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Newark and Sherwood District Council Level 2 SFRA: Phase One-Three Strategic Sites

Newark & Sherwood District Council

June 2010

QM

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	DRAFT	Final		
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Project number	11501309	11501309		
File reference	DRAFT	FINAL		

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Executive Summary

Following on from the Level 1 Strategic Flood Risk Assessment (SFRA), Newark and Sherwood District Council (NSDC) have commissioned WSP to undertake a Level 2 SFRA for three strategic sites centred around the Newark Growth Point. The Level 2 SFRA has been divided into two separate stages. The three strategic sites; Land South of Newark, Land East of Newark and Land around Fernwood are shown in Appendix A.

An analysis of the three strategic sites constitutes Phase One. A Level 2 SFRA of these sites provides a comprehensive and robust assessment of the extent and nature of flood risk in these areas and the implications for land use planning.

A second stage to the Level 2 SFRA (Phase Two) will be prepared in due course; this will assess the development potential of a wider range of sites in terms of flood risk. The study will encompass the Newark and Sherwood District Council study area as assessed through the Level 1 SFRA (i.e. the wider district area around Newark).

The main aim of the Phase One study is to provide an understanding of the flood risk constraints for the three sites and to help inform the Local Development Framework (LDF) for the District. The study area has been categorised into Flood Risk Zones in accordance with Planning Policy Statement 25: 'Development and Flood Risk' (PPS25).

This Level 2 SFRA for the three strategic sites, provides a sound framework with an appropriate level of detail required at this stage, for making consistent and sustainable future planning decisions. The Level 1 SFRA has provided the main source of data.

Bespoke hydrodynamic modelling for each strategic site has been undertaken for this phase of the Level 2 SFRA. This allows an assessment of a site's overall sustainability in terms of development and flood risk.

One of the key findings of the SFRA is that the majority of land within each of the three strategic sites falls into Flood Zone 1 which is an area of low flood risk. Other non fluvial flooding sources pose a low risk to each of the three sites.

A key reason for the production of the SFRA is to allow NSDC to undertake further analysis that provides the evidence base for the Sequential and Exception test. This Level 2 SFRA focuses on parts of the sites where there is potential development pressures in zones of medium to high flood risk, and where there are no other suitable alternative areas for development after applying the Sequential Test.

Hydrodynamic modelling has been undertaken in order to assess the full extent of the flood risk and detailed nature of the flood hazard at each site.

The SFRA evaluates the current (2010) flood risk situation and the future flood risk situation over a 105 year timeframe (2115), incorporating the impacts of climate change in line with PPS25.

The East Midlands Regional Assembly's East Midlands Regional Flood Risk Appraisal Consultation Report (Oct.09), highlights that there is a high risk of fluvial flooding in Newark. A key recommendation of the Consultation Report is that if development is required in Flood Zone 3, then it must be located in areas of least flood risk informed by an SFRA.

Completion of the Level 2 SFRA will provide NSDC with the information for understanding flood risk at the local level which will allow for full consideration of flood risk issues when preparing plan policies and making planning decisions.

The Level 2 SFRA should be reviewed annually and updated at least every five years, to reflect any amendments in future growth proposals.

GLOSSARY

AEP	Annual Exceedance Probability e.g. 1% AEP is equivalent to 1% probability of occurring in any one year (or, on average, once in every 100 years).
DCLG	Department for Communities and Local Government.
Catchment	An area drained by a specific river/ watercourse.
Catchment Flood Management Plan	A Catchment Flood Management Plan is a strategic planning tool through which the Environment Agency seeks to work with other key decision-makers within a river catchment, to identify and agree policies for sustainable flood risk management.
Core Strategy	The Development Plan Document within the Council's Local Development Framework which sets the long-term vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to sustainable development.
Cut-off Drain	A drain constructed to intercept surface water and lead it away to an outlet.
DEFRA	Department of Environment, Food and Rural Affairs.
Development	The carrying out of building, engineering, mining or other operations, in, on, over or under land, or the making of any material change in the use of a building or other land.
EA	Environment Agency.

EA Main River	These are all watercourses shown on the statutory main river maps held by the EA and DEFRA listed as a 'Main River'. This may include any structure or appliance for controlling or regulating the flow of water into a channel; the EA has permissive powers to carry out works of maintenance and improvement on these rivers.
Flood Hazard Map	Maps showing the level of flood hazard within a flood plain based on depth and velocity of water for a specific return period.
Floodplain	Any area of land over which water flows or would flow or be stored in the absence of flood defences.
Flood Zone Map	Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency. Shows the areas at risk of flooding based on various return periods.
Fluvial	Relating to a watercourse (river or stream).
Formal Flood Defence	A structure built and maintained specifically for flood defence purposes.
Functional Floodplain	PPS25 Flood Zone, defined as areas at risk of flooding in the 5% AEP (20 year) design event.
Green Infrastructure	A network of multi-functional green space for the promotion of natural and ecological processes set at a strategic planning level.
Greenfield Site	Land that is usually agricultural and has not been previously developed.
Groundwater	Water occurring below ground in certain geological formations.
Hydraulic Model	A computer simulation of the stages and flows of water within a watercourse.
LiDAR	(Light Imaging Detection and Ranging). A method of detecting distant objects and determining their position by analysis of pulsed laser light reflected from their surfaces.
Local Development Framework (LDF)	Will comprise of a portfolio of local development documents which will provide the framework for delivering the spatial strategy for the area.

Planning Policy Statement (PPS)	A series of statements issued by the Government, setting out policy guidance on different aspects of planning. They have replaced Planning Policy Guidance Notes.
Pluvial Flooding	Flooding that is directly derived from surface water run-off. It is usually localised in its effects and is caused by rainfall flowing over ground.
PPS25	Planning Policy Statement 25: Development and Flood Risk Department of Communities & Local Government, 2006.
Previously Developed (Brownfield) Land	Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land.
Regional Spatial Strategy (RSS)	Planning strategies developed by the regions. These were previously called Regional Planning Guidance.
Residual Risk	An assessment of the outstanding flood risks and uncertainties that have not been explicitly quantified and/or accounted for as part of the review process.

Source Protection Zone (SPZs)	This is an area where recharge is captured by an abstraction borehole. SPZs are designated by the Environment Agency so as to protect potable water supplies against polluting activities.
SuDS	Sustainable Drainage Systems. These are management practices and control structures designed to minimise the impact of surface water on flood risk and the environment. The overall aim is to imitate the natural hydrological cycle.
Sustainable Development	“Development that meets the needs of the present without comprising the ability of future generations to meet their own needs” (The World Commission on Environment and Development, 1987).
Zone 1 Low Probability	PPS25 Flood Zone, defined as areas outside of Zone 2 Medium Probability. These areas have less than a 0.1% (1 in 1000) AEP of river or sea flooding in any year.
Zone 2 Medium Probability	PPS25 Flood Zone, defined as areas at risk of flooding in events that are greater than the 1% (100 year) AEP, and less than the 0.1% (1000 year) AEP event or between a 0.5% (200 year) and 0.1% (1000 year) AEP of sea flooding.
Zone 3a High Probability	PPS25 Flood Zone, defined as areas at risk of flooding in the 1% (100 year) AEP design event for river flooding and 0.5% (200 year) or greater AEP of sea flooding.
Zone 3b Functional Floodplain	PPS25 Flood Zone, defined as an area where water has to flow or be stored in times of flooding. This has a 5% (20 year) AEP potential of occurring.

