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Strategic Flood Risk Assessment

Levels 1 & 2

August 2022

Leicester City Council

Document History

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Notice

This document was produced solely for the use of Leicester City Council. The document should not be used for any purpose other than that which was originally intended. Any third-party making use of or relying upon the contents of this document does so entirely at their own risk. In particular, flood risk information should always be verified with the Risk Management Authorities and updated where necessary.

Cover Photo

The cover photo is a view of the River Soar (also known as the River Biam) at Aylestone Meadows, in flood conditions during October 2019.

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AEP

Annual Exceedance Probability: the likelihood of a flood event being equalled or exceeded in any given year

CEAP

Climate Emergency Action Plan

CFMP

Catchment Flood Management Plan

EA

Environment Agency

FRA

Flood Risk Assessment

Fluvial flooding

Flooding from rivers and streams

FWMA

Flood and Water Management Act 2010

LFRMS

Local Food Risk Management Strategy

LiDAR

Light Detection and Ranging

LLFA

Lead Local Flood Authority

mAOD (N)

metres Above Ordnance Datum (Newlyn)

Main River

A watercourse included on the Main River Map, within the jurisdiction of the EA

NPPF

National Planning Policy Framework

Ordinary Watercourse

All watercourses other than Main Rivers

Pluvial flooding

Overland flooding from surface water runoff

RMA

Risk Management Authority. Bodies with a responsibility for flood risk management set out in the Flood and Water Management Act 2010

SuDS

Sustainable Drainage Systems

SFRA

Strategic Flood Risk Assessment

SWMP

Surface Water Management Plan

WFD

Water Framework Directive

1. Executive Summary

This Strategic Flood Risk Assessment (SFRA) has been prepared in accordance with the National Planning Policy Framework to support Leicester's Local Plan.

The main sources of flood risk in Leicester are fluvial flooding from the Main Rivers, Ordinary Watercourses and pluvial flooding from direct surface runoff and sewer flooding. Flood risk along the corridor of the River Soar is primarily generated from runoff in the rural headwaters south of the city. However, flood risk from the tributaries of the River Soar which flow through the suburbs of the city is heavily influenced by runoff from the urbanised area. As such, there are interactions between pluvial and fluvial flood risk along these watercourses and Sustainable Drainage Systems (SuDS) have a key role to play in the management of flood risk in the city.

Climate change has the potential to increase river flows in Leicester by up to 60% by the 2080s in the more pessimistic emissions scenario. As such, is it essential that i) new development takes into account the potential for climate change to increase flood risk in the city and ii) potential increases in rainfall are accommodated in the design of SuDS.

The SFRA and accompanying flood risk maps provide a starting point for the assessment of flood risk for new development proposals. Where flood risk is identified as a potential constraint to new development, more detailed analysis should be undertaken by planning applicants in a site-specific Flood Risk Assessment. The Risk Management Authorities (Leicester City Council, Environment Agency, Severn Trent Water) should be contacted early in the planning of new developments to ensure that the assessment makes use of the best available data, which may supersede the information presented in this report.

The analysis undertaken for this SFRA alongside the Sustainability Appraisal has enabled site allocations to be steered where possible towards areas of lower flood risk in accordance with the objectives of the Sequential and Exception Tests set out in the NPPF. However, since it is not possible to accommodate all development in Flood Zone 1, there are sites where flood risk is a constraint and careful design will be required in order to prevent an unacceptable degree of flood risk to people and property. The SFRA and its appendices provide high level guidance on the management of flood risk to new development in Leicester.

2. Introduction

2.1. Purpose of this Report

This Strategic Flood Risk Assessment (SFRA) has been undertaken to support the Local Plan for Leicester in accordance with the requirements of the National Planning Policy Framework[1] (NPPF). Paragraph 160 of the NPPF requires strategic policies to be informed by a strategic flood risk assessment to manage flood risk from all sources. Plans should apply a sequential, risk-based approach to the location of development taking into account both present and future flood risk. This SFRA has been prepared to help ensure that the Local Plan fulfils those requirements.

The objectives of the SFRA are:

- To set out the flood risk in Leicester from all sources;
- To enable future development to be allocated to locations at lower risk of flooding;
- To work alongside the Sustainability Appraisal of the Local Plan;
- To provide guidance to assist site-specific flood risk assessments for new development proposals; and
- To identify opportunities to reduce flood risk and enhance the blue-green infrastructure in the city through the development process.

2.2. Previous Reports

The previous SFRA for Leicester[2] was prepared in 2012 by URS Environment and Infrastructure (URS) under Planning Policy Guidance Note 25: Development and Flood Risk, which preceded the NPPF. The study was informed by a range of data sources, some of which have now been superseded. This updated SFRA has been prepared in light of the subsequent changes to national planning policy and in order to ensure that the Local Plan is prepared using the most up to date information concerning flood risk in Leicester. Early stages of the Local Plan process were informed by v1.4 of this SFRA. The SFRA was updated to v2.0 in July 2022 for the final stages of the process, to account for new Environment Agency (EA) flood risk data

[1] Ministry of Housing, Communities and Local Government, 2021. National Planning Policy Framework. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf. [Accessed 13 July 2022].

[2] URS, 2012. Leicester City Council Level 2 Strategic Flood Risk Assessment Final Report.

2.3. SFRA content

There are two 'levels' of SFRA that planning authorities can undertake when preparing their Local Plan. The content of each level of SFRA is described within guidance that accompanies the NPPF[3]. Broadly speaking, a level 1 SFRA is appropriate to geographical areas where, following a review of the flood risks, development can be allocated in areas of low flood risk. A level 1 SFRA[4] should include information on the following:

- the sources of flood risk;
- areas where flood risk assessments will be needed;
- flood management and defences;
- land that is likely to be needed for flood risk management features and structures;
- reservoir flood risk;
- the cumulative impacts of development and land-use change;
- expected effects of climate change;
- functional floodplain;
- opportunities to reduce the causes and impacts of flooding;
- recommendations on how to address flood risk in development.

Where it is not possible to allocate future development outside flood risk areas, a more detailed 'level 2' analysis of the flood risks must be undertaken. The level 2 contents are bespoke to each geographical area and depend upon the nature of the flood risks, the available information and the future planned growth. However, the study should enable the planning authority to:

- identify the severity of and variation in flood risk within medium and high flood risk areas from all sources;
- establish whether proposed allocations or windfall sites, on which the Local Plan will rely, are capable of being made safe throughout their lifetime without increasing flood risk elsewhere;
- apply the Exception Test, where relevant.

[3] Ministry of Housing, Communities & Local Government, 2021. Flood Risk and Coastal Change. Available at https://www.gov.uk/guidance/flood-risk-and-coastal-change. [Accessed 13 July 2022].
[4] Department for Environment, Food & Rural Affairs and EA, 2019. How to prepare a strategic flood risk assessment. Available at https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment#which-level-of-sfra-to-produce. [Accessed 13 July 2022].

Early in the SFRA development process it was found that due to the variety of sources of flood risk in the city and the presence of key brownfield sites along the river corridor, the SFRA for Leicester must incorporate both level 1 and level 2 analysis.

The EA national guidance on the content of SFRAs and climate change allowances, as well as flood model data of the River Soar and its tributaries, was updated a number of times during the preparation of the Local Plan. As such, the updated guidance and data has been incorporated where possible.

2.4. Future updates

It is important to recognise that our understanding of flood risk is an evolving science. Of note is our understanding of the way in which climate change will impact upon peak river flows and both summer and winter rainfall patterns. The strategic assessment of flood risk should therefore always be considered a 'live' topic. The mapping which accompanies this SFRA and, where appropriate, the accompanying report should be updated on a regular basis to take account of new information.

2.5. Limitations of the study

SFRAs are strategic-level documents which utilise catchment-scale flood risk data from a variety of sources. As part of the Local Plan Exception Test process, flood risk to potential site allocations has been analysed, but the analysis is high level and must in due course be refined at a local scale by site-specific flood risk assessments (FRAs) undertaken by applicants as part of the planning application process.

Site-specific FRAs should not rely solely on the mapping contained within this report. Instead, the author of a FRA should investigate the available flood model output alongside local data (such as site-specific topographic survey). The author should also ensure that the flood risk data is up to date by contacting the Risk Management Authorities (RMAs) early in the process. Where local data is added to hydraulic models, or the output is compared to topographic survey, the conclusions of a site-specific FRA may deviate from the strategic-level findings of a SFRA.

3. Policy context

3.1. National Planning Policy Framework

NPPF paragraph 161

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

National planning policy in relation to flood risk to new development is set out in the National Planning Policy Framework (NPPF). The NPPF states that inappropriate development in areas at risk of flooding should be avoided by directing development away from the areas of highest flood risk (paragraph 159).

When preparing Local Plans, the 'Sequential Test' must be applied to land allocations in order to steer development towards the areas of lowest risk (paragraph 161). This involves an examination of the available flood risk information against potential future development proposals. Where it is not possible to locate new development in areas which are at a low risk of flooding, consideration may be given to sites at a higher risk of flooding, applying the 'Exception Test' where required. The Exception Test requires that new development proposed in areas at risk of flooding must a) provide wider sustainability benefits to the local community that outweigh flood risk, and b) be safe for its lifetime, without increasing flood risk elsewhere and where possible reducing flood risk overall.

In addition, the NPPF requires that:

- the impacts of climate change are taken into account in the Local Plan;
- land that is required, or likely to be required, for current or future flood management is safeguarded in the Plan;
- opportunities provided by new development to reduce the causes and impacts of flooding are identified;
- opportunities are taken to relocate development to more sustainable locations where necessary for sustainability reasons.

The NPPF also sets out the circumstances in which planning applications must be accompanied by site-specific Flood Risk Assessments (FRAs). Chapter 5 provides further guidance on FRAs.

3.2. Other relevant flood risk management legislation and policy

Flood Risk Management in England and Wales is undertaken by a range of Risk Management Authorities who regularly produce reports, strategies and plans to meet their statutory duties and objectives. The management of river systems to reduce the risk of flooding cannot be separated from wider environmental issues such as biodiversity, water quality and the important recreational role that waterbodies often play. As such, it is important when developing land to understand the wider water management policy context.

National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England

In July 2020 the EA published a new FCERM Strategy[5]. The strategy is prepared under paragraph 7 of the Flood and Water Management Act 2010 and sets out objectives for managing flood and coastal erosion risk at a national level. The draft strategy is split into three high level ambitions:

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

The strategy identifies a potential increase in the number of properties in the floodplain due to population growth projections, the need for new homes and climate change. However, the strategy also highlights the important role of spatial planning in steering development away from areas of highest risk and making sure new development is safe for its lifetime without increasing risks elsewhere. The strategy suggests that as long as local planning authorities implement national planning policy effectively, the increase in future property damage from flooding should be relatively modest at 4%. However, if national planning policy or its local implementation is weakened, the outlook could be very different, with property damages potentially increasing by over 30% over the next 50 years.

[5] EA, 2020. National Flood and Coastal Erosion Risk Management Strategy for England. Available at: https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2 [Accessed 13 July 2022]

2020 National FCERM Strategy: Strategic Objective 2.1

"Between now and 2030 all new development will contribute to making places resilient to flooding and coastal change."

River Trent Catchment Flood Management Plan

The River Trent Catchment Flood Management Plan (CFMP) was published in 2010 by the EA. The plan divides the River Trent into 10 sub-catchments, each with a preferred flood risk management policy for the next 50 to 100 years. The policy for Leicester (sub-area 9) is policy 4: areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.

River Trent CFMP key messages

- Assess long-term opportunities to move development away from the floodplain and create green river corridors through parts of Leicester.
- We will work with others to minimise disruption to people and communities caused by flooding, taking into account future climate change and urban growth.
- We will work with others to reduce the disruption caused by flooding to transport, particularly the A50 and A47, and several 'B' roads around Leicester.
- Work to minimise the cost of flood damage in Leicester, taking into account future climate change and urban growth.
- Return watercourses to a more natural state, increasing biodiversity and opening up green river corridors through urban areas of Leicester.
- Sustain and increase the amount of BAP habitat in the catchment

Protection and enhancement of the blue-green infrastructure corridor along the River Soar through Leicester is a key message from the CFMP in relation to spatial planning policy. In the years following the publication of the CFMP a number of projects have been undertaken along the River Soar corridor to reduce flood risk by improving green spaces.

Flood Risk Regulations 2009

The Flood Risk Regulations implemented the requirements of the EU Floods Directive (2007/60/EC) in UK law. The Floods Directive set out a three-stage process whereby:

- Member States undertake a Preliminary Flood Risk Assessment (PFRA) to identify areas where potential significant flood risk exists.
- Where real risks of flood damage exist, flood hazard maps and flood risk maps must be developed for those areas.
- Finally, Flood Risk Management Plans (FRMP) must be developed for those areas.

The PFRA for Leicester was undertaken in 2011 by Leicester City Council and updated in 2017[6]. A FRMP for the Humber river basin was published in 2016[7] and incorporates information relating to flood risk in Leicester. The FRMP identified a number of key messages for flood risk management in Leicester. Consultation on a new draft FRMP closed in January 2022.

Key Messages for Leicester from the Humber FRMP

- Assess long-term opportunities to move development away from the floodplain and create green river corridors through parts of Leicester;
- Work with others to reduce the disruption caused by flooding to transport, particularly the A50 and A47, and several 'B' roads around Leicester;
- Minimise the cost of flood damage in Leicester, taking into account future climate change and urban growth;
- Return watercourses to a more natural state, increasing biodiversity and opening up green river corridors through urban areas of Leicester.

Flood and Water Management Act 2010

The Flood and Water Management Act was introduced following a review of the 2007 UK floods by Sir Michael Pitt which made a number of recommendations to government to improve the management of flood risk. The Act, alongside the Flood Risk Regulations, established Leicester City Council as a Lead Local Flood Authority (LLFA). The LLFA acts as a consultee to planning applications on flood risk matters, with an emphasis on local flood risks and drainage. The LLFA is responsible under the Act for managing flood risk from surface water, Ordinary Watercourses and groundwater.

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[6] AECOM, 2017. Leicester Preliminary Flood Risk Assessment Update. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698266/PFRA_Leicester_City_Council_2017.pdf. [Accessed 13 July 2022].

[7] EA, 2016. Humber River Basin District Flood Risk Management Plan. Available at https://www.gov.uk/government/publications/humber-river-basin-district-flood-risk-management-plan. [Accessed 13 July 2022].

Leicester Local Flood Risk Management Strategy (LFRMS)

The Flood and Water Management Act requires Leicester City Council, as the LLFA, to develop, maintain, apply and monitor a strategy for local flood risk in the city. The LFRMS sets out the objectives for managing local flood risk and the measures proposed to achieve those objectives. The LFRMS for Leicester was published in 2015 and then incorporated into the CEAP (Climate Emergency Action Plan) in 2020[8].

Leicester Local Flood Risk Management Strategy Objectives

- Reduce the number of properties at risk from flooding;
- Help residents, property and business owners in the area become more resilient to flood events;
- Reduce the area of highway under water for a given storm event and minimise traffic disruption from flooding;
- Increase the area of green space in the area contributing to mitigating the flooding risk;
- Reduce the number of pollution incidents affecting watercourses in the city.

The LFRMS also includes a number of specific measures related to spatial planning. These include promoting the use Sustainable Drainage Systems (SuDS) in new development, the preparation of SuDS guidance, and aligning planning policy with the LFRMS.

Leicester Surface Water Management Plan

In 2012 Leicester City Council undertook a study into the risk of flooding from surface water. The study included the identification of surface water flooding 'hotspots' and 'critical drainage areas' which are described in more detail in chapter 3.

[8] Leicester City Council, 2020. Climate Emergency Action Plan. Available athttps://www.leicester.gov.uk/your-council/policies-plans-and-strategies/environment-and-sustainability/climate-emergency/

Leicester City Council Sustainable Drainage Guidance

The Council have prepared two guidance documents relating to sustainable drainage for new developments. The first Sustainable Drainage Guide was issued in 2015[9] and provides an overview of the principles behinds SuDS and the methods available. The SuDS Technical Guide was published in 2021[10] and provides technical standards relating to the design, operation and maintenance of SuDS features for new developments.

Water Environment (Water Framework Directive) Regulations 2003

These regulations transposed the EU Water Framework Directive (200/60/EC) into UK law. The Directive imposes legal duties upon European member states to protect and improve the water environment. The Directive establishes a framework for the protection of surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. It aims to ensure that all aquatic ecosystems meet 'good status'. For heavily modified and artificial water bodies, the aim is to achieve good ecological potential and good surface water chemical status.

Development projects which affect a watercourse should support the actions set out in the relevant River Basin Management Plan (RBMP) and should not:

- cause a deterioration of the status of potential of surface waters and groundwater;
- prevent a waterbody from achieving good ecological status (or for heavily modified/ artificial water bodies, good ecological potential) and good chemical status;
- prevent WFD objectives being met in other water bodies;
- cause failure to meet good groundwater status, or result in a deterioration of groundwater status;
- prevent the implementation of mitigation measures which improve the hydromorphology of heavily modified water bodies.

