South Kesteven District Council Strategic Flood Risk Assessment

Level 2

South Kesteven District Council

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Quality information

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1	July 2017	Amended to reflect EA comments and climate change updates	JCS	Jo Somerton	Principal Flood Risk Consultant
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List of Acronyms

Acronym	Definition
ABDs	Areas Benefitting from Defence
AEP	Annual Exceedance Probability
AIMS	Asset Information Management System
AOD	Above Ordnance Datum
AStGWF	Areas Susceptible to Groundwater Flooding
AStSWF	Areas Susceptible to Surface Water Flooding
CDAs	Critical Draiange Areas
CFMP	Catchment Flood Management Plan
CRT	Canal and River Trust
DCLG	Department for Communities and Local Government
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FWD	Floodline Warnings Direct
FRMPs	Flood Risk Management Plan's
FWMA	Flood and Water Management Act
GAAP	Grantham Area Action Plan
GIS	Geographical Information Systems
ha	hectares
IDB	Internal Drainage Board
LCC	Lincolnshire County Council
LDF	Local Development Framework
LLFA	Lead Local Flood Authority
LFRMS	Local Flood Risk Management Strategy
LPA	Local Planning Authority
MDSF	Modelling and Decision Support Framework
NPPF	National Planning Policy Framework
PDA	Potential Development Area
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
PPS	Planning Policy Statement
RBMPs	River Basin Management Plans
RFCC	Regional Flood and Coastal Committee
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water Map
SAB	Sustainable Drainage Systems Approval Body
SAC	Special Areas of Conservation
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment
SKDC	South Kesteven District Council

SoP	Standard of Protection
SPZs	Source Protection Zones
SSSI	Sites of Scientific Interest
SuDS	Sustainable Urban Draiange Systems
WFD	Water Framework Directive

1. Introduction

1.1 Terms of Reference

AECOM Ltd ('AECOM') has been commissioned by South Kesteven District Council (SKDC) to review and revise the Level 1 and Level 2 Strategic Flood Risk Assessment (SFRA) for its administrative area. This report comprises the Level 2 SFRA.

1.2 Project Background

The National Planning Policy Framework[1] (NPPF) and associated Planning Practice Guidance for Flood Risk and Coastal Change (PPG)[2] emphasise the active role Local Planning Authorities (LPAs) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. The NPPF outlines that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA) and LPAs should use the findings to inform strategic land use planning. The overall approach of the NPPF to flood risk is broadly summarised in Paragraph 103:

> *When determining planning applications, LPAs should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:*
>
> - *within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and*
> - *development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems."*

1.2.1 Level 1 SFRA Deliverables

An updated Level 1 SFRA report has been prepared for the District. The purpose of the Level 1 SFRA was to collate and analyse the most up to date readily available flood risk information for all sources of flooding, and provide an overview of flood risk issues across the study area. The district wide mapping deliverables for SKDC are presented in the **Level 1 SFRA Appendix B**.

The Level 1 SFRA provides guidance on:

- The application of the Sequential Test by SKDC when allocating future development sites to inform their Local Plans, as well as by developers promoting development on windfall sites.
- Managing and mitigating flood risk, the application of sustainable drainage systems (SuDS), and the preparation of site specific Flood Risk Assessments (FRAs).
- Potential flood risk management objectives and policy considerations which may be developed and adopted by SKDC as formal policies within their developing Local Plans.

[1] Department for Communities and Local Government. 2012. National Planning Policy Framework. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2

[2] **Department for Communities and Local Government. 2014. *Planning Practice Guidance: Flood Risk and Coastal Change.* Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/**

1.3 Level 2 SFRA

Using the strategic flood risk information presented within the Level 1 SFRA, SKDC undertook the Sequential Test to document the process whereby future development is steered towards areas of lowest flood risk. Where it was not possible to accommodate potential development sites outside those areas identified to be at risk of flooding, the Exception Test may be required, as set out in Table1. This Level 2 SFRA Report provides information to support the application of the Exception Test for future development sites.

Table 1. Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG, 2014)

Flood Zone	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
1	ü	ü	ü	ü	ü
2	ü	ü	Exception Test Required	ü	ü
3a	Exception Test Required	ü	û	Exception Test Required	ü
3b	Exception Test Required	ü	û	û	û

Key:
ü - Development is appropriate
û - Development should not be permitted

1.3.1 Exception Test

The purpose of the Exception Test is to ensure that where it may be necessary to locate development in areas at risk of flooding, new development is only permitted in Flood Zone 2 and Flood Zone 3 where the flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

The NPPF states that for the Exception Test to be passed:

- Part 1 - "It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared; and
- Part 2 - A site-specific Flood Risk Assessment must 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."

Both elements of the test have to be passed for development to be allocated or permitted.

In order to determine Part 1 of the Exception Test, applicants should assess their scheme against the strategic objectives set out in the LPA's Sustainability Appraisal[3].

In order to demonstrate satisfaction of Part 2 of the Exception Test, relevant measures, related to those presented within Section 7 and Section 9 of the Level 1 SFRA, should be applied and demonstrated within a site-specific flood risk assessment (FRA), as detailed in Section 9 of the Level 1 SFRA.

[3] AECOM (2017) Sustainability Appraisal for the South Kesteven Local Plan. SA Report to accompany the Consultative Draft Local Plan 2017. July 2017

1.3.2 Level 2 SFRA Deliverables

This Report comprises the Level 2 SFRA for SKDC. The scope of the Level 2 SFRA is to consider the detailed nature of the flood characteristics within a flood zone including, where appropriate:

- flood probability;
- flood depth;
- flood velocity;
- rate of onset of flooding; and
- duration of flood.

The Level 2 SFRA provides a detailed assessment of the flood risk for specific development sites which have been identified by SKDC as requiring the application of the Exception Test. Site Assessment Pro Forma are presented in Appendix A.

1.3.3 Level 2 SFRA Sites for Assessment

Appendix C of the Level 1 SFRA provides a database of 136 potential development sites that have been identified by SKDC through their Call for Sites. For each site, an assessment of the risk of flooding, based on the datasets presented in the Level 1 SFRA, has been undertaken and provided to SKDC to enable the direct comparison of sites in the application of the Sequential Test and the subsequent identification of sites that require the Exception Test.

Throughout the preparation of the Consultative Draft Local Plan, SKDC have undertaken the Sequential Test and identified a number of potential development sites which will be required to undergo the Exception Test, and therefore require a Level 2 assessment of flood risk. These areas are listed in Table 2 and comprise 4 development sites, it is not expected that all of the sites listed in Table 2 will be allocated. Additional sites have been included for flexibility, should some of the Preferred Sites not receive an allocation.

Table 2. Sites identified by SKDC for Exception Test and Level 2 SFRA

Site Ref	Site Address	Proposed Use
SKLP66	Bourne	Residential
SKLP126	Bourne	Residential
SKLP130	Baston	Residential
SKLP269	Somerby Hill/Great North Road, Grantham	Residential

1.4 Updated Climate Change Allowances

The Environment Agency has released the updated guidance 'Flood Risk Assessment Climate Change Allowances'[4] (19th February 2016), and has been used to update the Environment Agency Adapting to Climate Change: Advice for flood and coastal erosion risk management authorities (April 2016[5]). The new guidance determines the climate change allowances that should be considered for net sea level rises, peak river flow and peak rainfall intensity across England and Wales and are significantly different to its predecessor.

The fluvial flood models for the river Witham and the River Welland have been updated to incorporate the latest climate change allowances as part of the Level 2 SFRA (See Section 4.5).

The updated climate change allowances relevant to the SKDC Level 2 SFRA have been summarised in the following sections. Tidal flood risk has not been included as there are no areas within SKDC which are shown to be at risk of tidal flooding.

[4] Environment Agency (2016) Flood risk assessments: climate change allowances. Available at https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. Accessed May 2016
[5] Environment Agency (April 2016) Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities

1.4.1 Fluvial Flood Risk Allowance

Table 3 shows peak river flow allowances for the Anglian river basin district. The Environment Agency Flood Zone(s) and NPPF flood risk vulnerability classification of the development should be used to determine which Allowance Category is most appropriate to be applied to the assessment (as shown in Table 4).

The lifetime of the development should be considered when determining which future climate change allowance time period should be used. The lifetime of a proposed development should be judged based on the characteristics of the development. In the case of residential developments, a minimum lifetime of 100 years should be taken when selecting climate change allowance percentages. For other types of development, the applicant should assess how long they anticipate the development to be in place for, and justify the lifetime of the development. Otherwise, a 75 year lifetime should be used. Therefore, in most cases, it is suggested that applicants use the '2060 to 2115' allowances in Table 3.

All site-specific FRAs should demonstrate that finished floor levels are at a minimum of 300mm above the 1% AEP (1 in 100 year) flood event plus an appropriate allowance for climate change. Table 4 identifies that for More Vulnerable developments in Flood Zone 2, the 'Central' (25%) climate change allowance is the Environment Agency's minimum benchmark for flood risk mitigation, and in Flood Zone 3a the minimum benchmark for flood risk mitigation is the 'Higher Central' (35%) climate change allowance. A sensitivity test should also be undertaken using the higher central (35%) in Flood Zone 2 and the Upper End allowance (65%) in Flood Zone 3a, to ensure that the finished floor levels are a minimum of 50mm above this flood water level.

Table 3. Peak river flow allowances for the Anglian River Basin District (use 1961 to 1990 baseline)

Allowance category	(2010 to 2039)	2040 to 2059	2060 to 2115
Upper End	25%	35%	65%
Higher Central	15%	20%	35%
Central	10%	15%	25%

Table 4. Flood Zone and development vulnerability classification used to identify peak river flow allowance category

NPPF flood risk vulnerability classification	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Essential Infrastructure	Higher Central and Upper End allowances	Upper End Allowance	Upper End Allowance
Highly Vulnerable	Higher Central and Upper End allowances	Development should not be permitted	Development should not be permitted
More Vulnerable	Central and Higher Central allowances	Higher Central and Upper End allowances	Development should not be permitted
Less Vulnerable	Central allowance	Central and Higher Central allowances	Development should not be permitted
Water Compatible	Use none of the allowances	Central allowance	Central allowance

Developers should check with the Environment Agency for the latest guidance on climate change allowances.