1 Introduction

1.1 BACKGROUND

1.1.1 Newark and Sherwood as a designated Growth Point are required to deliver 14,800 new homes by 2026 together with associated employment led development. Of this 3,000 units are already committed (i.e. have planning consent). Newark and Sherwood District Council therefore need to allocate the residual figure of 11,800 homes. This level of growth represents a significant increase in housing supply in the area.

1.1.2 Newark and Sherwood District Council are currently in the process of preparing their Core Strategy for the Local Development Framework; the Core Strategy is due to be adopted by early 2011. As part of the Core Strategy for the area, NSDC are seeking to allocate three strategic sites as follows (See Appendix A);

- **Land South of Newark;**
- **Land around Fernwood;**
- **Land East of Newark.**

1.1.3 Any remaining housing number requirements will be determined from other sites including those identified through the Strategic Housing Land Availability Assessment.

1.2 OBJECTIVES

1.2.1 The overall objective of the Stage 2 Strategic Flood Risk Assessment for the three strategic sites is to:

- Consider the detailed nature of the flood hazard taking account of the presence of flood defences;
- Provide the necessary evidence base to facilitate a sequential approach to site allocation within a flood zone;
- Allow policies and practices to be developed to ensure that development in flood risk areas can satisfy the requirements of the Exception Test and to incorporate such policies/practices into the Local Development Documents;
- To advise and inform private and commercial developers of their obligations under PPS25 in relation to sustainable development and flood risk.

1.3 SCOPE

1.3.1 Phase One of the Level 2 SFRA focuses on the identification and assessment of the principle sources of flood risk associated with the study area in relation to the three strategic sites. All aspects of surface water, ground water and fluvial flooding have been assessed in line with the requirements of a Level 2 SFRA as detailed in Planning Policy Statement 25 and the supporting Practice Guidance. Hydrodynamic modelling has been completed to understand the detailed nature of fluvial flooding providing flood risk and flood hazard mapping for each strategic site. Recommendations on the application of various SuDS techniques have also been provided.

1.3.2 The SFRA is essentially a planning tool. It is an assessment of flood risk intended to inform the spatial planning process and therefore the level of detail and accuracy should relate to this strategic objective. The SFRA will help to steer future land use in a sequential and holistic manner, taking into consideration sustainability and the requirements of PPS25 (Development and Flood Risk (2010) and associated Practice Guidance (2009).

1.4 THE SEQUENTIAL TEST

1.4.1 The Sequential Test as set out in PPS25 aims to steer vulnerable development towards areas of lower flood risk. The Sequential Test should demonstrate where there are sites available in areas of a lower probability of flooding. Following on from the Level 1 SFRA, a key reason for the completion of the Level 2 SFRA is to provide supporting evidence for NSDC to undertake this test in relation to the three strategic sites. Adopting a sequential approach within a site boundary, will prevent more vulnerable land uses occurring in areas of high flood risk.

1.5 THE EXCEPTION TEST

1.5.1 PPS25 expands the Sequential Test by incorporating the Exception Test. Following application of the Sequential Test, if it is not possible for the development to be located in zones of lower probability of flooding, the Exception Test can be applied. This must be consistent with other sustainability objectives.

1.5.2 The Exception Test provides a mechanism for managing flood risk while still allowing necessary development to occur. It should not, however, be used to justify 'highly vulnerable' development in Flood Zone 3a, or 'less vulnerable', 'more vulnerable' and 'highly vulnerable' development in Flood Zone 3b.

1.5.3 For the Exception Test to be passed it must be demonstrated that;

- 1) the development provides wider sustainability benefits to the community that outweigh flood risk, informed by an SFRA where one has been prepared;
- 2) the development should be on developable, previously developed land or if it is not on previously developed land, that there is no reasonably alternative sites that are on previously developed land; and
- 3) the Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.

1.5.4 Phase One of the Level 2 SFRA, provides supporting information for the Exception Test to be undertaken for any potential development sites that fall within areas of medium to high flood risk. This SFRA takes no account of other socio-economic or sustainability factors other than flood risk and drainage infrastructure. These wider issues are to be considered by NSDC as part of their Sequential Test and Exception Test procedures.

1.6 LOCAL PLANNING CONTEXT

1.6.1 The District Council is currently preparing a Local Development Framework (LDF) to replace the existing Local Plan. Given the nature of the flood risk in the District and the level of growth envisaged in the East Midlands Regional Plan, this SFRA will be a key piece of the District's LDF evidence base. The strategic element of the LDF, the Core Strategy Development Plan Document, is being progressed as a priority. Consultation on Options culminated in December 2009 with a view to submission in June 2010; adoption is scheduled for early 2011. Work on the site specific and development management policy element of the LDF will begin in summer 2010; submission will be in May 2011 with adoption scheduled for December 2011.

1.7 RIVER TRENT CATCHMENT FLOOD MANAGEMENT PLAN

1.7.1 Since the production of the Level 1 SFRA, the Trent Catchment Flood Management Plan (CFMP) Consultation Draft (January 2010) has been issued by the Environment Agency. This high level strategic document assesses the sustainable management of flood risk within the catchment over the next 50 to 100 years. The Level 1 SFRA lists the overall objectives of the Trent CFMP. The EA have stated that the final version of the Trent CFMP is due to be issued in the autumn of 2010.

1.7.2 For the purposes of this Level 2 SFRA, reference will be made to this draft document.

1.7.3 The overall role of the CFMP is to establish flood risk management policies which will deliver sustainable flood risk management for the long term within the River Trent CFMP area.

1.7.4 The key objective of the Trent CFMP is to set policies across the whole catchment which will achieve long-term sustainable flood risk management. More specifically, the aims are to:

- Reduce the overall risk from flooding and harm to people, and the natural, historic and built environment;
- Work with natural processes so that flood risk management brings benefits and contributes effectively to sustainable development;
- Inform and support planning policies, statutory land use plans and implementation of the Water Framework Directive.

1.7.5 The EA has set out a list of policies to be adopted across the CFMP area; these are driven by the extent, nature and scale of current and future flood risk within different parts of the catchment. These six policies (as given in the Level 1 SFRA) are listed below;

- Policy Option 1- No active intervention (including flood warning and maintenance). Continue to monitor and advise.
- Policy Option 2- Reduce existing flood risk management actions (accepting that flood risk will increase over time).
- Policy Option 3- Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline).

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- Policy Option 4- Take further action to sustain the current scale of flood risk into the future (responding to the potential increases in flood risk from urban development, land use change and climate change).
 - Policy Option 5- Take further action to reduce flood risk.
 - Policy Option 6- Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

1.7.6 As stated in the Level 1 SFRA, the entire Trent catchment is divided up into ten different Policy Units. Policy Unit 4 (Shelford to Gainsborough) impacts on the majority of Land East of Newark and the western half of Land South of Newark, part of the eastern half of Land South of Newark and a small part of Land around Fernwood (see Appendix D). Areas of this study relating to the maintenance and upgrading of flood defence infrastructure in relation to these sites have been incorporated within this document.

1.8 RIVER WITHAM CATCHMENT FLOOD MANAGEMENT PLAN

1.8.1 A small area of the south east part of Newark and Sherwood District encompassing all three strategic sites falls within the area of the EA's Witham Catchment Flood Management Plan (see Appendix D). As with the Trent CFMP (Consultation Draft), the River Witham CFMP provides an overview of the current and future flood risk within the catchment area. The CFMP also sets out the preferred policies for sustainable flood risk management over the next 50 to 100 years.

