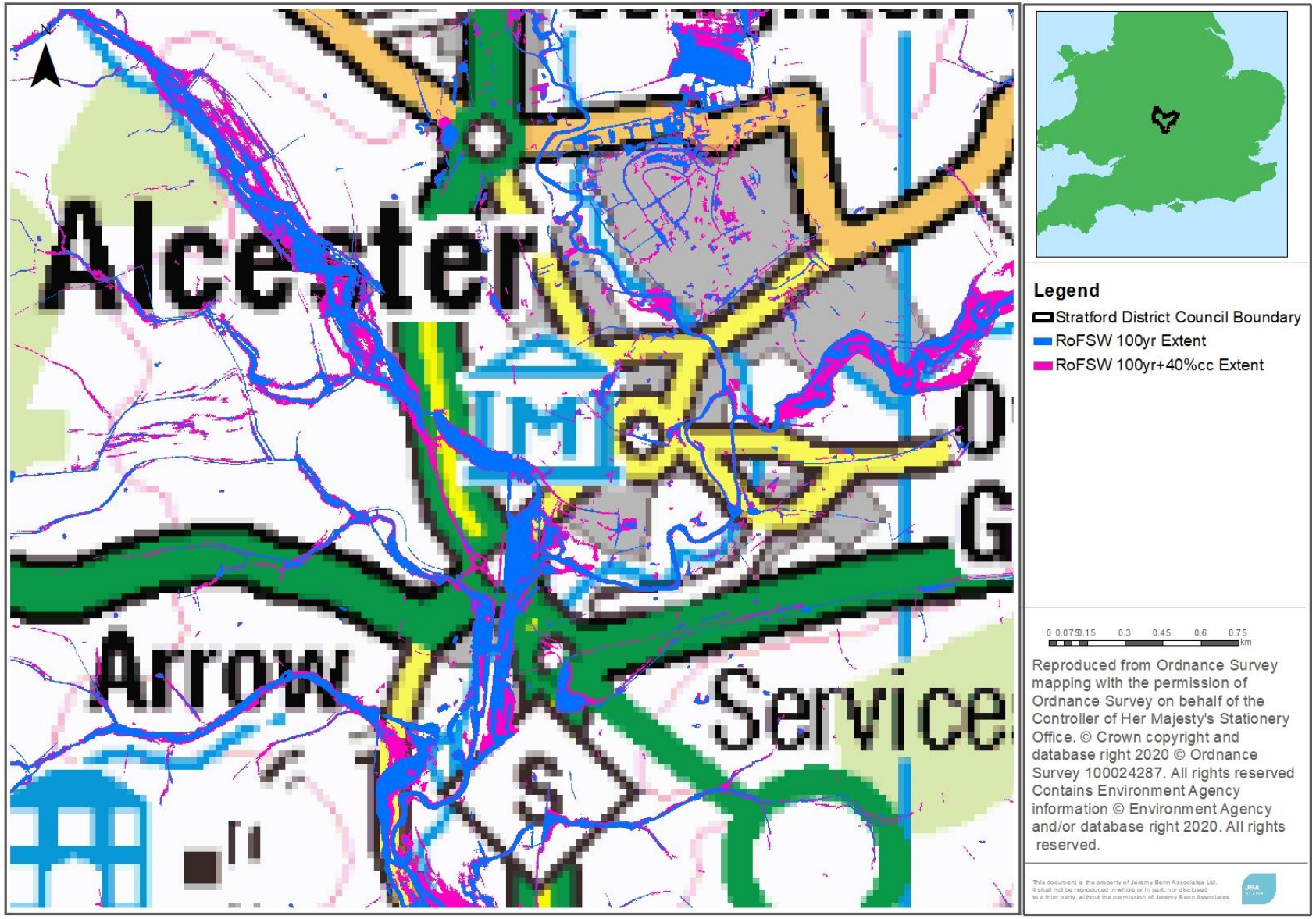
Stratford On Avon District southern section Surface Water flooding 100yr +40% climate change



