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Final report

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Hinckley and Bosworth Borough Council

Hinckley & Bosworth Borough Council

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Contract

This report describes work commissioned by Chris Colbourn, on behalf of Hinckley and Bosworth Borough Council, by an email dated 6th September 2019. Copper Lewis and Lucy Finch of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

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Executive summary

The Hinckley and Bosworth Borough Council Strategic Flood Risk Assessment (SFRA) is presented in two parts:

- Level 1 SFRA (2019)
- Level 2 SFRA (2019), covering detailed assessment of the preferred SHELAA sites (this document)

SFRA objectives

The objectives of the Level 2 SFRA are to:

- Screen preferred SHELAA sites to determine which sites are at the highest risk of flooding and require a detailed Level 2 assessment.
- Provide individual flood risk analysis for site options using the latest available flood risk data.
- Using available data, provide information and maps presenting flood risk from all sources for each site.
- Consider the cumulative impact of development.

Level 2 SFRA outputs

The Level 2 SFRA includes detailed assessments of the proposed sites. These include:

- An assessment of all sources of flooding including fluvial flooding, surface water flooding, groundwater flooding, mapping of the functional floodplain and the potential increase in fluvial flood risk due to climate change.
- An assessment of existing flood warning, including an assessment of whether there is safe access and egress during an extreme event.
- Advice and recommendations on the likely applicability of sustainable drainage systems (SuDS) for managing surface water runoff.
- Advice on appropriate policies for sites which could satisfy the first part of the Exception Test and on the requirements necessary for a site-specific Flood Risk Assessment, supporting a planning application to pass the second part of the Exception Test.

As part of the Level 2 SFRA, detailed site summary tables have been produced for the proposed sites, covering the above. To accompany each site summary table, there is an Interactive Geo-PDF map, with all the mapped flood risk outputs.

Summary of the Level 2 SFRA

As part of the Level 2 SFRA, detailed site summary tables have been produced for 13 of the original 65 considered; these sites are shown to be at risk of fluvial flood risk from watercourses running either through or adjacent to the site as a result of the site screening process against flood risk information.

The summary tables set out the flood risk to each site, including Flood Zone coverage, maps of extent, depth and velocity of flooding as well as hazard mapping for the 100-year defended event. Climate change mapping has also been produced for each site to indicate the impact which different climate change allowances may have on the site. Each table also sets out the NPPF requirements for the site as well as guidance for site-specific FRAs. A broadscale assessment of suitable SuDS options has been provided giving an indication where there may be constraints to certain sets of SuDS techniques. This assessment is indicative and more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. It may be possible that those SuDS techniques highlighted as possibly not being suitable can be designed to overcome identified constraints.

To accompany each site summary table, there is an Interactive Geo-PDF map, with all the mapped flood risk outputs per site. This is displayed centrally, with easy-to-use 'tick box' layers down the right-hand side and bottom of the mapping, to allow easy navigation of the data.

The following points summarise the Level 2 assessment:

- All sites with a detailed Level 2 summary table are at fluvial flood risk. The degree of flood risk varies, with some sites being only marginally affected along their boundaries, and other sites being more significantly affected, which will require more detailed investigations on sequential site layouts, SuDS possibilities, safe access and egress etc.
- Two of the sites not taken forward to a Level 2 assessment are at high risk of surface water flooding (AS809 and AS1027) and this should be considered as part of a sitespecific FRA or Surface Water Drainage Strategy.
- Nine of the sites not taken forward to a Level 2 assessment are at very low fluvial flood risk (≤5% of the site within the Flood Zones). These sites are AS585, AS303, LPR64, LPR70, LPR72, LPR26, LPR119, LPR96 and LPR107. At these sites the fluvial flood risk is confined to the site boundaries or corners of the sites, in which case development could be steered away from these areas.
- One site not taken forward to a Level 2 assessment has several unnamed and unmodelled watercourses flowing through the site (LPR24). These would need to be modelled as part of a site-specific FRA to understand the fluvial flood risk to the site.
- The majority of sites are at risk from surface water flooding, with more areas of ponding in the higher return period events. Surface water tends to follow topographic flow routes, for example along the watercourses or isolated pockets of ponding where there are topographic depressions. Surface water should be considered when assessing safe access and egress to and from the site.
- Climate change mapping indicates that flood extents will increase. As a result, the depths, velocities and hazard of flooding may also increase. The significance of the increase tends to depend on the topography of site and the percentage allowance used. The Council and the Environment Agency require the 100-year plus 30% and 100-year plus 50% climate change scenarios for fluvial risk to be considered in future developments, and the 100-year plus 40% for surface water risk.
- Blockage locations were determined by visual inspection of the OS mapping and LIDAR in the vicinity of the site, to determine whether a structure upstream, downstream, or within the site could have an impact on the site. The risk from blockages may need to be considered as part of a site-specific assessment.
- No Level 2 sites are located in a Groundwater Source Protection Zone.
- No Level 2 sites have areas within them designated by the Environment Agency as being a historic landfill site.
- A strategic assessment was conducted of SuDS options using regional datasets. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.
- For a number of sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles.
- Nineteen of the 65 sites fall partially or wholly within the Rothley Brook catchment; this
 was identified in the Level 1 SFRA cumulative impact assessment as requiring more
 detailed drainage strategy work to consider how the cumulative effects of development
 would impact on peak flows, timing and duration of flooding on the Rothley Brook, which
 drains towards Leicester City and Charnwood Borough. The potential for betterment
 through flood storage areas for these sites has been considered as part of the Level 2
 assessment.

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Recommendations

Site allocations

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

The Council should use the information provided within this SFRA for their Sequential Test decision-making, following which, if land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development, the Exception Test will need to be applied. This is where the Level 2 SFRA supports, as it considers the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

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

Site-specific assessment considerations

For development sites located in Hinckley and Bosworth Borough, it is recommended that developers consider the following:

- Developments should be sustainable and support adaption to climate change, which may involve flood resilience and resistance measures.
- Any site-specific FRA would need to adequately assess the local topography, geology and drainage systems (including sewer capacity) to ensure the risk posed from surface water is appropriately taken into account, for example discharge destinations and justifications.
- Consider reservoir flooding and residual risk at the planning stage.
- Safety is a key consideration for any new development and includes the likely impacts of climate change and, where there is a residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.
- The adoption and maintenance of drainage systems and flood defence infrastructure.
- Taking positive measures to conform to the Water Framework Directive, where on and offsite water quality can be affected by development, for example in terms of 'deterioration' in waterbody ecological status or potential.

As Hinckley and Bosworth Borough sits on high ground near the top of river catchments many of the watercourses react quickly to heavy rainfall. Because there are no major flood defences affecting proposed development sites there is no risk from sudden flood defence failure. Subject to a suitable warning system being put in place for future occupiers of developments it should be possible to provide advance notice of flooding, although this could amount to hours rather than days given the upper catchment location. Alerts based on heavy rainfall forecasts may provide earlier warning, although have a higher potential for false alarms.

Analysis of past flood hydrographs shows that the duration of flooding is typically less than a day, although this will depend on the nature of the weather. Repeat storms may cause flooding to last for longer or double peaks on watercourses, where river levels start to fall and then rise again in response to later storms.

The Level 2 site analysis has used information on the depth, velocity and hazard from flooding to put forward development recommendations. Further site-specific work at planning application stage should consider further the depth, velocity and hazard from flooding, as well as the onset and duration of flooding when developing site level mitigation plans and warning systems.

Flood risk assessments

The Level 2 SFRA is not intended to replace site-specific FRAs. Site-specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test. Part b requires a FRA to 'demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall'.

A FRA is required for all developments:

- In Flood Zone 2 and 3;
- Over 1 ha in Flood Zone 1;
- Less than 1 ha in Flood Zone 1 including a change of use in development type to a more vulnerable class where they could be affected by a source of flooding other than rivers and sea;
- In an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency.

Developers must, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including the latest climate change allowances), inform development zoning within the site and prove whether Part B of the Exception Test can be passed. Developers should include an assessment of the residual risk where developments may be at risk of infrastructure failure e.g. culverts becoming blocked. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

Where there is historical evidence of flooding at sites, any developments will require a detailed Flood Risk Assessment to fully understand and verify flood risk and flooding mechanisms.

Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites by reducing the amount of surface water runoff generated on a site. The functional floodplain should be protected from development and returned to greenfield status (where possible).

Future developments

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

- Reducing volume and rate of surface water runoff based on local planning policy and LLFA Guidance
- Locating development to areas with lower flood risk
- Leaving an 8m easement from top of bank to development to manage flood risk
- Creating space for flooding
- Integrating green infrastructure into mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

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

At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances, published by the Environment Agency in February 2016), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. It is recommended that as part of the early discussions relating to development proposals, developers discuss requirements relating to site-specific FRAs and drainage strategies, to identify any potential issues that may arise from the development proposals.

Promotion of SuDS

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

- Wherever possible, SuDS should be promoted.
- It is essential that developers consider sustainable drainage at an early stage of the development process ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS.
- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- Development should aim to achieve Greenfield runoff rates and ensure that surface water runoff is managed as close to its source as possible.
- Where possible developments must utilise the most sustainable form of drainage systems, in accordance with the SuDS hierarchy.
- Water quality requirements for sustainable development should comply with current SuDS guidance.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough and if soils have adequate permeability to allow for SuDS techniques that are designed to encourage infiltration.
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable, and guidance should be sought from the LLFA.
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints.
- The LPA will need to consider drainage schemes for major and minor applications, as well as review of SuDS on both types of application. It is advised that developers utilise the LLFA's policies and guidance to develop their drainage schemes for applications. Hinckley and Bosworth Borough Council have adopted a Good Design Guide Supplementary Planning Document and developers should consider this guidance when developing drainage schemes.
- Where SuDS are provided as part of a development, applicants should detail how it will be maintained in the long term.