1.8.2 The CFMP aims to recommend broad policies for the management of current and future flood risk in the River Witham CFMP area. These were identified through appraising different policies against a number of objectives. Seven objectives were set based on specific issues, taking into account opportunities and constraints associated with sustainable flood risk management. The seven objectives are as follows;

- Minimise flood related risks to the population;
- Minimise community disruption from flooding of critical infrastructure;
- Manage flood risk to sites of cultural, architectural and heritage value;
- Manage the economic impacts of flooding;
- Ensure future investment in the catchment is proportional to the risks;
- Minimise economic agricultural damages;
- Manage flood risk to habitats and species.

1.8.3 The CFMP is divided up into fourteen sub areas, called Policy Units. Each unit represents similar types of flood risk, in terms of mechanisms of flooding, the level of risk and type of receptor (people, environment etc). Each of these units has been assigned an appropriate policy through a detailed objective-led appraisal process using the seven catchment objectives. Policy Units PU1 (Upper Witham) and PU13 (Outer Lincoln South), impact on a small part of Land East of Newark, Land around Fernwood and the eastern half of Land South of Newark (see Appendix D).

1.8.4 The Policy Options for the River Witham CFMP are the same as those listed for the River Trent.

1.8.5 Of particular relevance to Phase One of the Level 2 SFRA are the policies towards maintaining and upgrading the flood defence network within the Trent and Witham catchments. The policies adopted from the CFMP process will help the EA to prepare System Asset Management Plans (SAMPs). These plans will provide information on all flood defence structures (including third party assets) and at a high level, provide guidance on how to manage them and whether changes will be needed in the future. The CFMP states that SAMPs will allow the EA to undertake the following activities;

- Improve their understanding of flood defence assets;
- Improve their understanding of their library of assets;
- Understand their asset's whole life costs;
- Better understand their financial commitments;
- Make correct and informed investment decisions;
- Target flood risk more efficiently;
- Identify critical assets;
- Deliver efficiency by identifying and targeting benefits.

1.8.6 For Policy Unit 1 of the Witham CFMP, Policy 2- **Reduce current levels of flood risk management (accepting that flood risk will increase with time)** was selected.

1.8.7 The reason why this policy was selected is that there is currently a low risk of flooding in the Upper Witham Policy Unit. If there is a reduction in flood risk activities, then flood risk is not forecast to increase significantly under the future scenario. No additional people or property will be at risk, and the risk to the economy will only increase slightly. Adopting Policy 2 allows the flood risk in the Upper Witham Policy Unit to be sustained into the future.

1.8.8 One of the catchment wide opportunities identified by this Policy Unit is to develop a SAMP to phase out flood risk management activities on all systems. The CFMP also highlights that the SAMP should also investigate how and where the EA can reduce maintenance of defences. Ceasing maintenance activities provides the opportunity to improve floodplain connectivity, in stream geomorphology and aquatic habitats.

1.8.9 As set out in the CFMP, the objectives met by this policy are as follows;

- Manage the economic impacts of flooding;
- Ensure future investment in the catchment is proportional to the risks;
- Minimise economic agricultural damages;
- Minimise flood related risks to the population;
- Minimise community disruption from flooding of critical infrastructure;
- Manage flood risk to sites of cultural, architectural and heritage value;
- Manage flood risk to habitats and species.

1.8.10 For Policy Unit 13 of the Witham CFMP, Policy 6- **Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment** was selected.

1.8.11 Adopting Policy 6 in the Outer Lincoln South Policy Units allows the flood risk in the Lincoln Policy Unit to be sustained at the current level in the future. The scale of flood risk in this area is considered to be low. The CFMP states that selecting this Policy Unit, supports the economic, social and environmental sustainability through taking action to sustain future flood risk.

1.8.12 One of the catchment wide opportunities identified in the CFMP is to develop a SAMP within this Policy Unit for Lincoln; this will allow the recommendations in the flood risk study to be carried out in the most sustainable way.

1.8.13 As set out in the CFMP, the objects which are met by adopting this policy are as follows;

- Manage the economic impacts of flooding;
- Ensure future investment in the catchment is proportional to the risk;
- Minimise flood related risks to the population;
- Minimise community disruption from flooding of critical infrastructure ;
- Manage flood risk to sites of cultural, architectural and heritage value;
- Manage flood risk to habitats and species.

2 Study Area

2.1 DESCRIPTION OF STUDY AREA

2.1.1 The three strategic sites that are being assessed as part of Phase One of the Level 2 SFRA are listed as follows with approximate site areas in hectares;

- **Land East of Newark (122 ha);**
- **Land South of Newark (598 ha);**
- **Land around Fernwood (248 ha).**

2.1.2 Newark and Sherwood District Council was awarded Growth Point status by the government in 2005. The Growth Point initiative is part of a wider government strategy to build 240,000 new houses a year by 2016. The government's overall target is to provide 3,000,000 new homes by 2020. The three strategic sites centred around the Newark Growth Point contribute towards the ambitions of NSDC to expand economic and infrastructure investment within the District and address affordable housing shortages. In order to ensure that development is sustainable, flood risk is one of the key issues that requires a robust assessment.

2.1.3 The proposed development layouts for the three strategic sites are based on the plans provided in the NSDC Publication Core Strategy (March 2010). These proposals/land uses have been used as a basis for this study and the hydrodynamic modelling outputs illustrated in Appendix C.

2.1.4 All three sites are situated to the east and south of Newark on Trent (see Appendix A). As previously stated, most of the eastern half of Land South of Newark and the majority of Land around Fernwood fall into the River Witham CFMP area. The remaining western half of Land South of Newark and most of the Land East of Newark fall within the Trent CFMP area.

Land East of Newark

2.1.5 Land East of Newark is currently a greenfield site with Sodbridge Drain running through the centre. This watercourse flows in an east to west direction (see Appendix B). There are also two drains running opposite one another in a north to south direction which flow into Sodbridge Drain. The western part of the site is bounded by the railway embankment. Urban areas of Newark and Balderton are situated to the north and east; the site's eastern boundary is marked by the A1 running in a north to south direction. The principle source of fluvial flood risk to Land East of Newark is from Sodbridge Drain. A small pond (classified as a Site of Interest for Nature Conservation) is located to the south of the site adjacent to the railway and the A1. As set out in the NSDC Publication Core Strategy, the current proposals for Land East of Newark are for 1,600 residential units.

Land around Fernwood

2.1.6 Land around Fernwood (see Appendix A) is also predominately a greenfield site, however the existing Fernwood development around Balderton Hospital is located in the central northern part of the site. The northern boundary of the site is bounded by the railway line to the east and the A1 to the west. The A1 acts as the boundary of the site to the west and Shire Dyke acts as the site's boundary to the east. Various ditches and drains on the site flow into Shire Dyke. The River Witham is located 500m to the east of the site boundary. The principle source of fluvial flood risk to Land at Fernwood is from the River Witham, Shire Dyke and the various ditches and drains that flow into it. The northern part of the site is impacted by the floodplain from Lowfield Drain. As set out in the Publication Core Strategy, the current proposals for Land around Fernwood are for 3,200 residential dwellings.

Land South of Newark

2.1.7 Land South of Newark (see Appendix A) is a predominantly greenfield site which stretches in an east to west direction south of Newark and Balderton. The site is bisected by the Sustrans Route that runs in a north to south direction. The site is bounded to the west by the River Devon which flows in a northerly direction. Middle Beck runs through the western half of the site from east to west eventually flowing into the River Devon. Lowfield Drain flows in an east to west direction through the eastern half of the site. Approximately 700m to the west of the site's western boundary is the River Trent. The principle source of fluvial flood risk to the site is from the River Devon, the River Trent, Middle Beck and Lowfield Drain. Car Dyke and Doge Dyke that flow into the River Devon from the south, contribute to the flood risk mechanism for this watercourse. As set out in the Publication Core Strategy, the current proposals for Land South of Newark are for 3,100 dwellings.