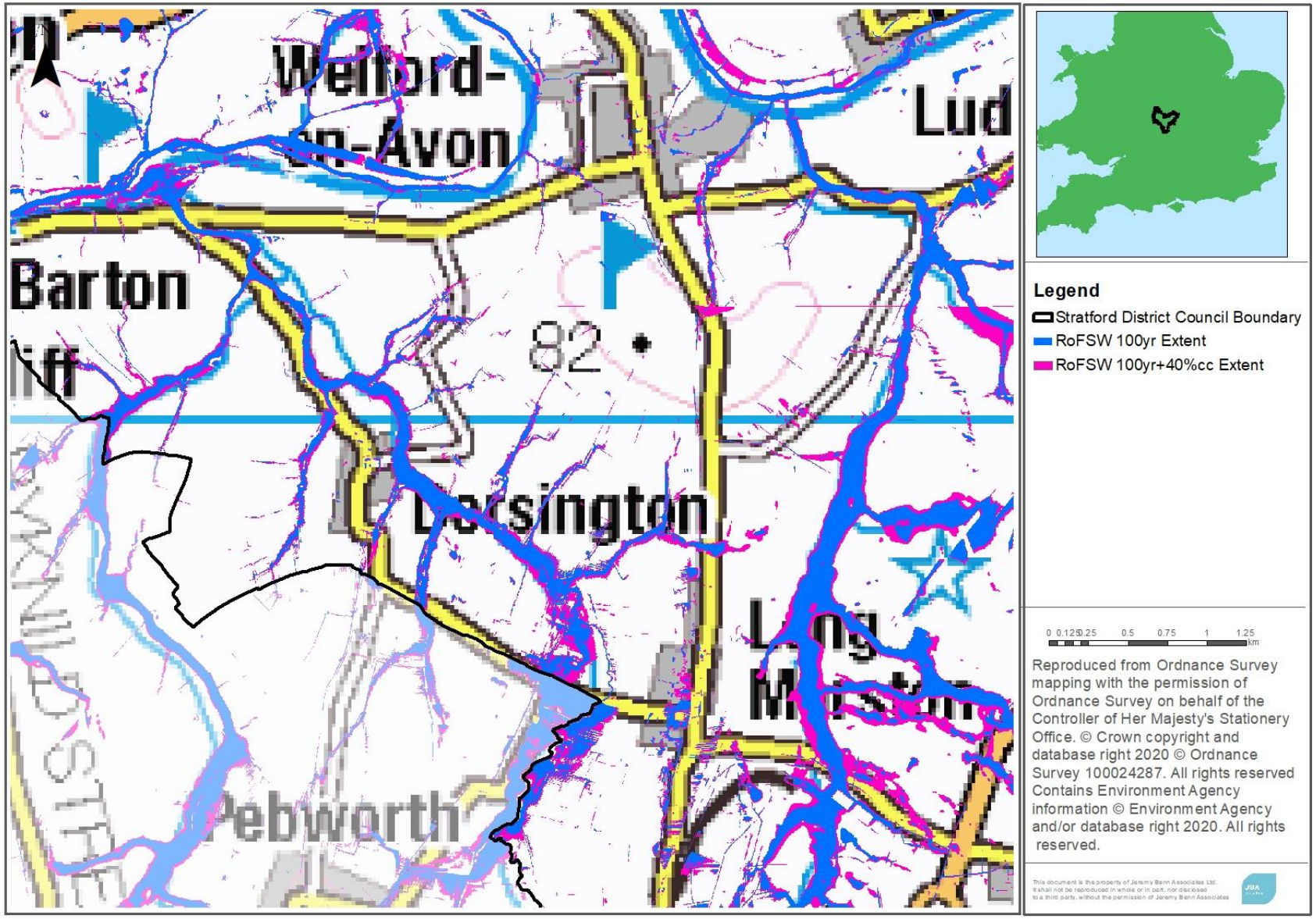
Stratford On Avon District western section Surface Water flooding 100yr +40% climate change



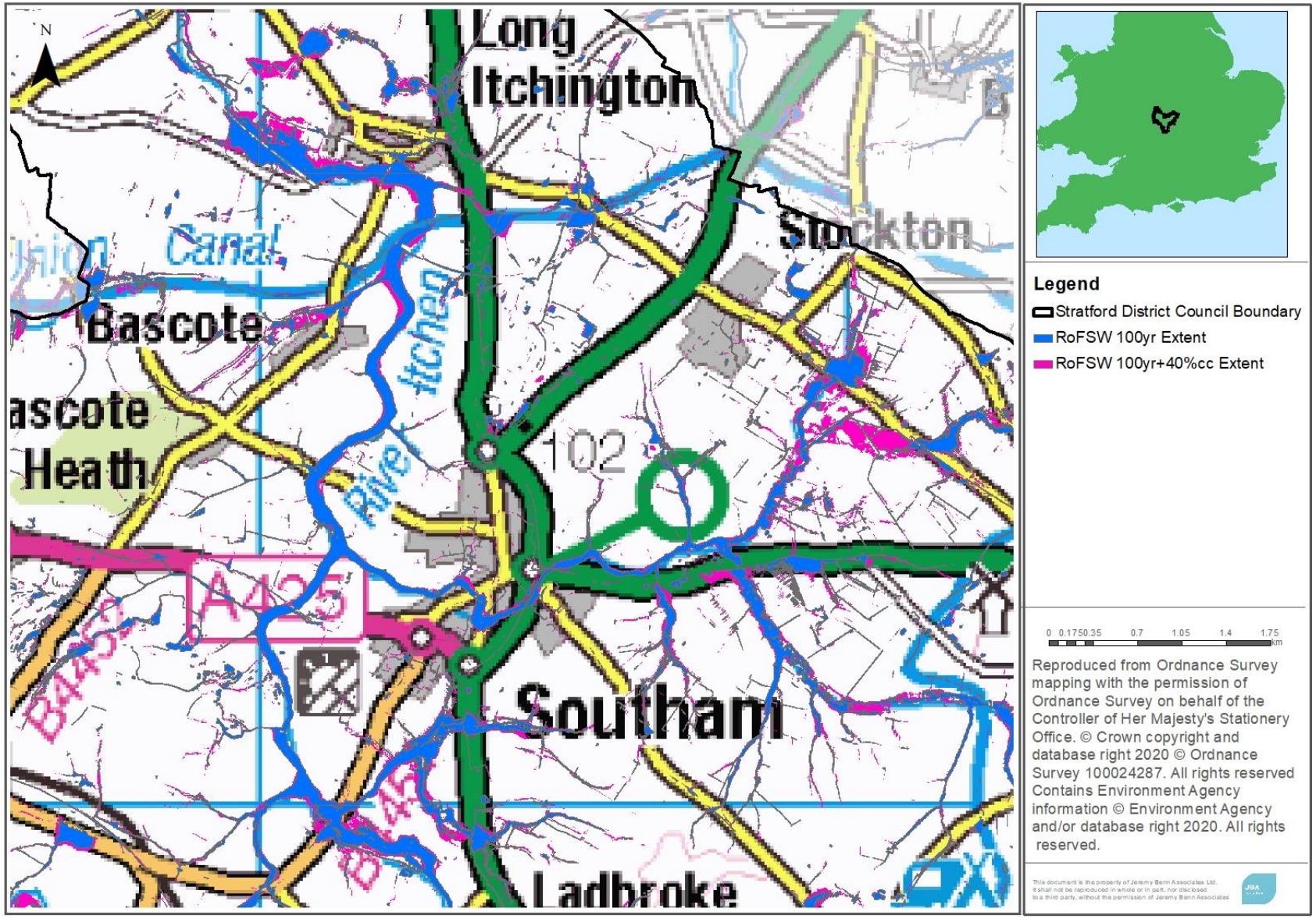