Infrastructure and Access

 Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard should be identified and the use of developer contributions considered to fund improvements. None of the sites assessed in this Level 2 assessments are protected by formal flood defences, though this should be a consideration for any future windfall sites which may be located near to flood defences. • Safe access and egress for residents and emergency and service vehicles will need to be demonstrated at all development sites.

Cumulative impact assessment

The Level 1 SFRA highlighted that development in the Rothley Brook catchment is at high risk with the regards to the cumulative impact of development, affecting Leicester City and Charnwood Borough neighbouring authorities. The recommendations for betterment through flood storage areas as outlined in section 6.4 should be considered by developers as part of site-specific assessment; however, it is recommended that more detailed modelling is conducted by the developer, to fully understand the requirements and possible locations for flood storage areas.

Use of SFRA data and future updates

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

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

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

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

How to use this report

The below table summarises the contents of each chapter of this report and outlines how each section should be used.

Section	Contents	How to use
1. Introduction	Outlines the purpose and objectives of the Level 2 SFRA	
2. Sources of information used in preparing the Level 2 SFRA	Summarises the data used in the Level 2 assessments and GeoPDF mapping	Users should refer to this section in conjunction with the summary tables and GeoPDF mapping to understand the data presented.
		Developers should refer back to this section when understanding requirements for a site-specific FRA.
3. Screening of potential development sites	Provides results of the site screening assessments, showing the percentage of sites at risk of fluvial and surface	Planners should use this section as an overview of flood risk to all potential development sites.
	water flooding. This section summarises the results and provides considerations for some sites not	Planners and developers should use this section to understand what considerations are required for Preferred

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	taken forward to a Level 2 assessment.	SHELAA sites without a detailed site summary table.
4. Level 2 assessment methodology	Summarises the sites taken forward to a Level 2 assessment and the outputs produced for each of these sites.	This section should be used in conjunction with the site summary tables and GeoPDF mapping to understand the data presented.
5. Summary of Level 2 assessment	Summarises the results and conclusions of the Level 2 assessment.	Developers and planners should use this section to provide an overview of the Level 2 assessment.
		Planners should use this section to identify which potential site allocations have the least risk of flooding.
		Developers should use this section when considering requirements for a site- specific FRA.
6. Cumulative impact assessment	Builds on recommendations from the Level 1 SFRA, identifying the cumulative impact of development in	Planners should use this section to help develop policy recommendations for the Rothley Brook catchment.
	the Rothley Brook catchment and providing recommendations for storage and betterment for all potential development sites in the catchment.	Developers should use this section to understand the potential storage requirements and betterment opportunities for sites in the Rothley Brook catchment.
7. Recommendations	Provides recommendations for allocations, site-specific assessments and SuDS.	Planners should use this section to inform policy on flood risk within the Local Plan.
		Developers should use this section understand considerations for site- specific assessments and SuDS.
Appendix A.1. Level 2 Site summary tables	Provides a detailed summary of flood risk for sites requiring a more detailed assessment. The section	Planners should use this section to inform the application of the sequential and exception tests, as relevant.
considers flood risk, emergency planning, climate change, broads assessment of possible SuDS, exception test requirements and requirements for site-specific FR,		Developers should use these tables to understand flood risk, access and egress requirements, climate change, SuDS and FRA requirements for site-specific assessments.
Appendix A.2. GeoPDF mapping	Provides interactive PDF mapping for each Level 2 assessed site showing flood risk at and around the site.	Planners and developers should use these maps in conjunction with the site summary tables to understand the nature and location of flood risk.

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Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AStGWf	Areas Susceptible to Groundwater flooding
Brownfield	Previously developed parcel of land
CC	Climate change - Long term variations in global temperature and weather
	patterns caused by natural and human actions.
DTM	Digital Terrain Model
EA	Environment Agency

Exception Test	Set out in the NPPF, the Exception Test is used to demonstrate that flood risk to people and property will be managed appropriately, where alternative sites at a lower flood risk are not available. The Exception Test is applied following the Sequential Test
Flood defence	Informative week a protect an area against fleeds as fleedwalls and
Flood defence	embankments; they are designed to a specific standard of protection (design standard).
Flood Map for	The Environment Agency Flood Map for Planning (Rivers and Sea) is an online
Planning	mapping portal which shows the Flood Zones in England. The Flood Zones
	defenses and do not account for the possible impacts of climate change
Flood rick Aroo	An area determined as having a significant rick of flooding in accordance with
FIOOU FISK Area	auidance published by Defra and WAG (Welsh Assembly Government).
FWA	Flood Warning Area
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a River
FRA	Flood Risk Assessment - A site-specific assessment of all forms of flood risk to
	the site and the impact of development of the site to flood risk in the area.
Greenfield	Undeveloped parcel of land
На	Hectare
IH124	A hydrology methodology produced by the Institute of Hydrology to assess the runoff from small catchments.
JBA	Jeremy Benn Associates
Iflow	2D generalised hydrodynamic modelling software.
LIDAR	Light Detection and Ranging
	Lead Local Flood Authority - Local Authority responsible for taking the lead on
	local flood risk management
m AOD	metres Above Ordnance Datum
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
	National Recentor Database
Ordinary	All watercourses that are not designated Main River Local Authorities or
Watercourse	where they exist IDBs have similar permissive powers as the Environment
Watercourse	Agency in relation to flood defence work. However, the riparian owner has the
	responsibility for maintenance.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing
	over the ground surface (surface runoff) before it enters the underground
	drainage network or watercourse or cannot enter it because the network is full
	to capacity.
ReFH	Revitalised Flood Hydrograph
Risk	In flood risk management, risk is defined as a product of the probability or
	likelihood of a flood occurring, and the consequence of the flood.
RoFfSW	Risk of Flooding from Surface Water (formerly known as the Updated Flood Map
Sequential Test	Set out in the NPPE, the Sequential Test is a method used to steer new
Sequential Test	development to areas with the lowest probability of flooding
SFRA	Strategic Flood Risk Assessment
SP7	(Groundwater) Source Protection Zone
Stakeholder	A person or organisation affected by the problem or solution or interested in
Stakenoluei	the problem or solution. They can be individuals or organisations, includes the
	public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control
	structures that are designed to drain surface water in a more sustainable
	manner than some conventional techniques
Surface water	Flooding as a result of surface water runoff as a result of high intensity rainfall
flooding	when water is ponding or flowing over the ground surface before it enters the
	underground drainage network or watercourse or cannot enter it because the
	network is full to capacity, thus causing what is known as pluvial flooding
URBEXT	Urban extent catchment descriptor, describing the level of urbanisation in a
-	catchment.

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

JBA Consulting were commissioned by Hinckley and Bosworth Borough Council to prepare a Level 1 Strategic Flood Risk Assessment (SFRA) in March 2019. Following on from this, a Level 2 SFRA was commissioned in September 2019, to provide detailed assessments of the Council's preferred SHELAA options.

This Level 2 SFRA will be used to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

This document should be considered in conjunction with the Level 1 SFRA (published in 2019).

1.2 Levels of SFRA

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

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

This report fulfils the requirements of a Level 2 SFRA.

1.3 SFRA Objectives

The objectives of the Level 2 SFRA are to:

- Screen preferred SHELAA sites to determine which sites are at the highest risk of flooding and require a detailed Level 2 assessment.
- Provide individual flood risk analysis for site options using the latest available flood risk data.
- Using available data, provide information and maps presenting flood risk from all sources for each site.
- Consider the cumulative impact of development.

1.4 Context of the Level 2 assessment

The Level 1 SFRA was submitted in July 2019 and appraised flood risk from all sources in Hinckley and Bosworth Borough.

JBA Consulting were provided with a list of preferred SHELAA sites from the Council, which were screened against flood risk information to provide a summary of flood risk to each site. This screening helped to identify which sites required a detailed Level 2 assessment.

A Level 2 assessment should be undertaken on sites located in the Flood Zones. A detailed Level 2 assessment was undertaken for sites where >5% of the site was located in the Flood Zones, as those lower than 5% were at negligible risk. A detailed assessment was not conducted for the following sites, though the implications and recommendations for these sites have been considered separately as part of this report:

- Sites that are located in the Flood Zones, but with <5% risk following a visual check against the flood risk datasets and ground levels, professional judgment deemed these sites to not warrant a detailed assessment due to negligible risk.
- Sites with a watercourse or drain not included in the EA Flood Zones or SFRA modelled flood extents – data limited/ not available to assess flood risk, but as

there will still be some flood risk, recommendations for site-specific assessment have been made. Sites with a risk of surface water flooding alone – there are no sites that are not covered by a Level 2 assessment for fluvial reasons, where surface water risk is deemed high enough to warrant a Level 2 purely for surface water risk. However, it is deemed appropriate to provide site-specific recommendations for developers on sites where there is still surface water risk. Table 3-2 mentions sites where there is some surface water risk in the more extreme events. The LLFA will expect the developer to take these into account at an early stage when planning the form and layout of a site, the surface water drainage system and any surface water mitigation measures that may be necessary.

2 Sources of information used in preparing the Level 2 SFRA

This chapter discusses all the datasets used in the Level 2 SFRA to assess the sites against flood risk. Several different sets of data may have been used to inform the extent, depth, hazard and velocity for each site.

2.1 Flood Zones

The data used to prepare the fluvial mapping for this study is based on the results from hydraulic models, either provided by the Environment Agency or prepared for the purposes of this SFRA.