1.4.2 Pluvial Flood Risk Allowance

Table 5 shows anticipated changes in extreme peak rainfall intensity in small and urban catchments. The anticipated increase in rainfall intensity may cause greater volumes and rates of rainfall to enter the sewer network during storm events.

SKDC requires all site-specific FRAs and Drainage Strategies to assess both the Upper End and Central allowances to understand the range of impact. The lifetime of the development should be considered when determining which future climate change allowance time period should be used.

Table 5. Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Allowance Category	2010 to 2039	2040 to 2059	2060 to 2115
Upper End Estimate	10%	20%	40%
Central	5%	10%	20%

2. Level 1 Strategic Flood Risk Assessment

2.1 Introduction

The updated Level 1 SFRA for SKDC was completed in June 2017 and is available on the SKDC website. This chapter outlines the key findings of the Level 1 SFRA.

2.2 Study Area

The study area, as shown below in Figure 1, is defined by the administrative area of SKDC, and lies to the south west of Lincolnshire. South Kesteven is bordered to the north by Newark and Sherwood and North Kesteven Districts, to the west by the district of Melton and Rutland, to the south by the City of Peterborough and to the east by the South Holland District.

SKDC covers an area of approximately 969.5km^2, with a population of around 138,000. Grantham is the main town and administrative centre of the District. There are three other market towns located within the district, Stamford, Bourne and The Deepings and over 100 villages and hamlets. In total, approximately 60% of the population lives in the District's market towns: the other 40% residing in the villages and countryside.

South Kesteven is predominantly rural, with large areas of open farmland, and has approximately 2,194 hectares (ha) of ancient woodland. The District is characterised by flat fenland in the east, gently undulating central limestone Uplands and more regulated field patterns to the north of the neighbouring Trent and Belvoir Vale. The District has 27 nationally important Sites of Scientific Interest (SSSI) and 2 Natura 2000 sites (SACs).

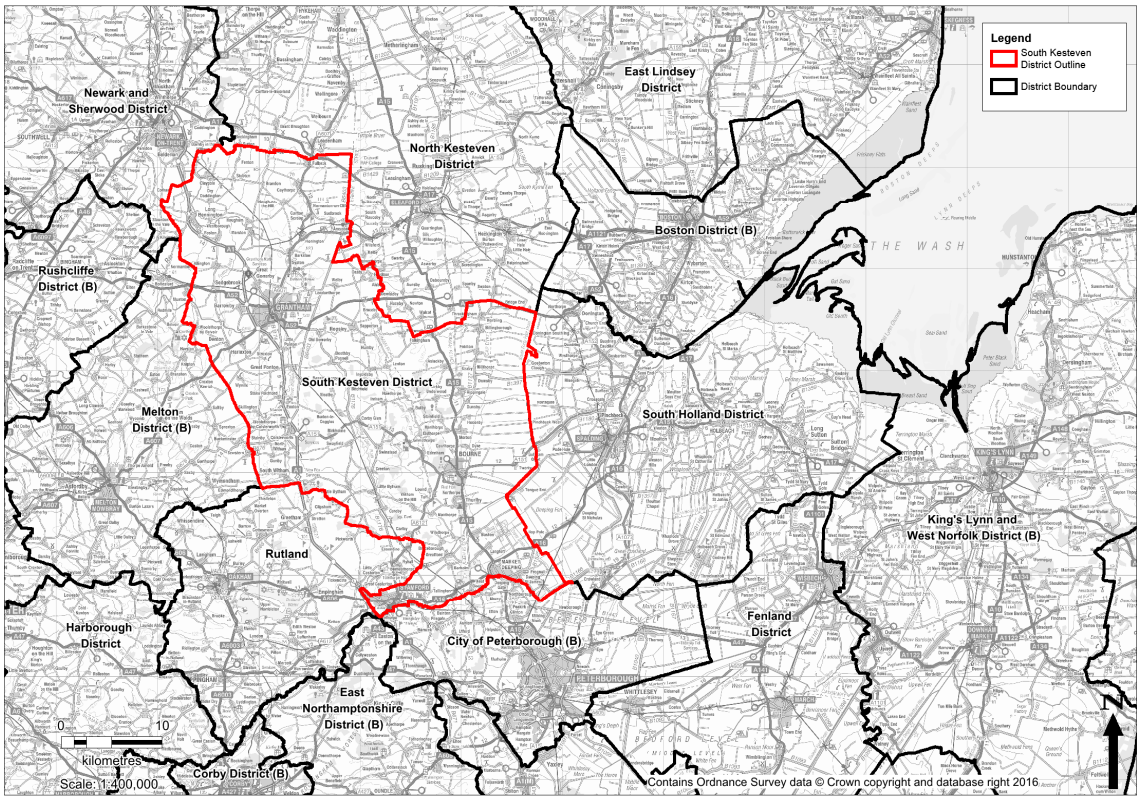

Figure 1. SKDC Study Area

2.3 Baseline Data

The Level 1 SFRA provides a good strategic overview of flood risk across SKDC including descriptions of existing flood risk from fluvial, surface water, groundwater and sewer / artificial sources. Where data was available historic flood records were referred to and climate change scenarios were mapped for fluvial watercourses, as provided by the Environment Agency.

2.4 NPPF Flood Zones

The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The NPPF seeks to assess the probability of flooding from rivers and sea by categorising areas within the floodplain into zones of low, medium and high probability, as defined in Table 6 and presented on the 'Flood Map for Planning (Rivers and Sea)' available on the Environment Agency website[6], or illustrated in the **Level 1 SFRA Appendix B Figure 8**.

The Flood Zone extents shown on the Environment Agency Flood Map for Planning depict the risk of tidal and fluvial flooding to the District without the presence of flood defences. Areas benefitting from flood defences are presented, however, for the purpose of the Level 1 SFRA, all assessments are based on the undefended flood risk scenario.

Table 6. NPPF Flood Zones (extracted from the NPPF PPG, 2014)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1 (Low Probability)	Land having a less than a 0.1% Annual Exceedance Probability (AEP) (1 in 1,000 chance of river or sea flooding in any one year). Shown as clear on the Flood Map – all land outside Flood Zones 2 and 3.	Low
Flood Zone 2 (Medium Probability)	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% - 0.1%) in any year.	Medium
Flood Zone 3a (High Probability)	Land 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.	High
Flood Zone 3b (Functional Floodplain)	Land where water has to flow or be stored in times of flood based on flood modelling of a 5% AEP event (1 in 20 chance of flooding in any one year) or greater, or land purposely designed to be flooded in an extreme flood event (0.1% AEP). Where detailed modelling is not available, it is assumed that the extent of Flood Zone 3b is equal to Flood Zone 3a. For the purposes of this SFRA, land modelled to flood during a 5% AEP (1 in 20 chance of flooding in any one year) has been mapped. Where detailed modelling is not available, it is assumed that the extent of Flood Zone 3b is equal to Flood Zone 3a.	Very High

2.5 Tidal Flood Risk

The Level 1 SFRA identifies that none of the watercourses located within South Kesteven District are tidally influenced therefore the risk of tidal flooding to the study area is low. The tidal limit of both the River Welland and the River Witham are located approximately 6 km to the east of the District boundary with the tidal limit of the River Welland and Glen located at Spalding and Surfleet respectively.

With reference to the Environment Agency Climate Change projections[7] the cumulative sea level rise anticipated for the Eastern region of England is 1.21m by 2115. Whilst considering this projection, and given the distance of the

[6] Environment Agency. 2016. *Flood Map for Planning (Rivers and Sea).* Available at: http://maps.environment-agency.gov.uk/ [Accessed: 26-11-2016]
[7] Environment Agency, 2016. *Flood risk assessments: climate change allowances*. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

study area from the tidal limits of the River Welland and River Witham, the future risk of tidal flooding in South Kesteven is not likely to increase and therefore the risk of flooding from this source will remain low.

2.6 Fluvial Flood Risk

2.6.1 Current Fluvial Flood Risk

The Level 1 SFRA highlights both current and historic fluvial flood risk from across the district using Environment Agency datasets, including the Environment Agency's Flood Map for Planning which is based on the undefended flooding scenario. The Level 1 SFRA summarised current fluvial flood risk in South Kesteven to be:

- A large section of the District between Grantham and the A15, which covers the upper reaches of the River Witham, the East Glen River and the West Glen River, has a Flood Zone 3 extent which is very similar to that of Flood Zone 2. This is primarily due to the confined nature of the river channels and floodplains. Any developments within Flood Zone 2 or 3 will need to consider the risk from more frequent events. Where hydraulic modelling has not been completed, this may require additional assessment.
- The largest area of Flood Zone 3 within the District is associated with watercourses located within the low lying Fenland to the east of the A15 and south of the A16. The large number of drains, including the Bourne Eau, River Glen, Car Dyke, Old Beck and the South Forty Foot Drain, combined with the low lying nature of the Fenland, increases the risk of flooding in this area.
- Within Grantham, Stamford and Market Deeping the extent of Flood Zone 3 is minimal. This is likely associated with the high density of flood defences within these areas, restricting the passage of flows into the floodplain.
- There is an extensive area of Flood Zone 3 associated with the most downstream section of the River Witham through the District and its tributaries to the south of Long Bennington, where floodplains start to widen as ground levels gradually decrease from 70m AOD to 10m AOD at the northern boundary.

2.6.1.1 Flood Defences

From the Level 1 SFRA it was noted that South Kesteven has a network of fluvial flood defences that comprise of flood walls, embankments and raised land. The flood defences extend along large sections of the River Witham, the River Welland and their associated tributaries, particularly where the rivers pass through larger settlements such as Grantham, Long Bennington, Stamford and the Deepings. It also indicates that there are no Flood Storage Areas that lie within the District. Although areas of the District are shown to benefit from the presence of these flood defences, for the purposes of the SFRA, all flood extents assessed are based on the undefended scenario as a worst case scenario.

