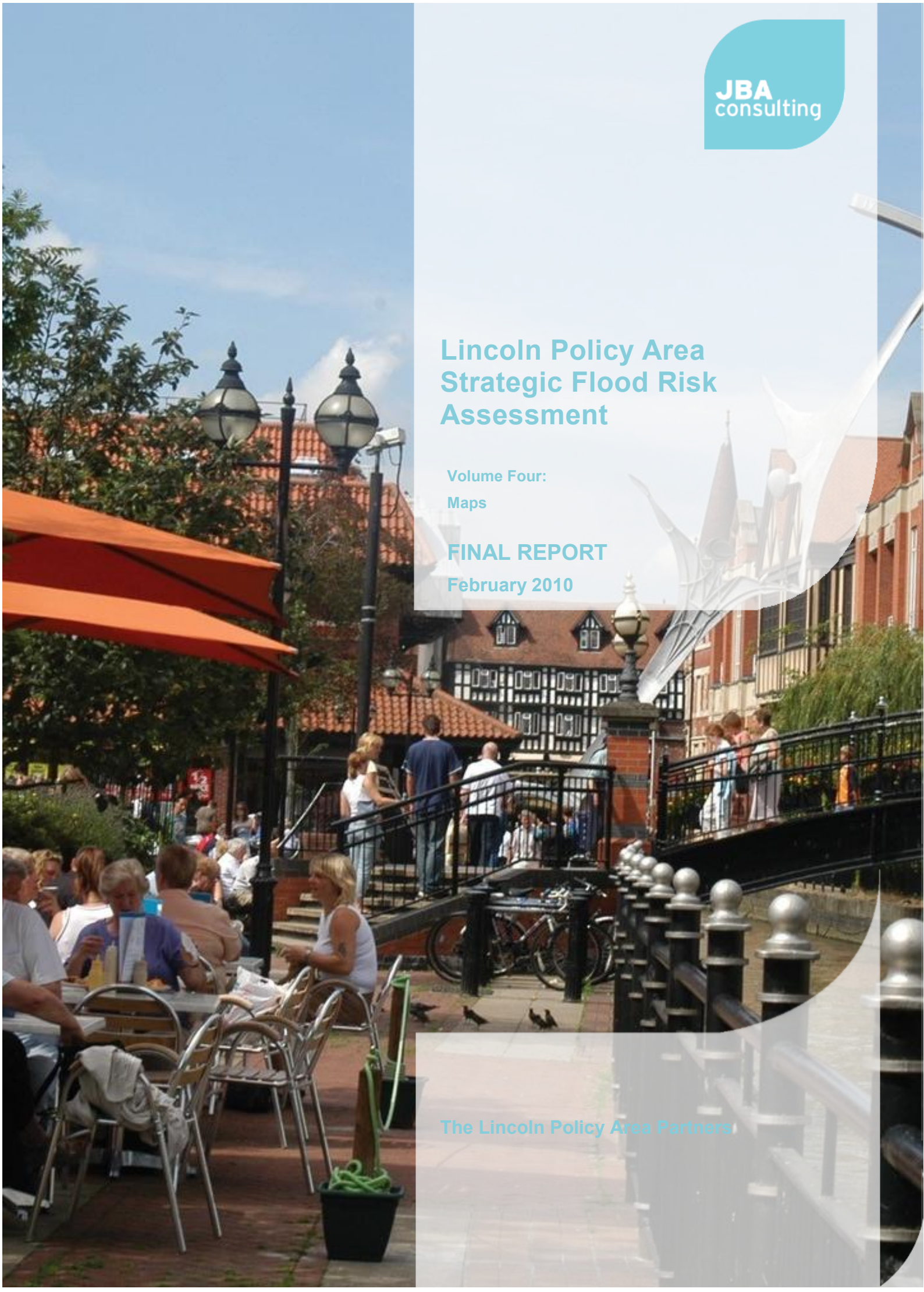

Lincoln Policy Area Strategic Flood Risk Assessment

Volume Four:

Maps

FINAL REPORT

February 2010

The Lincoln Policy Area Partners

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Contract

This report describes work commissioned by The City of Lincoln Council, on behalf of The Lincoln Policy Area Partners. The City of Lincoln Council 's representative for the contract was Toby Forbes-Turner. Matthew Hemsworth of JBA Consulting carried out this work.