2.1.1 Flood Zones 2 and 3a

2D generalised modelling was undertaken for the majority of the watercourses in the Borough as part of the 2014 SFRA, and the 100-year and 1,000-year outputs have been used to define Flood Zones 3a and 2 respectively. Where detailed modelling existed, these outputs were used in preference of the 2D generalised modelling, such as on the River Anker and Sence Brook.

A small number of minor watercourses did not have detailed hydraulic models or 2D generalised modelled outputs; in this case, the Environment Agency's Flood Map for Planning Flood Zones have been used.

2.1.2 Flood Zone 3b

Flood Zone 3b has been identified as land which would flood with an annual probability of 1 in 20 years (5% AEP). It has been derived from the 20-year defended modelled flood extents from either the detailed hydraulic models or the 2D generalised modelling. Where no modelled outputs were available, Flood Zone 3a has been used as an indication of Flood Zone 3b.

2.2 Surface water

Mapping of surface water flood risk in Hinckley and Bosworth has been taken from the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) mapping, which is a slightly more detailed resolution than that published online by the Environment Agency. Surface water flood risk is subdivided into the following four categories:

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

The results should be used for high level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be required to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the RoFfSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

2.3 Climate change

Three climate change allowances were modelled by re-running the Environment Agency's detailed fluvial models or 2D generalised fluvial modelling, by upscaling the 100-year flow event by the relevant climate change factor. These runs represented the Central (100-year +20%), Higher Central (100-year +30%) and Upper End (100-year +50%) climate change allowances for the 2080s epoch for the Humber River Basin District, as agreed with the Environment Agency.

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The mapping provides a strategic assessment of climate change risk; developers should undertake detailed modelling of climate change allowances as part of a site-specific FRA, following the **climate change guidance** set out by the Environment Agency.

The Council and the Environment Agency require the 100-year plus 40% allowance to be considered for future developments for the effect of climate change. In the absence of surface water climate change modelling, the 1 in 1,000-year (0.1%) RoFfSW extent can be used as an indication of the potential impact of climate change. Sites where there is significant increase in surface water flood extent between the 100-year and 1,000-year events may be more sensitive to the impacts of climate change.

2.4 Groundwater

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

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

2.5 River networks

Main Rivers are represented by the Environment Agency's Statutory Main River layer. Ordinary Watercourses are represented by the Environment Agency's Detailed River Network Layer. Caution should be taken when using these layers to identify culverted watercourses which may appear as straight lines but in reality, are not. Developers should be aware of the need to identify the route of, and flood risk associated with culverts and model these/use CCTV where necessary.

2.6 Flood Warning and Flood Alert

Flood Warning and Flood Alert Areas are represented by the Environment Agency's GIS datasets.

2.7 Reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area has been identified from the Environment Agency's **Long Term Flood Risk Information website**.

2.8 Historic flooding

Historic flooding was assessed using the Environment Agency's Historic Flood Map, as well as any incidents picked up in the historic flooding register provided by Leicestershire County Council as LLFA.

2.9 Residual risk

The residual flood risk to sites is identified as where potential blockages or overtopping/breach of defences could result in the inundation of a site.

There are two flood defences in the Borough, however neither of these are located near to any of the Level 2 sites. Potential culvert blockages that may affect a site were identified by querying the Environment Agency's Detailed River Network Layer and using background mapping to determine where watercourses flow into culverts or through structures (i.e. bridges) in the vicinity of the site. These may need to be considered by the developer as part of a site-specific Flood Risk Assessment.

2.10 Depth, velocity and hazard to people

The Level 2 assessment seeks to map the probable depth and velocity of flooding as well as the hazard to people during the defended fluvial 100-year event. The 100-year flood event has been investigated in further detail because the Level 2 assessment helps inform the Exception Test and usually flood mitigation measures and access/ egress requirements focus on flood events lower than the 1,000-year event (e.g. the 100-year or 100-year plus climate change events). As part of a site-specific FRA, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood depth, velocity and hazard based on the relevant 100-year plus climate change event as part of a site-specific FRA, using the relevant climate change allowance based on the type of development and its associated vulnerability classification. Not all of this information is known at the strategic scale.

Depth velocity and hazard information was derived from 2D generalised modelling, or detail modelling where this exists.

The depth, hazard and velocity of the 100-year surface water flood event has also been mapped and considered in this assessment. Hazard to people has been calculated using the below formula as suggested in Defra's FD2321/TR2 "Flood Risk to People". The different hazard categories are shown in Table 2-1.

Description of Flood Hazard Rating	Flood Hazard Rating	Classification Explanation
Very Low Hazard	<0.75	Flood zone with shallow flowing water or deep standing water
Danger for some (i.e. children)	0.75 - 1.25	Danger: flood zone with deep or fast flowing water
Danger for most	1.25 - 2.00	Danger: flood zone with deep fast flowing water
Danger for all	>2.00	Extreme danger: flood zone with deep fast flowing water

Table 2-1 Defra's FD2321/TR2 "Flood Risks to People" classifications

2.11 Note on SuDS suitability

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

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

- Historic landfill sites
- Groundwater Source Protection Zones
- Detailed River Network
- Flood Zones derived as part of this L2 SFRA

This data was then collated to provide an indication of particular groups of SuDS systems which might be suitable at a site. SuDS techniques were categorised into five main groups, as shown in Table 2-2. This assessment should not be used as a definitive

guide as to which SuDS would be suitable but used as an indicative guide of general suitability. Further site-specific investigation should be conducted to determine what SuDS techniques could be used on a particular development, informed by detailed ground investigations.

Table 2-2 Summary of SuDS categories

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

The suitability of each SuDS type for the site options has been described in the summary tables, where applicable. The assessment of suitability is broadscale and indicative only; more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. Leicestershire County Council as LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors.

2.12 Use of SFRA data and future updates

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

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

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

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

3 Screening of potential development sites

3.1 Introduction

JBA were provided with Hinckley and Bosworth Borough Council's preferred SHELAA sites, which were screened against flood risk information to provide a summary of flood risk to each site. The screening identified where a site required a Level 2 assessment, and where sites may not require a Level 2 assessment but where the implications and recommendations for flood risk to the site could be considered as part of this SFRA.

The site screening assessed the following:

- The proportion of the site in each Flood Zone
- Whether the site is shown to be at risk in the Risk of Flooding from Surface Water map, and the proportion of the site in each surface water category
- The proportion of the site within the Environment Agency's Historic Flood Map
- Whether the site is within 100m of a watercourse identified in the Environment Agency's Detailed River Network (DRN) layer.

The screening was undertaken using JBA in-house software called "FRISM". FRISM is an internal JBA GIS package that computes a range of flood risk metrics based on flood and receptor datasets, giving a clear spatial picture of flood risk. The site boundaries were queried using FRISM against the flood risk information including Flood Zones, surface water and historic flood map.

The results of the screening provide a quick and efficient way of identifying sites that are likely to require a Level 2 Assessment, assisting Hinckley and Bosworth Borough Council with Sequential Test decision-making so that flood risk is taken into account when considering allocation options.

3.2 Site screening

Table 3-1 summarises the flood risk to the 65 preferred SHELAA sites. Where sites are shown to be in Flood Zone 1, these were then checked against OS mapping for any drains or ordinary watercourses which may pose a risk, as well as the surface water mapping for further consideration. None of the preferred SHELAA sites covered by the Environment Agency's Historic Flood Map, and therefore this has not been included in Table 3-1.

Table 3-1 Site screening against flood risk datasets

Site code			Proportion of site shown to be at risk (%)								Area of
(SHELAA Reference)	Location	Area (ha)		Flood Zones			Risk of flooding from surface water			Within 100m of detailed	outside of Flood Zones
			FZ3b	FZ3a	FZ2	FZ1	30yr	100yr	1,000yr	river network?	(ha)
AS5	Land at Station Road, Bagworth Part 1	1.09	0%	0%	0%	100%	0%	0%	0%	NO	1.09
AS6	Land at Station Road, Bagworth Part 2	1.48	0%	0%	0%	100%	0%	0%	2%	NO	1.48
AS7	Land at Station Road, Bagworth Part 3	1.58	0%	0%	0%	100%	0%	<1%	1%	NO	1.58
AS12	Field for land at Park Lane, Bagworth	2.89	0%	0%	0%	100%	0%	0%	<1%	NO	2.89
AS16	Land at Station Road, Bagworth	0.61	0%	0%	0%	100%	0%	0%	0%	NO	0.61
AS32	Land at Thornton, Thornton	2.04	0%	0%	0%	100%	0%	0%	10%	NO	2.04
AS66	Land at Shilton Road, Barwell	1.31	0%	0%	0%	100%	0%	0%	1%	NO	1.31
AS455	Land at Barton Road, Barlestone	3.25	0%	0%	0%	100%	0%	2%	10%	NO	3.25
AS466	Ashfield Farm, Kirkby Road, Desford	1.25	0%	0%	0%	100%	0%	0%	0%	NO	1.25
AS519	Land to the west of Sheepy Magna	2.29	0%	0%	0%	100%	<1%	1%	1%	NO	2.29
AS585	Land east of Witherley	4.46	1%	3%	5%	95%	1%	1%	3%	YES	4.22
AS586	Land east of Witherley	3.16	18%	23%	32%	68%	12%	28%	47%	YES	2.15
AS33	Land to the rear of Sharps Close, Thornton	2.09	0%	0%	0%	100%	0%	0%	0%	NO	2.09
AS201	Land at Peckleton Lane, Desford	3.84	0%	0%	0%	100%	0%	0%	0%	NO	3.84
AS407	Land fronting Ratby Lane, Markfield	0.52	0%	0%	0%	100%	0%	0%	0%	NO	0.52
AS303	Land at Barwell Lane, Hinckley	10.40	<1%	<1%	<1%	99%	<1%	1%	5%	YES	10.30
AS589	Land at 59 Kennel Lane, Witherley	4.95	13%	38%	53%	47%	3%	7%	41%	YES	2.34
AS616	The Limes, Main Road, Sheepy Magna	0.66	0%	0%	0%	100%	5%	12%	22%	NO	0.66
AS618	Poplars, Main Road, Sheepy Magna	2.32	0%	0%	0%	100%	0%	1%	1%	NO	2.32
AS686	Land off Beech Drive, Thornton	3.00	0%	0%	0%	100%	0%	0%	1%	NO	3.00
AS809	Land at Lychgate Lane, Burbage	0.76	0%	0%	0%	100%	0%	2%	40%	NO	0.76
AS392	Land north of Station Road, Market Bosworth	4.15	0%	0%	0%	100%	0%	<1%	6%	NO	4.15
AS1050	Land north of Station Road, Market Bosworth	4.16	0%	0%	0%	100%	1%	2%	10%	NO	4.16
AS58	Land at Stapleton Lane, Barwell	133.33	3%	4%	5%	95%	3%	6%	13%	YES	126.78
AS1008	Land south of Sacheverell Way, Groby	38.59	11%	11%	12%	88%	4%	8%	16%	YES	34.14