2.7 Surface Water Flood Risk

The Level 1 SFRA indicates there is a documented history of surface water flooding within the South Kesteven District. Using the latest version of the Risk of Flooding from Surface Water (RoFSW) mapping, published in 2013 by the Environment Agency, widespread surface water flood risk can be seen across the District. Through an assessment of the dataset, it can be seen that surface water flood risk can typically be associated with the following, although this list is by no means exhaustive:

- **Fluvial Corridors**: The risk of surface water flooding tends to coincide with the fluvial floodplains of Main Rivers and Ordinary Watercourses, which, due to their low lying nature, allow flows to be accumulated and passed downstream. In these areas, there is significant interaction between fluvial and surface water flows, especially within the upper extents of river catchments (such as at South Witham). Within areas of urban development, any surface water drainage networks which discharge to watercourses may be restricted by flood locked outfalls.
- **Land Drains**: Within the eastern extent of South Kesteven, there is an extensive network of land drainage systems and Ordinary Watercourses, which act as conveyance routes for surface water. Although these features tend to occur in primarily rural, undeveloped areas, there is the potential that new sites, particularly minerals and waste allocations, may coincide with these features. The risk of flooding as a result of these flow routes, will need to be examined as part of any development, even if the current risk appears to be minimal.

- **Urban Areas**: Surface water flooding frequently occurs in urban areas as a direct result of topographic features, such as buildings and roads, which restrict infiltration, deflect flows and encourage localised ponding. This can be seen within the majority of the urban areas in South Kesteven, but is especially prevalent in the areas surrounding Grantham, Stamford, Bourne and Long Bennington.
- **Railway and Road Embankments**: The presence of raised embankments, such as those usually associated with highway and rail networks, can have a significant impact on surface water flow routes, which restrict flows leading to localised areas of deep ponding. This is evident across the District and increases flood risk to those communities which align with this infrastructure.
- **Roads**: Roads, highways and railway lines can act as conveyance routes for surface water whilst flooding can also affect the operational potential of this infrastructure. The risk to these receptors should be considered as part of any future development application, ensuring safe access and egress to sites during times of flood. Of notable accent, includes the A15, A1 north of Grantham, the B1177, the A607 and the railway line north of Grantham, which all show surface water accumulation on the highway. SKDC should also consider the risk of the receptors in terms of emergency planning.
- **Underpasses**: Where underpasses are present, the lower elevation allows for the increased risk of surface water flooding. In these areas, although the extent may be minimal, the depth of flooding experienced may be significant.

However, this assessment has been based on the RoFSW which is a high level, national scale dataset and is subject to a number of limitations:

- The model used to generate the mapping assumes a single drainage rate for all urban areas;
- It does not show the susceptibility of individual properties to surface water flooding;
- The mapping has significant limitations for use in flat catchments;
- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses;
- In a number of areas, modelling has not been validated due to a lack of surface water flood records; and
- As with all models, the RoFSW is affected by a lack of, or inaccuracies, in available data.

2.8 Groundwater Flooding

Using the Environment Agency's Areas Susceptible to Groundwater Flooding (AStGWF) map for South Kesteven, susceptibility to groundwater flooding was seen to coincide with the distribution and thickness of Glacial Till (typically Boulder Clay) within the superficial geology. As such, the greatest susceptibility to groundwater flooding occurs to the north east and south west of the District and along the river corridors where Glacial Till cover is typically thin or absent.

2.9 Flooding from Sewers

The Anglian Water DG5 Sewer Flooding 'Risk' Register was used to locate areas at risk of flooding as a result of insufficient hydraulic capacity in the sewer network. The majority of these DG5 records are located within the larger urban areas of Grantham, Stamford and The Deepings. There are fewer isolated incidents of sewer flooding at village level across the District.

2.10 Flooding from Reservoirs

The Level 1 SFRA shows five reservoirs have the potential to affect property and infrastructure in the District if a breach was to occur. These include Denton Reservoir, the Lake at Grimsthorpe, Rutland Water, Boathouse Pond and Knipton Reservoir.

3. Level 2 SFRA Methodology

3.1 Overview

As outlined in Section 1.1, the main purpose of the Level 2 SFRA is to increase the scope undertaken for the Level 1 SFRA and provide sufficient information for the application of the Exception Test for site allocations that may be at risk of flooding.

3.2 Information/Data Collected

A large quantity of data was collected for the Level 2 SFRA, the key datasets are summarised in Table 7 below.

Table 7. Data Collected for Level 2 SFRA

Data Source	Dataset
Environment Agency	· Flood Map For Planning; · Groundwater Vulnerability Map; · Areas Benefiting from Defences Outlines; · Risk of Flooding from Surface Water (RoFSW) Outlines; · Modelled outputs from the River Witham and River Welland fluvial models; · Geographical Information Systems (GIS) Layer of detailed river network; and · Historic flooding extents and records.
Lincolnshire County Council	· Flood Incident Reports; and · Preliminary Flood Risk Assessment (PFRA).
South Kesteven District Council	· Ordnance Survey (OS) maps (Mastermap, Streetview, 1:10,000, 1:50,000 and 1:250,000 scale); · GIS layers for preferred, alternative and additional housing and employment potential development areas and Strategic Housing Land Availability Assessment (SHLAA) sites; · County Boundary/District Boundaries; and · SFRAs - All previously completed SFRAs (draft or final).
Anglian Water	· DG5 sewer flooding data.

3.3 Tidal Flooding

The updated Level 1 SFRA indicates that none of the watercourses located South Kesteven District is tidally influenced with both the River Welland and River Witham tidal limits located approximately 6 km to the east of the District boundary. Based on this evidence, an assessment of flood risk from tidal sources has not been undertaken at the potential development listed in Table 2.

3.4 Fluvial Flooding

The Environment Agency has provided hydraulic models of the River Witham and River Welland for the Level 2 SFRA. These are both 1D models and therefore only provide flood extent information without flood depth and velocity information on the floodplain.

The modelled outputs from the Welland and Witham models have been used to identify the risk of fluvial (river) flooding across South Kesteven together with the Environment Agency Flood Maps for Planning to map the Flood Zone 2 and Flood Zone 3 extents.

The Witham and Welland fluvial model outputs for a 20% AEP flood event have been used to define the functional floodplain (Flood Zone 3b).

As part of the programme of modelling undertaken by the Environment Agency, hydraulic models have not been developed for a number of the watercourses in the District adjacent to potential development sites, such as the Mow Beck, Car Dyke, the Bourne Eau, the River Gwash and King Street Drain. **Outputs for these watercourses are limited to the Flood Zones derived from JFLOW modelling.**

As part of future planning applications, new modelling will be required for development sites adjacent to these watercourses, to more accurately determine the probability of flooding, and to assess the impact of a range of climate change allowances, as described in Section 1.4 and the Level 1 SFRA Report.

For the purpose of the Level 2 SFRA, the Flood Zone information has been used to determine the issues that will need to be addressed in order to demonstrate the satisfaction of the Exception Test.

The Environment Agency updates the national flood maps on a quarterly basis and will inform the LLFA of any updates in their administrative area

3.4.1 Maximum Flood Depth

During a flood event, the water depth and velocity can vary considerably across the flooded area. It is therefore important to identify which areas are more likely to be hazardous to people and new development. Mapping of maximum flood depth has been generated, which identifies the maximum depth of flooding experienced at each development site.

3.4.2 Hazard Rating

Flood Hazard categorises the danger to people for different combinations of flood water depth and velocity. The derivation of these categories is based on the methodology set out by Defra in Flood Risk Assessment Guidance for New Development FD2320/TR28 using the following equation:

Flood Hazard Rating = ((v+0.5)*D) + DF

Where v = velocity (m/s), D = depth (m), DF = debris factor

Table 8. Hazard categories based on FD2320, Defra & Environment Agency 2005

Flood Hazard Rating		Description
Low	HR < 0.75	Caution – Flood zone with shallow flowing water or deep standing water
Moderate	0.75 ≥ HR ≤ 1.25	Dangerous for some (i.e. children) – Danger: flood zone with deep or fast flowing water
Significant	1.25 > HR ≤ 2.0	Dangerous for most people – Danger: flood zone with deep fast flowing water
Extreme	HR > 2.0	Dangerous for all – Extreme danger: flood zone with deep fast flowing water

As the 1D models used to inform this assessment only provide flood extent information rather than flood depth and velocity information, floodplain hazard rating has not been undertaken at the potential development sites. Any site specific FRA should, where necessary, assess potential hazard categories with regard to development type and site use.

[8] Defra and Environment Agency (2005) FD2320/TR2 Flood Risk Assessment Guidance for New Development

It is noted that at this time, outputs regarding the rate of onset of flooding and duration of flood have not been extracted from the Environment Agency's hydraulic models from the Witham and Welland as the 1D models used to inform this assessment provide flood extent information only.

3.5 Fluvial Flooding – Climate Change

The Environment Agency has provided hydraulic models of the River Witham, River Welland, River East Glen and River West Glen for the Level 2 SFRA. Climate change scenarios were run for the 1% AEP design event in accordance with current Environment Agency guidance.

The guidance regionalises the impacts across England and Wales. For the South Kesteven District, the applicable region was the Anglian river basin district; therefore the hydraulic models were re-run for the 1% AEP design event with 25%, 35% and 65% increases in flow. For these design events, the 1% AEP design event peak flow estimates have been increased by 25%, 35% and 65% respectively and the model inflow boundaries have subsequently been rescaled to reflect these changes in peak flow.

As the models provided by the Environment Agency are 1D only, the flood extents produced from these model runs are based on maximum water levels taken from the cross sections closest to the site and applied to the most current LiDAR data covering the site. The 65% increase for climate change to the 1% AEP peak flow the model results show a flood extent that generally lies between that of the 1% AEP flood outline, and the 0.1% AEP event.

3.6 Flooding from the Land

The Pitt Review[9] into the summer 2007 flooding in the UK identified the importance in quantifying the risk of flooding from land, or 'surface water' flooding. In response to the Pitt Review, the Environment Agency released Areas Susceptible to Surface Water Flooding (AStSWF) Maps in 2008/9. The AStSWF Maps were the first iteration (1st generation) maps used to quantify surface water flood risk on a national scale.