2.1.8 A description of proposed land uses within each site is provided in the table below broken down into approximate individual areas in hectares (see Appendix A);

	Land East of Newark	Land around Fernwood	Land South of Newark
Residential Areas (ha)	52.5	132.4	83.2
Landscape Buffer (ha)	14.3	40.7	18.9
Green Infrastructure (ha)	54.2	60.4	169.7
Proposed Business Use (ha)		13.3	
Proposed Industrial Use (ha)			44.3
Existing and Future Minerals Extraction (ha)			273.9
Total (ha)	121	246.8	590

2.2 HYDRAULIC STRUCTURES

2.2.1 Details of hydraulic structures such as sluices, weirs and defences in close proximity to the three strategic sites have been provided in (Appendix B). As illustrated in these plans, there are no significant raised defences in close proximity to the three sites. A key requirement of a Level 2 SFRA as set out in PPS25 Practice Guidance is to assess the probability and consequences of overtopping or failure of flood risk management infrastructure. Based on the information provided in Appendix B, a detailed breach analysis of the failure or overtopping of flood defence infrastructure is not required within Phase One of the Level 2 SFRA.

2.3 GEOLOGY, HYDROGEOLOGY & ENVIRONMENT

Geological Maps

2.3.1 Sustainable Drainage Systems (SuDs) infiltration feasibility plans, are shown in Appendix B. These have been provided for each of the three strategic sites drawing on the information provided in the Level 1 SFRA. These plans indicate the potential suitability for SuDs infiltration techniques based on the permeability of ground conditions. Infiltration methods rely on discharging to ground, where suitable ground conditions allow. A detailed site specific FRA, will need to assess the permeability of the underlying soil through ground investigations. The plans in Appendix B provide an initial indication of the suitability of these methods. This has been assessed in greater detail in Section 7.

Source Protection Zone Maps

2.3.2 Source Protection Zones (SPZ's), relate to groundwater supplies used for drinking and the risk of contamination through pollution. The EA classify them into three main zones; Zone 1 (Inner Protection Zone), Zone 2 (Outer Protection Zone), Zone 3 (Total Catchment) and Zone of Special Interest. The location of these SPZ's should be taken into consideration when assessing the application of infiltration SuDs techniques at each of the three strategic sites. Information provided in the Level 1 SFRA, has been shown in Appendix B. An analysis is provided for each strategic site in Section 7.

Contaminated Land Issues

2.3.3 Information on potential land contamination issues, has been provided by NSDC for each of the three strategic sites. An assessment has been provided in Section 7 of this SFRA, in relation to application of infiltration SuDs techniques and ground contamination issues. A detailed site specific FRA, will need to assess these issues in greater detail.

2.4 ADMINISTRATIVE BOUNDARIES

2.4.1 Land Drainage/Flood Risk Management

EA (East Area, Midlands Region) covers the entire area of the District in which the three strategic sites fall into. The Newark Area Internal Drainage Board (NAIDB) administer the areas of Land South of Newark and Land East of Newark; the Upper Witham Internal Drainage Board (UWIDB) administer the area in which Land around Fernwood is located in (see Appendix B). None of the three strategic sites fall within the EA's flood warning areas as shown within the Level 1 SFRA.

2.4.2 Sewerage

2.4.3 Sewerage records were reviewed for the three strategic sites. A comprehensive set of these records are kept in NSDC's Environmental Services department.

2.4.4 All three sites are located in areas where the sewer network is administered by both Anglian Water and Seven Trent Water (see Appendix B). According to Severn Trent Water the following sewage treatment works (STW) would process foul flows from each of the sites;

- **Land South of Newark-** Balderton STW (Newark);
- **Land East of Newark-** Balderton STW (Newark);
- **Land around Fernwood-** Balderton STW and Crankley Point STW (Newark).

2.4.5 As taken from the JMP Water Cycle Study the following capacity information is provided in the table below regarding the sewage treatment works that impact on the three strategic sites;

Site	Receiving Water	Equivalent Population	Other
Balderton	Middle Beck	10,835 (Capacity increase required to support growth)	Serves SE quadrant of Newark and Balderton
Newark (Crankley)	River Trent	66,125 (Current capacity is reasonable for growth)	Main works to Newark and surrounding area to north.

2.4.6 As highlighted in the Level 1 SFRA, Severn Trent Water have stated that they would not oppose development on the grounds of capacity. If required, they would take the necessary steps to upgrade existing works. The detailed Water Cycle Study completed by JMP, highlighted that Severn Trent Water have indicated that a scheme is being developed to address capacity issues in Newark, which will cater for part of the forecast expansion of the town.

2.4.7 The Water Cycle Study states that Crankley Point works in Newark has reasonable capacity to accommodate the future growth in those sections of the town that are served by this works. However, Balderton sewage treatment works will need an expansion to accommodate the growth that is predicted to the south and south east of Newark. Any such growth is predicted to stimulate action by Severn Trent Water to progress such measures.

3 Methodology

3.1 DATA SOURCES

3.1.1 Data sources to produce Phase One of the Level 2 SFRA were predominately drawn from the information provided in the Level 1 SFRA. Additional site specific survey data was commissioned so that the 2D hydrodynamic modelling could use the most up to date and accurate information for the three strategic sites. Additional LiDAR data was also purchased. This relates to the production of Flood Zone and Flood Hazard mapping.

3.1.2 Findings and recommendations within the Witham and Trent (Consultation Draft) Catchment Flood Management Plans issued by the EA have been key in providing recommendations within the SFRA, specifically relating to flood defence maintenance and upgrades and the three strategic sites.

3.1.3 Information provided in this Phase One study has also drawn on the findings provided in Detailed Water Cycle Strategy produced by JMP consultancy (Sept. 09).

3.2 APPROACH AND METHODOLOGY

3.2.1 This Level 2 SFRA has been conducted in line with the Department for Communities and Local Government (DCLG's) Planning Policy Statement 25: Development and Flood Risk (2010), the DCLG's PPS25-Development and Flood Risk Practice Guide (2009) and NSDC SFRA Level 2 Invitation to Tender document (Aug.09). Phase One of the Level 2 SFRA has also adhered to the recommendations made within the Level 1 SFRA produced for NSDC.

3.2.2 This section outlines the purpose and deliverables associated with Phase One of the Level 2 SFRA. In line with PPS25, Phase One of the Level 2 SFRA contains the following requirements;

- 1. An appraisal of the current condition of flood defence infrastructure and of likely future flood management policy with regard to its maintenance and upgrade;*
- 2. An appraisal of the probability and consequences of overtopping or failure of flood risk management infrastructure, including an appropriate allowance for climate change;*
- 3. Definition and mapping of the functional floodplain in locations where this is required;*
- 4. Maps showing the distribution of flood risk across all flood zones from all sources of flooding taking climate change into account;*
- 5. Guidance on appropriate policies for sites which satisfy parts a) and b) of the Exception Test, and requirements to consider at the planning application stage to pass part c) of the Exception Test as set out in PPS25;*
- 6. Guidance on the preparation of FRA's for sites of varying risk across the flood zones, including information about the use of SuDS techniques;*
- 7. Identification of the location of critical drainage areas and identification of the needs for Surface Water Management Plans;*
- 8. Meaningful recommendations to inform policy, development control and technical issues.*

3.2.3 Phase One of the Level 2 SFRA, provides clear guidance on appropriate risk management measures for adoption on potential areas of the three strategic sites which fall within Flood Zones 2 and 3. The SFRA uses Flood Risk and Flood Hazard mapping to illustrate the variation of risk within flood zones. The application of these detailed flood risk and flood hazard maps allows the SFRA to provide recommendations in terms of the sustainable development of each of the three strategic sites in relation to development and flood risk issue.