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Purpose

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Acknowledgments

JBA would like to thank all those at Lincoln City Council, the Environment Agency and IDB's who provided information and data to support this project. Their assistance is gratefully acknowledged.

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Executive Summary

This report is a Strategic Flood Risk Assessment (SFRA) for The Lincoln Policy Area. It is a combined Level 1 and Level 2 SFRA that incorporates the requirements of a scoping study SFRA (Level 1) and increased scope SFRA (Level 2). This SFRA has been prepared in accordance with current best practice, Planning Policy Statement 25 Development and Flood Risk (PPS25) and updates the previous SFRA published in 2002.

The SFRA constitutes one of a number of planning tools that enables the local authority to select and develop sustainable site allocations away from areas of greatest vulnerability to flooding in Lincoln. The assessment does not focus on specific development sites. The report discusses the broad scale flood risk within the whole policy area, and also focuses in more detail in an extended area of the City of Lincoln including North Hykeham and the Western Growth Corridor (Figure 1-1). This allows for an informed decision to be taken when allocating future development sites. It sets out the procedure to be followed when assessing sites in the future. The SFRA will provide the local planning authorities with the necessary detailed information to make informed decisions when considering development and flood risk issues.

The SFRA is intended to be a "live" document, updated when appropriate to reflect changes in the area and as new information becomes available.

Relevant planning, policy and guidance documents have been taken into account in preparing this SFRA. The documents which have been reviewed include national, regional and local planning legislation, together with Environment Agency policy guidance.

A thorough review of existing information and the construction of new hydraulic models has identified the level of flood risk in the Lincoln Policy Area from fluvial (river flooding).

Consultation has been undertaken with the City of Lincoln Council, the Environment Agency, local Internal Drainage Boards (IDB), British Waterways and Anglian Water to assess the current flood risk from all sources.

The Environment Agency Flood Zone Maps are included in the SFRA. The Flood Zone Maps show indicative flood outlines based on a broadscale assessment of fluvial flood risk only and do not take into account the protection offered by any defences. There are three Flood Zones. Flood Zone 1 classifies areas with a low probability of flooding. Flood Zone 2 (1 in 1000yr) is considered suitable for water-compatible, less vulnerable, more vulnerable and essential infrastructure. Highly vulnerable development is only allowed where the Exception Test is passed. Flood Zone 3 is split in to 2 sections; Zone 3a represents areas with a high probability of flooding (ie 1 in 100yr) and Zone 3b represents the functional floodplain. This is normally defined by the 1 in 20 year flood outline where water is able to spill out of the river channel. In Lincoln 1 in 20 year flows remain in channel except for in specified washland areas designed to hold flood waters.

Hydraulic modelling has been undertaken for the level 2 SFRA within the City of Lincoln to establish more realistic indicative flood outlines in key areas that take into account defences and consider how flood water flows within a floodplain. This modelling (which includes allowances for climate change to 2108) calculates expected depths and velocities of flood water across the floodplain and allows consideration of the flood risk to people and properties. Modelled flood outlines also take in to account the effects of climate change.

The flood scenarios considered in the SFRA are 1 in 100 year with climate change and 1 in 1000 year with climate change annual chance flood events, which may also be expressed as 1%+cc and 0.1%+cc Annual Exceedance Probability (AEP) flood events.

An investigation has been carried out into the effect of defences on flood risk and the risk that remains behind them, for example by failure (due to breach) or overtopping. Purpose built, formal defences have been considered and also other features such as privately owned walls and road and rail embankments, which were not built specifically as flood defences, but which have an impact on the flow of flood water due to their elevated level.

The main flood risk within the Lincoln Policy Area is considered to be from fluvial flooding.

Following major flooding in 1947 and 1958, feasibility studies were undertaken in 1977 to investigate flood risk in Lincoln and possible flood alleviation schemes. As a result, a scheme was implemented, which consisted of two controlled washlands constructed upstream of Lincoln City Centre; one at the confluence of the River Witham and Brant, known as the Witham washlands (5km south of Lincoln), and the other on the River Till (7km to the north-west), which provide a 1 in 100-year level of flood protection. The washlands were created by building shallow embankments across the river valley, with control sluices in the rivers, which allow the amount of water in the washlands to be regulated. Pumping stations aid the final draining of the washlands. The scheme was completed in 1991.