The accompanying guidance document published with the AStSWF Maps state that these maps have been produced using a simplified method where a single rainfall event has been used to analyse the surface water flooding. The method also excludes any underground sewerage and drainage systems, smaller over ground drainage systems and buildings. Therefore, the maps only provide a general indication of areas that are more likely to overwhelm from surface water flooding.

The Environment Agency has more recently undertaken further modelling of surface water flood risk at a national scale (October 2013) producing maps referred to as the RoFSW identifying areas at risk during three annual exceedance probability (AEP) events:

- 1 in 30 year (>=3.33% AEP) – High Risk,
- 1 in 100 year (>=1% AEP) – Medium Risk, and
- 1 in 1000 year (>=0.1% AEP) – Low Risk.

These now provide the Environment Agency, LCC (as the LLFA), and the public access to information on surface water flood risk that is consistent across England and Wales.

The RoFSW modelling methodology represents a significant improvement on previous mapping, (namely the AStSWF dataset), for example:

- Increased model resolution to 2m grid providing a more detailed representation of ground levels;
- Representation of varying infiltration rates taking into account the land use and soil type;
- Representation of buildings and flow routes along roads and manual editing of the model for structural features such as subways, flyovers etc.;
- Use of 3 return period storm scenarios;

[9] Cabinet Office, 2007. *Learning lessons from the 2007 floods*. Available at: http://webarchive.nationalarchives.gov.uk/20100807034701/http:/archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html

- Incorporation of appropriate local mapping, knowledge and flood incident records; and
- Local validation by LLFAs where flood records were available.

As such, the RoFSW map is considered the most appropriate dataset available to inform the assessment of surface water flood risk at the development sites as part of this Level 2 SFRA to assist SKDC in their duties relating to management of surface water flood risk.

However, it should be noted that this national mapping has the following limitations:

- Use of a single drainage rate for all urban areas;
- It does not show the susceptibility of individual properties to surface water flooding;
- The mapping has significant limitations in flat catchments;
- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses;
- In a number of areas, modelling has not been validated due to a lack of surface water flood records; and
- As with all models, the RoFSW mapping is affected by a lack of, or inaccuracies, in available data.

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding; although a range of return periods are provided (3.3%, 1% and 0.1% AEP). For development purposes and where site specific modelling is not available, it is advised that the 0.1% AEP flood extent is used to represent the climate change scenario. SKDC should however, note the conservative nature of this approach.

Where the developer proposes to carry out surface water modelling, the revised Environment Agency climate change allowances, presented in Table 5, should be utilised.

3.7 Flooding from Groundwater

Environment Agency Groundwater Vulnerability Maps obtained during Level 1 SFRA show the study area to be underlain by several aquifers, the aquifer boundaries can be seen to coincide with the changing bedrock geology across the district. The east of the District is underlain by a Secondary A aquifer within the Kellaways and Oxford Clay Formations. The central area of the District is underlain by a Principal Aquifer that coincides with the Great and Inferior Oolite Groups. To the north west of Grantham, the district is underlain by a mix of Secondary A, Secondary B and Secondary Undifferentiated aquifers that coincide with the Lias Group. Secondary A aquifers are capable of supporting water supplied at a local, rather than a strategic scale. Principal Aquifers support water supply at a strategic scale. As such, there are a number of Source Protection Zones (SPZs) within this area. The greatest susceptibility to groundwater occurs to the north east and south west of the District and along river corridors where Till cover is typically thin or absent.

3.8 Flooding from Sewers

During the Level 1 SFRA, Anglian Water provided their DG5 data based on 100m^2 grid squares. The data set uses 100m^2 grid squares to flag up areas where Anglian Water has properties on their DG5 sewer flooding registers. The data enabled the identification of localised areas at risk of hydraulic sewer flooding within each drainage catchment area.

The DG5 register defines internal flooding as flooding "*which enters a building or passes below a suspended floor*"; whilst external flooding is defined as "*flooding which is not classed as internal*". Properties at risk are defined as "*properties that have suffered or are likely to suffer internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant period*". The water company irrespective of the severity of the storm should register all flooding incidents. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.

3.9 Flooding from Reservoirs

The locations of reservoirs and artificial flood sources have been identified using Environment Agency and OS data. A reservoir is defined by the FWMA (2010) as a large raised structure capable or designed at holding over 25,000 m^3 of water. A review into reducing the capacity to which a reservoir will be regulated from 25,000 m^3 to 10,000 m^3 is expected to be phased in to improve the safety legislation and regulation of reservoirs[10].There are several reservoirs within the study area and within the river catchments upstream of the development sites that fall under the FWMA, including Denton Reservoir, the Lake at Grimsthorpe, Rutland Water, Boathouse Pond and Knipton Reservoir. In addition, there are numerous smaller reservoirs and lakes within the study area.

[10] Flood and Water Management Act (2010). *Chapter 29 Schedule 4- Reservoirs*. Available at: http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

4. Level 2 Strategic Flood Risk Assessment

4.1 Level 2 Site Assessments

The purpose of the Level 2 SFRA is to determine the potential for a site to pass the Exception Test, and to provide recommendations for the issues that would need to be considered by the LPA and potential developers as the sites come forward for development.

Appendix A provides the Level 2 assessments for each of the potential development sites identified by SKDC. For each potential development site, the datasets described in Section 3 have been used to assess the flood risk to the site; any further information that would be required as part of a site specific FRA for the site has been identified; and, recommendations for measures to avoid, manage and mitigate flood risk have been provided in accordance with the guidance presented in Section 6 of the Level 1 SFRA Report. It should be noted that some of these sites have been included in the Level 2 assessment as alternatives, should some of the potential allocations not come forward.

The potential development sites are presented in the order set out in Table 2.

Appendix A Potential Development Sites Proforma

South Kesteven District Council Level 2 SFRA - Site Assessment Summary				
Location: Bourne	**SKDC Site Reference:** SKLP66	**Area (ha):** 15	**Proposed Use:** Residential	**Vulnerability Classification:** More Vulnerable

Sequential Test Status:
The Sequential Test has been undertaken by SKDC for this Site as part of the preparation of the Local Plan Site Allocations.

Tidal and Fluvial Flood Risk

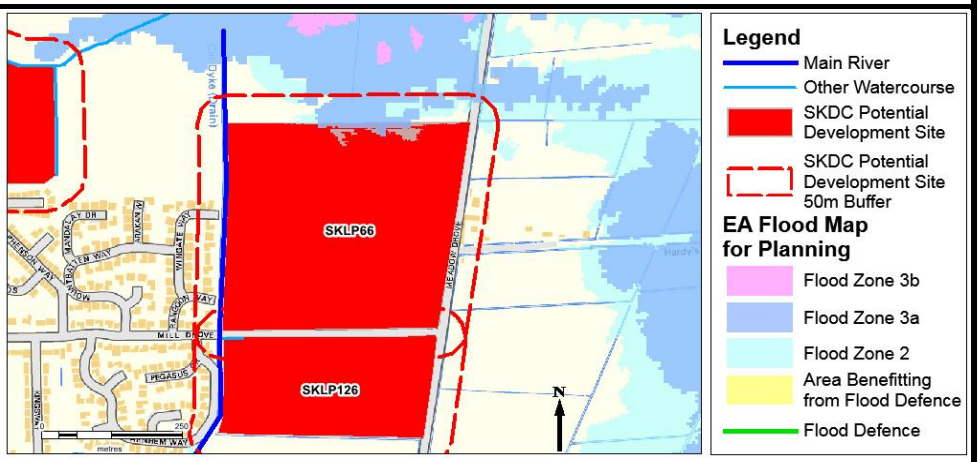

Figure 1- Flood Map for Planning

Environment Agency Flood Zone	3b	3a	2	1
Flood Zones present at the Site:	No	Yes	Yes	Yes
Area of Site in Flood Zones (ha)	-	0.18	0.22	14.61
% of Site in Flood Zones	-	1.2	1.5	97.3

Flood Zones and Flood Defences
Site SKLP66 covers an area of low lying farmland in the north east of Bourne. Car Dyke, identified as a 'Main River' flows in a southerly direction along the western border of the Site, converging with Bourne Eau approximately 1 km to the south. The majority of the Site (97.3%) is defined as Flood Zone 1, with low probability of flooding from fluvial and tidal sources (Figure 1). There is a small area towards the northern Site boundary that lies in Flood Zone 2 (2.6%) and Flood Zone 3 (1.2%), defined as medium and high probability of flooding, respectively.

The site is not shown as benefitting from formal flood defences. Private and / or natural defences may be present but are not recorded. Site SKLP66 lies within the jurisdiction of the Black Sluice IDB who are responsible for clean water drainage and water level management within the designated IDB area.

Functional Floodplain
The Flood Map for Planning indicates there is no Flood Zone 3b, Functional Floodplain, present at the Site.

Climate Change
As the Site is considered more vulnerable and lies partially within Flood Zone 3a the Upper End climate change allowances have applied to the Welland Model (1% AEP + 25%, 1% AEP + 35%, 1% AEP + 65%). Figure 1 shows the largest of the three scenarios considered to increase flooding from the River Welland to the east of the Site, producing a flood extent that affects a large area to the east of the Site. Results from the model shows maximum in-channel water levels reaching 5.9mAOD and in-channel velocities reaching 75.05m/s at the cross sections closest to the Site. This results in maximum water depths of 1.5m at the Site as shown in Figure 2.