Stratford On Avon District 250k Res. – Alcester (Re. Table 6-1)



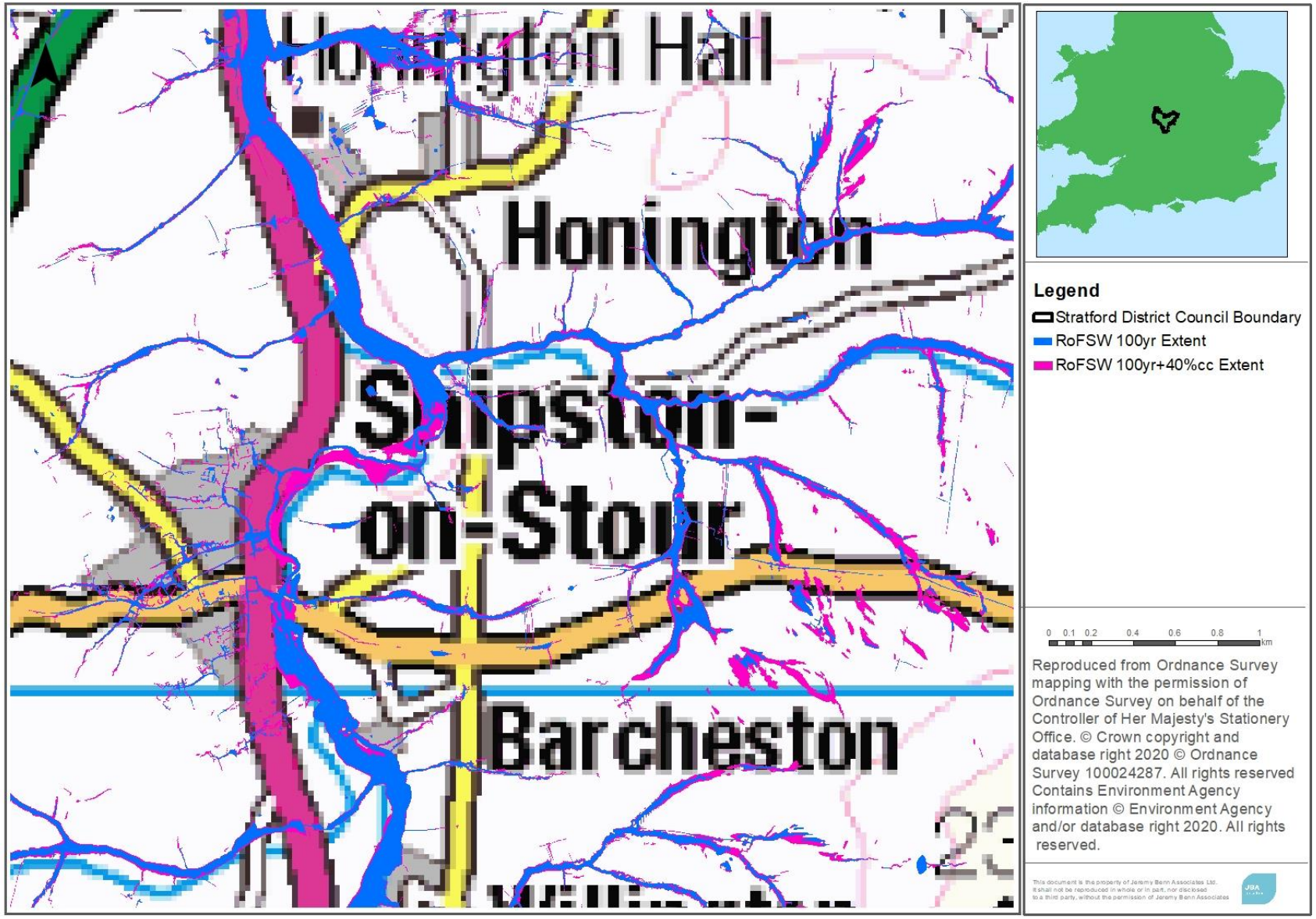
Stratford On Avon District 250k