The WFD is of particular relevance to future development which is taking place adjacent to watercourses in the city and to the design of urban drainage schemes, which should

[9] Leicester City Council, 2015. Sustainable Drainage Guide. Available at https://www.leicester.gov.uk/media/179759/suds-guidance-april-2015.pdf. [Accessed 13 July 2022].
[10] Leicester City Council, 2021. SuDS Technical Guide. Available at https://www.leicester.gov.uk/planning-and-building/urban-design-and-sustainability/ [Accessed 12 August 2022].

incorporate SuDS techniques in order to prevent a decrease in the water quality of rivers and streams which ultimately receive the runoff.

Leicester Green Infrastructure Strategy 2015-2025

Leicester's Green Infrastructure Strategy sets out a strategic environmental vision for green spaces in Leicester and the ways in which they can be created, managed and maintained to provide maximum benefits to the people of Leicester. The strategy identifies five priorities for the city:

PRIORITY 1 - A Place to Do Business and Get About – linked to economic growth, regeneration, housing targets but also sustainable transport and car travel.

PRIORITY 2 - A Bio-diverse and Beautiful City – linked to provision of habitats, access to nature, attractive and well-maintained areas of green space.

PRIORITY 3 - A Healthy and Active City – linked to green transport routes and formal/informal recreation to address health and quality of life issues.

PRIORITY 4 - A Naturally Sustainable City – linked to flood storage, controlling impacts of climate change, improving soil, water and air quality

PRIORITY 5 - Planning for GI – embedding the strategy within local policy and developing a strategic green network of space capable of providing multiple benefits in a cost effective and sustainable way

The Green Infrastructure Strategy identifies watercourses in the city which have been straightened, concreted or culverted as part of historic land drainage works along with opportunities to reinstate natural channels to improve their ecological value and reduce flood risk. These opportunities have been considered alongside flood risk to potential site allocations within the SFRA site appraisal process.

3.3. Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment

In 2017 the planning authorities in Leicestershire commissioned a joint Strategic Flood Risk Assessment (SFRA) to provide an evidence base to support the production of the Strategic

Growth Plan (SGP)[11]. The SFRA collated flood risk data from the Risk Management Authorities and made recommendations in relation to new development. The SFRA concluded that all the potential growth areas identified within the SGP are at flood risk, either from single or multiple sources, and that the source of flooding is primarily Ordinary Watercourses. With the focus of the study being the SGP, there was no specific assessment of flood risk to development sites within Leicester City administrative area. However, recognising that flood risk management is a cross boundary issue, with risks and opportunities that may extend from one planning authority area into another, it is important to note a number of the conclusions and recommendations in the SFRA (pages 103-105) which are consistent with the guidance contained in this report:

- the sequential approach to development and flood risk should be adopted, directing new development to areas of lowest risk.
- climate change modelling and mapping should be taken into consideration when identifying sites for development.
- developers should consult with the relevant Local Planning Authorities, Lead Local Flood Authority and the EA (where relevant), at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.
- new development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site.
- it should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water.
- safe access and egress at sites will need to be demonstrated by the developer; the development should be higher than the 1 in 100-year flood level, plus an allowance for climate change, and emergency vehicular access should be possible during floods.
- the cumulative impact of development and the effect of land use change should be
- considered at the planning application and development design stages and the appropriate mitigation measures undertaken.
- 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.

[11] JBA Consulting, 2017. Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment. Available at https://www.llstrategicgrowthplan.org.uk/the-plan/stage-two/developing-the-evidence-base/leicestershire-leicester-city-level-1-strategic-flood-risk-assessment/. [Accessed 13 July 2022].

3.4. Risk Management Authorities: Roles and responsibilities

There are a number of organisations responsible for managing flood risk in Leicester. These organisations work collaboratively to manage and where possible reduce the risk of flooding. Their main flood risk management responsibilities are summarised below.

Leicester City Council

- Lead responsibility for flooding from Ordinary Watercourses, pluvial sources and groundwater;
- Statutory consultee from a drainage perspective for all major developments;
- Prepares and updates the Local Flood Risk Management Strategy;
- Contributes to emergency planning and is a category 1 incident responder under the Civil Contingencies Act
- Maintains a register of flood risk assets;
- Investigates significant flooding incidents;
- Regulates works affecting Ordinary Watercourses and enforces unconsented activities.

Environment Agency

- Lead responsibility for management of flooding from designated Main Rivers
- Strategic overview of all forms of flooding
- Statutory consultee for developments in Flood Zones 2 and 3
- Prepares and updates the National Flood Risk and Coastal Erosion Management Strategy
- Enforcement Authority under the Reservoirs Act 1975 for large, raised reservoirs in England, as well as being an owner and operator
- Contributes to emergency planning and is a category 1 incident responder under the Civil Contingencies Act
- Regulates works affecting Main Rivers and enforces unconsented activities.

Severn Trent Water

- Sewerage undertaker for Leicester.
- Maintains public sewers.
- Comments on the capacity of the sewer network to accommodate new development as part of the planning application process
- Invests in sewer system upgrades as part of ongoing investment
- Works in partnership with other RMAs to address pluvial/ sewer flooding issues

4. Flood risk in Leicester

4.1. Geography of the study area

Leicester is located approximately mid-way along the River Soar, a river which drains the majority of Leicestershire in a northerly direction towards the River Trent. The administrative area of the city is approximately 73km^2 (figure 4.1).

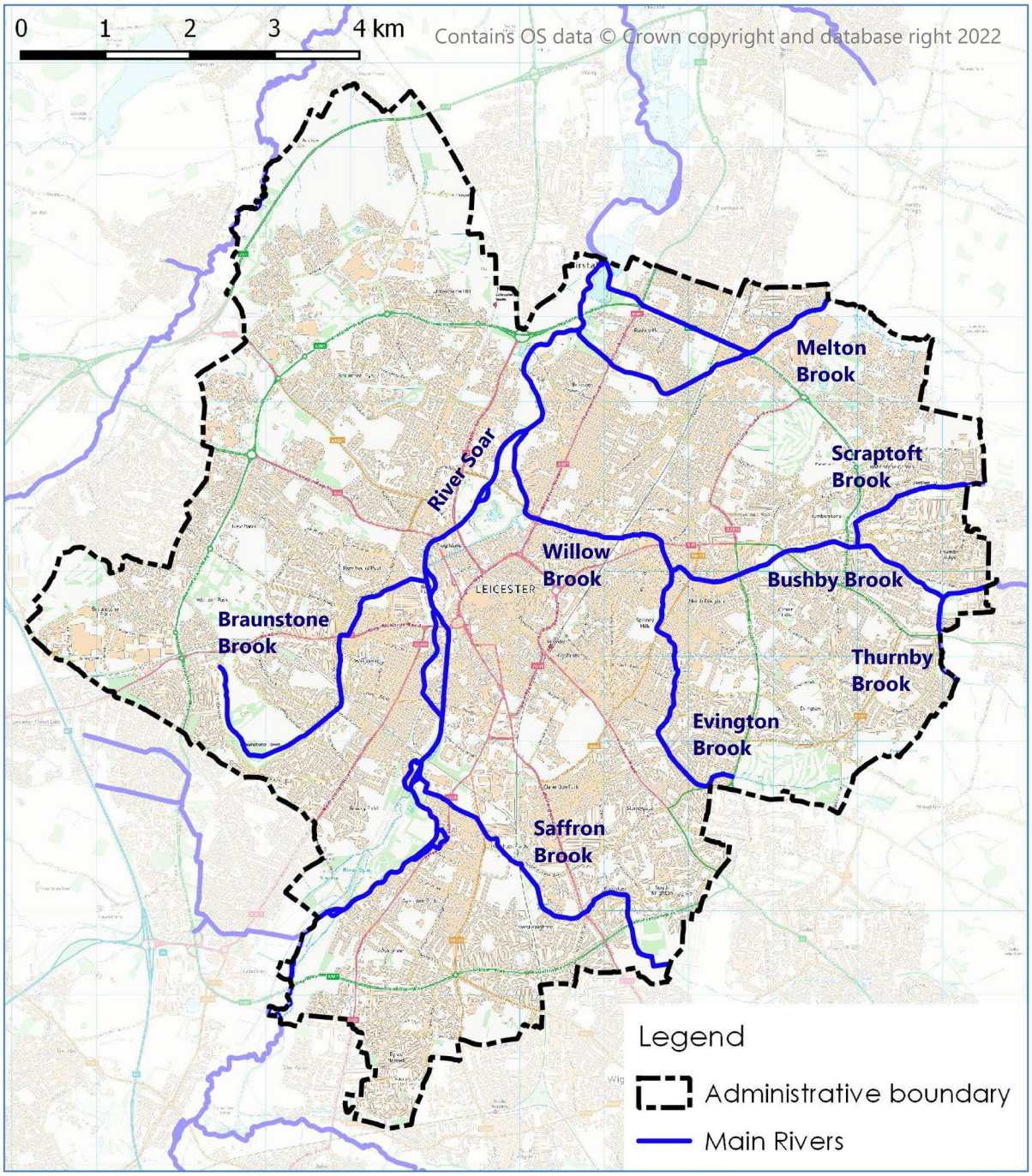

Figure 4.1 Leicester administrative area and designated Main Rivers.

The historic core of the city was founded on relatively high land to the east of the river above the natural floodplain, but as the city expanded either side of the river, development began to encroach onto lower land near the River Soar and the small tributaries which now flow through the suburbs.

The topography of Leicester (figure 4.2) directs the vast majority of surface runoff towards the River Soar via the urban tributary streams, though a small part of the city to the north west of the administrative area drains into the Rothley Brook. Across most of the city clay soils with impeded drainage result in relatively high runoff rates, though areas of freely draining soil can be found especially along the river valley.

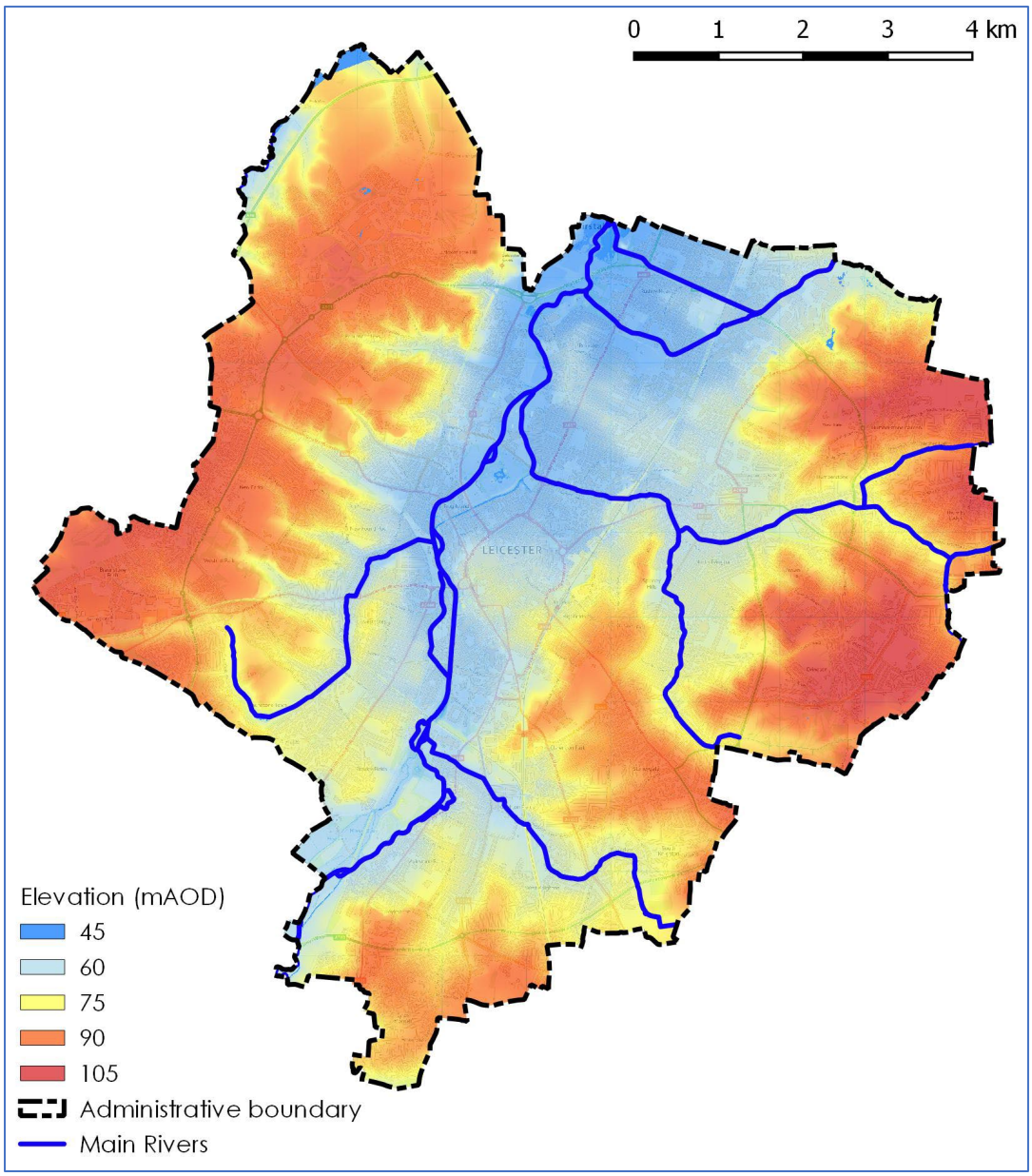

Figure 4.2 Topography of Leicester.

There are five designated Main River catchments flowing through Leicester:

- River Soar
- Braunstone Brook
- Melton Brook
- Saffron Brook
- Willow Brook

River Soar

The River Soar is a lowland river which drains an area of approximately 1380km2 to the River Trent. It is a lowland river with a relatively low gradient and a broad floodplain which is inundated annually in many places along the Soar Valley. Extensive engineering works in the 18th Century made the River Soar navigable for approximately 40km from the River Trent. In Leicester, the canal weaves in and out of the River Soar, with a system of locks and weirs that maintain the water level in the navigation channel.

Figure 4.3 The River Soar viewed from Soar Island, Leicester.

Historic maps suggest that the canal broadly follows the course of small channels which were once branches of the River Soar. The towpaths along the canal provide public access along much of the river corridor.

Historic engineering works to improve flood protection and enable navigation removed many of the natural features associated with river channels; fluvial landforms such as pools, riffles and bars are notably absent through the city and much of the natural river bank habitat has been replaced with brick walls and sheet piling. However, over the course of the

20th century, riverside vegetation has recovered in many places. Although the river banks are predominantly engineered through Leicester, vegetation has colonised areas of deposited silt in the river channel, particularly downstream of the navigation weirs where the channel has been over-widened in the past. The green spaces alongside the river, such as Abbey Park and Ellis Meadows, provide important habitat for many species, including those with statutory protection such as otters, badgers and bats. South of Leicester, Aylestone Meadows is an extensive area of green space containing the most natural section of the River Soar within Leicester administrative boundary. Here, the river is quite shallow and in places fast-flowing, with pool-riffle sequences and a variety of habitat (figure 4.4).

Figure 4.4 The River Soar (also known as the River Biam) at Aylestone Meadows.

Leicester's urban watercourses

Whilst the River Soar has been a source of flooding throughout the course of Leicester's history, the more notable flood events during the 20th century (esp. July 1968) occurred along the small urbanised streams which drain agricultural land to the east and west of the city and which convey much of the runoff from the city suburbs towards the River Soar. A number of these brooks - Braunstone, Melton, Saffron and Willow, along with their tributaries - are designated as Main Rivers and fall under the jurisdiction of the EA. Following the flooding in 1968, extensive engineering works were undertaken to increase flood capacity, but they remain a potential source of flood risk. Other watercourses (Ordinary Watercourses) such as the Ethel Brook also convey urban runoff towards the river and fall under the jurisdiction of Leicester City Council as the LLFA.

4.2. Flood risk from Main Rivers

Flood Zones

An overview map of the Flood Zones in Leicester is included in **Appendix A**

More detailed mapping can be found in the Interactive Maps in **Appendix I**

The Flood Zones are defined in the guidance which accompanies the NPPF and refer to the probability of river and sea flooding, ignoring the presence of defences.

Flood Zone 1: Low Probability. Land having a less than 1 in 1,000 annual probability of river flooding (<0.1% AEP). This land is shown as unshaded areas on the Flood Map – it refers to all land outside Flood Zones 2 and 3.

Flood Zone 2: Medium Probability. Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% to 1% AEP). This land is shown in light blue on the Flood Map.

Flood Zone 3a: High Probability. Land having a 1 in 100 or greater annual probability of river flooding (>1% AEP). This land is shown in mid blue on the Flood Map.