Tidal and Fluvial Flood Risk

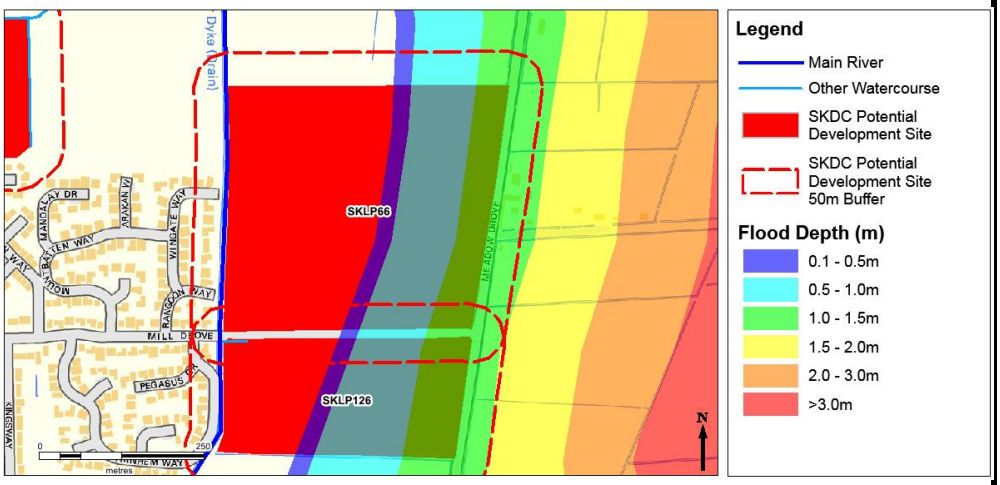

Figure 2 - Modelled Flood Depths for the 1%AEP + 65% Climate Change Scenario

Surface Water

Figure 3- Risk of Flooding from Surface Water

Return Period	High 1 in 30 (3.3% AEP)	Medium 1 in 100 (1% AEP)	Low 1 in 1000 (0.1% AEP)	Very Low Less than 1 in 1000 (<0.1% AEP)
% of Site at risk of surface water flooding	0.1	0.7	1.2	98.8

Risk of Flooding from Surface Water (RoFSW)

The RoFSW indicates that the majority of the Site is considered to be at a very low risk of flooding from surface water (<0.1% AEP). The RoFSW mapping shows small potential flow paths along the western, northern and eastern boundary of the Site and in the central area passing through the centre of the Site that have a 1% to a 0.1% AEP (medium to low risk). The flow paths are localised and constrained to the land drainage channels.

The Site layout should be carefully designed to consider the risk of surface water flooding to any proposed development, and ensure development does not increase surface water runoff to these drains such that the risk of surface water flooding to the development and surrounding land would increase.

Geology

The underlying bedrock at the Site comprises a mixture of Kellaways Sand Member- Sandstone and Siltstone and Oxford Clay Formations- Mudstone, overlain by undifferentiated River Terrace Deposits 1 - Sand and Gravel. The underlying bedrock permeability is inferred to be low, while River Terrace superficial deposits have high permeability.

Surface Water

Historic Records
There are no historic flood records held by LCC as LLFA in the location and surrounding proximity of the potential development Site SKLP66.

Sewer

	Within the Site	Within the Site + 20m buffer	Within the Site + 50m buffer
Anglian Water Records of Sewer Flooding (DG5)	No	No	No

Anglian Water is responsible for clean and waste water in the South Kesteven District. The DG5 Register (Level 1 SFRA Appendix B Figure 11) shows no recorded incidents of sewer flooding at the Site or within a 50m buffer around the Site.

Groundwater

	< 25%	>= 25% < 50%	>=50% <75%	>= 75%
EA Susceptibility to Groundwater Flooding	-	Yes	-	-

Figure 10 in Appendix B of the Level 1 SFRA indicates that the Site is located above a Secondary A Aquifer. Secondary A Aquifers comprise permeable layers that form an important component of base flow to rivers. The Environment Agency AStGWF indicates that the Site is located within a 1km grid cell that is considered to have between a 25% to 50% susceptibility to groundwater flooding. Groundwater monitoring data is unavailable to inform this assessment. A Site-specific FRA should further quantify the risk from this source and identify appropriate SuDS for the Site.

Other

The Environment Agency 'Risk of Flooding from Reservoirs' online mapping shows the Site is not at risk of inundation of waters should a breach event or failure occur. There are no other artificial waterbodies, including canals, in close proximity to the potential development Site.

Site Specific Recommendations

As SKLP66 lies in Flood Zone 3 and Flood Zone 2 a site specific Flood Risk Assessment (FRA) would be required, in line with the requirements of the PPG (paragraph 102), "*a site-specific flood risk assessment must 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*".

Site Layout and Design
As the majority of the Site is identified as being in Flood Zone 1, low probability of flooding from fluvial and tidal sources, it should therefore be possible to locate all proposed residential development for this Site allocation within Flood Zone 1. Residential development should be avoided in areas defined as Flood Zone 3 on the northern edge of the Site, and instead lower vulnerability uses including landscaped open space should be located here. Residential development and drainage should also be carefully considered in areas of high and medium RoFSW, particularly around the flow paths identified above which could be exacerbated by surface water flow from an increase in impermeable surfaces.

The drainage strategy for the Site must be considered early in the site planning process to ensure adequate inclusion of SuDS, taking care to consider SuDS features in accordance with the hierarchy of SuDS (i.e. considering infiltration measures first wherever possible). Storage features should not be located within the floodplain of the Car Dyke, as they may be rendered ineffective during times of fluvial flooding.

Emergency Planning
The northern and western boundaries of the Site are shown to be within an Environment Agency Flood Warning and Flood Alert Area. Due to the proximity of the Site to Car Dyke, Flood Response Plans should be prepared by residents of the Site.

Site Specific Recommendations	**Access/Egress** Safe dry access to and from the Site should be provided. This is likely to be achievable from Tanners Lane. A unnamed watercourse runs adjacent to the road and the Site boundary. Further improvement works will be needed to sufficiently provide adequate Site access and egress of residents and emergency services during periods of floods. Any proposed works to the watercourse will required prior agreement/ consent from LCC and the Environment Agency. **Set-back Distance** Car Dyke is defined as a Main River by the Environment Agency and has no history of historic fluvial flooding at the Site (Level 1 SFRA Section 5.3). Due to the close proximity of the potential development Site, a suitable set-back distance should be used in consultation with LLFA (LCC), LPA (SKDC) and Environment Agency in order to ensure development is a suitable distance from the Car Dyke to reduce flood risk to the associated infrastructure. Finally the Environment Agency will need to be consulted and an Environmental Permit obtained, if required, for any works within 8 m of Car Dyke. The Environment Agency may require strips of land to be left undeveloped to allow access for maintenance for the defences and the Main River. **Floodplain Compensation** Land raising and any built development should be avoided within the floodplain of the Car Dyke. Where alterations to the floodplain are proposed, compensatory floodplain storage will need to be provided on a level-for-level and volume-for-volume basis. The land used to provide compensation storage will need to be in hydraulic connectivity with the existing floodplain, but not already part of the floodplain. **Finished Floor Levels** As the Site is allocated for residential development, it is classified in the PPG 'Flood Risk Vulnerability Classification' as 'more vulnerable'. As a result of this ground floor levels must follow Environment Agency standing advice, for single storey residential development ground levels should be set 300 mm above the 0.1% AEP (1 in 1000 year event) plus climate change allowance flood level and for other development finished floor levels should be set 300 mm above the 1% AEP (1 in 100 year event) plus climate change allowance flood level.
Summary	Based on the strategic assessment of flood risk and the recommendations for mitigation measures set out above, it is considered that proposed development on this site could be suitably designed to satisfy part 2) of the Exception Test.

South Kesteven District Council Level 2 SFRA - Site Assessment Summary				
Location: Bourne	**SKDC Site Reference:** SKLP126	**Area (ha):** 6.6	**Proposed Use:** Residential	**Vulnerability Classification:** More Vulnerable

Sequential Test Status:
The Sequential Test has been undertaken by SKDC for this site as part of the preparation of the Local Plan Site Allocations.

Tidal and Fluvial Flood Risk

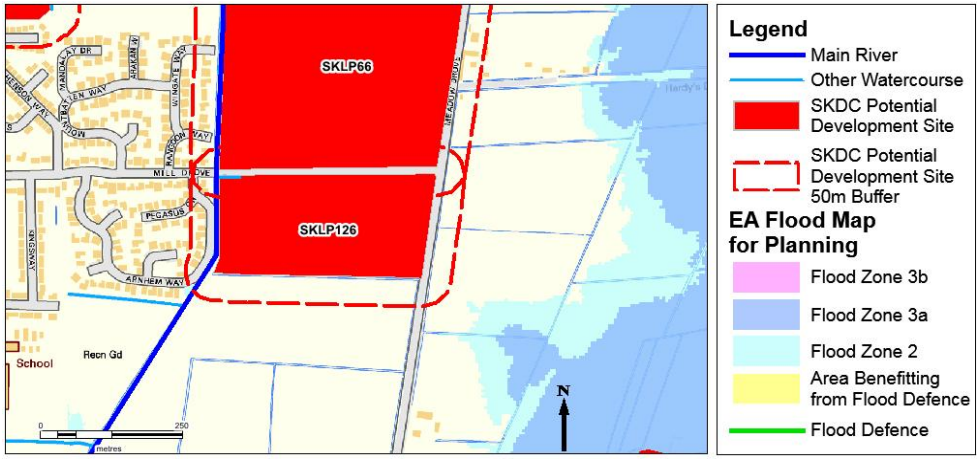

Figure 1- Flood Map for Planning

Environment Agency Flood Zone	3b	3a	2	1
Flood Zones present at the site:	No	Yes	Yes	Yes
Area of site in Flood Zones (ha)	-	0.02	0.02	5.96
% of site in Flood Zones	-	0.3	0.3	99.7

Flood Zones and Flood Defences
Site SKLP126 covers an area of low lying farmland in the north east of Bourne and is identified for residential development. Car Dyke, identified as a 'Main River' flows in a southerly direction along the western border of the site, converging with Bourne Eau approximately 1km to the south of the site. The majority of the Site is located in Flood Zone 1, low risk of fluvial flooding. A small portion of the north western area of the site lies in Flood Zone 2 and Flood Zone 3, medium and high risk of fluvial flooding. The flood defences have been included within the Flood Map.
Flood defences are present along the right and left banks of Car Dyke along the western boundary of the site. The high ground embankment is maintained by the Environment Agency and designed for a 1 in 100 year event. The overall condition of the defences is classed as 'Very Poor' according to the AIMs database. Site SKLP126 is located within the Black Sluice IDB, responsible for the clean water drainage and water level management within the designated IDB area.