Res. – Bidford, Welford and Weston-on-Avon (Re. Table 6-1)



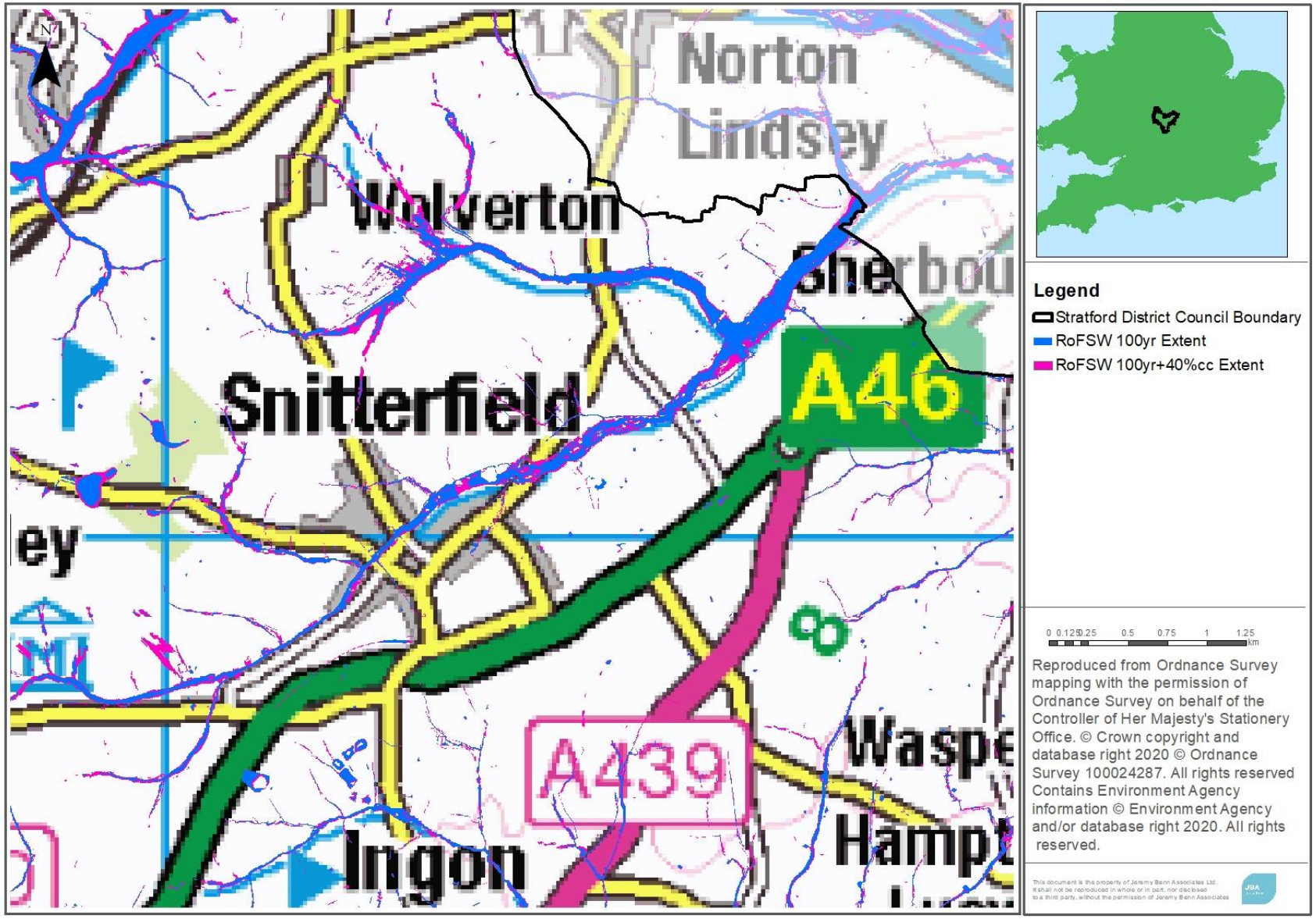
Stratford On Avon District 250k Res. – Long Itchington and