Apart from the control gates at the washlands there are also automated control gates at Stamp End and at the upstream end of Sincil Dyke (Bargate Sluices). All of these control gates are used to keep water levels in Lincoln below critical levels, which were set taking account of existing defence levels. The water level in Lincoln is kept between 4.36m AOD and 5.7m AOD. A set of rules and criteria for the operation of the washlands exists. This is held by the Lincs Washlands Operating Team. The control gates at the washlands are operated manually based on levels and flows from telemetry sites upstream.

The present flood risk within the Lincoln Policy Area has been determined with reference to the Environment Agency's Flood Zone Map (FZM) 2009 and overtopping and breach analysis of the flood defences within the City of Lincoln.

Overtopping and Breach analyses have been undertaken showing the possible depths and hazard mapping has been undertaken (taking into account depth and velocity). Overtopping and Breach analyses have been carried out using JBA's in-house raster based 2-D model JFLOW, to enable the production of maps showing overtopping and breach extent. Maps and GIS layers have been provided.

The flood defence condition has also been summarised (in Volume 2) from information received from the Environment Agency. The condition of flood defences throughout Lincoln ranges from Good to Poor.

2D flood modelling within the 'extended' area of the City of Lincoln (including north Hykeham and the Western Growth corridor) for both the 100 year with climate change and 1000 year with climate change flood scenarios has shown that flood defences will overtop. Breach analysis of flood defences has shown flood water to extend over a large area of the existing low land within the City area. The areas to the Western side of the River Witham in Lincoln are at the greatest risk from flood defence failure.

The SFRA provides guidance relating to future development. It provides advice on any site-specific requirements for a Flood Risk Assessment within the different flood zones, and advises the local authorities on the use of the Exception Test, should the Sequential Test be passed.

Guidance for the local authorities on the future management of development with respect to flood risk has been given, relevant to the different flood zones and possible types of development.

In addition, an outline has been given of requirements for developers for Flood Risk Assessments, with supporting guidance on reducing flood risk and making development safe, including Sustainable Drainage Systems (SuDS) and flood mitigation measures. Advice is also given on environmental improvement opportunities and other issues to consider as part of a development proposal.

The SFRA is presented in four volumes: Volume 1 provides a non-technical summary of the SFRA process and findings, Volume 2 provides a technical summary of methods used to produce the SFRA, Volume 3 provides guidance for those using the SFRA and Volume 4 includes the mapped outputs of the SFRA.

Contents

Abbreviations

AEP	Annual Exceedance Probability
AONB	Area of Outstanding Natural Beauty
CC	Climate Change
CFMP	Catchment Flood Management Plan
DEFRA	Department for the Environment, Food and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
FZ	Flood Zone
Ha	Hectare
JBA	Jeremy Benn Associates Ltd
LDD	Local Development Document
LDF	Local Development Framework
LPA	Local Planning Authority
m AOD	Metres Above Ordnance Datum
MSfW	Making Space for Water
OS NGR	Ordnance Survey National Grid Reference
PPG25	Planning Policy Guidance Note 25
PPS25	Planning Policy Statement 25
RFRA	Regional Flood Risk Appraisal
SFRA	Strategic Flood Risk Assessment
SSSI	Site of Specific Scientific Interest
SuDS	Sustainable Drainage Systems

Definitions

Annual Exceedance Probability	e.g. 1% AEP	Refer to 'probability'.
Brownfield		Brownfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has previously been developed'. Prior to PPS25, the term 'Brownfield' was used in Governmental Guidance and Statements, but in PPS25 has been replaced with 'Previously-developed land'. See 'Greenfield'.
Catchment Flood Management Plan	CFMP	A strategic planning tool through which the Environment Agency will seek to work with other key decision-makers within a river catchment to identify and agree policies for sustainable flood risk management.
Compensatory Storage		A floodplain (flood storage) area introduced to compensate for the loss of storage as a result of filling for development purposes.
Core Strategy	CS	This is the strategic vision of an area and is a central pillar of the Local Development Framework, comprising: A Vision, Strategic Objectives, a spatial land use strategy, core policies and a monitoring and implementation framework. The Core Strategy is a Development Plan Document which will determine overall patterns of future development, identifying broad locations where future growth will take place. All other Development Plan Documents should be in broad conformity with the Core Strategy Document The Core Strategy is a mandatory document, and a timetable for production is set out within the Local Development Scheme.
Defended Area		An area offered a degree of protection against flooding through the presence of a flood defence structure.