Functional Floodplain
The Flood Map for Planning indicates there is no Flood Zone 3b, Functional Floodplain, present at the Site.

Climate Change
As the site is considered more vulnerable and lies partially within Flood Zone 3a the upper end climate change allowances have applied to the Welland Model (1% AEP + 25%, 1% AEP + 35%, 1% AEP + 65). Figure 1 shows the largest of the three scenarios considered to increase flooding from the River Welland to the east of the site, producing a flood extent that affects a large area to the east of the site. Results from the model shows maximum in-channel water levels reaching 5.9mAOD and in-channel velocities reaching 75.05m/s at the cross sections closest to the site. This results in maximum water depths of 1.5m at the site as shown in Figure 2.

Tidal and Fluvial Flood Risk

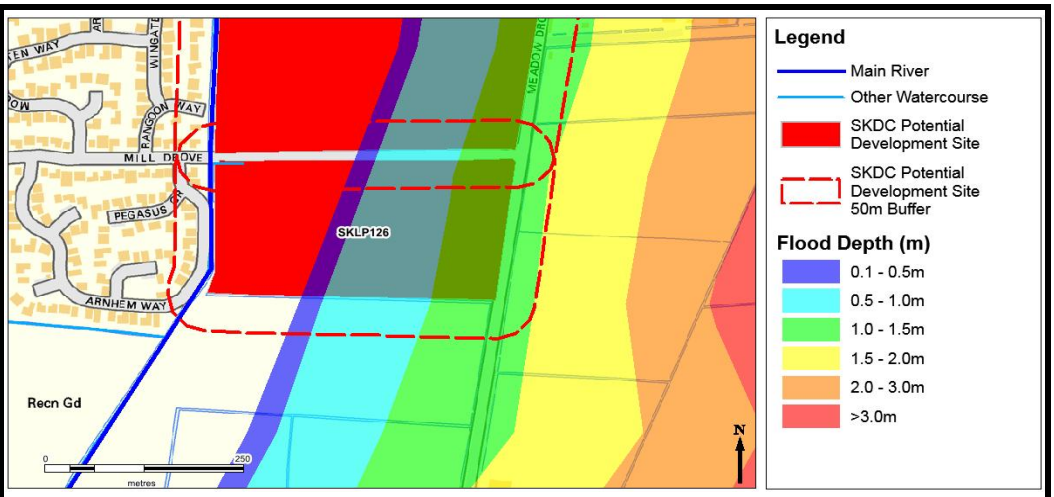

Figure 2 - Modelled Flood Depths for the 1%AEP + 65% Climate Change Scenario

Surface Water

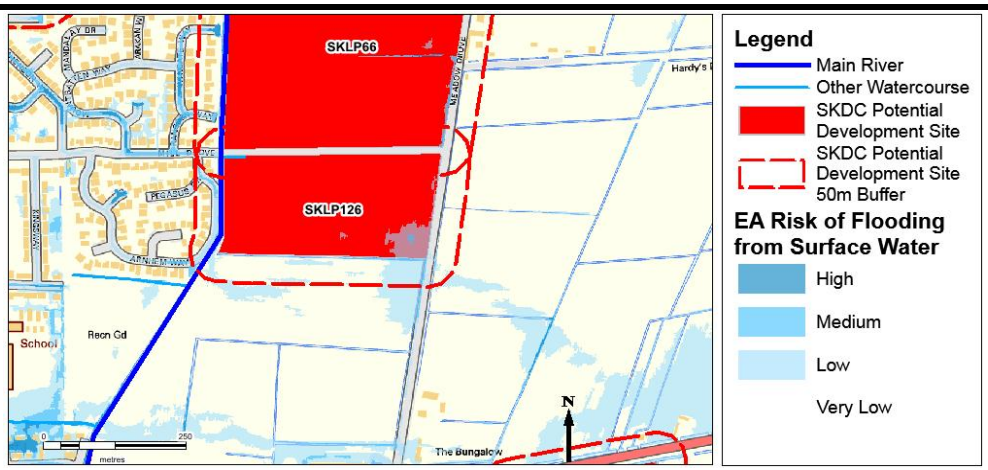

Figure 3 - Risk of Flooding from Surface Water

Return Period	High 1 in 30 (3.3% AEP)	Medium 1 in 100 (1% AEP)	Low 1 in 1000 (0.1% AEP)	Very Low Less than 1 in 1000 (<0.1% AEP)
% of site at risk of surface water flooding	-	0.2	6.5	93.5

Risk of Flooding from Surface Water (RoFSW)

The RoFSW mapping indicates the site lies mainly in an area defined as being at very low risk (< 0.1% AEP) of surface water flooding. There are areas of low (0.1% AEP) and medium (1% AEP) risk of surface water flooding along the eastern, southern and north west boundary of the site. The risk of surface water flooding is anticipated to be from localise surface water runoff from roads, land drains and Car Dyke.

Site layout and/ or drainage strategy should be carefully designed to consider the risk of surface water flooding to the proposed development, allocated for residential development, in order to minimise the risk of flooding to property particularly where there is risk of surface water ponding in the south east and along the drainage ditches.

Geology

The BGS Geology Mapper indicates the site is underlain by Kellaways Clay Member compromising of Mudstone in the southern and north east area of the site, the remaining north western area of the site is underlain by Kellaways Sand Member, comprising of Sandstone and Siltstone. The overlying superficial deposits, covering the entirety of the site, are River Terrace Deposits, 1- Sand and Gravel.

Surface Water

The underlying bedrock permeability is considered to be 'moderate' and superficial deposits considered to have 'high' permeability.

Historic Records

There are no historic flood records held by LCC as LLFA in the location and surrounding proximity of the potential development site SKLP240.

Sewer

	Within the site	Within the site + 20m buffer	Within the site + 50m buffer
Anglian Water Records of Sewer Flooding (DG5)	No	No	No

Anglian Water is responsible for clean and waste water in the South Kesteven District. The DG5 Register (Level 1 SFRA Appendix B Figure 11) shows no recorded incidents of sewer flooding at the site or within a 50m buffer around the site.

Groundwater

	< 25%	>= 25% < 50%	>=50% <75%	>= 75%
EA Susceptibility to Groundwater Flooding	-	Yes	-	Yes

The AStGWF mapping (Level 1 SFRA Appendix B Figure 10) shows the northern extent of the Site is located within a 1km square of between 25 % to 50% is susceptible to groundwater emergence. The southern extent of the Site is located within an area with greater than 75% susceptibility to groundwater flooding. The site is located above a Secondary A bedrock Aquifer associated with the Kellaways Clay Member and an Unproductive bedrock Aquifer associated with the Kellaways Sand Member. Secondary A Aquifers comprise permeable layers that form an important component of base flow to rivers and Unproductive Aquifers are rock layers with low permeability that have little significance on water supply. However, groundwater levels should be confirmed during a ground investigation survey to support development at the site.

Other

The Environment Agency flood existent from structural failure or breach of a reservoir mapping (Level 1 SFRA Appendix B Figure 12) shows the site is not at risk of inundation of waters in the event of a breach or failure of a reservoir. There are no other artificial waterbodies, including canals, in close proximity to the potential development site.

Site Specific Recommendations

As SKLP115 is greater than 1haa site specific Flood Risk Assessment (FRA) would be required, in line with the requirements of the PPG (paragraph 102), "*a site-specific flood risk assessment must 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*".

Site Layout and Design

As the majority of the Site is identified as being in Flood Zone 1, low probability of flooding from fluvial and tidal sources, it should therefore be possible to locate all proposed residential development for this site allocation within Flood Zone 1. AResidential development should be avoided in areas defined as Flood Zone 3a along the western and north western extent of the site associated with Car Dyke, and instead lower vulnerability uses including landscaped open space should be located here. Residential development and drainage should also be carefully considered in areas at RoFSW, particularly in the south eastern area where surface water flooding may be exacerbated by an increase in impermeable surfaces.

Site Specific Recommendations	The drainage strategy for the site must be considered early in the site planning process to ensure adequate inclusion of SuDS, taking care to consider SuDS features in accordance with the hierarchy of SuDS (i.e. considering infiltration measures first wherever possible). Storage features should not be located within the floodplain of the Car Dyke, as they may be rendered ineffective during times of fluvial flooding. **Emergency Planning** The site is not shown to be within an Environment Agency Flood Warning Area or a Flood Alert Area. Due to the proximity of the Site to the Car Dyke, it is recommended Flood Response Plans should be prepared by residents of the Site. **Access /Egress** Safe, dry access to and from the site should be provided to occupants and emergency services in time of flood. This is most likely to be achievable from the north of the site from Mill Drove **Set-back Distance** Car Dyke is defined as a Main River by the Environment Agency, and has history of historic fluvial flooding along its course. As the potential development site at the Somerby Hill location is bound partially along the River Witham along the western extent, a suitable set-back distance should be agreed in consultation with LLFA, LCC, and LPA, SKDC, in order to ensure properties are a suitable distance from the River Witham to reduce flood risk to the property. LCC will need to be consulted and consent obtained for any proposed works that may impact the flow within the channel of the Car Dyke. Finally the Environment Agency will need to be consulted and an Environmental Permit obtained, if required, for any works within 8 m of the River Witham. The Environment Agency may require strips of land to be left undeveloped to allow access for maintenance for the defences and the Main River. **Floodplain Compensation** Land raising and/ or levelling and any built development should be avoided within the floodplain of the River Witham. Where alterations to the floodplain are proposed, compensatory floodplain storage will need to be provided on a level-for-level and volume-for-volume basis. The land used to provide compensation storage will need to be in hydraulic connectivity with the existing floodplain, but located outside of the existing floodplain. **Finished Floor Levels** As the Site is allocated for residential development, it is classified in the PPG 'Flood Risk Vulnerability Classification' as 'more vulnerable'. As a result of this ground floor levels must follow Environment Agency standing advice, for single storey residential development ground levels should be set 300 mm above the 1% AEP (1 in 100 year event) plus climate change allowance flood level and for other development finished floor levels should be set 300 mm above the 1% AEP (1 in 100 year event) plus climate change allowance flood level. **Fluvial Modelling** As part of a site specific FRA for this site, a simple hydraulic model could be used to demonstrate the flood risk to the site incoporating the defences. Currently the Envrionment Agency Flood Map does not consider the presence of defences along this section of the Car Dyke.
Summary	Based on the strategic assessment of flood risk and the recommendations for mitigation measures set out above, it is considered that proposed development on this site could be suitably designed to satisfy part 2) of the Exception Test.