3.2.4 Phase One of the Level 2 SFRA, seeks to provide a reference and policy document for NSDC to help to steer future development within the three strategic sites, towards areas at low risk of flooding over the lifetime of the proposed developments. The SFRA also seeks to set out general guidance on requirements for site specific Flood Risk Assessments within these three sites. The Flood Risk and Flood Hazard maps provided in this SFRA are the basis for assessing development and flood risk issues.

3.2.5 It is acknowledged that one of the key outputs of the NSDC Level 2 SFRA is to provide recommendations on the need to undertake a Surface Water Management Plan (see section 5.6).

3.3 HYDRAULIC MODELLING

Introduction

3.3.1 A series of hydrodynamic models were built to fulfil the remit of this Strategic Flood Risk Assessment. The methodologies and considerations required to produce this series of models, were dependent on the available information at different locations across the study area, and are best detailed, on a location by location basis.

3.3.2 In general terms the models created for this Strategic Flood Risk Assessment were combined 1D-2D models. 1D modelling is suited for modelling river channel reaches; these models were run in either ISIS or Estry software. These 1D models were combined with 2D models which are suited for any potential 'out of channel' flow across the site during the modelled flood events; all 2D modelling was conducted using TufLOW software.

3.3.3 The combination of a 1D model of the river channels with a 2D model for potential 'out of channel' flow, provides the best modelling approach as it best represents the physics of both flow in the channel and across the floodplain. The 1D modelling also maintains accuracy and resolution in the 1D channels and structures within the channel. 2D modelling is the most appropriate method of modelling any flow across open terrain where multiple significant flow directions can occur, and allows the identification of significant overland flow routes and flood storage areas.

1D Modelling (Main Channels)

3.3.4 In terms of modelling a 1D network in either ISIS or Estry a series of channel cross sections are required and also any structures in the channel need to be included. The availability of existing models is of particular use in this regard as they can provide this survey data without the need to re-collate the information (though additional surveys were carried out in places where they were required). The river channel is then modelled in the software and judgement is required in order to determine energy losses in the channel via bed roughness and losses at the entrance and exit of structures.

3.3.5 Where there was a choice of modelling in Estry or ISIS, ISIS was the preferred option as it is considered to be a more robust method of modelling hydraulic structures than Estry which is designed for use with natural unmodified watercourses.

2D Modelling (Floodplain)

3.3.6 Modelling of a 2D domain is based on the generation of good quality Digital Terrain Maps (DTM) which are an electronic representation of the area being modelled. Digital Terrain Maps are usually constructed by means of aerial scanning which are then processed using a GIS mapping software such as MapInfo Vertical Mapper. The best available DTM sources are LiDAR, which are accepted as being of an accuracy of +/- 150mm and are the source preferred by the Environment Agency.

3.3.7 LiDAR data is not always available and is often patchy. The Trent and Devon catchment was not covered entirely by LiDAR and the DTM mapping had to be completed using other sources; i.e. photogrammetry and ground surveys, to 'fill in' the gaps in the LiDAR. A combination of LiDAR, photogrammetry and traditionally surveyed topographical data was used to complete the 2D modelling.

3.3.8 The 2D model also identifies any areas of different roughness and significant topographical features such as raised embankments on roads, and surface drainage ditches, which would affect any flow over the 2D model. This DTM is then processed in the model as a series of square cells (e.g. 20m grid), the size of which determines the resolution of the modelling. The size of these cells is a compromise between the ability to run the model in a reasonable time scale and maintaining the accuracy of the DTM representation of the actual topography.

Hydrological Analysis

3.3.9 The models were run for 1:20, 1:100, 1:100 plus 20% for climate change and 1:1000 as described in Planning Policy Statement 25. These events define the extents of Flood Zones on the modelled areas.

3.3.10 The inflow hydrographs for each catchment were generated using a combination of hydrological analysis methods such as ReFH and the Flood Studies Report (FSSR). These are standard methods used for generating hydrographs in the UK. These hydrographs were derived specifically for this SFRA by WSP or by the earlier third party modelling which has been acquired by WSP; namely KBR (now part of Jacobs), JBA and Faber Maunsell. The inflows generated for each watercourse run beyond a single peak flooding event.

3.3.11 The purpose of the modelling is to establish the flood zones associated with the watercourses, i.e. define the following design event envelopes:

- 0.1% Annual Exceedance Probability (1 in 1000yr);
- 1% Annual Exceedance Probability (1 in 100yr);
- 1% Annual Exceedance Probability (1 in 100yr) plus 20% climate change allowance;
- 5% Annual Exceedance Probability (1 in 20yr) (1 in 25 yr for Newark South West of the Sustrans Route).

3.3.12 The significant watercourses modelled (in the vicinity of the strategic sites) were; the River Trent and its tributaries, the River Devon, the Middle Beck, Doge Dyke, Car Dyke, Lowfield Drain and Sodbridge Drain (see Appendix B). The River Witham and its tributary Shire Dyke, were also modelled.

LAND SOUTH OF NEWARK

3.3.13 This development area occupies land either side of the Sustrans Route, which runs south to north through the centre of Newark. The western side covers the area between the south of Newark and the River Devon. The east side covers the area immediately to the south of Balderton and north of Staple Lane extending up to the A1. The central part of the site is enclosed by the Sustrans Route as the western boundary and Grange Road as the eastern boundary, and extends south as far as Balderton Grange (see Appendix A).

3.3.14 This model includes the River Trent, River Devon, The Middle Beck, Car Dyke, Doge Dyke, Lowfield Drain and Sodbridge Drain.

3.3.15 The modelling for this area was split across the Sustrans Route where Lowfield Drain is culverted into the Middle Beck. This approach allowed the use of a model under development by WSP, which covers the River Trent, River Devon, Middle Beck, Car Dyke and Doge Dyke to the west of the Sustrans Route.

3.3.16 For the area to the east of the Sustrans Route, WSP used a 1D model created by JBA which encompassed Lowfield Drain and Sodbridge Drain. This was modified and converted into a 1D-2D model.

3.3.17 In hydrological terms the Sustrans Route running in a north to south direction is a significant obstruction along the Lowfield Drain floodplain. The railway line would prevent any backwater effect from the River Devon and Middle Beck floodplain affecting flows along Lowfield Drain, as it is located upstream from the Trent floodplain. Treating Lowfield Drain and Sodbridge Drain in isolation is an appropriate modelling assumption.

West of the Sustrans Route

3.3.18 This model was the largest model constructed for the SFRA. The model covers a 13 km reach of the River Trent; starting from the east of Fiskerton heading north east and ends at the north of Newark-on-Trent, just after the point where the A1 crosses the Trent.

3.3.19 The size of this model is approximately 39.31 square kilometres, and contains the network of watercourses (River Devon, Middle Beck, Car Dyke and Doge Dyke) which are tributaries to the River Trent from the south.

3.3.20 The River Devon flows in a broadly south to north direction. Its tributaries are Car Dyke and Doge Dyke on its west bank and Middle Beck on its east bank. The Devon flows into the River Trent on its Newark branch, approximately 400m upstream of Longstone Bridge.

1D Model

3.3.21 For this model, the 1D channels of the River Trent, River Devon, Middle Beck, Car Dyke and Doge Dyke were constructed in Esty. The channel sections used were

taken from the KBR model of the A46 improvement scheme. This model was created in InfoWorks RS but was truncated to the site boundaries. The cross sections were used as the basis of WSP's Estry model.