Development Plan Documents	DPDs	These documents have Development Plan Status and consequently form part of the statutory development plan for the area. A DPD will be subject to an independent examination. Typical documents that will have DPD status include the Core Strategy, Site-specific Allocations of Land, Proposals Map, and Area Actions Plans (where needed).
Environment Agency	EA	An executive non-departmental public body. It's principle aims are to protect and improve the environment and to promote sustainable development.
Exception Test		An integral part of the risk-based approach at the core of PPS25, the Exception Test is designed to allow for those exceptional circumstances when, for wider sustainability reasons, development not entirely compatible with the level of flood risk may be permitted. For the Exception Test to be passed, all three of its components must be fulfilled.
Flood Estimation Handbook	FEH	Provides current methodologies for estimation of flood flows for the UK.
Flood Hazard		A classification system developed by DEFRA/Environment Agency that gives an assessment of the hazard posed by a flood event at a given location. It is defined using the maximum modelled flood depth, velocity and a factor to allow for debris.
Floodplain		Any area of land over which water flows or is stored during a flood event or would flow but for the presence of defences.
Flood Risk Assessment	FRA	A detailed site-based investigation that is undertaken by the developer at planning application stage.
Flood Risk Management		The introduction of mitigation measures (or options) to reduce the risk posed to property and life as a result of flooding. It is not just the application of physical flood defence measures.
Flood Risk Vulnerability Classification		Refer to Section **Error! Reference source not found.**.
Flood Zone 1	FZ1	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
Flood Zone 2	FZ2	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1%-0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5%-0.1%) in any year.
Flood Zone 3a	FZ3a	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Flood Zone 3b	FZ3b	This zone comprises land where water has to flow or be stored in times of flood. This is land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood.
Fluvial Flooding		Flooding caused by the overtopping of river or stream banks.
Formal Defence		A flood defence asset that is maintained by the Environment Agency.
Freeboard		A 'safety margin' to account for residual uncertainties in water level prediction and/or structural performance, expressed in mm.

Functional Floodplain		An area of land where water has to flow or be stored in times of (fluvial) flooding.
Greenfield		Greenfield (sites or land) is a term in common usage that may be defined as 'development sites or land that has not previously been developed'. Prior to PPS25 the term 'Greenfield' was used in Governmental Guidance and Statements, but in PPS25 has been replaced with 'Undeveloped land' See 'Brownfield'.
Informal Defence		A structure that provides a flood defence function, however is not owned nor maintained by the Environment Agency.
Internal Drainage Board	IDB	An Internal Drainage Board is a statutory body which provides flood protection and water level management services
ISIS		1-Dimensional hydraulic modelling software used to demonstrate flow within river channels
JFLOW		Proprietary 2-Dimensional hydraulic modelling software package developed by JBA, which demonstrates overland flow in floodplains
Local Development Framework	LDF	The Local Development Framework is made up of a series of documents that together will form part of the Development Plan. Broadly, Local Development Framework documents fall into two categories: - Development Plan Documents - Supplementary Planning Documents.
Local Development Scheme	LDS	A Local Development Scheme is a public statement of the Council programme for the preparation of Local Development Documents which will form the Local Development Framework.
Local Planning Authority	LPA	Local authority with responsibility for determining whether proposed developments are approved or otherwise.
Main River		A watercourse designated as such by DEFRA that is regulated and maintained by the Environment Agency using their permissive powers.
Measure		A deliverable solution that will assist in the effective management (reduction) of risk to property and life as a result of flooding, e.g. flood storage, raised defence, effective development control and preparedness, and flood warning.
Mitigation		The management (reduction) of flood risk.
Option		Refer to 'measure'.
PAG2		Project Appraisal Guidance (PAG) 2 (Strategic Planning) outlines the DEFRA requirements against which the Environment Agency must demonstrate that they are managing flood risk in a strategic (catchment wide) manner.
Probability	e.g. 1%	A measure of the chance that an event will occur. The probability of an event is typically defined as the relative frequency of occurrence of that event, out of all possible events. Probability can be expressed as a fraction, percentage or a decimal. For