South Kesteven District Council Level 2 SFRA - Site Assessment Summary				
Location: Baston	**SKDC Site Reference:** SKLP130	**Area (ha):** 1.8	**Proposed Use:** Residential	**Vulnerability Classification:** More Vulnerable

Sequential Test Status:
The Sequential Test has been undertaken by SKDC for this site as part of the preparation of the Local Plan Site Allocations and has been granted planning permission.

Tidal and Fluvial Flood Risk

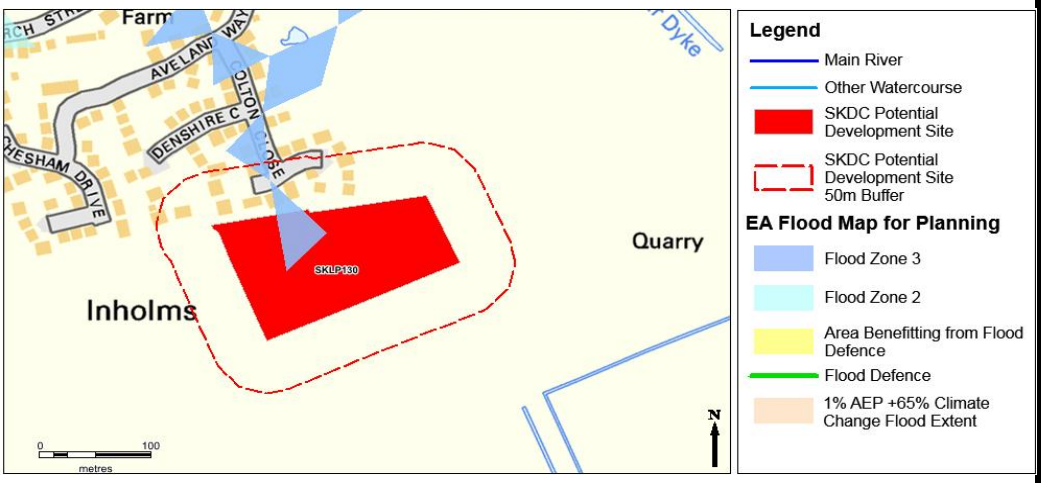

Figure 1- Flood Map for Planning

Environment Agency Flood Zone	3b	3a	2	1
Flood Zones present at the site:	No	Yes	Yes	Yes
Area of site in Flood Zones (ha)	-	0.1	0.1	1.7
% of site in Flood Zones	-	8.2	8.2	91.8

Flood Zones and Flood Defences
Site SKLP130 currently compromises arable farmland located in Baston. The site is not located in close proximity to any watercourse. The majority of the site lies in Flood Zone 1, low probability of fluvial flooding. A small portion of the northern extent, a combined 0.1 ha, is located in Flood 2 and Flood Zone 3 medium and high probability of flooding, respectively.

Although the site is not shown as benefitting from formal flood defences in the Flood Map for Planning, consultation with the Environment Agency concluded that the site does benefit from flood defences therfore floodplain compensation would not be required to develop the site. Private and / or natural defences may be present but are not recorded. Site SKLP130 is located within the Welland and Deepings IDB, responsible for the clean water drainage and water level management of the designated IDB area.

Functional Floodplain
The Flood Map for Planning indicates there is no Flood Zone 3b, Functional Floodplain, present at the Site..

Climate Change
As the site is considered more vulnerable and lies partially within Flood Zone 3a the upper end climate change allowances have applied to the Welland Model (1% AEP + 25%, 1% AEP + 35%, 1% AEP + 65%). The model shows the in channel water levels for the closest cross sections to the site reach 8.92mAOD and in-channel velocities reaching 6.92m/s, which is not large enough to cause flooding from this section of the watercourse.

Surface Water

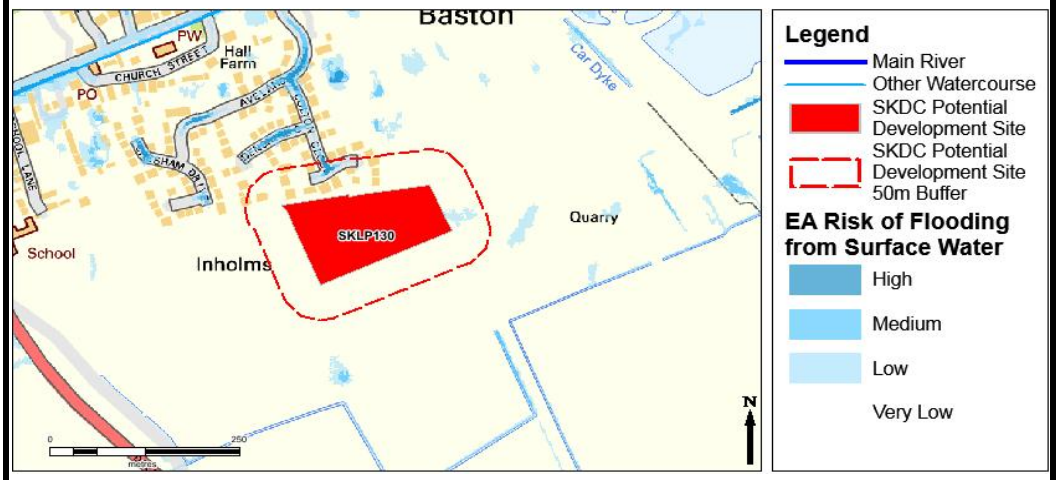

Figure 2- Risk of Flooding from Surface Water

Return Period	High 1 in 30 (3.3% AEP)	Medium 1 in 100 (1% AEP)	Low 1 in 1000 (0.1% AEP)	Very Low Less than 1 in 1000 (<0.1% AEP)
% of site at risk of surface water flooding	-	-	0.1	99.9

Risk of Flooding from Surface Water (RoFSW)
The RoFSW mapping indicates the majority of the site (99.9%) is at very low risk of surface water flooding. A small area of surface water ponding on the eastern boundary of the site encroaches within the Site boundary of SKLP130, posing low risk of surface water flooding. This of surface water flood risk is very negligible and will not pose any significant surface water flood risk to the site.

Geology
The BGS Geology Mapper indicates the underlying bedrock geology compromises of Kellaways Sand Member- Sandstone and Siltstone. Superficial deposits overlying the site consist of River Terrace Deposits, 1- Sand and Gravel. The underlying bedrock is anticipated to have moderate to low permeability, and the superficial deposits are inferred to be highly permeable.

Historic Records
There are no historic flood records held by LCC as LLFA in the location and surrounding proximity of the potential development site SKLP130.

Sewer

	Within the site	Within the site + 20m buffer	Within the site + 50m buffer
Anglian Water Records of Sewer Flooding (DG5)	No	No	No

Anglian Water is responsible for clean and waste water in the South Kesteven District. The DG5 Register (Level 1 SFRA Appendix B Figure 11) shows no recorded incidents of sewer flooding at the site or within a 50m buffer around the site.

Groundwater

	< 25%	>= 25% < 50%	>=50% <75%	>= 75%
EA Susceptibility to Groundwater Flooding	Yes	-	-	-

The AStGWF mapping (Level 1 SFRA Appendix B Figure 10) shows the entirety of the site is located in an area of less than 25 % of groundwater emergence. The site is located above a Secondary A Aquifer. Secondary A Aquifers comprise permeable layers that form an important component of base flow to rivers.

Other

The Environment Agency flood extent from structural failure or breach of a reservoir mapping (Level 1 SFRA Appendix B Figure 12) shows the Site is located in an area at risk of flooding from Rutland Water, approximately 9 km from the Site. The risk of structural failure or breach of the reservoir is very low, with regular inspection and maintenance of Rutland Water undertaken. There are no other artificial water bodies including canals in close proximity to the site.

Site Specific Recommendations

As SKLP130 is greater than 1ha and lies in Flood Zone 3 and Flood Zone 2 a site specific Flood Risk Assessment (FRA) would be required, in line with the requirements of the PPG (paragraph 102), "*a site-specific flood risk assessment must 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*".

Site Layout and Design

The majority of the site is located within Flood Zone 1, low probability of fluvial or tidal flooding, it should be therefore possible to locate all proposed residential development within Flood Zone 1. Residential development should be avoided in areas defined as Flood Zone 3a on the northern edge of the site, and instead lower vulnerability uses including landscaped open space should be located here.

The drainage strategy for the site must be considered early in the site planning process to ensure adequate inclusion of SuDS, taking care to consider SuDS features in accordance with the hierarchy of SuDS (i.e. considering infiltration measures first wherever possible).

Emergency Planning

The site is not shown to be within an Environment Agency Flood Warning Area. The Site does, however, lie in a Flood Alert Area where flood warnings are issued when flooding is possible. Therefore, it is recommended Flood Response Plans should be prepared by residents of the Site.

Access /Egress

Safe, dry access to and from the site should be provided to occupants and emergency services in times of flood. This is most likely to be achievable to the west boundary of the site where new residential development has recently taken place. As such there is potential for access to the site from the new development.

Finished Floor Levels

As the Site is allocated for residential development, it is classified in the PPG 'Flood Risk Vulnerability Classification' as 'more vulnerable'. As a result of this ground floor levels must follow Environment Agency standing advice, for single storey residential development ground levels should be set 300 mm above the 0.1% AEP (1 in 1000 year event) plus climate change allowance flood level and for other development finished floor levels should be set 300 mm above the 1% AEP (1 in 100 year event) plus climate change allowance flood level.

Summary

Based on the strategic assessment of flood risk and the recommendations for mitigation measures set out above, it is considered that proposed development on this site could be suitably designed to satisfy part 2) of the Exception Test.