Site code			Proportion of site shown to be at risk (%)								
(SHELAA Reference)	A Location e)		Flood Zones				Risk of flooding from surface water			Within 100m of detailed	outside of Flood Zones
			FZ3b	FZ3a	FZ2	FZ1	30yr	100yr	1,000yr	river network?	(ha)
AS1021	Land at junction of Normandy Way and Triumph access road, Hinckley	4.13	0%	0%	0%	100%	0%	0%	2%	YES	4.13
LPR10	Land off Orton Lane, Twycross	0.85	0%	0%	0%	100%	0%	0%	0%	YES	0.85
LPR18	Land at Poplar Terrace, Congerstone	0.46	0%	0%	0%	100%	0%	0%	0%	YES	0.46
LPR23	Land at Bagworth Working Mens Club, Station Road, Bagworth	1.10	0%	0%	0%	100%	0%	0%	0%	NO	1.10
LPR29	Land south of Bosworth Lane, Newbold Verdon	3.95	0%	0%	0%	100%	0%	0%	1%	NO	3.95
LPR30	Land east of Groby cemetery, Groby	4.41	8%	9%	11%	89%	5%	7%	16%	YES	3.93
LPR31	Land west of Hinckley	14.90	0%	0%	0%	100%	<1%	<1%	2%	YES	14.90
LPR35	Land north of Kirkby Road, Ashfield Farm, Desford	5.48	0%	0%	0%	100%	0%	0%	3%	NO	5.48
LPR36	Land east of Lutterworth Road, Burbage	11.51	0%	0%	0%	100%	0%	<1%	1%	NO	11.51
LPR39	Land off Roseway, Stoke Golding	2.91	0%	0%	0%	100%	0%	0%	0%	NO	2.91
LPR41	Land at Stoke Lane, Stoke Golding	7.64	0%	0%	0%	100%	<1%	4%	16%	NO	7.64
LPR43	Land at Hill Lane, Markfield	3.07	0%	0%	0%	100%	0%	0%	1%	NO	3.07
LPR50	Land opposite Hinckley Golf Club, Leicester Road, Hinckley	3.22	0%	0%	0%	100%	0%	0%	3%	NO	3.22
LPR16	Land east of Lutterworth Road, Burbage	236.14	6%	6%	8%	92%	2%	4%	10%	YES	217.77
LPR64	Land to the rear of Lea Farm, Twycross	1.09	2%	2%	2%	98%	0%	0%	0%	YES	1.07
LPR24	West of Neovia Logisitics/Caterpillar off Peckleton Lane, Desford	91.10	0%	0%	0%	100%	2%	4%	7%	YES	91.10
LPR37	Land east of Barns Way, Desford	3.41	0%	0%	0%	100%	0%	0%	5%	NO	3.41
AS1030	Land off Rectory Lane, Nailstone	0.44	0%	0%	0%	100%	0%	0%	1%	NO	0.44
AS1027	Land to the rear of former Marnard Arms Bagworth	1.79	0%	0%	0%	100%	17%	22%	30%	NO	1.79
LPR70	Land south of Jacqueline Road, Field Head, Markfield	5.57	<1%	<1%	<1%	99%	0%	<1%	2%	YES	5.51
LPR71	Land off Murphy Drive and Chestnut Drive, Bagworth	7.34	17%	24%	27%	73%	0%	<1%	13%	YES	5.38
AS53	Land off Bosworth Road and Cunnery Close, Barlestone	7.59	7%	8%	9%	91%	5%	8%	21%	YES	6.88

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Site code		Area	Proportion of site shown to be at risk (%)								
(SHELAA Reference)	Location	Area (ha)		Flood Zones			Risk of flooding from surface water			Within 100m of detailed	outside of Flood Zones
			FZ3b	FZ3a	FZ2	FZ1	30yr	100yr	1,000yr	river network?	(ha)
LPR72	Land off Bosworth Road, Barlestone	3.48	3%	3%	4%	96%	2%	3%	6%	YES	3.33
LPR75	Land at The Common, Barwell	11.53	0%	0%	0%	100%	2%	3%	8%	YES	11.53
AS445	Land to the south of Desford Road, Newbold Verdon		9%	10%	12%	88%	<1%	2%	11%	YES	14.18
AS134	Land at Manor Farm, Burbage	14.60	19%	22%	24%	76%	1%	3%	23%	YES	11.07
LPR26	Land off Sketchley Lane, Burbage		1%	1%	2%	98%	1%	3%	10%	YES	14.80
LPR79	Land north and west of Chapel Lane, Congerstone	1.26	7%	7%	9%	91%	5%	5%	7%	YES	1.15
LPR80	Fox Covert Farm, Main Street, Congerstone		0%	0%	0%	100%	1%	1%	4%	NO	2.31
LPR83	Land south of Hunts Lane, Desford	10.71	0%	0%	0%	100%	0%	1%	2%	YES	10.71
LPR119	Land south of Forest Rise, Desford	6.07	1%	1%	2%	98%	2%	2%	4%	YES	5.96
LPR90	Land adjacent to Cherry Orchard estate, Main Street, Higham on the Hill	2.78	0%	0%	0%	100%	0%	0%	1%	NO	2.78
LPR96	Land at Ratby Lane, Markfield	6.44	2%	3%	3%	97%	1%	3%	14%	YES	6.25
LPR100	Land off Bosworth Lane, Newbold Verdon	5.87	0%	0%	0%	100%	0%	0%	<1%	NO	5.87
LPR107	Land west of Ratby	39.08	1%	1%	1%	99%	2%	3%	7%	YES	38.74
LPR44	Hinckley sewage treatment works, Burbage	26.87	3%	3%	18%	82%	4%	8%	33%	YES	21.99
AS1015	Land off Crimson Way, Burbage		0%	0%	0%	100%	1%	2%	7%	NO	3.86
LPR93	Land south of Forest Road, Markfield	1.28	0%	0%	0%	100%	0%	0%	0%	NO	1.28
LPR94	Land south of London Road, Markfield	25.09	5%	5%	6%	94%	3%	7%	12%	YES	23.61
AS393	Land south of Station Road, Market Bosworth	7.79	0%	0%	0%	100%	0%	3%	30%	YES	7.79

3.3 Conclusions of site screening

The 65 sites were screened against a range of flood risk datasets. Of those sites, 22 were found to be at fluvial flood risk. These were each considered in more detail and it was decided that 9 of these 22 sites did not require a detailed Level 2 assessment, as the fluvial flood risk to these sites were very low (\leq 5% of the site was at fluvial flood risk). A further 4 sites are not within the Flood Zones but have been considered for either watercourses identified in OS Mapping through the site, or for high risk of surface water flooding. These 13 sites have however been considered in Table 3-2.

Table 3-2 Considerations for certain sites not taken forward to Level 2 assessment

Site code	Site name	Considerations
AS585	Land east of Witherley	Very low fluvial flood risk (only 5% of the site is within FZ2) and surface water flood risk is very low. Fluvial flood risk is concentrated to the north-eastern corner and eastern site boundary. If development could be steered away from this area, the flood risk to the site would be reduced. More detailed modelling of the watercourse near the site may need to be undertaken as part of a site- specific FRA to fully understand the fluvial flood risk to the site.
AS303	Land at Barwell Lane, Hinckley	Very low fluvial flood risk (<1% of the site is within FZ2) and surface water flood risk is very low. Development could be steered away from the north-western site boundary where the fluvial flood risk is located.
AS809	Land at Lychgate, Burbage	No fluvial flood risk; however, there is a 40% of the site at surface water flood risk in the extreme 1,000-year event. Risk in the 30-year and 100-year events is very low. Surface water flood risk at this site should be considered as part of a detailed site-specific FRA or Surface Water Drainage Strategy.
LPR64	Land at the rear of Lea Farm, Twycross	Very low fluvial flood risk (2% of the site is within FZ2) and there is no surface water flood risk. Development could be steered away from part of the western site boundary where the fluvial flood risk is located.
LPR24	West of Neovia Logistics/ Caterpillar off Peckleton Lane, Desford	No fluvial flood risk and very low surface water flood risk; however, OS Mapping shows watercourses through the middle of this site which have not been included in the Flood Zones. Detailed modelling may need to be undertaken at site-specific level to further understand the fluvial flood risk at this site.
AS1027	Land to the rear of former Marnard Arms, Bagworth	No fluvial flood risk; however, there is a high surface water flood risk in the more extreme surface water events (17% of the site is at risk in the 30-year event and 30% of the site is at risk in the 1,000-year event). Surface water flood risk at this site should be considered as part of a detailed site-specific FRA or Surface Water Drainage Strategy.
LPR70	Land south of Jacqueline Road, Field Head, Markfield	Very low fluvial flood risk (<1% of the site is within FZ2) and there is no surface water flood risk. Development could be steered away from the southernmost tip of the site along the narrowest part of the site where the fluvial flood risk is located.
LPR72	Land off Bosworth Road, Barleston	Very low fluvial flood risk (4% of the site is within FZ2) and very low surface water flood risk. Development could be steered away from the south-western site boundary where the fluvial flood risk is.
LPR26	Land off Sketchley Lane, Burbage	Very low fluvial flood risk (2% of the site is within FZ2) and low surface water flood risk. The fluvial flood risk is confined to the south-western site boundary, so development could be steered away from this area.
LPR119	Land south of Forest Rise, Desford	Very low fluvial flood risk (2% of the site is within FZ2) and very low surface water flood risk. The fluvial flood risk is confined to the north-western site boundary, so development could be steered away from this area.