Flood Zone 3b: The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. Flood Zone 3b is not shown on the EA's flood map for planning- it is defined within the SFRA.

The data used for the Flood Zone maps in this SFRA was provided by the EA in June 2022.

Functional Floodplain in Leicester

Flood Zone 3b in Leicester is defined as land which is inundated in a 1 in 30 annual chance fluvial flood event and / or land which is designated as a flood storage area.

n.b. At the time this SFRA was prepared, the NPPF practice guidance defined the functional floodplain as land which is inundated in the 1 in 20 annual chance event. As such, the maps in this report show the 1 in 20 event. More up to date data for the 1 in 30 annual chance event can be obtained from the Environment Agency or, if unavailable, may need to be modelled by the applicant.

Flood defences

A map of key flood defence infrastructure is included in **Appendix B**

Flood defences in Leicester comprise a mixture of channel enlargement to increase capacity, raised defences, bypass culverts and flood storage areas. These defences are:

- River Soar: Thurcaston Road flood walls
- River Soar: Thurmaston flood bank
- River Soar: Oakland Avenue flood bank
- River Soar: Marsden Lane flood defence
- Melton Brook: Troon Way bypass culvert
- Willow Brook: Dakyn Road washlands
- Ethel Brook: Storage area
- Braunstone Brook: Bolton Road bypass culvert
- Braunstone Brook: Braunstone Lakes flood storage area
- Saffron Brook: Knighton Park flood storage area
- Saffron Brook: Saffron Lane bypass culvert
- All: Channel walls extending above adjacent ground level
- All: Alterations to channel form below top of bank

The Flood Zone maps in Appendix A show the area of land at risk of flooding if the presence of flood defences is ignored, in line with the definition in the NPPF practice guidance. This is because a residual risk of flooding will always remain even in defended areas, should the defences fail, so it is important that new development behind defences is designed with adequate mitigation in place. However, it is not possible to remove every historic river engineering improvement from a hydraulic model because some of these modifications are intrinsic to the functioning of a watercourse and others are now permanent topographic features which do not require ongoing maintenance from a flood risk management perspective.

Fluvial Flood Risk and climate change (defended outlines)

An overview map of fluvial flood extents (taking account of flood defences) is included in **Appendix C**. Detailed mapping can be found in the Interactive Maps in **Appendix I**.

Flood risk is present along each of the Main River systems in Leicester even when taking into account the benefit of existing flood defences. This flood risk has the potential to increase as our climate warms. The mapping in this section of the report includes the 1 in 20, 1 in 100 and 1 in 1000 annual chance flood extents, along with the flood extent arising from a 1 in 100 annual chance event with a 30% increase in flow due to climate change.

The EA provides guidance to Planning Authorities on the potential increase in flood flow which is expected to occur due to climate change. Prior to publication of this SFRA update, the EA updated the 'central' climate change estimate for the River Soar to a flow increase of 28%, but the nearest simulation within the draft EA flood models (as of July 2022) includes a +30% increase in flow in line with previous estimates. As such, the climate change mapping in this chapter is provided as an approximation of the potential impacts of climate change under the 'central' emissions scenario. The central emissions scenario will be applicable to most residential and commercial development proposals. In practice, the difference in flood extent between a 28% increase in flow and a 30% increase is likely to be negligible, especially in the context of modelling uncertainty. This approach was agreed a priori with the EA given the draft status of the models and the late stage of the Local Plan. Further guidance on the consideration of climate change within site-specific flood risk assessments is provided in section 5.1.

River Soar

The response of the River Soar in Leicester to heavy rainfall is influenced by the upstream flows both on the River Soar itself and its major tributary, the River Sence. These two catchments are of broadly similar size. To the south of the city, the flood meadows between Braunstone and Aylestone are regularly inundated (figure 4.5), though property flooding is limited to higher return period events. Towards the city centre from Aylestone, the combination of the Mile Straight (the canal) and the Old River Soar have a much higher capacity and are able to contain the majority of flood flows within their channels (figure 4.6). However, this area is potentially vulnerable to the impacts of climate because the land adjacent to the river is relatively flat.

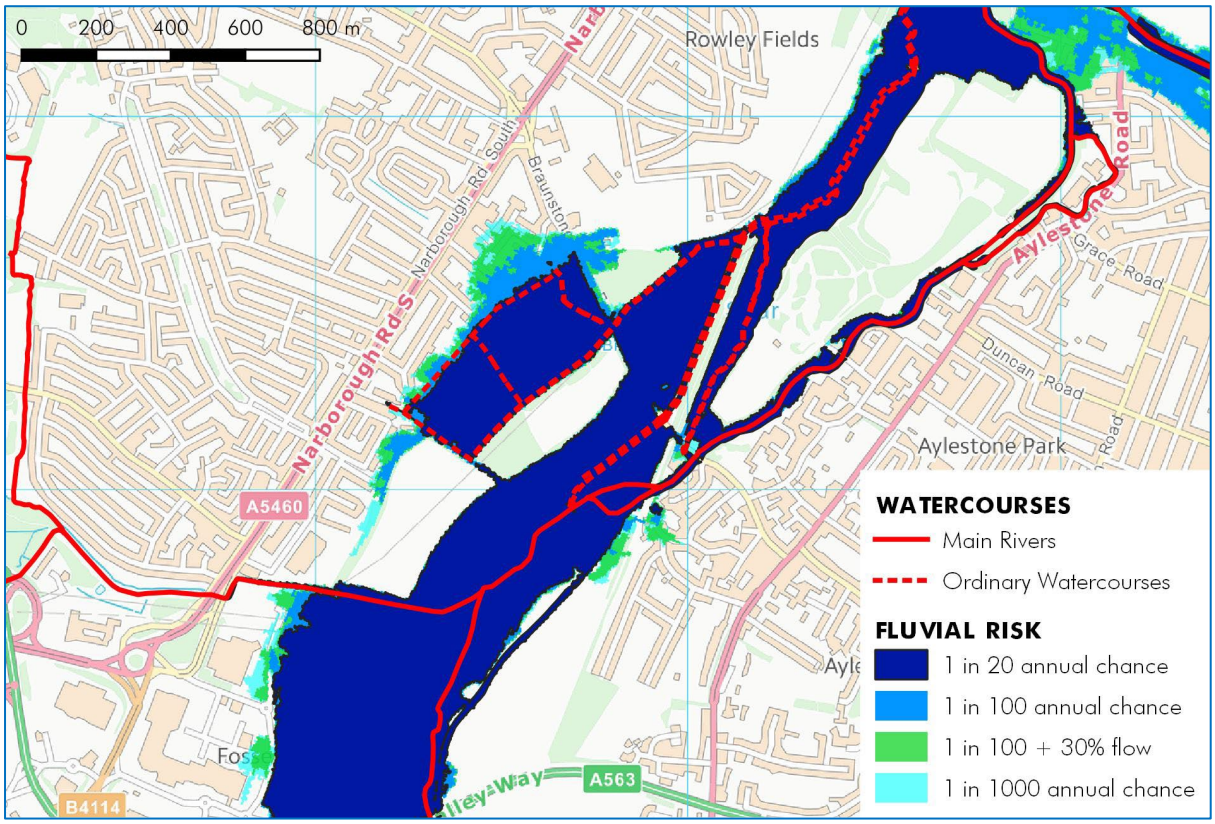

Figure 4.5 River Soar flood extents to the south of the city.

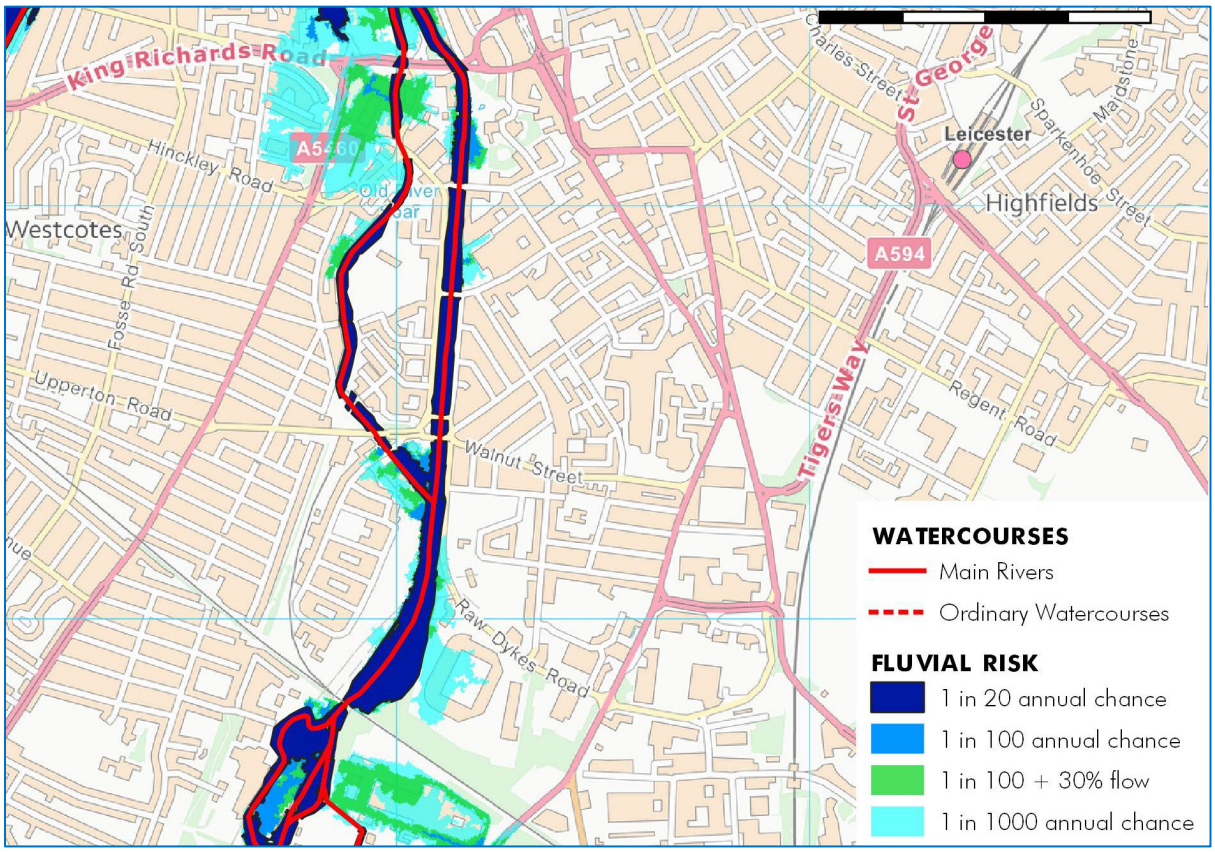

Figure 4.6 River Soar flood extents at the Mile Straight.

To the north of the city centre, the river and canal separate around Frog Island, with the river carrying flood flows around the north of the island past Woodgate area, through Abbey Park

and past the National Space Centre before re-joining the canal near to Corporation Road. Areas of potential flood risk which are vulnerable to increases in river flow due to climate change include Repton Street and Abbey Lane on the left bank floodplain and Belgrave on the right bank (figure 4.7).

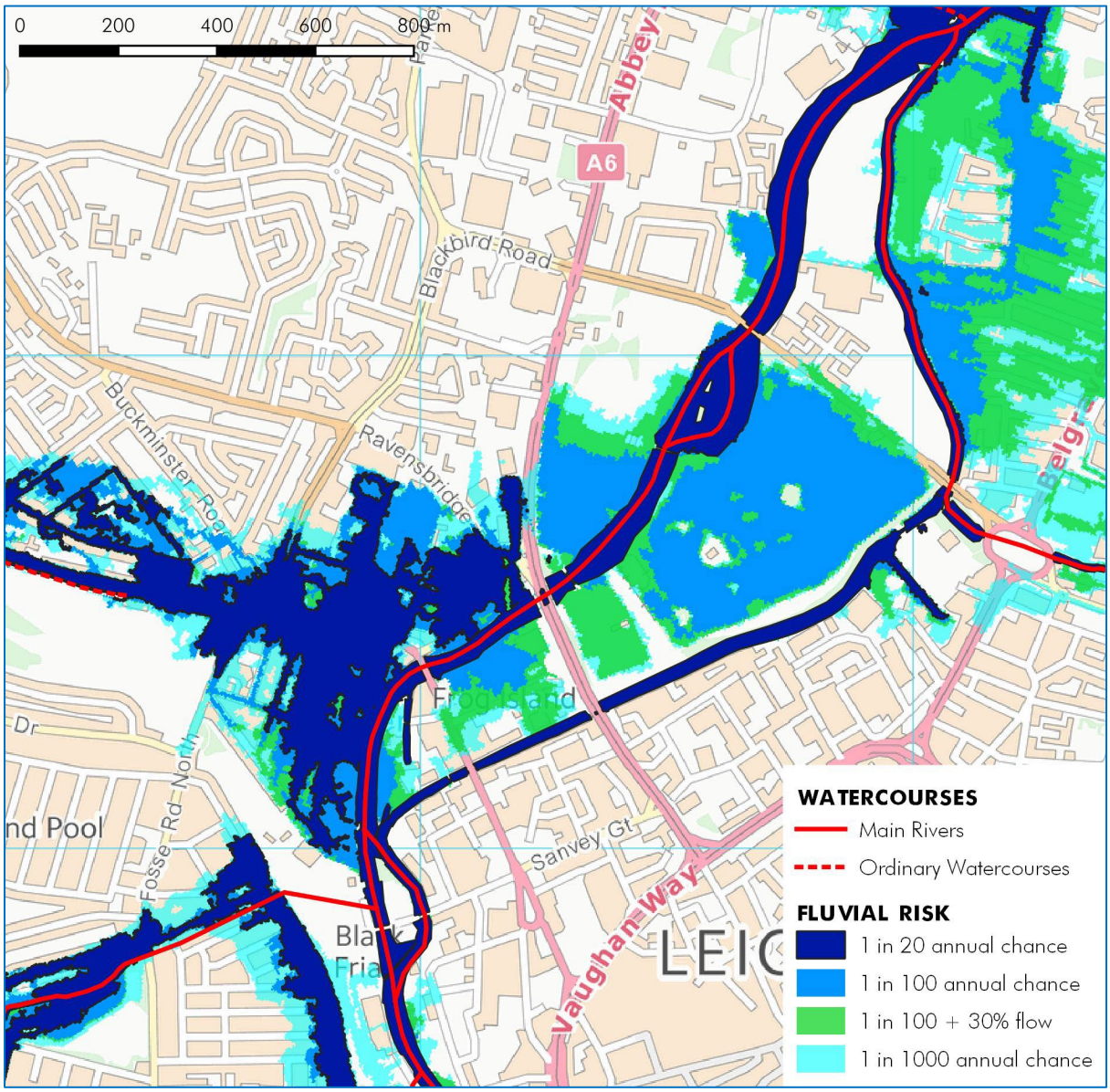

Figure 4.7 River Soar flood extents around Frog Island.

To the north of the city, the floodplain widens as the river enters Watermead Country Park, which is an area of natural floodplain lying between Birstall to the west and Thurmaston to the east (figure 4.8).