South Kesteven District Council Level 2 SFRA - Site Assessment Summary				
Location: Somerby Hill/ Great North Road, Grantham	**SKDC Site Reference**: SKLP269	**Area (ha):** 215.7	**Proposed Use:** Residential	**Vulnerability Classification:** More Vulnerable

Sequential Test Status:
The Sequential Test has been undertaken by SKDC for this site as part of the preparation of the Local Plan Site Allocations. The Site is currently going through the planning application process.

Tidal and Fluvial Flood Risk

Figure 1- Flood Map for Planning

Environment Agency Flood Zone	3b	3a	2	1
Flood Zones present at the site:	Yes	Yes	Yes	Yes
Area of site in Flood Zones (ha)	1.8	2.6	0.9	212.1
% of site in Flood Zones	0.9	1.2	1.6	98.4

Flood Zones and Flood Defences
The River Witham flows north towards the centre of Grantham. The watercourse, defined as a 'Main River', flows adjacent to the north west of the SKLP269 development Site. Approximately 98% of the site lies in Flood Zone 1, low probability of flooding from fluvial and tidal sources (Figure 1). The central area and small section running parallel to Houghton Road Industrial Estate, has areas of Flood Zone 2 and Flood Zone 3, medium and high probability of flooding as a result of the close proximity of the River Witham (Figure 1).

Flood defences are present along both the right and left banks of the River Witham. The defences along this stretch of the River Witham, adjacent to the site, compromises of high ground and embankment. The embankment is maintained by the EA, whilst the remaining high ground defences are privately maintained. None of the flood defences along this section of the River Witham are considered within the EA Flood Map. The overall condition of the flood defences range from 'Good' to 'Moderate'. Site SKLP269 is located within the Upper Witham IDB, responsible for the clean water drainage and water level management in the designated IDB area.

Functional Floodplain
Flood Zone 3b compromises of land where water has to flow or be stored in times of flood. Approximately 1.8 ha (0.9% of the total area) is located in Flood Zone 3b. The functional floodplain is located in the central area where the River Witham bisects the site. As such no development will be permitted in the functional floodplain.

Climate Change
As the site is considered more vulnerable and lies partially within Flood Zone 3a the upper end climate change allowances have applied to the Welland Model (1% AEP + 25%, 1% AEP + 35%, 1% AEP + 65%). Figure 1 shows the largest of the three scenarios considered to produce a maximum flood extent that lays betwwen Flood Zones 2 and 3 to the south of the site, then extends further into the site than Flood Zone 2 as the River Witham progresses northwards through the site. Results from the model shows maximum water levels between 55.65mAOD and 59.12mAOD, with in-channel velocities reaching 41.25m/s at the cross sections closest to the site.This results in water depths greater than 3.0m at the edge of the site.

Figure 2 - Modelled Flood Depths for the 1%AEP + 65% Climate Change Scenario

Surface Water

Figure 3 - Risk of Flooding from Surface Water

Return Period	High 1 in 30 (3.3% AEP)	Medium 1 in 100 (1% AEP)	Low 1 in 1000 (0.1% AEP)	Very Low Less than 1 in 1000 (<0.1% AEP)
% of site at risk of surface water flooding	0.1	0.4	2.1	97.9

Risk of Flooding from Surface Water (RoFSW)

The RoFSW mapping indicates the site lies mainly in an area defined as being at very low risk (< 0.1% AEP) of surface water flooding. A small portion of the site lies at high risk (> 3.3%) of surface water flooding. This high risk area is located to the north west of the Site where there is an apparent flow path from existing residential development located along Saltersford Road towards the River Witham. Associated areas at medium risk (1% AEP) are also found along this flow path. The RoFSW shows small areas at low risk (0.1% AEP) of surface water ponding throughout the Site and in the central area on the River Witham floodplain. On the western area of the site there are three medium (1% AEP) and low risk (0.1% AEP) surface water flow paths flowing east towards the River Witham.

Site layout should be carefully designed to consider the risk of surface water flooding to the proposed development, allocated for residential development, in order to minimise the risk of flooding to property particularly where there is high risk, clear surface water flow paths and along the floodplains to the western area of the Site. The drainage strategy should also address the surface water flood risk particularly the flow paths in the western site that stretch the width of the Site.

Geology

According to the BGS Geology Mapper, the land allocation at Site SKLP269 is mainly underlain by the Upper and Lower Lincolnshire Limestone Member across the central and eastern extent of the Site. The central area of the Site is underlain by a mixture of small areas of Northampton Sand Formation, Whitby Mudstone Formation and Grantham Formation formed from a mixture of Sandstone, Siltstone and Mudstone. Superficial deposits are only present in the central area to the site by the River Witham, consisting of Belton Sand and Gravel and Alluvium formed from a mixture of Clay, Silt, Sand and Gravel. Both the underlying bedrock and superficial deposits are known to be permeable.

Historic Records

There are no historic flood records held by LCC as LLFA in the location and surrounding proximity of the potential development site SKLP269. Anglian Water does hold records of sewer flooding within 50 m of the allocated site, the cause of this sewer flooding is not disclosed but surface water is known to be interrelated to sewer flooding (summarised in Level 1 SFRA- Section 5.6).

Sewer

	Within the site	Within the site + 20m buffer	Within the site + 50m buffer
Anglian Water Records of Sewer Flooding (DG5)	No	Yes	Yes

Anglian Water is responsible for clean and waste water in the South Kesteven District. There records of recorded flood incidents, known formally as the DG5 Register, shows no records of sewer flooding at the site, but there are records of sewer flooding within both 20 m and 50 m of the Site. The Risk of Sewer Flooding mapping (Level 1 SFRA Appendix B Figure 11) shows that the north western extent of the Site is located within a 1km square of which 8 records of sewer flooding are located.

Groundwater

	< 25%	>= 25% < 50%	>=50% <75%	>= 75%
EA Susceptibility to Groundwater Flooding	Yes	Yes	-	-

The AStGWF mapping (Level 1 SFRA Appendix B Figure 10) shows that the western extent of the Site is located within a 1km square of between 25 % to 50% is susceptible to groundwater emergence. The remainder of the Site is located within an area with less than 25% susceptibility to groundwater flooding. The site is located above a Principal Aquifer with a minor Secondary A Aquifer located in the north western corner. Principal Aquifers support water supply at a strategic scale and Secondary A Aquifers comprise permeable layers that form an important component of base flow to rivers. However, groundwater levels should be confirmed during a ground investigation survey to support development at the Site.

Other	The Environment Agency 'Risk of Flooding from Reservoirs' online mapping shows the site is not at risk of inundation of waters in the event of a breach or failure of a reservoir. There are no other artificial waterbodies, including canals, in close proximity to the potential development site.
Site Specific Recommendations	As SKLP269 is greater than 1ha and lies in Flood Zone 3 and Flood Zone 2 a site specific Flood Risk Assessment (FRA) would be required, in line with the requirements of the PPG (paragraph 102), "*a site-specific flood risk assessment must 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*". **Site Layout and Design** As the majority of the Site is identified as being in Flood Zone 1, low probability of flooding from fluvial and tidal sources, it should therefore be possible to locate all proposed residential development for this site allocation within Flood Zone 1. Residential development should be avoided in areas defined as Flood Zone 3a on the western edge of the site, and instead lower vulnerability uses including landscaped open space should be located here. Residential development and drainage should also be carefully considered in areas at RoFSW, where surface water flooding may be exacerbated by an increase in impermeable surfaces. The drainage strategy for the site must be considered early in the site planning process to ensure adequate inclusion of SuDS, taking care to consider SuDS features in accordance with the hierarchy of SuDS (i.e. considering infiltration measures first wherever possible). Storage features should not be located within the floodplain of the River Witham, as they may be rendered ineffective during times of fluvial flooding. **Emergency Planning** The site is not shown to be within an Environment Agency Flood Warning Area. However, residents should register to receive the warning service associated with the River Witham that runs adjacent to the western boundary of the Site. Due to the proximity of the site to the watercourse, Flood Response Plans should be prepared by residents of the site, particularly those located along the western extent. **Access /Egress** Safe, dry access to and from the site should be provided to occupants and emergency services in times of flood. This is most likely to be achievable to the eastern area of the site from Somerby Hill (A52), the western area from South Parade and from Albert Street for the north eastern area of the site located by the Houghton Road Industrial Estate. **Set-back Distance** The River Witham is defined as a Main River by the Environment Agency, and has history of historic fluvial flooding along its course. As the potential development site in Grantham is bisected by the River Witham, a suitable set-back distance for development should be agreed in consultation with LLFA, LCC, and LPA, SKDC, in order to ensure properties are a suitable distance from the River Witham to reduce flood risk to the property. LCC will need to be consulted and consent obtained for any proposed works that may impact the flow within the channel of the River Witham. Finally the Environment Agency will need to be consulted and an Environmental Permit obtained, if required, for any works within 8 m of the River Witham. The Environment Agency may require strips of land to be left undeveloped to allow access for maintenance for the defences and the Main River. **Finished Floor Levels** As the Site is allocated for residential development, it is classified in the PPG 'Flood Risk Vulnerability Classification' as 'more vulnerable'. As a result of this ground floor levels must follow Environment Agency standing advice, for single storey residential development ground levels should be set 300 mm above the 0.1% AEP (1 in 1000 year event) plus climate change allowance flood level and for other development finished floor levels should be set 300 mm above the 1% AEP (1 in 100 year event) plus climate change allowance flood level. **Floodplain Compensation** Land raising and/ or levelling and any built development should be avoided within the floodplain of the River Witham. Where alterations to the floodplain are proposed, compensatory floodplain storage will need to be provided on a level-for-level and volume-for-volume basis. The land used to provide compensation storage will need to be in hydraulic connectivity with the existing floodplain, but located outside of the existing floodplain. **Fluvial Modelling** As part of a site specific FRA for this site, a simple hydraulic model could be used to demonstrate the flood risk to the site incorporating the defences. Currently the Environment Agency Flood Map does not consider the presence of defences along this section of the River Witham.
Summary	Based on the strategic assessment of flood risk and the recommendations for mitigation measures set out above, it is considered that proposed development on this site could be suitably designed to satisfy part 2) of the Exception Test.