Southam (Re. Table 6-1)



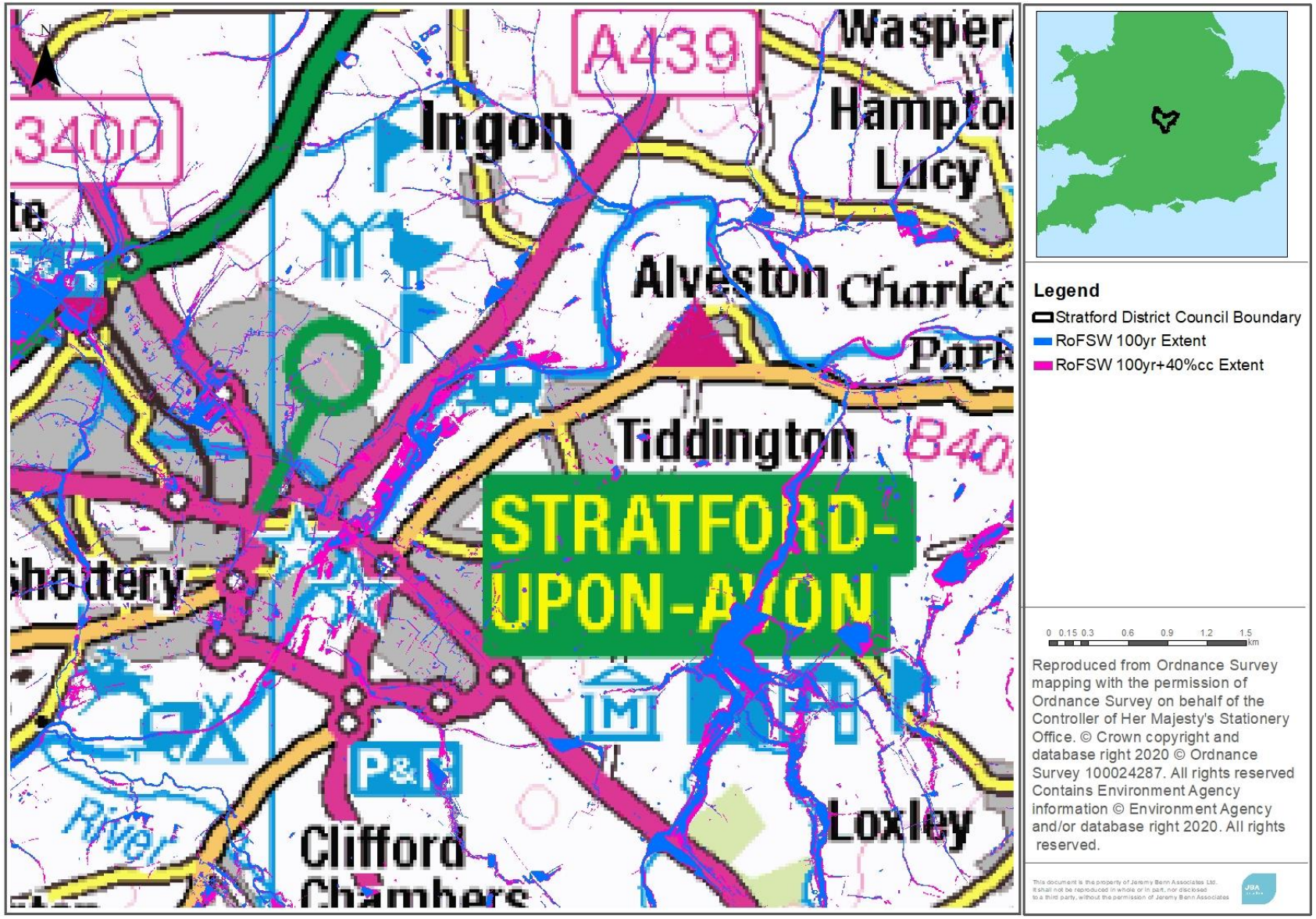
Stratford On Avon District 250k Res. – Shipston-on-Stour (Re. Table 6-1)