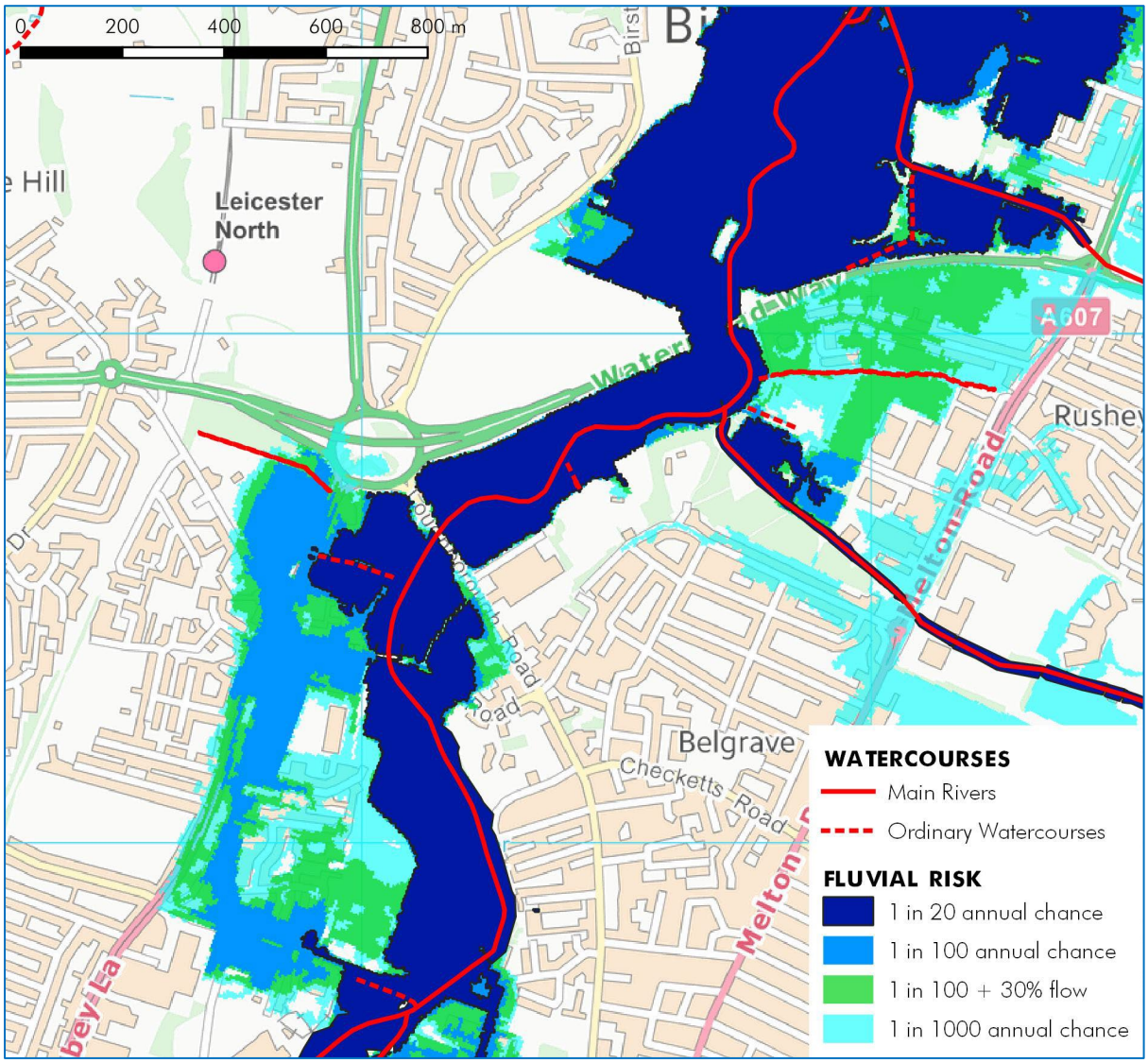

Figure 4.8 River Soar flood extents in North Leicester.

Flood characteristics

Flood events in Leicester often have a 'double peak'. Initially, the smaller urban tributaries respond to rainfall with rapid runoff from impermeable surfaces in the urban area (<5 hours), which makes the provision of flood warnings particularly challenging in relation to the urban watercourses. The second, larger flood peak arrives approximately 12-24 hours after the storm (depending upon the temporal and spatial distribution of the rainfall) as runoff from the rural headwaters of the river in south Leicestershire reaches the city. The flood response of the River Soar is highly dependent upon antecedent ground conditions and the relative flows of both the upper reach of the River Soar and the River Sence, which join to the south of the city in Enderby. This complicates flood peak estimation and the provision of flood warnings.

Braunstone Brook Catchment

The Braunstone Brook rises to the north-west of Leicester near to Leicester Forest East. The brook drains residential areas along Hinckley Road and industrial estates (notably Scudamore Road area) towards Braunstone Park, where the head of Main River is located. The park contains a large flood storage area which was constructed in response to floods in 1968. The brook leaves the park at Gooding Avenue and follows a relatively well defined, urbanised valley on its route to the River Soar, which it meets near to Soar Island. Figure 4.9 also shows the floodplains of the Gilroes Brook and Western Park Brooks which are tributaries of the Braunstone Brook.

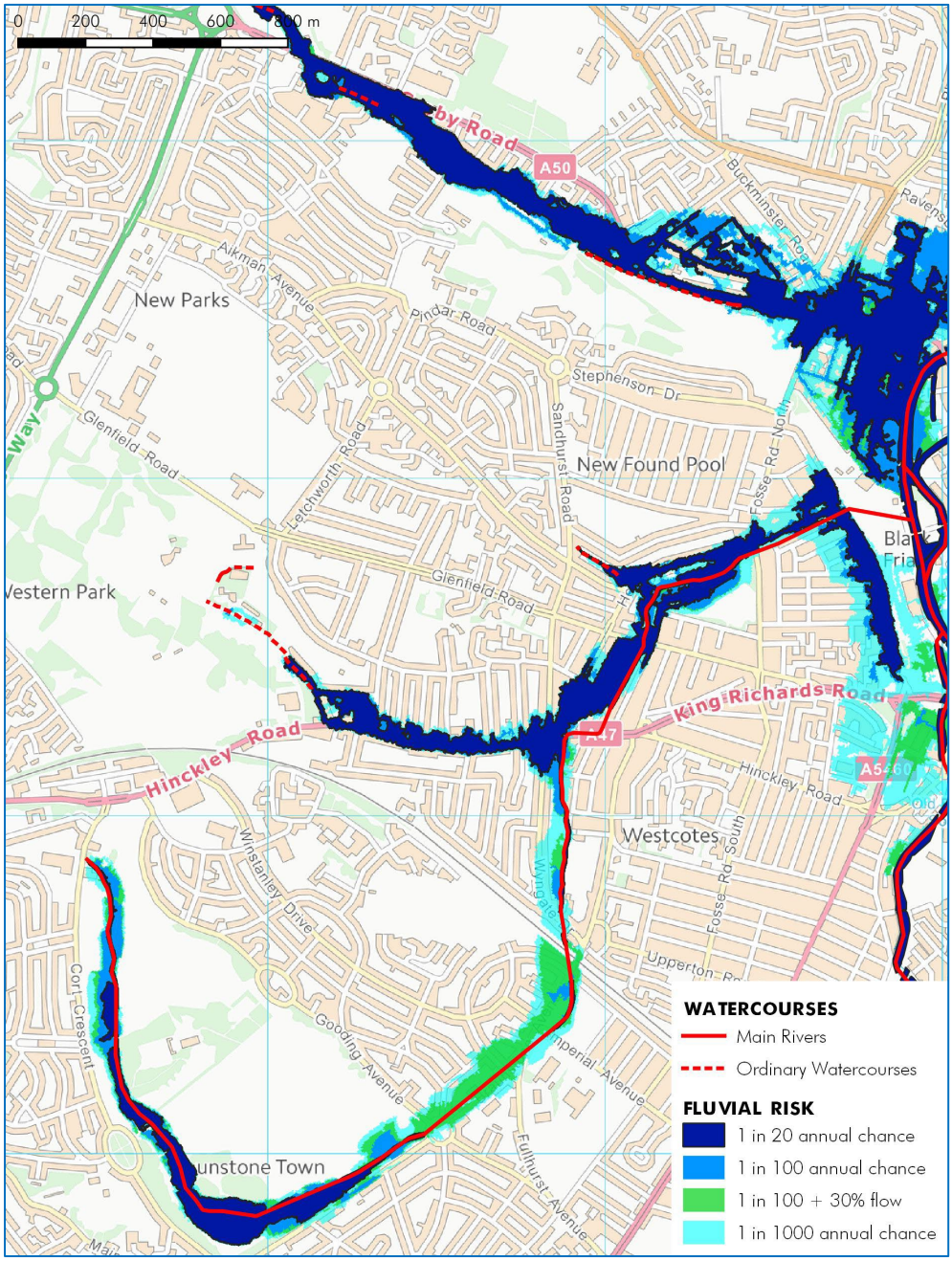

Figure 4.9 Braunstone Brook catchment flood extents.

Melton Brook Catchment

The Melton Brook rises to the east of Leicester in agricultural land. The brook was a source of repeated flooding in the first half of the 20th century, which led to flood alleviation works that included the construction of the Melton Brook bypass culvert. This is a large box culvert which carries flood flows alongside Troon Way, re-joining the River Soar in Watermead Country park. As a result of this historic engineering work, flood risk from the Melton Brook is significantly reduced, but areas of risk remain during extreme events (figure 4.10).

The most recent hydraulic modelling suggests that the capacity of the system could be exceeded in future climate change flood risk scenarios.

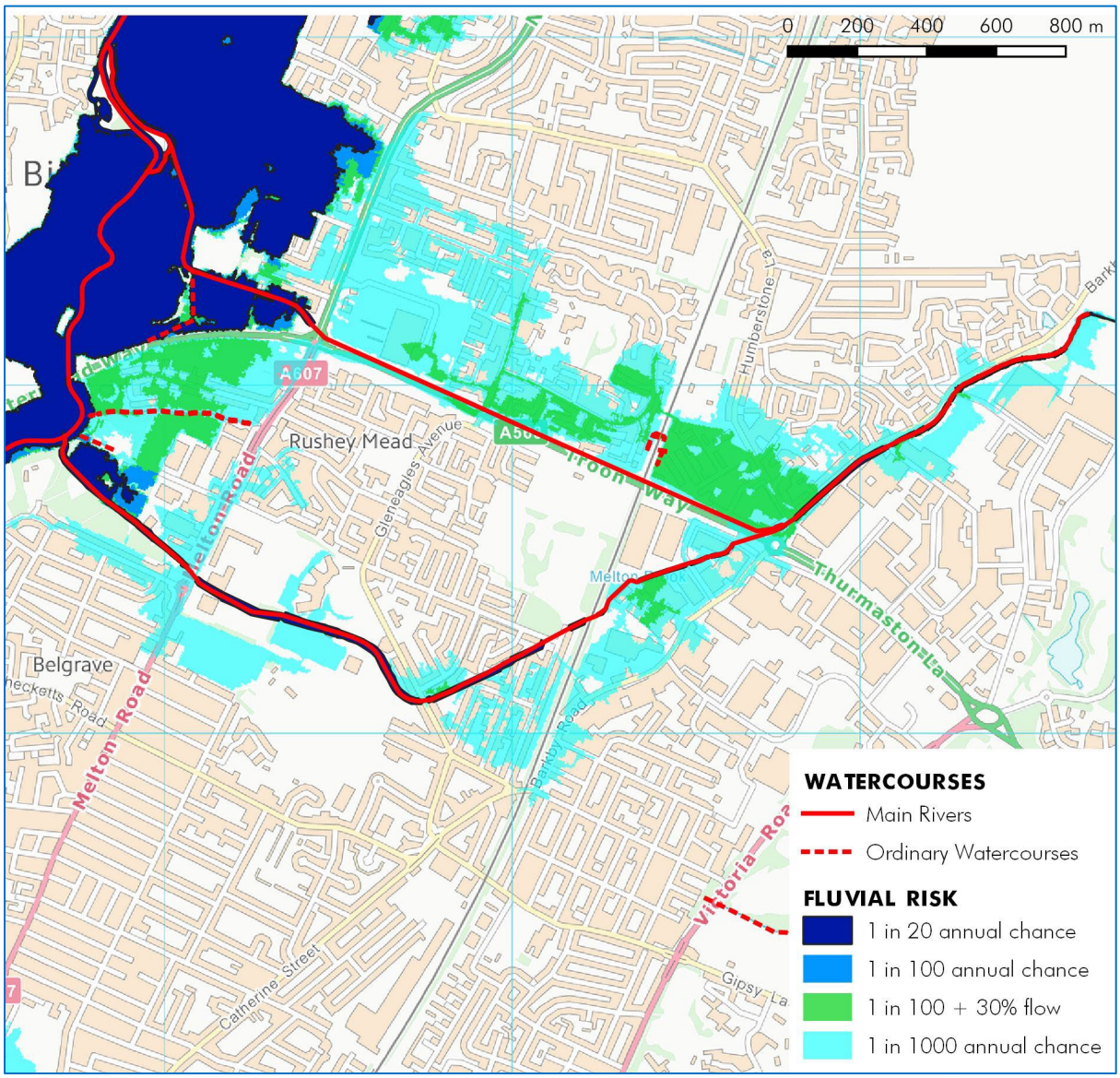

Figure 4.10 Melton Brook flood extents.

Saffron Brook catchment

The Saffron Brook rises to the southeast of Leicester and is known as the Wash Brook in its upper reach where it flows through the borough of Oadby and Wigston. The brook becomes a designated Main River at Knighton Park Washlands- a series of flood storage areas created to reduce downstream flood flows through the urban area.

The most recent hydraulic modelling suggests that whilst the washlands at Knighton Park do attenuate flood flows, a risk of flooding remains in the lower catchment due to urban runoff (figure 4.11). Figure 4.11 also includes the 1 in 100 and 1 in 1000 annual chance flood extents from a small tributary- the Hol Brook- which is an Ordinary Watercourse. Climate change scenario flood outlines are not available for the Hol Brook.

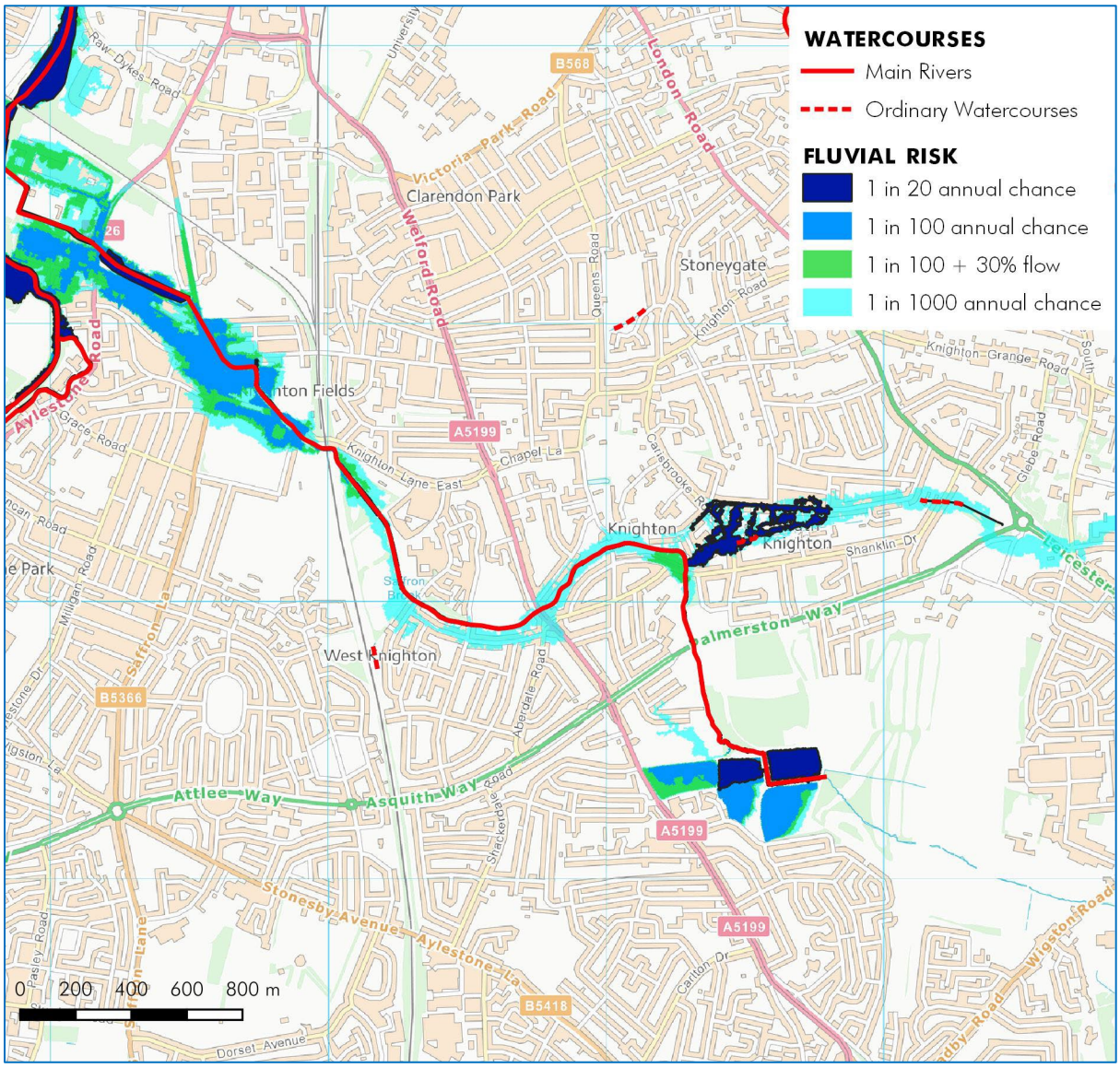

Figure 4.11 Saffron Brook catchment flood extents.

Willow Brook catchment

The Willow Brook is the largest of the urban tributaries of the River Soar in Leicester. The brook splits into a number of branches- the Bushby, Thurnby, Scraptoft, Evington and Ethel Brooks. The Thurnby and Bushby Brooks join near to the eastern boundary of the city at Dakyn Road flood storage area. This is an area of land which was lowered to store floodwater following extensive flooding in the lower catchment in 1968. Downstream of Dakyn Road washlands, the brook is joined by the Scraptoft and Evington Brooks, which are also designated Main Rivers. In the urban area, the Ethel Brook is a tributary of the Evington Brook and includes a flood storage area constructed in response to flooding in the 1960s.

The most recent EA modelling of the Willow Brook catchment suggests that flood risk is greatest along the Ethel Brook, though areas of risk exist along the whole network during extreme events, particularly in the lower catchment around Belgrave and North Evington (figure 4.12).