3.3.22 Cotham is the upstream extent of the River Devon model. The full extents of the tributaries of the River Devon were also modelled in the vicinity of the strategic sites.

2D Model

3.3.23 The 2D domain of this model was constructed in Tuflow. No single DTM source was available which covered the whole region so the DTM was constructed from a combination of existing LiDAR and existing photogrammetry.

3.3.24 Given the large area of the model, the 2D domain has been given as a 20m grid. This means that physical features in the 2D domain less than 20m wide could be ignored in the DTM. Features which would produce significant hydrological effects such as flood defence banks added to the DTM for the model. It was considered that objects less than 20m would have a negligible impact on any flow across the floodplain. Given the likely extent of flow across the floodplain an object less than 20m is highly unlikely to cause an obstruction relative to floodplain flow several hundred metres wide.

East of the Sustrans Route

3.3.25 The site is located approximately 2.5km south from Newark-on-Trent town centre and directly to the south of Balderton. The site is broadly rectangular in shape.

3.3.26 The north boundary of the site abuts the Jericho Road residential development at the northeast corner and Lowfield works at the northwest corner. The site encloses the sewage works at the north boundary and also the Jericho Works at the south west corner. The eastern boundary of the site is demarcated by the A1 which runs north-south, and the western boundary is marked by the Sustrans Route which also runs in a north-south direction.

3.3.27 There is an Environment Agency designated Main River (Lowfield Drain) running through the site which enters the site from the east via a culvert under the B6326. Lowfield drain flows broadly in an east to west direction across to the northern half of the site and is culverted under Staple Lane at the east of the site and the disused Sustrans Route to the west of the site.

3.3.28 Lowfield Drain flows into the Environment Agency Main River the Middle Beck which eventually joins the River Trent via the River Devon and is joined by smaller drainage channels which are associated with surface runoff from both the residential developments to the north of the site, (Manners Road and Jericho Road estates) and the existing greenfield areas on the site.

1D Model

3.3.29 An ISIS 1D model of Lowfield Drain was made available to WSP. This was undertaken by JBA with regard to a flooding event which occurred at the Jericho Road Estate in 2004 which abuts part of the northern bank of Lowfield Drain.

3.3.30 WSP have acquired this model to be the basis for the 1D modelling of Lowfield Drain. This model was updated using Halcrow's channel Survey Data which was provided by the EA.

3.3.31 The JBA model includes the major hydrological inflows to Lowfield Drain as Sodbridge Drain, which enters Lowfield Drain on the north bank of the Sustrans Route as well as runoff from a section of the A1 and surface runoff from Balderton Hospital, to the east of the site. There are also inflows from the Jericho Road Estate and the Manners Road Estate which lie to the north and have pumped surface water inflows directly into Lowfield Drain. There are further inflows from greenfield areas around the west and south of the sewage works by Cowfield Lane which enter Lowfield Drain via a drainage ditch on Cowfield Lane.

2D Model

3.3.32 Neither LiDAR data nor appropriate remotely sensed ground elevation data was available for the whole site, though partial photogrammetry of the site was undertaken. A detailed topographical survey was also taken to be used in conjunction with photogrammetry for the DTM.

3.3.33 Randall Surveys carried out a topographical survey of the area in November 2009 to a full RICS specification. Lowfield Drain was surveyed as part of the JBA ISIS model.

3.3.34 The resolution of the model was set at 5m grid. Any features which were not five metres wide could be ignored by the model.

LAND EAST OF NEWARK

3.3.35 Land East of Newark is located to the east of Newark and north of Balderton (see Appendix A).

3.3.36 Sodbridge Drain, is the only major watercourse on the site and is designated an Environment Agency 'Main River' west of the railway line. Sodbridge Drain has two un-named tributaries which act as feeders for two catchments which will be referred to as 'Greenacres' and 'The Firs'.

3.3.37 A combined 1D-2D model of Sodbridge Drain was developed by WSP for this Strategic Flood Risk Assessment.

1D Modelling

3.3.38 The channels are very flat in nature which has led to heavy siltation. In some cases the silt has completely submerged culverts leaving little or no space to convey flow. Therefore, due to the significant difference between the hard and soft beds, both cases have been modelled. The model using the soft beds has also taken the existing level of blockages into account though reduction in the cross-sectional area parameter. This then covers both scenarios where maintenance could be carried out in future.

3.3.39 The site is fed by three small catchments, 'The Firs', 'Greenacres' and the catchment associated directly to Sodbridge Drain. The small size of these catchments meant that the direct application of standard FEH, FSR or FSSR methods through WinFAP was inappropriate. The inflows were generated using the ReFEH method involving catchment descriptors fitted to peak-flows, which were estimated using the Institute of Hydrology Report 124 (IHR 124) methodology.

2D Modelling

3.3.40 No LiDAR or appropriately remote sensed ground elevation data was available for the site, therefore a detailed topological survey of the site was commissioned in order to produce the DTM for the site. The 2D Tuflow model was then integrated to the ISIS 1D model of Sodbridge Drain.

LAND AROUND FERNWOOD

3.3.41 The site is broadly rectangular and lies to the south east of Newark-on-Trent, and directly to the east of Balderton Hospital. The site is oriented broadly parallel to the east side of the A1 as it passes Balderton (see Appendix A).

3.3.42 The sites eastern and southern boundaries are demarcated by Shire Dyke, which is a designated 'Main River' by the Environment Agency. Shire Dyke runs from south to north past the site before heading east as a tributary of the River Witham which flows south to north, to the northeast of the site.

3.3.43 The site is currently greenfield with the Sustrans Route crossing the north of the site in a north western direction towards the centre of Newark, over both the River Witham and Shire Dyke.

1D Modelling and 'Quasi-2D' Modelling

3.3.44 Shire Dyke and the River Witham are separated by an area of floodplain between the east bank of Shire Dyke and the west bank of the River Witham directly adjacent to the east of the site.

3.3.45 The interaction of the River Witham and Shire Dyke across this floodplain during a flood, needs to be included in the modelling in order to determine whether the River Witham, as the larger of the watercourses, could drive a flood flow across both this floodplain and Shire Dyke onto the development area.

3.3.46 Faber Maunsell constructed a 1D model of the River Witham and Shire Dyke as part of the larger investigation of the flood improvements on the Upper River Witham. This model included the structures where Shire Dyke and the River Witham were crossed by the Sustrans Route.

3.3.47 This model is constructed in InfoWorks RS and represents a 'quasi-2D' model as it represents any out of channel flow onto the floodplain between Shire Dyke and the River Witham. The model works in terms of volumes being extracted as a series of reservoirs in a 1D network, rather than modelling any out of channel flow across a floodplain.

3.3.48 This 'quasi-2D' model is a suitable method for the purposes of this SFRA as it does not take into consideration interactions within a floodplain, only the effect of the volumes entering and leaving Shire Dyke to and from the River Witham.

2D Modelling

3.3.49 Unlike the floodplain area between the River Witham and Shire Dyke, the site area was modelled in 2D; this was undertaken as it is important to know where any out-of-channel flow onto the site area would be directed. LiDAR data was available for the site area, from which a DTM was interrogated using MapInfo Vertical Mapper software.

3.3.50 This 2D domain was then connected to the west bank of Shire Dyke in the ISIS quasi-2D model to determine the out of channel flows which would affect the site.

3.4 CLIMATE CHANGE

3.4.1 Annex B of PPS25 takes into account the impacts that climate change may have on flooding issues and sustainable development. Policy 10 within NSDC Publication Core Strategy addresses the issue of climate change. This policy highlights the need to mitigate the impacts of climate change through ensuring that new development proposals minimise their potential adverse environmental impacts, including the need to reduce the causes and impacts of climate change and flood risk. .