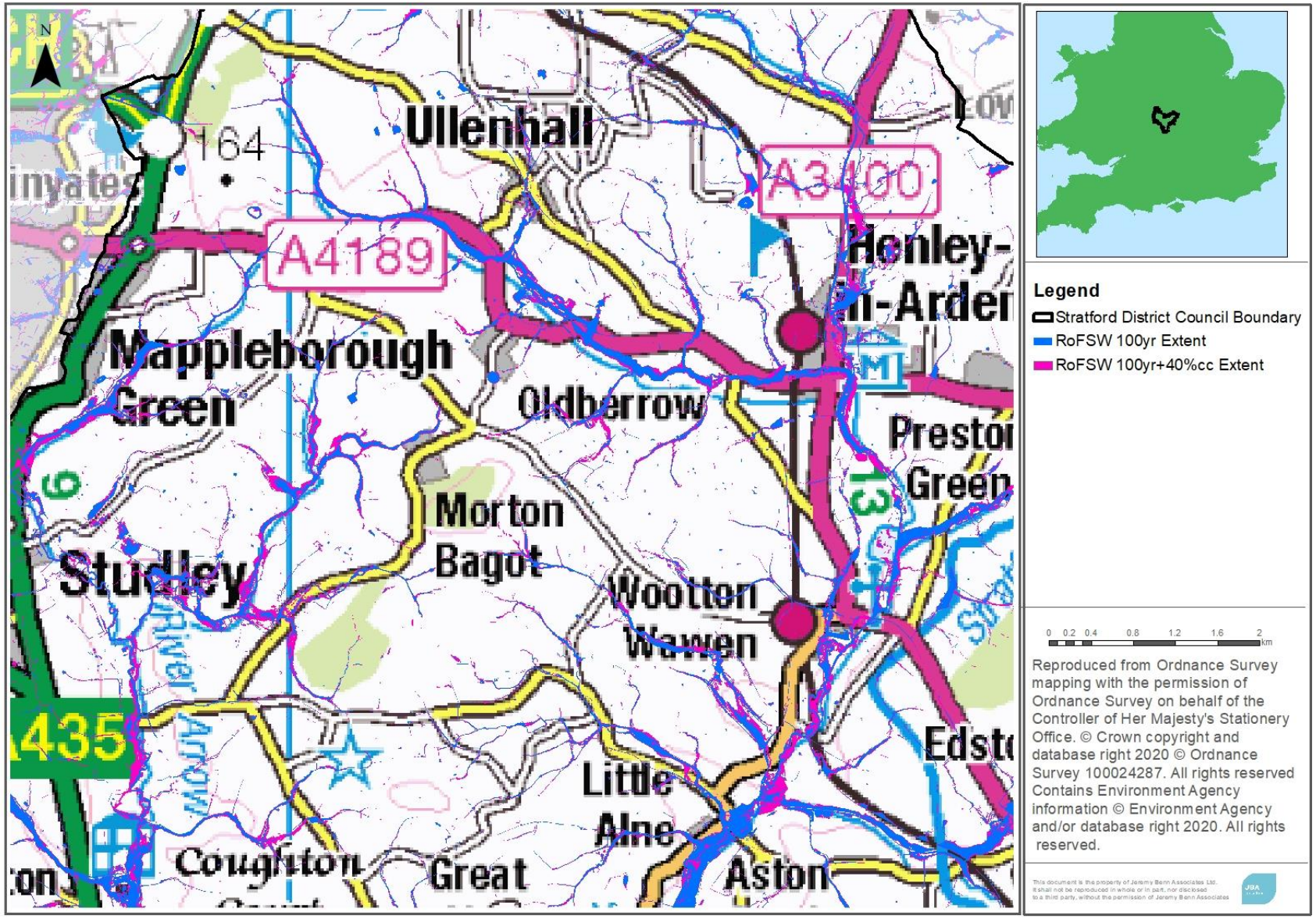
Stratford On Avon District 250k Res. – Snitterfield (Re. Table 6-1)



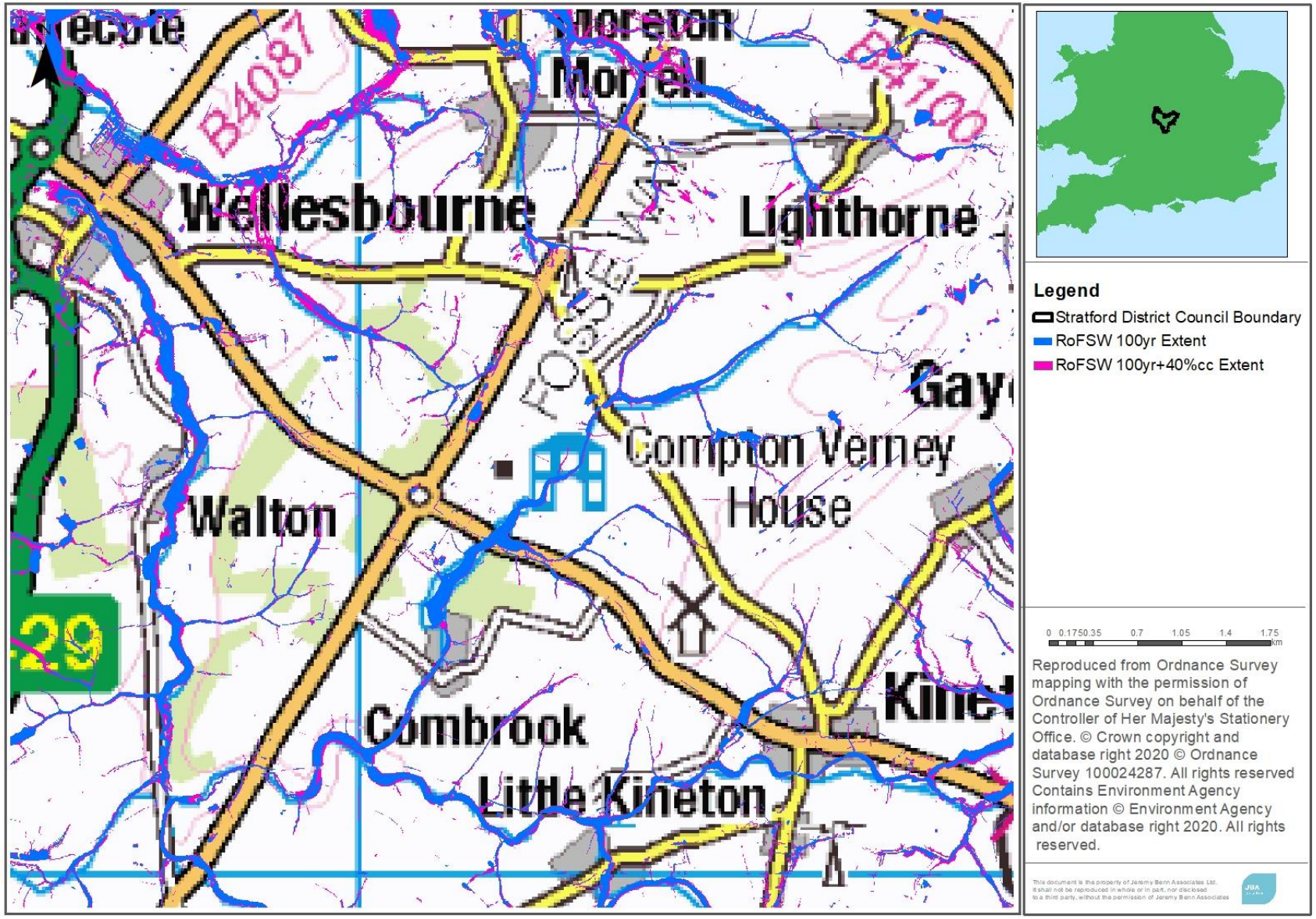
Stratford On Avon District 250k Res. – Stratford-on-Avon, Tiddington and Alveston (Re. Table 6-1)



Stratford On Avon District 250k Res. – Studley and Henley-in-Arden (Re. Table 6-1)



Stratford On Avon District 250k Res. – Kineton and Wellesbourne (Re. Table 6-1)



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