LPR96	Land at Ratby Lane, Markfield	Very low fluvial flood risk (3% of the sites is within FZ2) and low surface water flood risk. Fluvial flood risk is confined to the south-eastern corner of the site, so development could be steered away from this area.
LPR107	Land west of Ratby	Very low fluvial flood risk (1% of the site is within FZ2) and very low surface water flood risk. Fluvial flood risk is confined to a small corner on the western site boundary at Burroughs Road, and along the southern site boundary around the unnamed road. Development could be steered away from these areas.
AS393	Land south of Station Road, Market Bosworth	No fluvial flood risk; however, OS Mapping shows watercourses through the middle of this site which have not been included in the Flood Zones. Detailed modelling should be undertaken at site-specific level to further understand the fluvial flood risk at this site. Surface water flood risk in the 30-year and 100-year events are very low, but 30% of the site is at risk of flooding from the 1,000-year surface water event. Surface water flood risk at this site should be considered as part of a detailed site-specific FRA or Surface Water Drainage Strategy.

4 Level 2 assessment methodology

4.1 Introduction

Preferred SHELAA sites were provided by the Council for assessment. Following the screening assessment of the 65 sites, 13 were brought forward to undergo the Level 2 assessment. This was based on the fluvial flood risk posed to the sites. The sites are outlined in Table 4-1 below.

Table 4-1 Sites carried forward to a Level 2 assessment

Site code	Site name	Development type
AS53	Land off Bosworth Road and Cunnery Close, Barlestone	Mixed use
AS58	Land at Stapleton Lane, Barwell	Mixed Use
AS134	Land at Manor Farm, Burbage	Residential
AS445	Land south of Desford Road, Newbold Verdon	Residential
AS586	Land east of Witherley, Witherley	Residential
AS589	Land at 59 Kennel Lane, Witherley	Residential
AS1008	Land south if Sacheverell Way, Groby	Mixed use
LPR16	Land east of Lutterworth Road, Burbage	Residential
LPR30	Land east of Groby cemetery, Groby	Residential
LPR44	Hinckley Sewage Treatment Works, Burbage	Mixed Use
LPR71	Land off Murphy Drive and Chestnut Drive, Bagworth	Residential
LPR79	Land north and west of Chapel Lane, Congerstone	Residential
LPR94	Land south of London Road, Markfield	Residential

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

4.2 Site summary tables

As part of the Level 2 SFRA, detailed site summary tables have been produced for the sites listed above in Table 4-1. The summary tables can be found in Appendix A.

Readers should refer to Chapter 2 for detailed information on the datasets used to inform the site summary tables.

Where available, the results from existing detailed Environment Agency hydraulic models were used in the assessment to provide depth, velocity and hazard information.

Using the model information combined with the Flood Zones, climate change and Risk of Flooding from Surface Water (RoFfSW) extents, detailed site summary tables have been produced for the site options (see Appendix A). Each table sets out the following information:

- Basic site information
- Area, type of site, current land use (greenfield/brownfield), proposed site use
- Sources of flood risk
 - Existing drainage features
 - Fluvial proportion of site at risk including description from mapping/modelling
 - Surface Water proportion of site at risk including description from RoFfSW mapping

o Reservoir

- Flood History
- Flood risk management infrastructure
 - Defences type, Standard of Protection and condition (if known), and description
 - Description of residual risk (blockage scenarios)
- Emergency Planning
 - Flood Warning and Flood Alert Areas
 - Access and egress
- Climate change
 - Summary of climate change allowances and increase in flood extent compared to Flood Zones
 - Description of implications to the site
- Requirements for drainage control and impact mitigation
 - Broadscale assessment of possible SuDS to provide indicative surface water drainage advice for each site assessed for the Level 2 SFRA.
 - o Groundwater Source Protection Zone
 - Historic Landfill Site
- NPPF Planning implications
 - Exception Test requirements
- Requirements and guidance for site-specific FRA (including consideration of opportunities for strategic flood risk solutions to reduce flood risk)
- Mapping information description of data sources for the following mapped outputs:
 - $\circ \quad \text{Flood Zones}$
 - o Climate change
 - o Surface water
 - Fluvial depth, velocity and hazard mapping
 - Surface water depth velocity and hazard mapping

4.3 Interactive Geo-PDF mapping

To accompany each site summary table, there is an Interactive Geo-PDF map, with all the mapped flood risk outputs per site. This is displayed centrally, with easy-to-use 'tick box' layers down the right-hand side and bottom of the mapping, to allow navigation of the data. The Level 2 Geo-PDF mapping as well as the Borough-wide Geo-PDF maps from the Level 1 SFRA identify communities, features, structures and properties affected by flood risk.

Readers should refer to Chapter 2 for detailed information on the datasets used to inform the Geo-PDF mapping.

Flood risk information in the Geo-PDFs include:

- Site boundary and Council boundary
- Title bar showing area, grid reference, site name, proposed development use (e.g. residential/employment) and percentage Flood Zone coverage
- Flood Zones 2, 3a and 3b (functional floodplain)
- Modelled 100-year fluvial depth, velocity and hazard rating
- Surface water 100-year depth, velocity and hazard rating

- Climate change extents Central, Higher Central and Upper End allowances and Indicative climate change extents
- Flood risk from surface water dataset (30-years, 100-years and 1,000-years)
- Areas Susceptible to Groundwater Flooding
- Flood Warning and Flood Alert Areas
- Historic Landfill
- Defences (embankment and wall)
- Main Rivers/Ordinary watercourses

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5 Summary of Level 2 assessment

5.1 Assessment methods

As part of the Level 2 SFRA, detailed site summary tables have been produced for 13 of the original 65 considered; these sites are shown to be at risk of fluvial flood risk from watercourses running either through or adjacent to the site as a result of the site screening process against flood risk information.

The summary tables set out the flood risk to each site, including Flood Zone coverage, maps of extent, depth and velocity of flooding as well as hazard mapping for the 100-year defended event. Climate change mapping has also been produced for each site to indicate the impact which different climate change allowances may have on the site. Each table also sets out the NPPF requirements for the site as well as guidance for site-specific FRAs. A broadscale assessment of suitable SuDS options has been provided giving an indication where there may be constraints to certain sets of SuDS techniques. This assessment is indicative and more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. It may be possible that those SuDS techniques highlighted as possibly not being suitable can be designed to overcome identified constraints.

It is important to recognise that a number of different sets of data have been used to represent the Flood Zones. Mapping shown in the detailed site summary tables shown in Appendix A as part of the Level 2 assessment may differ to the Environment Agency Flood Zones and 'Flood Map for Planning', as the flood risk from ordinary watercourses flowing through site options has been included in the summary table mapping. It was also agreed with the Environment Agency that where there are detailed models present, the Flood Zones should be derived from these models.

5.2 Summary of key site issues

- All sites with a detailed Level 2 summary table are at fluvial flood risk. The degree of flood risk varies, with some sites being only marginally affected along their boundaries, and other sites being more significantly affected, which will require more detailed investigations on sequential site layouts, SuDS possibilities, safe access and egress etc.
- Two of the sites not taken forward to a Level 2 assessment are at high risk of surface water flooding (AS809 and AS1027) and this should be considered as part of a site-specific FRA or Surface Water Drainage Strategy.
- Nine of the sites not taken forward to a Level 2 assessment are at very low fluvial flood risk (≤5% of the site within the Flood Zones). These sites are AS585, AS303, LPR64, LPR70, LPR72, LPR26, LPR119, LPR96 and LPR107. At these sites the fluvial flood risk is confined to the site boundaries or corners of the sites, in which case development could be steered away from these areas.
- One site not taken forward to a Level 2 assessment has several unnamed and unmodelled watercourses flowing through the site (LPR24). These would need to be modelled as part of a site-specific FRA to understand the fluvial flood risk to the site.
- The majority of sites are at risk from surface water flooding, with more areas of ponding in the higher return period events. Surface water tends to follow topographic flow routes, for example along the watercourses or isolated pockets of ponding where there are topographic depressions. Surface water should be considered when assessing safe access and egress to and from the site.
- Climate change mapping indicates that flood extents will increase. As a result, the depths, velocities and hazard of flooding may also increase. The significance of the increase tends to depend on the topography of site and the percentage allowance used. The Council and the Environment Agency require the 100-year plus 30% and 100-year plus 50% climate change scenarios for fluvial risk to be

considered in future developments, and the 100-year plus 40% for surface water risk.