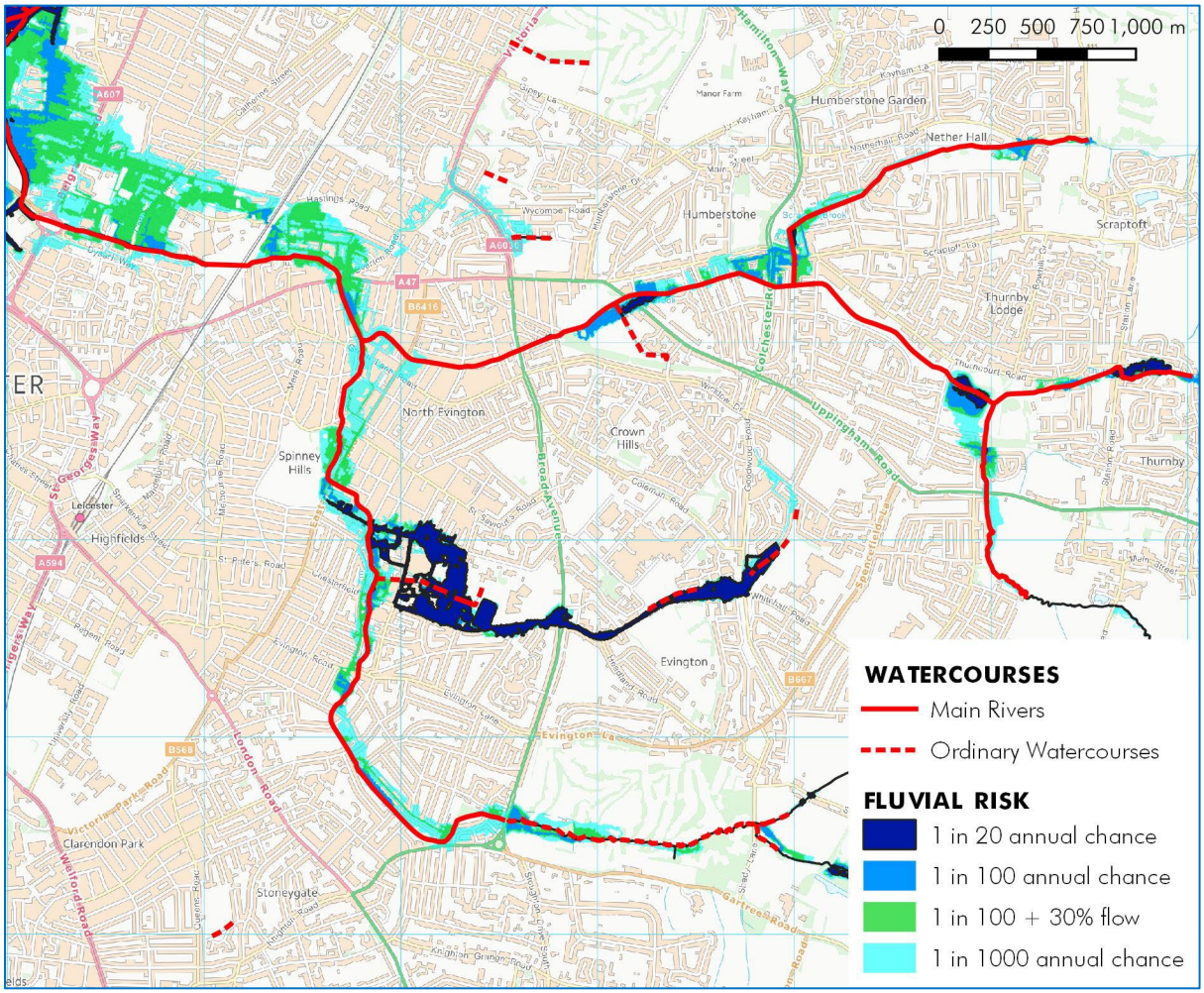

Figure 4.12 Willow Brook catchment flood extents.

Other small watercourses

The EA fluvial hydraulic models do not include every watercourse in the city. Whilst the areas of flood risk from these smaller watercourses may be less extensive, those proposing new developments and responsible for the preparation of flood risk assessments must check for the presence of Ordinary Watercourses on site and liaise with the Council's Flood Risk Management Team. A summary of data availability for notable Ordinary Watercourses is provided in table 3.3. This table is not definitive: other open channels do exist and must be protected, because they form part of the city's drainage infrastructure.

Flood risk data is available for the following Ordinary Watercourses:

- Ethel Brook: EA Willow Brook model
- Hol Brook: Leicester SWMP model
- Western Park brook: EA Braunstone Brook model
- Gilroes Brook: EA Braunstone Brook model
- Queen's Road Brook: Leicester SWMP model
- Portwey Brook: Leicester SWMP model
- Corporation Road Drain/ Glaisdale Close watercourse: Severn Trent Water Ltd may hold model data (sewer network only)

Climate change and flood risk: impacts on spatial planning

The available hydraulic models indicate that the area of Leicester at risk of Main River flooding in a 1 in 100 annual chance event could increase by 28% by the 2080s in the approximated central climate change emissions scenario (table 3.4). As such, climate change is an important factor in future land management decisions and the design of new development and has been included in the site appraisal process (Sequential and Exception Testing).

4.3. Surface water flood risk

An overview map of the Risk of Flooding from Surface Water is included in **Appendix E**

More detailed mapping can be found in the Interactive Maps in **Appendix I**

Surface water flood risk occurs when intense or prolonged rainfall cause water to flow over the land before reaching a river system.

Surface water flood risk was investigated by Leicester City Council in the SWMP. The study included 'direct rainfall modelling' to estimate which parts of the city are vulnerable to surface water flooding. However, more recent mapping was undertaken for the EA in 2013- the Risk of Flooding from Surface Water Maps- and those maps have been used as the basis for mapping surface water flood risk in this SFRA due to the more recent methodology. Developers should note that the EA is updating the Risk of Flooding from Surface Water Maps, with the release due in 2024. The Risk of Flooding from Surface Water maps define flood risk using the categories set out in table 35.

Risk of Flooding from Surface Water map definitions:

High risk: Land with an annual chance of flooding of greater than 3.3%.

Medium risk: Land with an annual chance of flooding of between 1% and 3.3%.

Low risk: Land with an annual chance of flooding of between 0.1% and 1%.

Very low risk: Land with an annual chance of flooding of less than 0.1%. This land is not shaded on the Risk of Flooding from Surface Water maps.

Flooding from surface water is difficult to predict for a number of reasons including:

- Variation in the capacity of the sewer network to accommodate runoff;
- Variation in runoff rates and local depression storage particularly in urban areas;
- Interactions with watercourses;
- Spatially varying rainfall depths and intensities, particularly from thunderstorms.

The Risk of Flooding from Surface Water maps provide a strategic scale information source which is appropriate for preliminary analysis at the Local Plan level, but further investigation of surface water flood risks may be necessary as part of a site-specific Flood Risk Assessment, including liaison with Severn Trent Water.

4.4. Surface Water Hotspots and Critical Drainage Areas

Maps of Hotspots and Critical Drainage Areas are reproduced in **Appendix F**

The SWMP identified a number of surface water flooding hotspots, where clusters of properties were found to be at risk. These hotspot areas are relatively consistent with the national Risk of Flooding from Surface Water maps and have been incorporated into this SFRA within the site appraisals. Particular attention will need to be given to surface water flood risk for new developments proposed within these Hotspot areas.

The SWMP also identified 'Critical Drainage Areas'. These are the catchments upstream of the Hotspots from where the urban runoff originates. In these areas, strict controls will be placed on discharge rates from new developments by the LFFA, and redevelopments should seek to reduce runoff back towards greenfield rates (figure 4.13).

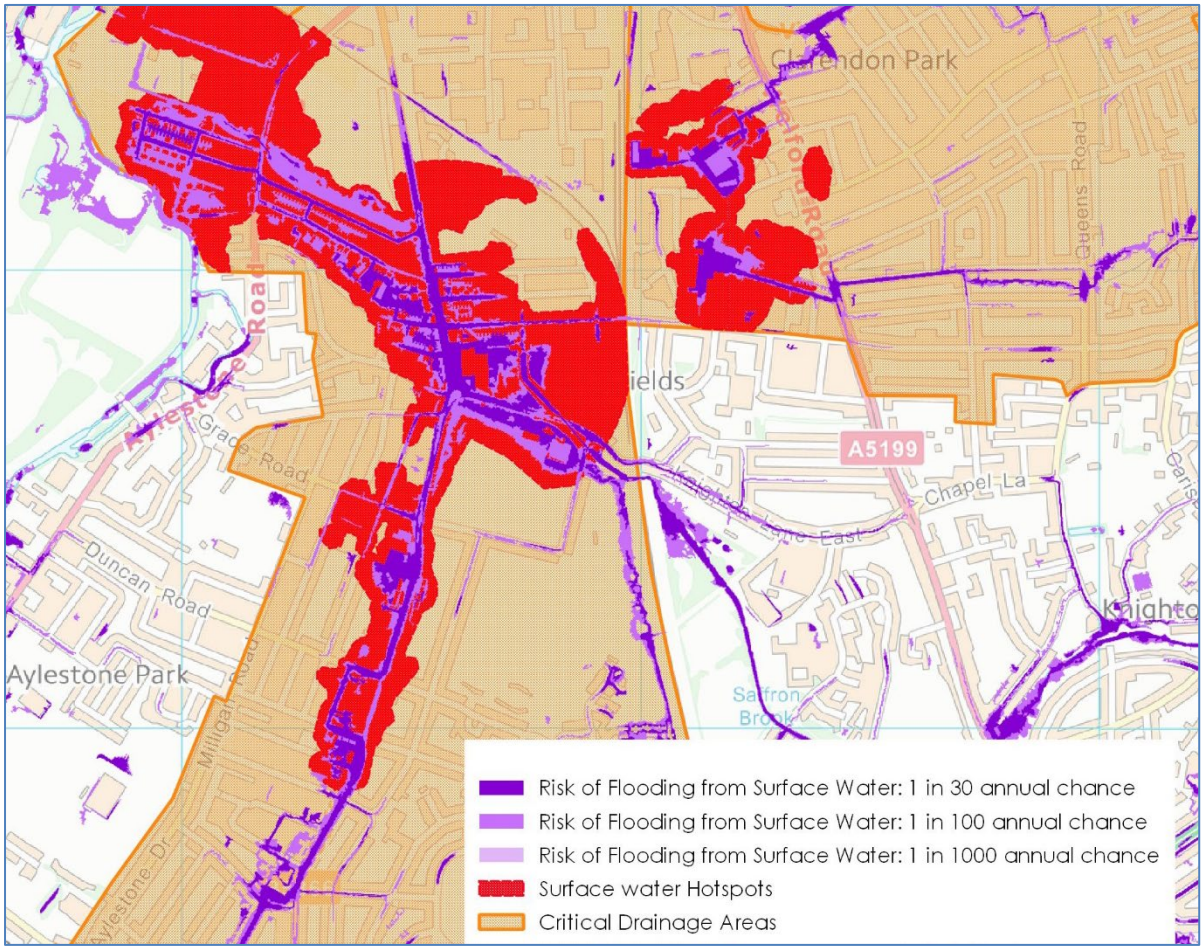

Figure 4.13 Example of surface water flood risk mapping.

4.5. Groundwater

A summary of groundwater flood risk is reproduced in **Appendix G**

Groundwater flood risk was analysed by URS for the Leicester Surface Water Management Plan and included in the previous Level SFRA. This remains the most up-to-date study and is included in Appendix G.

4.6. Reservoirs

Under the Reservoirs Act 1975, all reservoirs with an impounded volume of 25,000m3 and above must be registered with the EA. Reservoirs which are designated as 'high risk' are subject to regular inspection and supervision by suitably qualified reservoir engineers who provide the reservoir undertakers with guidance and directions on the work that needs to be taken to reduce the risk of failure.

In comparison to fluvial and surface water flooding, the actual likelihood of flooding due to reservoir failure is very low, but the potential severity of the consequences is very high due to the rapid release of vast quantities of water which exceeds even the most extreme natural floods on a river catchment. In addition, if issues arise at reservoirs during periods of high river flow, such as damage to a spillway, it may be necessary to release water at increased rates in order to protect the structure from further damage.

The EA provides maps of areas at risk of flooding due to reservoir-related inundation on the Long-Term Flood Risk Map for England. Reservoirs which have the potential to impact upon Leicester are listed in table 3.6. Developers should check the online maps and when developing in close proximity, consult with the reservoir owner.

The reservoirs with the potential to affect flood risk in Leicester and their purpose are:

- Braunstone Park Flood Storage Reservoir: Flood defence
- Knighton Park Flood Storage Area: Flood defence
- Dakyn Road Flood Storage Area: Flood defence
- Mallory Park Large Lake: Recreation
- Thornton Reservoir: Water supply

4.7. Flood warning

Maps of Flood Warning areas and Flood Alert Areas are included in **Appendix D**

The EA monitors the flow and level of the River Soar and a number of its tributaries on a continuous basis and uses this information, alongside rainfall data, to estimate the response of the river to rainfall. Warnings are issued when the river is expected to flood. There are five river gauges located in or upstream of Leicester:

- River Soar at Freemans Weir, Leicester
- River Soar at Littlethorpe
- River Soar at Sharnford
- River Sence at South Wigston
- Evington Brook, Spinney Hills, Leicester

Flood warning levels are as follows:

FLOOD ALERT: Flooding is possible, be prepared. Flooding of farmland, minor roads, fields, recreation land and car parks

FLOOD WARNING: Flooding is expected, immediate action required. Flooding of homes and businesses, rail infrastructure, roads with major impacts, extensive flood plain inundation (including caravan parks or campsites), major tourist/recreational attractions.

SEVERE FLOOD WARNING: Severe flooding, danger to life. Deep and fast flowing water, debris in the water causing danger, potential or observed collapse of structures, communities isolated by flood waters, critical infrastructure for communities disabled, large number of evacuees, military support.

5. Application of flood risk planning policy to new development

5.1. Introduction

The NPPF and accompanying guidance set out the way in which flood risk should be considered both during the development of a Local Plan and for individual planning applications. At the Local Plan level, the primary goal is to steer new development to areas of lower flood risk. This requires a strategic analysis across the administrative area of all sources of flooding, set against the requirements for future growth. The detailed assessment of flood risk for specific planning proposals occurs during the development planning stage.

5.2. The Sequential Test

The sequential, risk-based approach to the location of development in respect of flood risk is described in paragraph 161 of the NPPF. Central to the approach is the application of the 'sequential test'. The objective of the test is to steer new development to areas with the lowest risk of flooding (Flood Zone 1). Where there are no reasonably available sites for the new development in Flood Zone 1, the Local Planning authority can consider sites in Flood Zone 2 taking into account the vulnerability of the proposed development. If there remains an insufficient number of sites required to accommodate the future growth in the geographical area, the suitability of sites in Flood Zone 3 can then be considered, again taking into account the vulnerability of the proposed development (figure 5.1). It should also be recognised within this process that the risk of flooding can vary within Flood Zones 2 and 3 and that flood risk is likely to increase due to climate change.

At a Local Plan level the Sequential Test has been applied to the whole of Leicester administrative area in order to maximise the possibility of locating development in lower risk areas (Appendix I). The Test has been undertaken alongside the Sustainability Appraisal.

The Sequential Test does not need to be undertaken for individual planning applications where the site has been already allocated as part of the Local Plan, and it does not need to be undertaken for minor development or changes of use (with the exception of change of use to a caravan, camping or chalet site or to a mobile home or park home site).

Where development is proposed on sites which do not form part of the Local Plan, Sequential Test evidence will need to be submitted by the applicant. The extent of the geographical search for alternative sites at a lower risk of flooding should be agreed with Leicester City Council at the start of the process.