		example, the probability of obtaining a six with the shake of a fair die is 1/6, 16% or 0.166. Probability is often expressed with reference to a time period, for example, annual exceedance probability. For example, a 1% AEP event is an event with a 1% chance of occurring or being exceeded in any one year.
Proposals Map		This is an Ordnance Survey based map that spatially illustrates policies and proposals within LDDs. The Proposals Map will show planning policy designations and land allocations identified within DPDs, statutory land use and landscape designations and other land and area based designations. It will form part of the statutory development plan.
Residual Risk		The risk that inherently remains after implementation of a flood mitigation measure (option).
Return Period	e.g. 1 in 100-Year	The expected (mean) time (usually in years) between the exceedance of a particular extreme threshold. Return period is traditionally used to express the frequency of occurrence of an event, although it is often misunderstood as being a probability of occurrence.
Risk		The threat to property and life as a result of flooding, expressed as a function of probability (that an event will occur) and consequence (as a result of the event occurring).
Sequential Flood Risk Test	SFRT	The assessment and 'categorisation' of flood risk on a catchment-wide basis in accordance with PPS25.
Site Specific Allocations Development Plan Document		A mandatory document, the Allocations Development Plan Document is a high priority item for preparation, details of which are provided in the Local Development Scheme. Prepared in conformity with the Core Strategy, once approved, the Allocations Document will identify sites for development as part of the delivery of the overall planning strategy for the area.
Standard of Protection	SoP	The return period to which properties are protected against flooding
Strategic Flood Risk Assessment	SFRA	The assessment of flood risk on a catchment-wide basis for proposed development in a District
Strategic Flood Risk Management	SFRM	Considers the management of flood risk on a catchment-wide basis, the primary objective being to ensure that the recommended flood risk management 'measures' are sustainable and cost effective
Supplementary Planning Documents	SPD	Supplementary Planning Documents, or SPD, support DPDs in that they may cover a range of issues, both thematic and site specific. Examples of SPDs may be design guidance or development briefs. SPDs may expand policy or provide further detail to policies in a DPD. They will not be subject to independent examination.
Sustainable Drainage Systems	SuDS	Current 'best practice' for new development that seeks to minimise the impact upon the localised drainage regime, e.g. through the use of pervious areas within a development to reduce the quantity of runoff from the development.
TUFLOW		2-Dimensional hydraulic modelling software package with links to ISIS, which demonstrates overland flow in floodplains
Uncertainty		A reflection of the (lack of) accuracy or confidence that is considered attributable to a predicted water level or (modelled) flood extent.

Washlands	Areas which are not susceptible to flooding in a 20 year flood event and hence not classified as Flood Zone 3b, but are considered of vital importance as floodplains and should therefore be treated as functional floodplain
Windfall Sites	Sites that become available for development unexpectedly and are not included in a planning authority's development plan as allocated land.

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1 Introduction

This section introduces the SFRA and confirms the study format, objectives and key outputs.

1.1 Background

JBA Consulting was commissioned in November 2008 by The City of Lincoln Council on behalf of the Lincoln Policy Area Partners to undertake a review of the existing Strategic Flood Risk Assessment (SFRA) for the Lincoln Policy Area and update it in accordance with current best practice, Planning Policy Statement 25 Development and Flood Risk (PPS25).

The SFRA will provide the Local Planning Authorities (LPA) with the necessary detailed information to make informed decisions when considering development and flood risk issues thereby assisting in the preparation of the LDF process. This report sets out the procedure to be followed when assessing sites for development in the future.

The SFRA should be treated as a 'dynamic' document that is periodically reviewed as the policy area changes or if further information becomes available to provide a better understanding of flood risk. The SFRA should be updated when changes are made to policies or strategy reports relating to flood risk or if conditions change that impact on the nature of flood risk in the Lincoln Policy Area, for example the presence and characteristics of flood defences, flood defence schemes or significant development in the district. When the Environment Agency Flood Zone outlines are updated, they should be incorporated into the SFRA.

Building on information already available a Level 1 SFRA has been produced for the Lincoln Policy Area and a Level 2 SFRA has been produced for the City of Lincoln, North Hykeham and Western Growth Corridor.

The study has been carried out according to current best practice and the requirements of PPS 25 and the supporting guidance, "Development and Flood Risk: A Practice Guide". The East Midlands Regional Flood Risk Appraisal, the Lincoln Integrated Urban Drainage Pilot Study and the Lincoln Water Cycle Study have also been referred to.