- Blockage locations were determined by visual inspection of the OS mapping and LIDAR in the vicinity of the site, to determine whether a structure upstream, downstream, or within the site could have an impact on the site. The risk from blockages may need to be considered as part of a site-specific assessment.
- No Level 2 sites are located in a Groundwater Source Protection Zone.
- No Level 2 sites have areas within them designated by the Environment Agency as being a historic landfill site.
- A strategic assessment was conducted of SuDS options using regional datasets. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.
- For a number of sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles.
- Nineteen of the 65 sites fall partially or wholly within the Rothley Brook catchment; this was identified in the Level 1 SFRA cumulative impact assessment as requiring more detailed drainage strategy work to consider how the cumulative effects of development would impact on peak flows, timing and duration of flooding on the Rothley Brook, which drains towards Leicester City and Charnwood Borough. The potential for betterment through flood storage areas for these sites has been considered as part of the Level 2 assessment in section 6.

5.3 Exception Test considerations

All the sites taken forward to Level 2 will require the application of the Sequential Test prior to the Exception Test being applied. The Exception Test has two parts:

- 1 Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk
- 2 Demonstrating that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Table 5-1 below shows an overview of the type of development that is appropriate by Flood Zone, subject to the Sequential Test being passed. Residential development is classified as 'More Vulnerable' and employment development is classified as 'Less Vulnerable'. The table shows in which instances the Exception Test would need to be passed (e.g. Residential in Flood Zone 3a).

Vulnerability		Essential	Water	Highly	More	Less			
Classification	1	infrastructure	compatible	Vulnerable	Vulnerable	Vulnerable			
Flood	Zone	√	~	~	~	~			
Zones	1								
	Zone	✓	~	Exception	~	~			
	2			Test					
	Zone	Exception	~	x	Exception	~			
	3a	Test			Test				
	Zone	Exception	~	×	×	x			
	3b	Test							
Source: Table 3, NPPF Guidance - Flood risk and coastal change									

Table 5-1 Flood risk vulnerability and Flood Zone `compatibility' from the NPPF

5.3.1 Wider sustainability benefits

At the stage of allocating development sites, Local Planning Authorities should consider wider sustainability objectives, such as those set out in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.

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

5.3.2 Making a site safe from flood risk over its lifetime

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

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

Safe access and egress should be available during the design flood event. Firstly, this should seek to avoid areas of a site at flood risk. If that is not possible then access routes should be located above the design flood event levels. Where that is not possible, access through shallow and slow flowing water that poses a low flood hazard may be acceptable.

- Residual risk is the risk that remains after the effects of flood defences have been taken into account and/ or from a more severe flood event than the design event. The residual risk can be:
 - The effects of an extreme 0.1% chance flood in any year event. Where there are defences this could cause them to overtop, which may lead to failure if this causes them to erode, and/ or
 - Structural failure of any flood defences, such as breaches in embankments or walls.

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

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

At a planning application stage and to pass the second part of the Exception Test, the developer will need to be able to demonstrate that:

- within a site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- the development is appropriately flood resistant and resilient;
- the development incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

At an allocation stage and to pass the second part of the Exception Test, the Local Planning Authority will need to be able to consider the same points using the strategic information on flood risk available in the Level 2 SFRA. This does not mean the developer does not also need to apply the Exception Test, but that the Local Planning Authority will have demonstrated in principle that the Exception Test can be passed when allocating a site.

5.3.3 Considering the Exception Test for the proposed sites in Hinckley and Bosworth borough

In principle, it is possible for all sites assessed in the Level 2 SFRA to pass the Exception Test, for example by:

- siting development away from the highest areas of risk into Flood Zone 1 (in the majority of sites assessed, the risk is along a site boundary, so steering away from this is advised),
- considering safe access/ egress in the event of a flood (from all parts of the site, if say the site is severed by a flood flow path),
- using areas in Flood Zone 2 for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. Residential development should not be permitted in Flood Zone 3 and no development at all should be permitted in Flood Zone 3b (aside from essential infrastructure, such as a bridge crossing the lowest points of a site),
- testing flood mitigation measures if these are to be implemented, to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another),
- considering space for green infrastructure in the areas of highest flood risk.

However, some sites assessed need further considerations relating to more significant flood risk, and the number of houses possible on these sites may be lower than originally intended to be achieved. Sites assessed in the L2 SFRA which are deemed to be at more significant risk, and therefore only 'parts' of the site are developable, are:

- AS586 Land East of Witherley, Witherley
 - Approximately two-thirds of the site could be developable, and the access road is sited away from highest risk. The eastern third of the site is at high risk of both fluvial and surface water flooding. However, flood depths look to be shallow and detailed modelling as part of a Flood Risk Assessment may refine this flood extent.

- AS589 Land at 59 Kennel Lane, Witherley
 - Approximately half of the site could be developable, and the access road is sited away from highest risk. The eastern portion of the site is however severed by fluvial flood risk, so access considerations would be required for this part of the site. It is recommended to develop to the west of the watercourse, given high surface water risk in the east. However, flood depths look to be shallow and detailed modelling as part of a Flood Risk Assessment may refine these extents.
- LPR71 Land off Murphy Drive and Chestnut Drive, Bagworth
 - The fluvial flood risk modelling shows high flood risk from the small drains, particularly where the drains may be in culvert, so detailed hydraulic modelling would be recommended, along with site topographic survey, to confirm the risk and overland flow paths. The 2D generalised model outputs also do not align very well with areas shown to be at risk from surface water flooding, which usually serves as a good comparison of risk. A large area of the site is bisected by flood risk and therefore this may impact the amount of development possible at the site, particularly considering how safe access and egress can be achieved from one side to the other. Careful Masterplanning may be required including engineering mitigation works, depending on what detailed modelling shows.
- AS134 Land at Manor Farm, Burbage
 - The flood extents are quite wide on the site and a little misaligned with the detailed river network (for example where the river network may not be well-defined in the ground data and flood flows follow low topography), suggesting more detailed modelling will be required to refine the flood extents. The site is bisected by this watercourse and hence consideration of access from one half of the site to the other should be considered.

Additional considerations for these sites consist of:

- The need for site topographic survey, where ground levels may have changed, or where 2D generalised modelling does not align as well with the surface water mapping as would be expected, for example at site LPR71. This survey could be built into a detailed hydraulic model to better represent the site area.
- Careful Masterplanning, to steer development away from the highest risk areas, using Table 3 of the NPPF guidance to see what development vulnerability classification allows development in particular Flood Zones.
- Consideration of safe access/ egress and how this is impacted if parts of the site are bisected by fluvial or surface water risk, for example at sites AS134 and AS589.
- Mitigation works involving engineering, e.g. earth works, to make a site developable and overcome local issues, for example at site LPR71.
- More detailed hydraulic modelling where 2D generalised modelling has been used as an indication of flood risk in the absence of detailed EA models, this may be overestimating flood extents and also does not account for channel or structure dimensions. The channel is assumed to be bankfull (e.g. a 2-year flow) and remaining flow overspills into the floodplain to follow topography.
 - A developer would need to commission a hydraulic modelling study where channel topographic survey is collected, to refine and confirm the flood risk extents, particularly Flood Zone 3b and climate change extents. This is recommended at all of the abovementioned sites, as the 2D generalised modelling looks to spread more than would be

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expected for small drains, or is slightly misaligned with the watercourse where the overland flow routes are following lower topography.

• A Flood Risk Assessment would investigate and draw together these and the specific points above, to show how the site would be developed, managing and mitigating all sources of flood risk, ensuring safe access, detailed modelling to confirm flood risk and any post-development impacts, and a surface water drainage strategy.

6 Cumulative Impact Assessment

6.1 Introduction

Under the NPPF, strategic policies and their supporting Strategic Flood Risk Assessments (SFRAs), are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para. 156), rather than just to or from individual development sites.

When allocating land for development, consideration should be given to the potential cumulative impact of the loss of floodplain storage volume, as well as the impact of increased flows on flood risk downstream. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe.

All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing developments comply with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory they should not increase flood risk downstream.

The Level 1 SFRA assessed the catchments within the Borough to determine which catchments are at the highest risk from the cumulative impact of development and made recommendations based on the results. One of the recommendations as part of the cumulative impact assessment was for the Rothley Brook catchment, which drains towards neighbouring Leicester City and Charnwood Borough. The recommended policy was to:

"Undertake more detailed drainage strategy work as part of a Level 2 SFRA or detailed local area Strategic Drainage Study to consider further how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions/ enforce through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National and Local SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online/offline flood storage and where land should be safeguarded within proposed site allocations to fulfil this purpose."

This Level 2 SFRA looks at the effect of the proposed development in the Rothley Brook catchment downstream of Hinckley and Bosworth Borough, and gives a strategic indication of the storage measures that could be implemented at the sites to ensure flood risk isn't increased downstream. The site summaries in section 6.4 explore opportunities to go above and beyond site based surface water management and provide wider betterment, given the potential for increases in risk downstream.

6.2 Impact of the proposed development

Out of the 65 preferred SHELAA sites, 19 fall within the Rothley Brook catchment. Three of these sites are partially within the catchment, with the remaining sites lying wholly within the catchment as shown in Figure 6-1.

A hydrological analysis was undertaken to determine what impact development could potentially have on how the Brook responds to rainfall. This looked at any impact on the time the Brook takes to peak as well as the level at which it peaks. This is a conservative approach that does not take into account at this stage site level Sustainable Drainage Systems (SuDS), but can be used to inform future SuDS design across several sites in the catchment.

To ascertain the impact of the proposed development on downstream flows, catchment descriptors from the **FEH Webservice** were downloaded for the Rothley Brook catchment and a hydrograph was derived using ReFH with a 6.5 hour storm duration and a 0.5 hour timestep. These catchment descriptors were then amended to account for the proposed development in the catchment. The URBEXT (urban extent) value

was increased in line with the total area of development proposed in the catchment (assuming a developable area as outlined in the Council's **SHELAA methodology** and described in section 6.3). The hydrographs are shown in Figure 6-2. It should be noted that these hydrographs have been derived from ReFH using catchment descriptors only, a detailed hydrological assessment to obtain these hydrographs has not been undertaken.