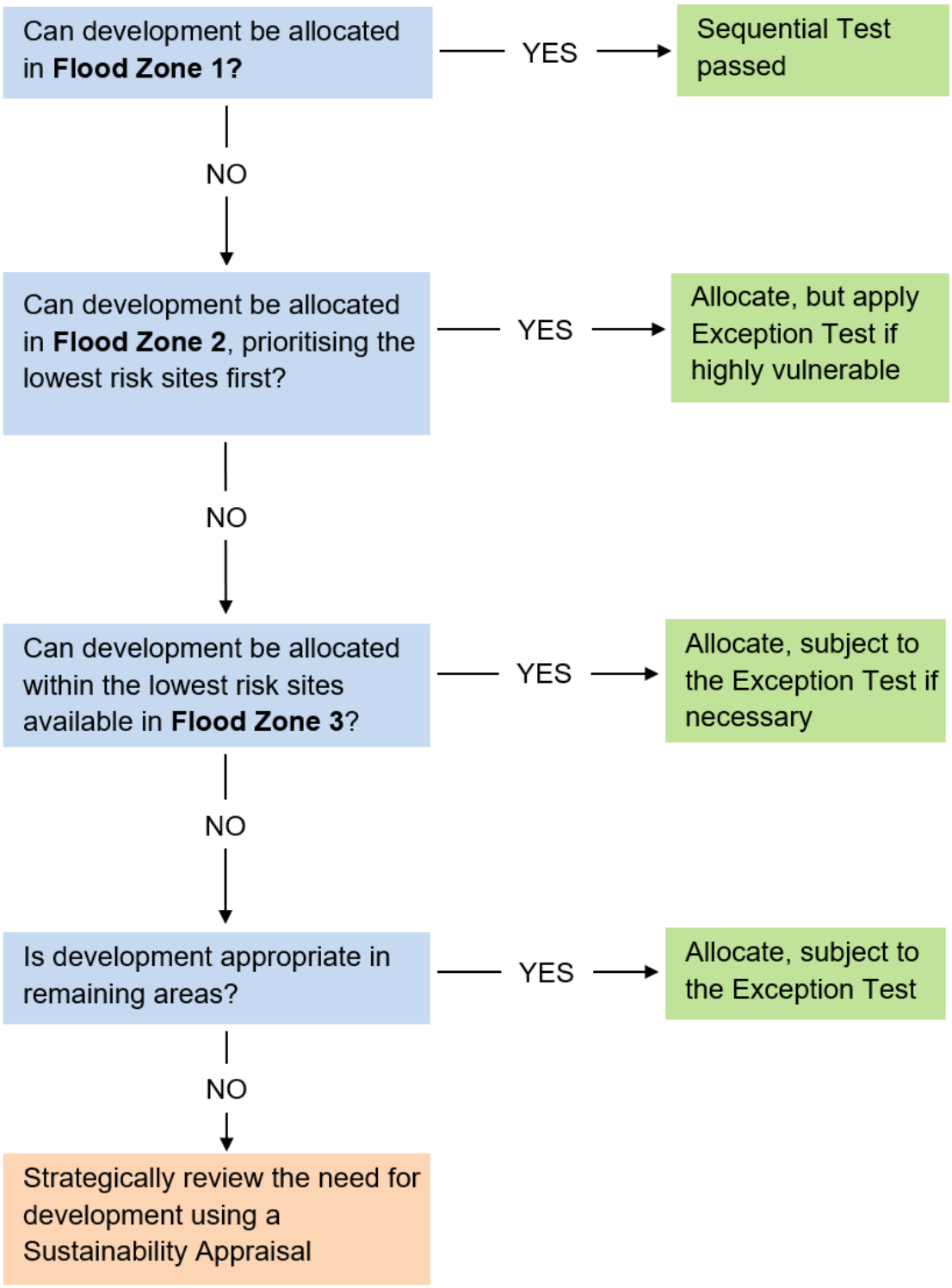

Figure 5.1 Application of the Sequential Test.

5.3. The Exception Test

The Exception Test is set out in paragraph 164 of the NPPF. The purpose of the test is to ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. Following application of the Sequential Test to a development proposal, table 5.1 sets out the circumstances in which the Exception Test must be undertaken for new development, according to the vulnerability of that development to flood risk.

Table 5.1 Flood risk compatibility (NPPF Practice Guidance Table 3).

Flood Zone	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Flood Zone 1	Yes	Yes	Yes	Yes	Yes
Flood Zone 2	Yes	Exception Test required	Yes	Yes	Yes
Flood Zone 3a	Exception Test required	No	Exception Test required	Yes	Yes
Flood Zone 3b	Exception Test required	No	No	No	Yes

In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to remain operational and safe for users in times of flood; result in no net loss of floodplain storage; not impede water flows and not increase flood risk elsewhere.

The Exception Test does not need to be applied to minor developments and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site. Where a mixed-use development is proposed, the highest vulnerability category should be used unless the development is considered in its component parts.

5.4. Flood Risk Vulnerability

Flood risk vulnerability classification (NPPF Practice Guidance Table 2) are as follows:

Essential infrastructure

- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
- Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood.
- Wind turbines.

Highly vulnerable

- Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding.
- Emergency dispersal points.
- Basement dwellings.
- Caravans, mobile homes and park homes intended for permanent residential use.
- Installations requiring hazardous substances consent*

More vulnerable

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
- Non–residential uses for health services, nurseries and educational establishments.
- Landfill* and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Less vulnerable

- Police, ambulance and fire stations which are not required to be operational during flooding.
- Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.
- Land and buildings used for agriculture and forestry.

- Waste treatment (except landfill and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.

Water-compatible development

- Flood control infrastructure.
- Ministry of Defence defence installations.
- Water and sewage transmission infrastructure and pumping stations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Sand and gravel working.
- Water-based recreation (excluding sleeping accommodation).
- Docks, marinas and wharves and navigation facilities.
- Lifeguard and coastguard stations.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.

Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'.

There are two parts to the Exception Test. For the test to be passed it should be demonstrated that:

a. the development would provide wider sustainability benefits to the community that outweigh the flood risk; and
b. 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.

Exception Test Part (a)

At the Local Plan level, part (a) of the Exception Test has been addressed through the Sustainability Appraisal and the process of site allocation. Appendix I sets out the flood risk to each of the site allocations. Provided that planning applications for allocated sites reflect the land use set out in the Local Plan and offer the same wider sustainability benefits, part (a) of the Exception Test will not need to be reassessed at the planning application stage.

When planning applications are submitted for sites which are not specifically allocated within the Local Plan, evidence to demonstrate that the development passes part (a) of the Exception Test will need to be submitted by the applicant. The criteria for assessing wider sustainability benefits will need to be agreed with Leicester City Council, taking the factors considered within the Sustainability Appraisal as a reasonable starting point. The Planning Authority will consider the use of planning conditions and/ or obligations to ensure that wider sustainability objectives can be achieved. Where compliance with part (a) cannot be achieved, the Exception Test has not been satisfied.

Exception Test Part (b)

At the Local Plan level, part (b) of the Exception Test has been considered, where required following application of the Sequential Test, using output from the available flood risk models. However, this analysis has only been undertaken at a strategic level, considering the type of development proposed within the land allocation against the constraints imposed by flood risk, because detailed development proposals are not available at this stage.

As such, conclusions reached at Local Plan level are only a preliminary guide and evidence to confirm that the development meets the requirements of part (b) of the Exception Test will need to be provided by the applicant as part of the planning application process. Where planning applications are submitted for sites which are not allocated in the Local Plan, both parts of the Exception Test will need to be addressed by the applicant.

Ideally, where evidence is required to demonstrate that a proposed development passes the Exception Test at planning application stage, this will be set out as dedicated chapter within the accompanying FRA. Part (a) is likely to require input from other disciplines e.g. planning specialists. Part (b) may take the form of a summary of the technical issues addressed in the FRA, demonstrating that the development will be safe over its lifetime and not increase flood risk elsewhere. Alternatively, the Exception Test may be addressed in a standalone document which references the appropriate sections of the FRA and other accompanying documents.

5.5. Flood Risk Assessments

When preparing individual planning applications, developers will need to undertake a site-specific flood risk assessment for certain types of development proposal. This includes:

- Development proposals in Flood Zones 2 and 3
- Development proposals in Flood Zone 1 where:
    - the site area is greater than or equal to one hectare;
    - the land has been identified by the EA as having critical drainage problems;
    - the land has been identified within the SFRA as being at increased risk of flooding in the future (due to climate change);
    - the land may be subject to other sources of flooding, such as surface water, where its development would introduce a more vulnerable land use than the existing.

Further high-level guidance on Flood Risk Assessments is available from Leicester City Council[12] and the Ministry of Housing, Communities and Local Government[13].

[12] https://www.leicester.gov.uk/media/184469/guidance-for-flood-risk-assessment-for-applicants-march-2019.pdf
[13] https://www.gov.uk/guidance/flood-risk-and-coastal-change

6. Flood Risk Assessment Technical Guidance

6.1. The benchmark for new developments

New development should be designed to be safe over its lifetime and not increase flood risk to others either now or in the future. As such, where a Flood Risk Assessment (FRA) is required to support a planning application, it is essential that the impacts of climate change on flood risk are taken into account.

In July 2021, the EA published updated guidance entitled "Flood risk assessments: climate change allowances[14]. The guidance sets out a series of anticipated flood flow increases on a catchment-by-catchment basis. The appropriate climate change allowances for the River Soar catchment, for a range of emissions scenarios, are reproduced from this guidance in table 6.1.

Table 6.1 Climate change allowances for the River Soar catchment.

Epoch	Central emissions scenario	Higher Central emissions scenario	Upper End emissions scenario
2020s	14%	18%	28%
2050s	16%	21%	35%
2080s	28%	37%	60%

The climate change allowances in table 5.1 are split into three epochs. New development must be tested against the climate change increases which could occur over the lifetime of the development. For example, residential development should be considered to have a lifetime of at least 100 years, meaning that the flood flow allowances set out in the '2080s' epoch should be used within the FRA. In the majority of cases it is only proposals for temporary use and some commercial developments which are likely to assessed against the climate change allowances for the '2020s' and '2050s' epochs. The applicant will be expected to justify the adopted lifetime of the development unless the 2080s epoch is used.

[14] EA, 2021. Flood risk assessments: climate change allowances. Available at https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. [Accessed 14 July 2022]

Which climate change allowance should be used to assess the proposed development?

The appropriate climate change allowance for different categories of development is set out in table 6.2, which is adapted from the EA (2021) guidance. The Higher Central allowance should be used in place of the Central allowance if the wider area at risk of flooding includes essential infrastructure.

Table 6.2 Application of climate change scenarios to categories of development.

Flood Zone	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Flood Zone 2	Higher Central	Central	Central	Central	Central
Flood Zone 3a	Higher Central	not permitted	Central	Central	Central
Flood Zone 3b	Higher Central	not permitted	not permitted	not permitted	Central

The climate change guidance may be superseded in the future by new published allowances and/ or new hydraulic model data, so it is important that applicants check the parameters of a FRA with the EA and the City Council Flood Risk Management Team early in the process. For new modelling studies, up to date allowances must be applied to fluvial inflows.

Rainfall allowances are used instead of peak flow allowances for drainage design and the hydraulic modelling of small (<5km2) urban catchments. Drainage systems for new developments should be tested against both the Central and the Upper End scenario. The allowances (as of July 2022) differ from river flow allowances in so far as they vary by rainfall return period (table 6.3).

Table 6.3 Rainfall allowances for the River Soar catchment.

Allowance category	Central allowance 3.3% AEP event	Central allowance 1% AEP event	Upper End allowance 3.3% AEP event	Upper End allowance 1% AEP event
2050s	20%	20%	35%	40%
2070s	25%	25%	35%	40%

The Risk of Flooding from Surface Water maps currently (July 2021) do not include any allowances for future climate change. Analysis of FEH 2013 rainfall data for Leicester indicates that the rainfall depths at the present day 1 in 1000 annual chance rainfall event exceed the Upper End climate change scenario allowance. As such, the flood risk arising from the 1 in 1000 annual chance event has been used as a precautionary approach to the site appraisal process. For individual FRAs where a risk of surface water flooding is indicated in the SFRA mapping, the assessment should include a consideration of the potential impacts of climate change on surface water flood risk. This may be through more detailed pluvial flood modelling (particularly if there is a flow route across the site) or by taking a similarly precautionary approach to the assessment of risk and layout of the site.

6.2. Flood risk to the development

New development which is classified as more or less vulnerable must be adequately protected against the 1 in 100 annual chance fluvial flood event including the appropriate allowance for climate change as set out in tables 5.1 and 5.2. In addition, freeboard should be in place to protect against uncertainty. Other categories of development may require a different standard of protection depending on the nature of the proposal and should be discussed with the EA and the Lead Local Flood Authority early in the development process. For example, within the 'water compatible use' category, sports changing rooms may be designed to a lower standard of protection with flood resilient design, but new flood control infrastructure may need a much higher standard of protection especially if electrics/ telemetry are involved.

Protection against surface water flood risk should be to a similar standard, noting that there is additional uncertainty in surface water model data due to, inter alia, representation of sewer capacity in a proxy form and lack of model calibration data. Where necessary, uncertainty in the flood risk data should be reduced though more detailed local analysis.

Sequential Approach to site layout

Where flood risk exists on part of site, a sequential approach to site layout- placing lower vulnerability land uses in areas of greater flood risk- should be taken, to ensure that new development is appropriate to the flood zone in which it is located. For example, where a residential development on a site which spans Flood Zones 1 to 3 includes a provision of green space, a sequential approach to site layout would steer the green space towards Flood Zone 3 and the housing towards Flood Zone 1.

Protection of property- raised floor levels

Where new development is considered to be sequentially acceptable in Flood Zones 2 or 3, it will be necessary for the applicant to demonstrate that the property will be safe over its lifetime in order to meet the requirements of the NPPF. The primary means of protecting new development against flood damage is often to raise the floor level of new buildings. As a starting point, freeboard of at least 600mm should be provided above the design flood level (which should include the appropriate allowance for climate change), though this may vary depending upon the characteristics of the flood risk at higher return periods. For example, it may be possible to reduce the freeboard to 300mm if this is also provides protection against the Upper End climate change scenario, because this indicates that the flood level is less sensitive to increases in river flow. Conversely, if a site is particularly vulnerable to the impacts of climate change, or is located near to a structure with a trash screen that could block with flood debris, then it may be necessary to raise floor levels further in relation to flood level to provide protection against extreme events and the uncertainty inherent in hydrological analysis and hydraulic modelling.

The appropriate freeboard allowance should be justified within the FRA and agreed with the EA and Leicester City Council, with the aim of providing a high level of certainty that the property will not be damaged by flooding either now or in the future. It is highly unlikely that a flood risk assessment accompanying a residential development proposal will be accepted with a floor level below the design flood level (including the appropriate allowance for climate change and an allowance for freeboard). In cases of commercial/ industrial redevelopment of an existing site, there may be greater flexibility provided that the redevelopment results in a net reduction in the exposure of property to flood risk.

Protection of property - flood resilient/ resistant design

In some cases, flood resilient construction may enable the freeboard to be reduced, or to protect against additional risks identified in extreme or unpredictable events (such as culvert blockage). This is not likely to be an acceptable alternative to a sequential approach to site layout, or to raising the floor levels for new residential development (especially for single storey residential development), but there may be scope within commercial development to incorporate resilient design measures, particularly in cases of redevelopment where the existing flood risk can be reduced.

Another example where flood resilient design may be acceptable is in the conversion of a factory to mixed use development, with commercial use retained on the ground floor and the upper storeys converted to residential use. In this scenario, providing that safe access is in place, the retrofitting of flood resilient design measures to the ground floor would decrease the exposure of the building to flood risk in circumstances where it may not be possible to raise the floor level internally.

Raising of ground levels

There may be occasions where a general raising of ground levels is preferable to raising floor levels as a means of protecting property against the risk of flooding. Equally, a combination of these two approaches may be used. However, this must not result in an increase in flood risk elsewhere and it increases the requirement for the provision of compensatory flood storage (see section 5.3).

Basement dwellings

Basement dwellings are particularly vulnerable to flood risk and are not permitted within Flood Zone 3 under the NPPF. In Flood Zone 2, basement dwellings are subject to the Exception Test and the impact of climate change must be considered. Basement dwellings should also be avoided in areas at risk from other sources of flooding, such as surface water and groundwater flood risk.

Protection of site users - safe access

Voluntary and free movement of people should be available to users of a new development, taking climate change into account. The safety of access routes to new development should be assessed in terms of the Flood Hazard Rating, calculated using the appropriate climate change scenario applied to the 1% AEP event (1 in 100 annual chance). Flood hazard output data from river models combines the factors of flood depth, velocity and the likely presence of debris to give a risk rating in accordance with a methodology set out in EA/DEFRA research document FD2320[15]. The application of flood hazard rating to new development

[15] EA/ DEFRA, 2005. FD2320 Flood Risk Assessment Guidance for New Development

should be considered against the explanatory note issued by the EA in 2008[16]. Flood hazard classifications from this explanatory note are reproduced in table 6.4 (correcting for minor inconsistencies). Table 6.5 provides indicative guidance on the application of flood hazard ratings to different categories of new development. However, the assessment of flood hazard is highly site-specific and local factors should be taken into account, such as the nature of the terrain, the proximity of rivers and fast-flowing secondary flow routes, visibility, the length of inundation along the access and the presence of un-marked drops. and manhole chambers.

Table 6.4 Hazard to people classification using hazard rating.