1.2 Format of the SFRA and Key Outputs

The Lincoln Policy Area SFRA has been broken down into four separate volumes:

Volume 1: Non - Technical Summary

Volume 2: Technical Summary

Volume 3: Guidance for Planners

Volume 4: Maps

1.3 Scope and Objectives

The SFRA involves a two step approach to the assessment of flood risk:

- Utilising existing available information, a broad scale assessment of flood risk to identify sites at risk from flooding across the whole Lincoln Policy Area (Level One Assessment of Flood risk); and
- An assessment of flood risk that is based upon more detailed river modelling. This includes consideration of flood risk management measures, such as flood defences, that may be present and the flood risk posed should such defences fail (breach) or be exceeded (overtopped) by extreme flooding (Level Two Assessment of Flood Risk).

Current Government policy requires local authorities to demonstrate that due regard has been given to the issue of flood risk as part of the planning process. It also requires that

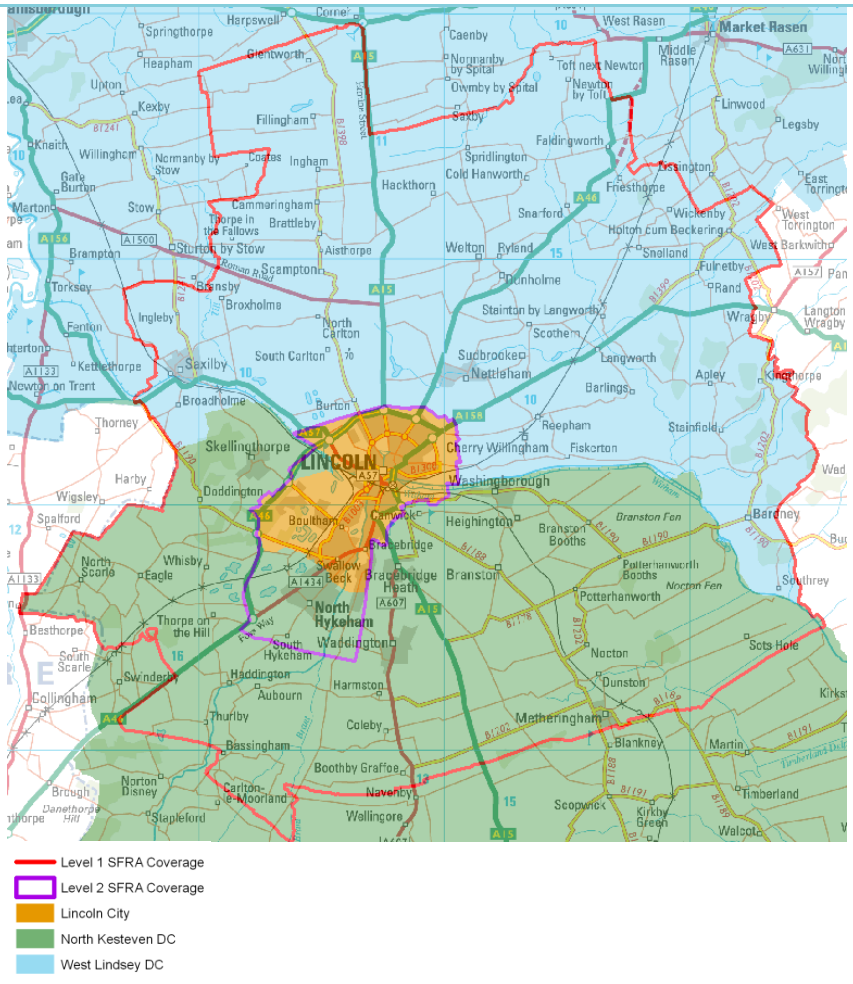
flood risk is managed in an effective and sustainable manner and where new development is exceptionally necessary in flood risk areas, the policy aim is to make it safe without increasing flood risk elsewhere. Where possible flood risks should be reduced overall.

The overall objective for this SFRA is to provide sufficient information for the application of the Sequential Test and to identify whether application of the Exception Test is likely to be necessary. It involves a broad scale assessment of flood risk to identify sites at flood risk from fluvial and other sources of flooding, utilising existing available information. In addition to this, the SFRA will allow the Lincoln Policy Area to:

- prepare appropriate policies for the management of flood risk within the policy area;
- inform the sustainability appraisal so that flood risk is taken into account when considering options and in the preparation of strategic land use policies;
- identify the level of detail required for site-specific Flood Risk Assessments (FRA) in particular locations, and
- enable the policy area to determine the acceptability of flood risk in relation to emergency planning capability.

1.4 Policy Area

Figure 1-1: Policy Area



1.5 Updating the SFRA

The SFRA is intended to be a "live" document, updated when appropriate to reflect changes in the area and as new information becomes available. It is recommended that the SFRA is reviewed annually in liaison with the Environment Agency. If changes are required the SFRA should be updated accordingly.