Figure 6-1 Sites within the Rothley Brook catchment

- Preferred SHELAA sites in

.5	1	1.5	2	2.5
1				km

Figure 6-2 Rothley Brook hydrograph pre- and post-development

JBA consulting Figure 6-2 shows that with the proposed development in the Rothley Brook catchment, peak flows downstream on the Rothley Brook would slightly increase and the time to peak of flooding would slightly decrease.

This shows that due to the cumulative impact of development, on-site storage could be required at the sites in the Rothley Brook catchment to ensure that the risk of flooding downstream in Leicester City and Charnwood Borough is not increased by this development. The potential extent of the storage required has been explored in the next section. This is for the purposes of developing strategic planning policy by highlighting the need for considering drainage amongst groups of nearby sites. It is not intended at this stage to set out the absolute level of storage that must be provided at site level because specific information about development sites is not yet known, such as how much of the site will be developed and in what way, as well as information on underlying geological and soil conditions based on ground investigations. At a sitelevel, developers will need to undertake detailed drainage strategies to refine calculations of the amount of storage required on site.

6.3 Assessing the storage need at potential development sites

The **UK SuDS Website** provides a variety of tools for the design and evaluation of sustainable drainage systems. The surface water storage volume estimation tool was used to provide estimates of storage volume requirements needed to meet best practice criteria from Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory technical standards for SuDS (Defra, 2015). It should be noted that the estimates from this tool should not be used for the detailed design of drainage systems and sewer modelling is recommended when designing a drainage scheme.

The tool works by selecting a point on a map for the calculation and entering characteristics for that site. For this assessment, the most downstream point of each site was selected, the site area was entered, and a developable area/ impermeable area was assumed as set out in the Council's **SHELAA methodology**:

- If a site is up to 0.4ha then the area calculated will remain unchanged;
- If a site is between 0.4 and 2ha then 82.5% of the site area is assumed developable;
- If a site is between 2 and 35ha then 62.5% of the site area is assumed developable;
- If a site is >35ha then 50% of the site area is assumed developable.

All other variables in the tool were left as default, to avoid a large number of assumptions. The IH124 method to calculate surface water storage requirements was used as a default and again to avoid further assumptions.

Where a site only partially fell into the Rothley Brook catchment, storage estimations have been provided for two scenarios: the first assuming that the entire site will discharge to the Rothley Brook catchment and the second assuming only the proportion of the site within the Rothley Brook catchment will discharge to this catchment, with the rest of the site discharging to another catchment. In reality, a site will generally discharge all to one catchment and where a site will discharge to is not yet known, this should be considered at a site-specific stage. Table 6-1 outlines the potential storage requirements for each site in the Rothley Brook catchment.

The calculations here are based on the site characteristics available to inform a strategic assessment and assumptions regarding the amount of development on each site as set out above. At a site-specific stage, developers will need to use more detailed site level data, e.g. the extent of the site, extent of developable areas, more detailed site investigations into underlying geological and soil conditions etc. to refine the necessary storage volume calculations.

Storage can be provided throughout a development site, taking a SuDS management train approach to drainage design, as set out in the Level 1 SFRA Section 9, where 2019s0332 - Hinckley and Bosworth Borough Council L2 SFRA Final v3.0.docx 26

hyperlinks are provided to national and local SuDS guidance. This should be explored further at a planning application stage and feed into the site Masterplan. For example, permeable paving, swales and ponds collectively could form part of the overall surface water storage solution for a site.

Table	6-1	Estimated	storage	volumes	required	at	sites	in	the	Rothley	Brook
catchn	nent,	taken from	the UK S	SuDS webs	site						

Settlement	Site	Attenuation storage 1 in 100 years (m ³)	Long term storage 1 in 100 years (m ³)	Total storage 1 in 100 years (m³)
	10042	1506*	58*	1565*
	LPR45	262**	7**	269**
	LPR93	728	154	881
Markfield	LPR94	12208	474	12682
	LPR70	2749	105	2854
	LPR96	3181	122	3303
	AS407	275	0	275
Bagworth	4612	1362*	55*	1417*
Bayworth	ASIZ	170**	0**	170**
	AS32	994	39	1033
Thornton	AS33	1030	40	1070
	AS686	1460	57	1517
Newbold		1944*	75*	2068*
Verdon	LFKZ9	944**	35**	979**
	LPR37	1763	64	1827
		39245*	0*	39245*
Decford	LPRZ4	4783**	0**	4783**
Desiora	LPR83	5546	203	5749
	LPR119	3140	115	3255
	AS201	1994	73	2067
Ratby	LPR107	16324	0	16324
Croby	LPR30	2253	83	2337
Groby	AS1008	16549	0	16549

*Storage assuming entire site is discharged into the Rothley Brook catchment

**Storage assuming only site area within the Rothley Brook catchment is being discharged to the catchment, with the remaining site area discharging to another catchment

6.4 Recommendations for storage and betterment

From analysing the results in Table 6-1, as well as the OS Mapping, LIDAR, Flood Zones and locations of other sites, high-level recommendations for flood storage and betterment have been proposed for sites in the Rothley Brook catchment. These recommendations should be considered by developers as part of a site-specific assessment, but it is recommended that more detailed modelling is undertaken by the developer to ascertain the true storage needs and potential at the sites. This should refine the estimates of storage required as set out in Table 6-1. In line with national planning policy and the national requirements for SuDS, storage will always be required for the 100-year plus applicable climate change allowance event. Whether any additional storage would benefit downstream areas depends on where the site is located within the catchment and has been explored below.

6.4.1 LPR93 and LPR94 – Markfield

These sites are located upstream of Thornton Reservoir, which would likely attenuate any increased flows from the sites receiving watercourses before discharging downstream towards the Rothley Brook. As there are no properties along the watercourse between these sites and Thornton Reservoir, it is not thought that additional volumes above the 100-year plus applicable climate change allowance would need to be stored on site, as flows and volumes are likely to be also attenuated in the reservoir. The receiving watercourse of these sites passes under the M1 downstream of LPR94, however the motorway is elevated well above the watercourse, and so flows are unlikely to need constraining as the M1 is unlikely to flood from these watercourses.

Figure 6-3 LPR93 and LPR94 – Markfield

6.4.2 LPR43 – Markfield

Only a small part of this site falls within the Rothley Brook catchment (approximately 22%) therefore it may be that discharge from the site is away from the Rothley Brook catchment. It is likely that this site would discharge to sewers and SuDS would be encouraged at this site to prevent increased runoff elsewhere given the proximity of the site to existing properties and gardens. There are potentially culverts near the site in Markfield and these should be thoroughly explored at site-specific stage.

Figure 6-4 LPR43 – Markfield

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6.4.3 LPR70, LPR96 and AS407 – Markfield

These sites are located upstream of a small pond on the Slate Brook, which lies upstream of Groby Pool. The pond and Groby Pool would likely attenuate any increased flows from the sites receiving watercourses before discharging downstream towards the Rothley Brook. There are a small number of properties along the watercourse between these sites and Groby Pool, so if there are localised flooding issues in these areas, onsite storage may need to be considered. Online storage areas could be located along the southern boundary of LPR96 on the Slate Brook tributary; however, it is unlikely that a storage area here is likely to have a wider catchment affect as flows are likely to be attenuated in Groby Pool. The impact on water quality should be fully investigated at any detailed design stage, given that surface water discharges would be essentially draining down to Groby Pool, a Site of Special Scientific Interest.

Figure 6-5 LPR70, LPR96 and AS407 – Markfield

6.4.4 AS12 – Bagworth

Only a small part of this site falls within the Rothley Brook catchment (approximately 16%); however, the majority of the site and the rest of Bagworth village is not part of the Rothley Brook catchment, and as the north-eastern site boundary is parallel to a railway line, is it most likely that this site will discharge away from the Rothley Brook catchment. Areas at lower elevations, which tend to be towards the centre of the site, could be used as additional storage areas within the site.

Figure 6-6 AS12 – Bagworth

6.4.5 AS32, AS33 and AS686 - Thornton

As these sites are adjacent to one another, the storage needs for these sites could be combined into one storage area. The total proposed storage across these three sites is 3620m³, which could be implemented to the south-west of the sites, where the elevations are lower. Storage needs can only be considered together if all sites were discharging to the same point, (i.e. single point on a watercourse or to a sewer) and depending on the phasing and the deliverability of the development. It is therefore recommended that developers of these sites work together or consider these three sites strategically as a whole. However, this will depend on the site-specific proposals, the phasing and land ownership of the sites – at a strategic level, it could offer an opportunity to provide wider sustainability and environmental benefits by including green corridors, additional attenuation volumes and sustainable urban drainage techniques.

Figure 6-7 AS32, AS33 and AS686 – Thornton

6.4.6 LPR29 – Newbold Verdon

Around half of this site falls within the Rothley Brook catchment (approximately 50%), however in reality, it is unlikely that discharge from a site would be split and it is more likely that all discharge would go to one catchment only. As the majority of the village of Newbold Verdon drains away from the Rothley Brook catchment, it is likely that the site will not discharge to the Rothley Brook catchment. It is likely that the site will discharge flows to existing sewers; however, pockets of infiltration could be possible, dependent on the concentration of clay in the soils at the site which are till/diamicton. SuDS and permeable paving may help provide storage volumes on-site and additional storage may be possible in lower areas, towards the eastern corner of the site. Careful design at site-specific stage is needed to ensure flood risk is not increased elsewhere as there are a number of existing dwellings near the site.