	Depth of flooding (m)												
	0.05	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
Velocity (m/s)	**Debris Factor** 0.50				**Debris Factor** 1.00								
0.00	0.53	0.55	0.60	0.63	1.15	1.20	1.25	1.30	1.40	1.50	1.75	2.00	2.25
0.10	0.53	0.56	0.62	0.65	1.18	1.24	1.30	1.36	1.48	1.60	1.90	2.20	2.50
0.30	0.54	0.58	0.66	0.70	1.24	1.32	1.40	1.48	1.64	1.80	2.20	2.60	3.00
0.50	0.55	0.60	0.70	0.75	1.30	1.40	1.50	1.60	1.80	2.00	2.50	3.00	3.50
1.00	0.58	0.65	0.80	0.88	1.45	1.60	1.75	1.90	2.20	2.50	3.25	4.00	4.75
1.50	0.60	0.70	0.90	1.00	1.60	1.80	2.00	2.20	2.60	3.00	4.00	5.00	6.00
2.00	0.63	0.75	1.00	1.13	1.75	2.00	2.25	2.50	3.00	3.50	4.75	6.00	7.25
2.50	0.65	0.80	1.10	1.25	1.90	2.20	2.50	2.80	3.40	4.00	5.50	7.00	8.50
3.00	0.68	0.85	1.20	1.38	2.05	2.40	2.75	3.10	3.80	4.50	6.25	8.00	9.75
3.50	0.70	0.90	1.30	1.50	2.20	2.60	3.00	3.40	4.20	5.00	7.00	9.00	11.00
4.00	0.73	0.95	1.40	1.63	2.35	2.80	3.25	3.70	4.60	5.50	7.75	10.00	12.25
4.50	0.75	1.00	1.50	1.75	2.50	3.00	3.50	4.00	5.00	6.00	8.50	11.00	13.50
5.00	0.78	1.05	1.60	1.88	2.65	3.20	3.75	4.30	5.40	6.50	9.25	12.00	14.75

Flood Hazard Rating	**Colour**	**Hazard to people classification**
Less than 0.75		Very low hazard- caution
0.75 to 1.25		Danger for some - includes children, the elderly and the infirm
1.25 to 2.00		Danger for most - includes the general public
Greater than 2.00		Danger for all - includes the emergency services

An Emergency Plan may help to demonstrate that a development can be made safe in respect of access to the site in flood conditions but is unlikely to overcome fundamental access issues that would expose people to an unacceptable degree of flood risk. The vulnerability of users must be considered in the FRA, including the fact that occupants of a building may be of restricted mobility or unable to leave their premises at short notice without support. The effective operation of a flood Emergency Plan generally requires the

[16] EA, 2008. Supplementary note on flood hazard ratings and thresholds for development planning and control purposes- Clarification of Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1.

presence of individuals with an oversight of health and safety issues on a site. Further guidance on the requirements for Emergency Plans is available in ADEPT/ EA guidance[17].

Table 6.5 Suitability of development type by flood hazard rating (indicative).

Flood Hazard	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
No flood hazard	Yes	Yes	Yes	Yes	Yes
Very Low hazard	Yes	No	Yes	Yes	Yes
Danger for Some	site specific	No	No	Yes *	site specific
Danger for Most	site specific	No	No	No	site specific
Danger for All	site specific	No	No	No	site specific

* For less vulnerable development, a hazard rating of 'danger to some' may be acceptable if a flood management plan is agreed with the planning authority which demonstrates that the facility can be left in advance of a flood, and that there is no requirement for ongoing operational presence during a flood.

Development behind defences

Flood defences reduce the risk of flooding but do not remove it entirely. Where development is proposed behind flood defences, those defences must provide a standard of protection which is appropriate for the type of development, be structurally sound and be designed to cope with flood risk over the lifetime of the development.

New development which is particularly close to raised flood defences may be at risk of rapid inundation in the event of defence failure or overtopping. In these cases the FRA should include an assessment of the impacts of defence failure as part of the determination whether the site will be safe. Mitigation should be in place to lessen the consequences of defence

[17] ADEPT/EA, 2019. Flood risk emergency plans for new development.

failure to property and users of the site. In addition, it is likely that the Risk Management Authorities will require an easement to be left free of development adjacent to raised defences, normally of 8m in width measured from the toe of the defence. This is to enable access for maintenance and repair/ rebuilding.

Construction of new defences

The installation of new flood defences (temporary or permanent) purely to protect new development is unlikely to be agreed, because of the potential for negative impacts on third parties, the need to ensure that the defence is maintained over the lifetime of the development and the residual flood risk that will remain (i.e. breach). There may be exceptional cases where new defences will be permitted if they provide a wider public benefit by reducing flood risk to existing communities, provided that the scheme can be secured through the planning system and agreed with the Risk Management Authorities. In such cases it would be preferable where space permits to design the new development as a raised ground platform rather than building new linear raised assets, because the latter would require maintenance investment into the foreseeable future.

6.3. Flood risk to others

New development must not cause an increase in flood risk elsewhere. This can arise due to due i) a reduction in the storage capacity of the floodplain, ii) the alteration of flood flow routes, or iii) an increase in runoff from the site.

Floodplain storage capacity

Floodplains attenuate the flow of water downstream by providing temporary storage outside the main river channel. Floodplains are a natural part of lowland river systems. New development in areas of flood risk has the potential to reduce this attenuating effect by displacing water, resulting in an increase in flood risk elsewhere. This can be a direct impact from a single new development, or a cumulative effect that occurs over time as the capacity of the floodplain is progressively reduced.

In order to prevent an increase in flood risk elsewhere it is necessary to preserve the volume of floodplain available for the storage of floodwater. Where raising of ground levels or an increase in building footprint occurs, compensatory works must be undertaken to preserve the overall capacity of the floodplain, on a 'level-for-level' basis. This means the provision of new areas set aside for flooding, at the same elevation as those areas which are lost, on a part of the site where this does not result in unacceptable flood risks. For example, it may be

possible to set aside areas of public open space for flood storage as part of the blue-green infrastructure network. Where sufficient land within the site is not available for the provision of compensatory floodplain storage provision, off-site compensatory works may be acceptable, provided that the scheme can be secured through the planning system and ensures that flood risk is not increased to third parties.

The need for hydraulic testing of compensatory floodplain works as part of the flood risk assessment process depends upon the scale and nature of the proposal and should be discussed at an early stage with the EA and/ or Leicester City Council. Off-site works are likely to require hydraulic testing, since geographical separation between the location of the floodplain storage loss and the compensatory storage gain introduces additional uncertainty.

Flood flow routes

New development proposals must ensure that risk is not increased elsewhere by the alteration of flood flow routes. This includes both fluvial and pluvial sources. Examination of flood model data, particularly time series animations and depth and velocity grids can aid the identification of flood flow routes. Where a flood flow route does cross a site, the provision of level-for-level compensatory works may not be sufficient to prevent an increase in flood risk elsewhere as these works may not recreate the existing flow routing. In these cases, it is likely that hydraulic testing of the development will be necessary through adaptation of an existing hydraulic model or development of a new model. New drainage systems should be designed with safe routing for exceedance flows to avoid flood risk to property during extreme or unpredictable events (e.g. sewer blockage).

Runoff

Increases to the area of hard surfacing on a site can lead to increases in the volume and peak rate of rainfall which runs off a site following storm events. In order to demonstrate that flood risk will not be increased elsewhere as a result of increased runoff, a drainage strategy must be incorporated into the FRA. Further guidance is provided in chapter 6.

6.4. Protection of watercourses

The EA and Leicester City Council as Risk Management Authorities (RMAs) generally require buffer strips, free of development, to be left adjacent to watercourses for the following reasons:

- to provide for maintenance access;
- to allow for the natural geomorphological evolution of a watercourse;
- to protect the biodiversity value of watercourses and the adjacent riparian zone.

As a general guide, an 8-metre buffer strip free of development (measured from the top of the bank) is usually required, both by the EA and the Lead Local Flood Authority. Early consultation is recommended when development is proposed on a site which a watercourse flows through or runs adjacent to.

The appropriate treatment of the land alongside the watercourse will depend on its existing state (developed/ natural), the requirement for access to facilitate maintenance, and the nature of the watercourse itself (e.g. semi-dry ditch, small stream, river). The riparian zone alongside watercourses often provides important habitat, so the treatment of the watercourse should also be considered in terms of its value as a blue-green infrastructure asset. There may be opportunities to improve watercourses during the redevelopment process, providing a reduction in flood risk, ecological benefit or public amenity.

The culverting, bridging or diversion of watercourses requires the prior written consent of the EA (Main Rivers) or Leicester City Council (Ordinary Watercourses). Culverting of a watercourse is unlikely to be permitted, except for access crossings where no alternatives exist.

6.5. Extensions to existing buildings

In cases of minor development where an extension is proposed to an existing building, such as a domestic extension, floor levels should be set no lower than existing levels. This may also be a good time to introduce flood resilience measures to the existing property if it is at a high risk of flooding.

6.6. Interpretation and use of flood risk model data

The interpretation of data from hydraulic models requires input from experienced flood risk professionals. The following section provides some general guidance on the use of data which can be supplied by the EA or Leicester City Council depending upon the source of flooding. However, this guidance is not definitive and each site should be discussed with the appropriate RMA.

The flood risk data used to inform this SFRA is drawn from coupled 1d-2d hydraulic models (fluvial flooding) and 2d-only hydraulic models (pluvial flooding). Main River models can be sourced from the EA. Ordinary Watercourse models can be sourced from Leicester City Council (or the EA where these are amalgamated into Main River models). Output data from the Risk of Flooding from Surface Water Maps is available online but the models themselves are not. It is important to recognise in the preparation of a FRA that whilst hydraulic models can provide an important source of evidence for estimating the flood risk to a site, there is always a degree of uncertainty because models are, by definition, a simplification of complex physical processes. In addition, flood hydrology becomes increasingly uncertain at high magnitude events.

Climate change output

The EA provided new (draft) hydraulic models of the Main Rivers and a number of Ordinary Watercourses in June 2022 for this update of the SFRA. The models do not directly replicate the updated climate change allowances published in July 2021. As such, if using EA model output data to inform a flood risk assessment, a precautionary approach should be taken using the nearest set of simulations which equal or exceed the published climate change allowances. Alternatively, applicants may choose to re-run the hydraulic models with the new allowances. As of July 2022:

Central 2080s scenario: Use the 1% AEP+30% model output or update the model.

Higher Central 2080s scenario: Use the 1% AEP +50% model output or update the model.

Climate change output is not available as of 12th August 2022 for the Hol Brook and Portwey Brook models held by the City Council. As such, a precautionary approach should be taken using the 1 in 1000 annual chance event as the benchmark for assessing the safety of a new development over its lifetime. Alternatively, the models could be re-run with the appropriate climate change allowance. Further guidance on climate change is provided in section 5.1. As our understanding of climate change develops, new flood flow and rainfall allowances may be issued, or the methodology by which new development proposals should be assessed may change. FRAs should use the most up to date guidance. Early consultation with RMAs is important for agreeing the parameters of a FRA.

Water level output data

The flood models in Leicester provide water level data in a grid format. In-channel water levels can also be obtained from the 1d model nodes. Care should be taken when interpreting water levels in areas where there is a notable change over a small distance. This can arise around structures, along flow routes, or in parts of the floodplain into which limited volumes of water spill and in which the maximum water level is volume dependent.

Flood depth output data

In general, depth of flooding should be confirmed by comparing a site topographic survey against modelled water levels rather than relying solely upon modelled flood depth output data, because the hydraulic models rely on remotely sensed ground elevation data with a wider error margin than ground survey. Where notable differences are found between site topographic survey and the remotely sensed LiDAR data used in the hydraulic models, it may be necessary to re-run the hydraulic model using the updated topographic survey. Early discussions with the RMAs are especially important in these cases. Flood depth output may also be useful in the early identification of flood flow routes and the provision of compensatory floodplain storage.

Flood hazard output data

Flood hazard output data can be used to help assess the safety of a development in respect of access and egress (section 5.2). Where topographic survey of a site deviates notably from the LiDAR used in the hydraulic model (which can be established by comparing modelled flood extents against mapping of water levels against topographic survey, or by comparison of the survey against the model DEM), it may be necessary to re-run the hydraulic model to update the assessment of flood hazard. This is because the velocity and depth of flooding may change and velocity cannot readily be re-calculated without re-running the hydraulic model. Early discussions with the RMAs are especially important in these cases.

Velocity output data

Velocity output data as a means of assessing flood risk to people is less useful than flood hazard data, because it is generally considered to be the combination of velocity, flood depth and the presence of debris which influences the hazard to users of a site. For example, shallow flooding with a relatively high velocity may present a lower risk to people than deeper water flowing at a lower velocity. As such, velocity data only provides part of the picture. In conjunction with flood depth output, velocity data may be useful in the identification of flood flow routes.

Other output data

Other output data can be extracted from the available hydraulic models, but care must be taken with its use in a FRA. For example, duration of inundation is highly dependent upon the characteristics of the design storm and the ability of the local drainage system to remove water after the flood wave passes downstream and may vary considerably in real floods. Time to inundation is also highly dependent upon the characteristics of the storm and may be considerably over- or underestimated when compared to real floods. The urban tributaries in Leicester can respond very rapidly to thunderstorms or more slowly to long duration rainfall in the rural headwaters. As such, care must be taken when using these types of output data in a FRA.

Confluence Areas

In confluence areas, there may be a risk of flooding from more than one watercourse. For example, parts of Belgrave may be at risk from both the River Soar and the Willow Brook. All sources of flooding will need to be considered within the FRA, but the conclusions should take the more significant source of flood risk as the primary benchmark for assessing the safety of the development over its lifetime. For example, this would mean ensuring that finished floor levels are above the modelled flood level for the River Soar if this is higher than the modelled flood level for the Willow Brook. The development should not lead to an increase in flood risk elsewhere from any source of flooding.

Pluvial model output data

The EA has made available output data concerning the depth, velocity and flood hazard from the Risk of Flooding for Surface Water maps. Where this data indicates a potentially unacceptable degree of flood risk, it may be necessary to undertake more detailed surface water modelling. In such cases, applicants should liaise with Leicester City Council Flooding Team and Severn Trent Water in relation to surface water flood risk and to agree the nature of any required modelling work. The Risk of Flooding from Surface Water maps are a national dataset based upon a generalised modelling approach, which represents the capacity of sewers in a proxy form. It is important to recognise the limitations of this model when assessing flood risk to new development and to investigate the risk of flooding in more detail where, prima facie, pluvial flooding risks may exist.

Using the best available data

The hydraulic models used for flood risk management in Leicester are periodically updated, incorporating new datasets and taking advantage of software and hardware improvements. Although this SFRA should be regularly updated with the best available data, there may be periods between updates when new data is available from the RMAs, but not yet reflected in the content of the SFRA or the accompanying maps. In order to ensure that FRAs make use of the best available data, requests for flood risk information should be made to the RMAs at the earliest opportunity in the development planning process.

7. Sustainable Drainage

7.1. Background

Sustainable Drainage Systems (SuDS) encompass a range of techniques which drain water in a sustainable manner by mimicking natural processes. The aims of SuDS are to:

- Reduce the peak flow and volume of water which runs of a development site following heavy rainfall;
- To protect and where possible enhance water quality;
- To provide habitat for wildlife;
- To enhance the amenity value of shared spaces on new developments;
- To encourage groundwater recharge

Traditional approaches to the drainage of new developments often involved removing runoff from sites as quickly as possible, conveying it to the downstream sewer system or watercourses which may already be at full capacity. SuDS help to prevent the negative impacts associated with traditional approaches to surface water management on new developments, which can include an increase in downstream flood risk and increases in pollutant concentrations in receiving watercourses.

7.2. The requirement for SuDS: National Policy

Paragraph 169 of the NPPF requires the incorporation of sustainable drainage systems into major developments unless there is clear evidence that this would be inappropriate. These systems should:

- take account of advice from the LLFA (Leicester City Council);
- have appropriate proposed minimum operational standard;
- have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
- where possible, provide multifunctional benefits.

The non-statutory technical standards for SuDS[18] set out basic technical requirements for new sustainable drainage systems.

[18] DEFRA, 2015. Sustainable Drainage Systems: Non-statutory technical standards for sustainable drainage systems. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf. [Accessed 14 July 2022].

7.3. Application of SuDS to new development in Leicester

Surface water flood risk data indicates that Leicester has a relatively high risk of surface water flooding. The Lead Local Flood Authority (LLFA) expects SuDS to be used where practicable for all new developments, to reduce surface water runoff and deliver other benefits such as improving water quality, providing visual amenity and biodiversity benefits, and lower maintenance requirements. This is reflected Policy 2 of the 2014 Core Strategy. Development proposals should demonstrate that SuDS can be managed and maintained throughout the lifetime of the development.

Early consultation with the Leicester City Council is advised during the development planning process. Specific technical queries relating to SuDS and requests for data to assist with a Flood Risk Assessment can be directed to the Flooding Team. More general queries relating to development of a site, including SuDS in public open spaces along with landscape design and ecological requirements should be made through a request for pre-application advice at https://www.leicester.gov.uk/planning-and-building/planning-applications/apply-for-pre-application-advice/.

In addition, it is important to engage early with Severn Trent Water if the intention is to discharge water into the public sewer network, the EA if discharging to a designated Main River, or the Canal and River Trust if discharging into the Grand Union Canal.