3.4.2 Phase One of the Level 2 SFRA has taken into consideration the various climate change outlines for each of the three sites based around the 1 in 100 year event. These outlines have been produced through detailed hydraulic modelling (see Appendix C). Climate change has been taken into consideration when providing advice within the Flood Risk Assessment tool kit provided in (Appendix E) for each strategic site.

3.4.3 The effects of climate change should be taken into account as part of Phase Two of the Level 2 SFRA.

3.5 POTENTIAL SOURCES OF FLOODING

3.5.1 The principle sources of flooding within the study area that have been focused on include;

- Fluvial flooding from 'out of bank' flows from rivers and watercourses;
- Groundwater flooding, including groundwater-fed watercourses;
- Sewer flooding;
- Localised surface water flooding, including from highway drainage;
- Surface runoff/overland flow;
- Fluvial flooding is the dominant flood risk issue affecting the three strategic sites and will clearly have the greatest influence upon sustainable land-use planning;
- Due to the lack of raised defences in close proximity to the three strategic sites, overtopping and breaching of flood defence structures has **not** been taken into consideration.

4 Flood Defence Infrastructure

4.1 STANDARD OF PROTECTION OF FLOOD DEFENCES

4.1.1 In line with the key requirement of PPS25 Practice Guidance, a Level 2 SFRA is required to provide the following information in relation to flood defences;

- an appraisal of the current condition of flood defence infrastructure and of likely future flood management policy with regard to its maintenance and upgrade;
- an appraisal of the probability and consequences of overtopping or failure of flood risk management infrastructure including an appropriate allowance for climate change.

4.1.2 Using the National Flood and Coastal Defence Database (NFCDD) information provided in the Level 1 SFRA (see Appendix B) and observations made through site investigations, the following can be stated regarding the extent of raised defences adjacent to the three sites. For the purposes of the SFRA flood defences with a defence level return period of 1 in 75 years and above were assessed. Those with lower return periods are not deemed to provide an adequate level of protection by the home insurance industry;

Land South of Newark;

- There are no raised flood defences that impact on the site and would form a zone of rapid inundation in the event of defence failure along the River Devon. According to the NFCDD data base, there are 2840m of raised defences along the Devon to the south west of the site between Newark and Hawton; these provide a 1 in 100 year level of defence. However, these defences are on the left bank of the river and in the event of overtopping or failure would not impact on the Land South of Newark site on the right bank.
- The raised defences along the Farndon Road allotments provide a 1 in 100 year level of protection from flooding along the Devon. However, in the event of overtopping or defence failure they do not pose any risk to the Land South of Newark site.
- The defences along the River Trent to the west of the A46 at Farndon provide a 1 in 100 year level of protection along the right hand bank of the river for 231m. However, they do not pose a risk to the site in terms of overtopping or defence failure due to their distance and intervening topography.
- According to the NFCDD data base (see Appendix B), raised defences are shown around the Manners Road Estate. These defences are 463m in length and provide a 1 in 100 year standard of protection. These defences provide a level of flood defence to this housing estate from out of bank flows along Lowfield Drain. Failure from breaching or overtopping of these defence pose no risk to the Land South of Newark site due to their location north of Lowfield Drain.

Land East of Newark;

- There are no formal raised flood defences in close proximity to the Land East of Newark site. Defences are not shown by the NFCDD database along Sodbridge Drain. The raised flood defences shown around the Manners Road Estate pose no risk to Land East of Newark in the event of overtopping or defence failure.

Land around Fernwood;

- According to the NFCDD, there are no raised defences along Shire Dyke. Raised defences are present along the River Witham (500m to the east of the site). However these only provide a 1 in 10 year standard of protection to agricultural areas as highlighted in the Witham CFMP.

4.2 RIVER TRENT CATCHMENT FLOOD MANAGEMENT PLAN

4.2.1 Since the production of the Level 1 SFRA, the River Trent CFMP has been issued as a Consultation Draft for Comment. As stated in section 1.7.6, Policy Unit 4 (Shelford to Gainsborough) of the CFMP impacts on the western section of Land South of Newark and all of Land East of Newark. The CFMP states that flood defence schemes are planned for Newark as significant flooding occurs along the Trent at this point.

4.2.2 As previously stated in the Level 1 SFRA, Policy Option 4 (**Take further action to sustain the current level of flood risk into the future– responding to the potential increases in risk from urban development, land use change and climate change**) was chosen for this Policy Unit. The reason why this Policy Option was chosen is because although flood risk is currently managed, it is expected to rise significantly in the long term. Under these circumstances, the EA need to do more in the future to reduce the expected increase in risks.

4.2.3 The Policy Unit objectives are as follows;

- Sustain and protect cultural and social heritage in the catchment, including the Scheduled Ancient Monuments within the River Trent floodplain through this policy unit;
- Minimise disruption to people, communities and commerce caused by flooding, taking into account future pressure resulting from climate change;
- Minimise the increase in cost of flood damage, taking into account future pressures from climate change, which may increase flood risk;
- Sustain and improve the status of environmentally designated areas of Allington Meadows and Besthorpe Meadows through appropriate frequency, extent and duration of flooding.

4.2.4 Policy Unit 4 states that raised earth embankments from the Nottingham villages to Newark offer a standard of protection ranging from 1% to 10% annual probability of being overtopped. It is generally only, agricultural land and a small number of properties that are only protected by a 10% standard defence. The CFMP also goes on to say that from the Nottinghamshire villages down to Newark the flood risk is assessed as medium to high. If overtopping or a breach of the embankment occurs, large areas of land would be flooded and significant disruption would occur as a result.

4.2.5 The main factor that is highlighted to change the future flood risk within this Policy Unit is climate change. The future flood risk to this area is predicted to be from medium to high.

4.2.6 The following actions will be carried out as part of the implementation of this policy;

- Investigate feasibility of local schemes and projects;
- Review maintenance practices;
- Review the role of IDB's within the area;

-
- Optimise flood risk management and habitat creation within Beckingham Marshes;
 - Investigate options for removing sections of embankment;
 - Aggregate companies to work more closely with the Environment Agency to create more beneficial restoration;
 - Support the implementation of the proposed scheme at Gainsborough;
 - Support the proposed scheme for Newark;
 - Investigate flood resilience for infrastructure, i.e. roads, power and water;
 - Investigate options for restoring wash lands to accommodate climate change;
 - Investigate further the risks from the River Trent to the neighbouring Witham catchment;
 - Combine actions from the CFMP and those already agreed within the Tidal Trent Strategy and Humber.

4.2.7 The CFMP states that the EA have agreed a set of actions that will help them achieve their objectives and help them meet the overall aims of the policies for each Policy Unit. For Policy Unit 4 some of these key actions relating to flood defences are set out below;

- Complete supporting studies for the proposed scheme for Newark and implement the appropriate scheme option to maintain flood risk at the current level, taking into account climate change (i.e. increased flows);
- Review maintenance practices to determine where further effort will be needed in the future to allow better long-term planning;
- Investigate options for removal, abandonment or breaching or sections of embankments where they provide little or no flood risk management benefit, to allow more targeted effort where it is needed.

4.2.8 The CFMP concludes by stating that Policy Option 4 will allow further action, including improvements to existing flood defences so that flood risk does not increase to an unacceptable level. Only relatively minor improvements to existing flood defences are likely to be needed to maintain the current standard of protection, which is already relatively high. The CFMP goes on to say that there may be local opportunities within the upper parts of the policy unit to remove some of the low level embankments which currently protect farmland from frequent flooding. This would allow more frequent inundation of the natural floodplain with little detrimental impact.