The following areas should be subject to a future review in order to ensure the most up to date information is being used:

- Environment Agency Flood Zones Maps - these are updated periodically by the Environment Agency
- OS Background Mapping - These are updated periodically by Ordnance Survey
- PPS25 Practice Guidance Updates and Flooding Policy - A consultation is currently taking place into proposed amendments to Planning Policy Statement 25 (PPS25). The SFRA should be updated accordingly if the proposed amendments are brought in to force.
- Climate Change Predictions - Predictions for this SFRA are based on current guidance. Any future reviews of the SFRA should consult the Environment Agency to ensure the most up to date predictions are being used.

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2 SFRA Maps

Information and guidance on using the maps can be found in Volumes 1 (Non technical summary) and 3 (Guidance). A technical overview which provides further detailed information on the creation of the maps is provided in Volume 2.

The maps in Volume 4 have been produced as part of the SFRA in order to delineate the flood zone outlines and establish, in key areas, the variation of risk within the flood outlines.

The starting point for application of the Sequential and Exception Tests should be the Flood Zone Maps included in Volume 4.

2.1 Flood Zone Maps

These are provided for the whole of the Lincoln Policy Area. They include the latest Environment Agency Flood Zone 3 (100 year) and Flood Zone 2 (1000 year) outlines, which have been generated using broad scale modelling techniques and do not include the effect of any defences. ***They should be used as the starting point for application of the Sequential and Exception Tests for all areas within the policy area.***

2.2 Non Fluvial Risk Maps

These maps show indicative flooding caused by surface water run off during an extreme (1 in 200 year) rainfall event, assuming sewer networks are full to capacity. The surface water flooding is categorised according to its depth and associated risk. The maps also highlight areas where instances of sewer flooding have been recorded. The maps should be used to inform Flood Risk Assessments.

2.3 Defence Overtopping Flood Depth Maps

These maps are provided for within the level 2 SFRA area (City of Lincoln). The maps are based on 2 dimensional modelling and show the variation in flood depth as a result of overtopping for the 100 year with climate change and 1000 year with climate change flood scenario. ***Depth Maps should be used to apply the sequential approach in Flood Zones 3 and 2 and to inform the application of the Exception Test.***

2.4 Defence Breach Flood Depth Maps

These maps demonstrate the effects of a failure of a flood defence. The maps are based on 2 dimensional modelling and show the variation in flood depth for the 100 year with climate change and 1000 year with climate change flood scenario. Breaches were simulated throughout the City of Lincoln area. A maximum breach outline has been provided in the maps contained in Volume 4. This outline displays the worst case flood depth for all areas which could be effected by the failure of a defence. ***Depth Maps should be used to apply the sequential approach in Flood Zones 3 and 2 and to inform the application of the Exception Test.***

2.5 Hazard Maps

These maps are provided for within the level 2 SFRA area (City of Lincoln) and are based on 2 dimensional modelling. The maps give details of the degree of flood hazard within the 100 year with climate change and 1000 year with climate change defended outlines (flooding as a result of overtopping) and undefended outlines (flooding as a result of defence failure). The hazard rating is dependent on flood depth and velocity and has been calculated according to the methodology given in the DEFRA report FD2320. Three hazard categories are displayed – danger for some (includes children, elderly and infirm), danger for most (includes the general public) and danger for all (includes the emergency

services). ***Hazard Maps should be used to apply the sequential approach in Flood Zones 3 and 2 and to inform the application of the Exception Test.***

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3710-068	Breach Depth (1000 yr with CC) Map 1
3710-069	Breach Depth (1000 yr with CC) Map 2
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3710-075	Breach Depth (1000 yr with CC) Map 8
3710-076	Breach Hazard (100 yr with CC) Map 1
3710-077	Breach Hazard (100 yr with CC) Map 2
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3710-079	Breach Hazard (100 yr with CC) Map 4
3710-080	Breach Hazard (100 yr with CC) Map 5
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3710-084	Breach Hazard (1000 yr with CC) Map 1
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3710-088	Breach Hazard (1000 yr with CC) Map 5
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3710-090	Breach Hazard (1000 yr with CC) Map 7
3710-091	Breach Hazard (1000 yr with CC) Map 8
3710-092	Surface Water Flooding Map 1
3710-092	Surface Water flooding Map 2

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