7.4. Technical guidance

Best practice guidance on the design and implementation of SuDS can be found in a range of publications including:

- CIRIA (2015) C753 SuDS Manual.
- Local Authority SuDS Officer Organisation (2016) Non-Statutory Technical Standards for Sustainable Drainage Practice Guidance.
- DEFRA/ EA (2012) Preliminary rainfall runoff management for development Rev E

The LLFA will expect drainage proposals to comply with the standards set out in industry guidance and to maximise benefits under the four 'pillars' of SuDS: water quantity, water quality, biodiversity and amenity[19].

Surface Water Drainage Strategy / Statement

For minor development, a Drainage Statement should be provided for the LLFA detailing how surface water is currently managed on the site and how it will be managed following the development. For all major development, the same principles apply and should be presented in more detail with accompanying drawings and calculations that form a detailed Surface Water Drainage Strategy. Where a Flood Risk Assessment is required as part of the planning application process, the Surface Water Drainage Strategy may either be incorporated into the FRA or submitted as a standalone document which is clearly referenced at the appropriate points in the FRA.

The discharge hierarchy

Runoff from new developments should be directed according to the discharge hierarchy set out in part H of the Building Regulations. The hierarchy is as follows, listed in order of priority:

- an adequate soakaway or some other adequate infiltration system, or, where that is not reasonably practicable;
- a watercourse, or where that is not reasonably practicable;
- a sewer.

Infiltration

Across much of Leicester the potential for infiltration SuDS is restricted by the nature of the soil and geology, though potential may exist for infiltration SuDS in combination with surface attenuation. If a soakaway or other infiltration-based system is to be used as the method of surface water discharge from the site, the LLFA will require infiltration rates to be estimated in accordance with BRE Digest 365 or CIRIA guide C156. Furthermore, the location of soakaways must conform to Part H of the Building Regulations.

[19] Woods-Ballard, B., Wilson, S., Udale-Clarke, H., Illman, S., Scot, T., Ashley, R. and Kellagher, R., 2015. The SuDS Manual. C753, CIRIA, London, UK.

Runoff rates and volumes

The LLFA expect that SuDS will be integrated into a new development to manage runoff rates and volumes in accordance with the guidance contained in CIRIA publication C753 The SuDS Manual. Where development is proposed on greenfield sites, the LLFA expect the surface water runoff regime to emulate a greenfield response. Preferably, the greenfield rate runoff rate should be calculated using Flood Estimation Handbook methods and evidenced with accompanying drainage calculations.

Where major development is proposed on brownfield sites, the LLFA expect a minimum 50% reduction on pre-development site runoff rates where practicable. In those parts of the city which have been identified as Critical Drainage Areas, runoff rates should be reduced to pre-development greenfield rates where practicable due to the high level of downstream flood risk to which the existing development may currently be contributing. Severn Trent Water may also require a reduction in runoff rate in relation to brownfield sites and should be contacted early in the development process. For minor development on brownfield sites, the aim should be to provide betterment on runoff rates.

Designing for exceedance

It is important that new development is able to cope with unexpected or extreme situations where the capacity of the drainage system is exceeded. This may occur through blockage or collapse of drainage infrastructure, or extreme rainfall that exceeds the design standard of the drainage system. Good design should ensure that surface water can be safely routed to parts of the site where flooding will not cause significant damage or risk to people. Ensuring that building floor levels are substantially above adjacent highway levels (e.g. >150mm) will help to reduce the risk of flooding from exceedance of the drainage network.

Construction Phase

The construction phase of a development often presents challenges to the management of stormwater, including high percentage runoff, mobilisation of silt/ earth from exposed ground and flood flow routing across unfinished topography. Measures should be detailed to ensure that the level of flood risk on site or to adjacent property is not increased during construction and that the site is resilient to any potential flooding. These measures should also limit excess surface water runoff and silt/ earth entering the public sewer systems, private drainage and watercourses.

Biodiversity, Water Quality and Amenity

SuDS provide an opportunity to enhance the public spaces within development sites and to offer much-needed habitat for wildlife in urban areas. Furthermore, it is important runoff from new surfaces does not cause a reduction in the water quality of receiving watercourses. CIRIA guidance document C753 provides useful information on the water quality performance of a range of SuDS features and design guidance which can help to maximise biodiversity and amenity value. The LLFA will expect the design of SuDS features to maximise opportunities for biodiversity enhancement and good quality open spaces. Well-designed SuDS may also contribute to meeting Biodiversity Net Gain requirements.

8. Opportunities to reduce flood risk

8.1. Policy context

Paragraph 161 of the NPPF requires opportunities to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques) to be identified at the Local Plan level. Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, opportunities should be sought to relocate development, including housing, to more sustainable locations. Paragraph 164 of the NPPF requires new development proposals, where possible, to reduce flood risk overall (part (b) of the Exception Test). Opportunities to reduce the risk of flooding may exist on both greenfield and brownfield sites.

8.2. Reducing flood risk through redevelopment

Historically, the River Soar and its tributaries played an important role in the growth of the manufacturing industry in Leicester, supplying water for industrial processes and transport links for goods via the Grand Union Canal. Growth of the city has been coupled with improvements in flood protection, but there are areas of developed, low-lying land near to watercourses which are at risk of flooding. The redevelopment of previously developed sites on the floodplain can provide an opportunity to reduce the exposure of people and property to flooding. This may be a reduction in flood risk at the site itself, or in some cases an overall reduction in flood risk to the local community.

Reducing flood risk to property

In cases where redevelopment involves the demolition of existing buildings and construction of new buildings, new buildings should be protected against the risk of flooding. This is usually achieved by raising the building floor level or the ground level above the design flood level (including freeboard- see section 5.2). Over time, this redevelopment process, particularly in riverside industrial areas, can reduce the overall exposure of the city to flood risks provided a good standard of mitigation is incorporated. The onus is on developers to ensure that new property is not exposed to flood risk and it should be noted that grant-in-aid funding for public flood protection works is not available to new dwellings built from 2012 onwards[20].

[20] DEFRA, 2012. Flood and Coastal Resilience Partnership Funding.

The conversion or renovation of a building offers an opportunity to incorporate flood resilience or flood resistant design measures into the ground floor of the structure if internal floor levels cannot be raised. However, these measures alone may not provide sufficient protection for a more vulnerable form of development on the ground floor than the existing use. In exceptional circumstances, flood resilient/ resistant design may be justifiable where the intention is to return to residential use a dwelling which was previously converted to non-residential use (e.g. a ground floor shop) whilst living accommodation remained above, provided that bedrooms are not located on the ground floor.

Reducing flood risk to people

The redevelopment of brownfield sites can offer an opportunity to reduce the risk of flooding to site users by relocating buildings to higher land with a lower flood hazard rating along access routes.

Reducing downstream flood risk through SuDS

Historically the goal of drainage was usually to remove water from a site as quickly and efficiently as possible, with little consideration of the potential increase in flood risk downstream. In Leicester, much of the flow in the urban tributaries of the River Soar is derived from extensive areas of impermeable surface in the city. In particular, those parts of the city which have been identified in the SWMP as critical drainage areas contribute towards flood risk in flooding hotspots downstream. Where practicable, the LLFA will expect runoff to be reduced towards greenfield rates during redevelopment in these areas and at least a 50% betterment on all other sites from which runoff is currently unattenuated. Over time, this could make a significant contribution to reducing flood risk in the city and restoring more natural flow regimes to the watercourses which flow through the suburbs.

Flood defences

In general, the construction of new raised defences to protect new development can be problematic in policy terms, due to the residual risk that will remain, the potential increase in flood risk which may arise elsewhere due to a reduction in floodplain storage capacity and the difficulty of ensuring that the new defences can be maintained over the lifetime of the development. However, there may be exceptional cases where flood defences associated with new development can contribute to the wider flood risk management objectives of the RMAs and bring flood risk benefits to existing communities. This may be achieved through partnership funding contributions to RMA-led flood alleviation schemes, or through the

construction of raised land or new flood defence assets as part of the redevelopment process. Such cases are only likely to arise where existing strategies have identified a need for flood alleviation measures to protect an existing community and where partnership working can help to deliver the identified solutions. In these cases it would still be necessary to ensure that there is no significant increase in flood risk elsewhere and that provision can be made for maintenance of any new assets over the lifetime of the development. Early discussion with the RMAs is essential where any new flood defence is proposed.

8.3. Reducing flood risk through blue-green infrastructure

Where there is a requirement for the provision of open space on a new development or to preserve the corridor of a watercourse which runs through or adjacent to a site, there may be opportunities to reduce flood risk to the wider community through the provision of well-designed blue-green infrastructure. For example, this may include 'slowing the flow' of watercourses which have been straightened and concreted historically (provided this does not cause a local flood risk), or through the creation of areas of floodplain storage adjacent to a river channel. Ellis Meadows in north Leicester (figure 8.1) provides a good example of the way in which green infrastructure can be used to reduce flood risk and facilitate regeneration. This scheme, a partnership between the EA and Leicester City Council, reduced flood risk to the local community by transforming an underused public open space.

Figure 8.1 Ellis Meadows wetlands.

Leicester's Green Infrastructure Strategy[21] identifies opportunities throughout the city for the enhancement of green infrastructure. Figure 8.2 overlays the Risk of Flooding from Surface Water maps onto these opportunity sites, illustrating the numerous locations in which green infrastructure could be used to reduce flood risk through techniques such as river channel restoration, wetland creation and other forms of natural flood management. Developers should consult the Green Infrastructure Strategy when developing their proposals. Where there is a requirement for public open space provision as part of the development, in an area that intersects or lies adjacent to a watercourse or an area of flood risk, early discussions with the RMAs will help to identify opportunities to reduce flood risk and enhance biodiversity through the provision of multi-functional blue-green infrastructure that can bring wider benefits, such as biodiversity enhancement and mitigation of climate change impacts.

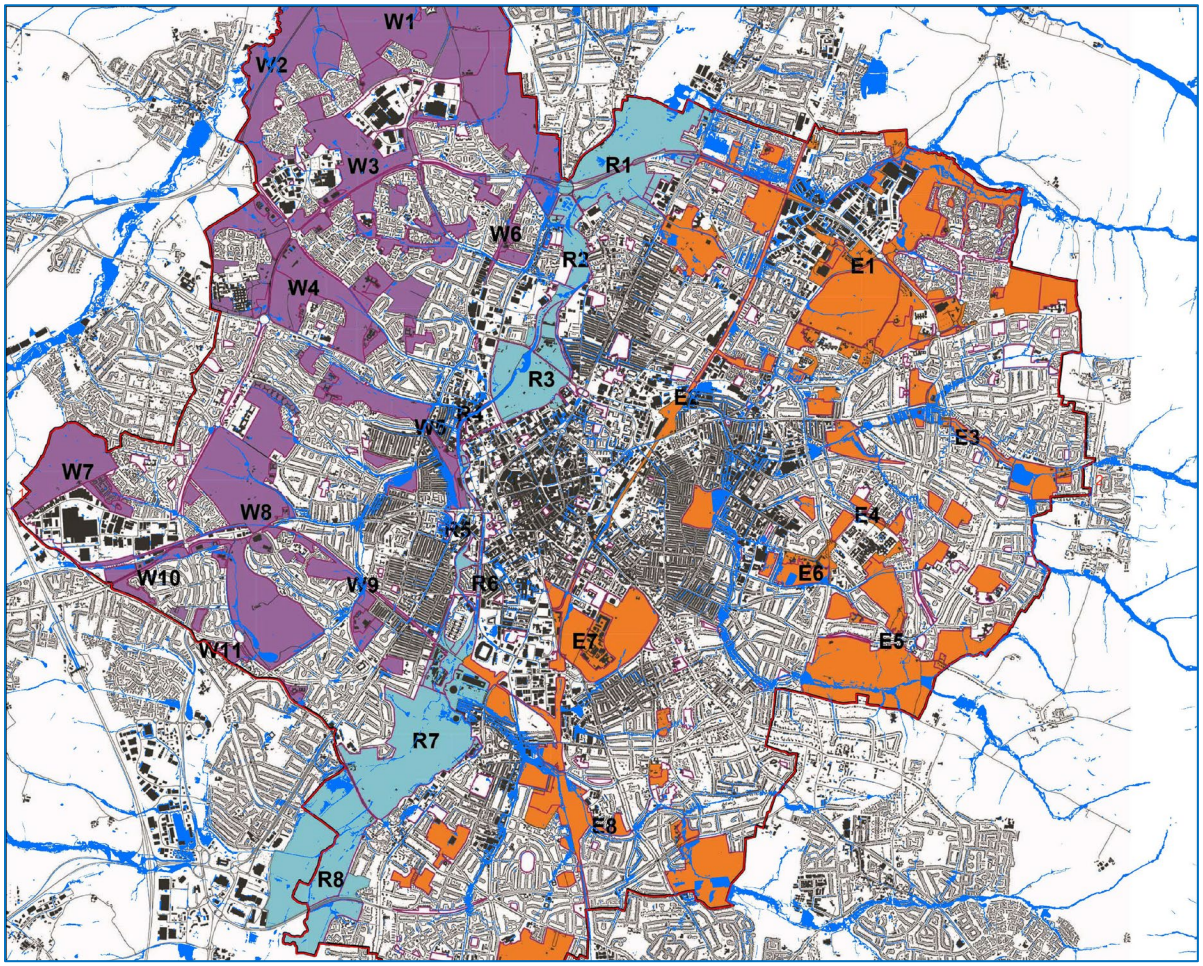

Figure 8.2 Green Infrastructure sites identified within the Green Infrastructure Strategy.

[21] Leicester City Council, 2015. Green Infrastructure Strategy. Available at https://www.leicester.gov.uk/your-council/policies-plans-and-strategies/environment-and-sustainability/green-infrastructure-strategy/. [Accessed 14 July 2022]

9. Summary and Recommendations

9.1. Summary

This Strategic Flood Risk Assessment has been prepared in accordance with the National Planning Policy Framework and associated guidance, to inform Leicester's Local Plan and future development of the city. The report updates the previous SFRA where necessary to reflect changes in planning policy and to incorporate new flood risk data.

The SFRA and accompanying maps provide a starting point for the assessment of flood risk to new developments. Where flood risk is identified as a potential constraint on new development, more localised analysis should be undertaken by planning applicants as part of a site-specific Flood Risk Assessment.

As a pre-cursor to this SFRA the hydraulic models of the Main Rivers in Leicester were updated in 2017 to provide new Flood Zone maps and detailed flood risk output datasets including flood levels, extents, depths, velocities and flood hazard ratings. This information is available from the EA, and information on flood risk from Ordinary Watercourses is available from the Flooding Team at Leicester City Council. An analysis of this data against potential site allocations indicated that it would not be possible to accommodate all future growth and regeneration within Flood Zone 1, so further analysis was undertaken on the nature of flood risk to sites across the city in Flood Zones 2 and 3. The process, undertaken alongside the Sustainability Appraisal, has enabled site allocations to be steered towards areas of lower flood risk and high level guidance to be provided for those sites which are subject to application of the Exception Test.

9.2. Recommendations

The SFRA report and appendices should be reviewed regularly (e.g. annually) to ensure that the report makes use of the best available flood risk data and reflects national and local flood risk policy and guidance. When undertaking a Flood Risk Assessment, planning applicants should contact the RMAs for the best available data, which may at times differ from that contained within the most recent published SFRA.

The standards for new development in relation to the management of flood risk are set out in the NPPF and the accompanying guidance. The following recommendations are made in relation to new development, which is intended to reaffirm and supplement the wider

literature. None of these recommendations should be taken as contradictory to the NPPF and accompanying guidance, which take precedence.

Recommendation 1: Protecting against climate change

The safety and impact of new development on flood risk should be assessed considering the impacts of climate change on pluvial and fluvial flood risk in Leicester.

Recommendation 2: Taking a sequential approach

A sequential approach should be taken to site layout, steering new development to those parts of the site at lower risk of flooding.

Recommendation 3: Preventing risk to others

New development should not reduce the storage capacity of the floodplain or alter flood flow routes in a manner which would increase flood risk to others.

Recommendation 4: Ensuring safe development

The safety of new development in areas of flood risk should be demonstrated through a Flood Risk Assessment which confirms that new buildings are adequately protected against flooding and that safe access arrangements are in place for users of the site.

Recommendation 5: Reducing wider flood risk

New development (and re-development of existing sites) should make best use of opportunities to reduce flood risk both on- and off-site. This may be through reconfiguration of an existing developed site, enhancement of blue-green infrastructure or installation of SuDS. Opportunities for working in partnership with the Risk Management Authorities should be explored.

Recommendation 6: Using Sustainable Drainage methods

New development should utilise Sustainable Drainage Systems (SuDS), designed in accordance with industry guidance such as CIRIA Report C753: The SuDS Manual. SuDS in Leicester should be designed to contribute positively to the city's blue-green infrastructure in respect of biodiversity, water quality and public amenity.