Figure 6-8 LPR29 – Newbold Verdon

6.4.7 LPR83 – Desford

This site could potentially discharge to sewer along the B562, and there could potentially be the opportunity for infiltration to ground, as the soils around the site are glacial sand and gravels. Partial discharge to the watercourse west of the site may also be possible. Areas of lower ground where additional storage areas could be possible would be along the western site boundary, parallel to the access road to Lockey Farm. There is possibly a culvert near to the site as a small pond is present around Lockeymead Drive, and the presence of culverts should be investigated at a site-specific stage.

6.4.8 LPR24 – Desford

This site is very large (91ha) and therefore it is likely that development at this site will be phased, but a strategic overview of the entire red line boundary should be considered at site-specific stage. Approximately 11% of the site is within the Rothley Brook catchment with the remainder of the site part of the Thurlaston Brook catchment. There are numerous watercourses in the south of the site outside of the Rothley Brook catchment that the site could discharge to, and online storage areas could be implemented along these watercourses to create blue corridors, make space for water and provide a downstream benefit to the Thurlaston Brook. The northern part of the site within the Rothley Brook catchment could potentially discharge to sewer in Desford. It is recommended that no culverting on site is undertaken, unless it is to enable access and detailed hydraulic modelling should be undertaken to understand flood risk to the site from the watercourses in the Thurlaston Brook catchment.

Figure 6-10 LPR24 – Desford

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6.4.9 AS201, LPR119 – Desford

As these sites are adjacent to one another, and due to the lack of highway access at LPR119 but the fact that it can discharge to the Bam Brook along the northern site boundary, it is recommended that developers at these sites work together to enable growth and to provide wider sustainability benefits. Online storage along the Bam Brook e.g. open ponds could attenuate flows from AS201 and LPR119 and provide benefit to areas at flood risk downstream, as well as providing water quality benefits and wider environmental benefits – providing that both the sites are developed within a similar timeframe.

Figure 6-11 AS201, LPR119 – Desford

6.4.10 LPR37 - Desford

This site is relatively constrained in terms of its proximity to watercourses and other proposed development sites and discharge is likely to be to existing sewers. On-site attenuation should be used to limit site runoff to greenfield rates, but additional storage volumes above the 100-year plus applicable climate change allowance at this site is unlikely to give a discernible betterment downstream in the Rothley Brook catchment. Areas of lower elevation where there is potential for offline storage would be towards the east of the site.

Figure 6-12 LPR37 – Desford

6.4.11 LPR107 - Ratby

Discharge from this site is likely to be to the unnamed watercourse west of the site at the culvert under Burroughs Road, but could also be to the watercourse to the south of the site. Online storage areas along either of these watercourses could provide storage above and beyond the minimum estimated requirements of the site (16,324m³) to provide additional betterment in the Rothley Brook catchment.

Figure 6-13 LPR107 – Ratby

6.4.12 LPR30 - Groby

Areas on the unnamed watercourse to the east of the site could provide on-site storage for LPR30, however providing storage areas greater than the minimum estimated 2019s0332 - Hinckley and Bosworth Borough Council L2 SFRA Final v3.0.docx 34

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requirement (2,337m³) is unlikely to have significant downstream benefits, as discharges from the M1 and A46 into the Rothley Brook means that additional storage volumes above the 100-year plus applicable climate change allowance at LPR30 may have a negligible impact.

Figure 6-14 LPR30 – Groby

6.4.13 AS1008 - Groby

There are watercourses to the east and the south of the site that the site could discharge to and where storage areas may be possible, however if the M1 and A46 also discharge to these watercourses, there may not be the capacity for AS1008 to discharge at greenfield runoff rates. A lower rate than greenfield rates should be considered, and long-term storage volumes provided. Any betterment to calculated greenfield runoff rates should be considered at a site-specific stage with storage areas and site design accounting for any unrestricted discharges and highway drainage from the M1 and A46.

Figure 6-15 AS1008 – Groby

7 Recommendations

7.1 Site allocations

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

The Council should use the information provided within this SFRA for their Sequential Test decision-making, following which, if land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development, the Exception Test will need to be applied. This is where the Level 2 SFRA supports, as it considers the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

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

7.2 Site-specific assessment considerations

For development sites located in Hinckley and Bosworth Borough, it is recommended that developers consider the following:

- Developments should be sustainable and support adaption to climate change, which may involve flood resilience and resistance measures.
- Any site-specific FRA would need to adequately assess the local topography, geology and drainage systems (including sewer capacity) to ensure the risk posed from surface water is appropriately taken into account, for example discharge destinations and justifications.
- Consider reservoir flooding and residual risk at the planning stage.
- Safety is a key consideration for any new development and includes the likely impacts of climate change and, where there is a residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.
- The adoption and maintenance of drainage systems and flood defence infrastructure.
- Taking positive measures to conform to the Water Framework Directive, where on and offsite water quality can be affected by development, for example in terms of 'deterioration' in waterbody ecological status or potential.

As Hinckley and Bosworth Borough sits on high ground near the top of river catchments many of the watercourses react quickly to heavy rainfall. Because there are no major flood defences affecting proposed development sites there is no risk from sudden flood defence failure. Subject to a suitable warning system being put in place for future occupiers of developments it should be possible to provide advance notice of flooding, although this could amount to hours rather than days given the upper catchment location. Alerts based on heavy rainfall forecasts may provide earlier warning, although have a higher potential for false alarms.

Analysis of past flood hydrographs shows that the duration of flooding is typically less than a day, although this will depend on the nature of the weather. Repeat storms may cause flooding to last for longer or double peaks on watercourses, where river levels start to fall and then rise again in response to later storms.

The Level 2 site analysis has used information on the depth, velocity and hazard from flooding to put forward development recommendations. Further site-specific work at planning application stage should consider further the depth, velocity and hazard from

flooding, as well as the onset and duration of flooding when developing site level mitigation plans and warning systems.

7.3 Flood risk assessments

The Level 2 SFRA is not intended to replace site-specific FRAs. Site-specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes Part B of the Exception Test. Part B requires a FRA to 'demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall'.

A FRA is required for all developments:

- In Flood Zone 2 and 3;
- Over 1 ha in Flood Zone 1;
- Less than 1 ha in Flood Zone 1 including a change of use in development type to a more vulnerable class where they could be affected by a source of flooding other than rivers and sea;
- In an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency.

Developers must, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including the latest climate change allowances), inform development zoning within the site and prove whether Part B of the Exception Test can be passed. Developers should include an assessment of the residual risk where developments may be at risk of infrastructure failure e.g. culverts becoming blocked. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

Where there is historical evidence of flooding at sites, any developments will require a detailed Flood Risk Assessment to fully understand and verify flood risk and flooding mechanisms.

Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites by reducing the amount of surface water runoff generated on a site. The functional floodplain should be protected from development and returned to greenfield status (where possible).

7.3.1 Future Developments

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

- Reducing volume and rate of surface water runoff based on local planning policy and LLFA Guidance
- Locating development to areas with lower flood risk
- Leaving an 8m easement from top of bank to development to manage flood risk
- Creating space for flooding
- Integrating green infrastructure into mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

The Local Planning Authority should consult the National Planning Practice Guidance and Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', published in March 2014, when reviewing planning applications for proposed developments at risk of flooding. At the planning application stage, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances, published by the Environment Agency in February 2016), inform development zoning within the site and prove, if required, whether the Exception Test can be passed.

It is recommended that as part of the early discussions relating to development proposals, developers discuss requirements relating to site-specific FRAs and drainage strategies, to identify any potential issues that may arise from the development proposals.

7.3.2 Promotion of SuDS

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

- Wherever possible, SuDS should be promoted.
- It is essential that developers consider sustainable drainage at an early stage of the development process ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS.
- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- Development should aim to achieve Greenfield runoff rates and ensure that surface water runoff is managed as close to its source as possible.
- Where possible developments must utilise the most sustainable form of drainage systems, in accordance with the SuDS hierarchy.
- Water quality requirements for sustainable development should comply with current SuDS guidance.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough and if soils have adequate permeability to allow for SuDS techniques that are designed to encourage infiltration.
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable, and guidance should be sought from the LLFA.
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints.
- The LPA will need to consider drainage schemes for major and minor applications, as well as review of SuDS on both types of application. It is advised that developers utilise the LLFA's policies and guidance to develop their drainage schemes for applications. Hinckley and Bosworth Borough Council have adopted a Good Design Guide Supplementary Planning Document and developers should consider this guidance when developing drainage schemes.
- Where SuDS are provided as part of a development, applicants should detail how it will be maintained in the long term.

7.3.3 Infrastructure and Access

Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard should be identified and the use of developer contributions considered to fund improvements. None of the sites assessed in this Level 2 assessments are protected by formal flood defences, though this should be a consideration for any future windfall sites which may be located near to flood defences.

Safe access and egress for residents and emergency and service vehicles will need to be demonstrated at all development sites.

7.4 Sites in the Rothley Brook catchment

The Level 1 SFRA highlighted that development in the Rothley Brook catchment is at high risk with the regards to the cumulative impact of development, affecting Leicester City and Charnwood Borough neighbouring authorities. The recommendations for betterment through flood storage areas as outlined in section 6.4 should be considered by developers as part of site-specific assessment. These recommendations should be considered; however, it is recommended that more detailed modelling is conducted by the developer, to fully understand the requirements and possible locations for flood storage areas.

7.5 Use of SFRA data and future updates

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

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

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

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

Appendices

- A Level 2 Assessment
 - A.1 Level 2 Site Summary Tables
 - A.2 Geo-PDF mapping

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