4.2.9 As previously stated, the flood defences along the River Trent as mentioned in the CFMP, have no impact on the western half of the Land South of Newark site and therefore do not need to be assessed to any further level of detail at this stage.

4.2.10 The full extent of raised flood defences adjacent to the three strategic is shown in Appendix B.

4.3 RIVER WITHAM CATCHMENT FLOOD MANAGEMENT PLAN

4.3.1 The River Witham CFMP sets out various policies for maintaining flood defence assets along the Witham. As previously stated, Policy Units One and Thirteen apply to the Witham catchment. These Policy Units impact on Land around Fernwood, Land East of Newark and Land South of Newark sites.

4.3.2 According to the Witham CFMP, flood defence assets within the catchment are grouped into flood risk management systems. A flood risk management system is a group of assets that manage flood risk in a particular location. Using a risk based approach, the EA inspect assets at greater risk more than those at lower risk; the risk of each system is determined by assessing the potential impact and likelihood of flooding occurring within that system.

4.3.3 As shown in figure 3.9 (see Appendix D) within the CFMP, the asset systems along the Witham in the vicinity of the Land at Fernwood development are shown to be of medium risk; these assets are inspected every 18-24 months. These defences provide a very low level of protection with only a 1 in 10 year level of defence. Defences providing this level of protection are deemed suitable only for agricultural land.

4.3.4 Along the Witham the EA undertake the following maintenance activities of the existing flood defence assets;

- Operational Inspections; to ensure that control structures are operating at the correct water levels to avoid using the wash lands inadvertently;
- Asset Monitoring; operation and inspection of assets such as culverts, bridges, locks, sluices, pumps and formal flood defences;
- Environmental Management; this involves managing the environmental impacts of the EA's flood risk management activities.

4.3.5 Adopting Policy 2 (**reduce existing flood risk management actions**) within Policy Unit 1 (Upper Witham) demonstrates that there is currently a low risk of flooding with this Policy Unit area. Details on any future upgrades to the existing defences in this area are not highlighted within the CFMP. According to the CFMP the raised earth embankments in this area along the Witham are historic defences, dating back to draining of the fens when land was protected for agricultural production.

4.3.6 As stated in section 1.8.5 it has been recommended in this Policy Unit that a System Asset Management Plan is developed, to reduce flood risk maintenance activities within this Policy Unit. Ceasing maintenance activities would provide the opportunity to improve floodplain connectivity, in stream geomorphology and aquatic habitats.

4.3.7 Adopting Policy 6 (**Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment**) within Policy Unit 13 (Outer Lincoln South) demonstrates that there is currently a low level of flood risk within this area. However, climate change is expected to increase the flood risk in this Policy Unit over the next 100 years.

4.3.8 Adopting this policy allows flood risk in the Lincoln policy unit to be sustained at the current level of flood risk. This Policy Unit impacts on the River Witham adjacent to the Land East of Newark site. Details on any future upgrades to the existing defences (raised earth embankments) in this area are not highlighted within the CFMP. As stated in section 1.8.12 it is recommended that a SAMP is developed for this Policy Unit.

4.3.9 The CFMP states that by adopting Policy 6 in this Policy Unit, the EA are identifying the land in this area as having potential to be used to store excess water during times of flooding.

4.3.10 The flood defences along the River Witham as discussed in the CFMP and shown in the NFCDD, have no impact in defending Land East of Newark or Land at Fernwood and therefore do not need to be assessed in relation to a breach analysis.

5 Sources of Flooding

5.1 OVERVIEW

5.1.1 This Level 2 SFRA provides a strategic overview of flood risk and its impact on the three strategic sites of Land around Fernwood, Land East of Newark and Land South of Newark. In line with the Level 1 SFRA, it should be noted that;

- this Level 2 SFRA reflects current national planning policies and guidance at the time of writing;
- policies may change; and
- flood levels/flood zone classifications may change.

5.2 DATA SOURCES

5.2.1 Phase One of the Level 2 SFRA, has drawn heavily on the findings of the bespoke 1D and 2D hydrodynamic modelling that was undertaken for each strategic site. This has allowed a thorough investigation of fluvial flood risk from various sources. Flood Risk and Flood Hazard maps have been provided in Appendix C. In line with the requirements of the PPS25 Practice Guidance, definition and mapping of the Functional Floodplain (1 in 20 year event), has been provided where necessary. Historical flood outlines for the study area can be viewed in the Level 1 SFRA.

5.3 HYDRODYNAMIC MODELLING

5.3.1 As previously stated, 1D and 2D hydrodynamic modelling has been completed for each of the three strategic sites in order to provide detailed flood outlines for the following return periods;

- 1 in 20/1 in 25 year event (Flood Zone 3b-Functional Floodplain);
- 1 in 100 year event (Flood Zone 3a);
- 1 in 1000 year event (Flood Zone 2);
- 1 in 100 year plus climate change event.

5.3.2 This modelling excludes the presence of any formal flood defences as there are none present in close proximity to the three sites (see Appendix B). The primary output from the hydrodynamic modelling is the production of Flood Risk and Flood Hazard maps for each strategic site. Maps showing depths, levels and velocities of flood water for each of the return periods across the various sites have also been provided in Appendix C.

5.3.3 Flood Zone maps show areas potentially deemed to be at risk from fluvial (river) flooding and provide the extent for various return periods.

5.3.4 Flood Hazard maps take into consideration the velocity and depth of flood water and link this as a hazard to people based on (DEFRA guidance FD2320/TR2-Extended version). This table has been provided in (Appendix E) and relates to Low (Very low hazard-caution), Moderate (Danger for some-including children, the elderly and the infirm), Significant (Danger for most-including the general public) and Extreme (Danger for all-including the emergency services) levels of risk shown on these plans. The potential for debris in flood water is also taken into consideration within these hazard ratings.

5.3.5 The rate of onset of flooding for each site has also been provided. As previously stated, none of the three strategic sites are defended. When defences are present, zones of rapid inundation can be identified in the event of a breach or overtopping of these defences using Flood Hazard mapping.

5.3.6 Flood Risk and Flood Hazard maps in combination allow a detailed assessment to be made of the overall sustainable development of the three strategic sites in terms of fluvial flood risk.

5.3.7 Maps illustrating flood depth, level and velocity across the three strategic sites for each of the return periods have also been provided in Appendix C.

5.3.8 A description of the different Flood Zones as provided in PPS25 and the Level 1 SFRA are given below;

- **Flood Zone 1** is classified as land where the risk of flooding is greater than 1 in 1000 years. It is classed as an area of '**low probability**' risk of fluvial flooding.
- **Flood Zone 2** is classified as land having between 1 in 100 and 1 in 1000 year annual probability of fluvial flooding. It is classed as an area of '**medium probability**' risk of fluvial flooding.
- **Flood Zone 3a** is classified as land having a potential to flood for storm events greater than 1 in 20 year return period and up to 1 in 100 year annual probability. It is classed as an area of '**high probability**' risk of fluvial flooding.
- **Flood Zone 3b** is classified as land having the potential to flood for storm events up to 1 in 20 year return period. It is classed as '**functional floodplain**'.

5.4 DETAILED METHODOLOGY

5.4.1 A strategic assessment of the principle sources of flood risk affecting the three strategic sites has been made based on the data collected. The sections below set out the findings of the hydrodynamic modelling for each site based on their proposed land uses shown in the NSDC Publication Core Strategy report (2010). A more detailed analysis has been provided in section 7 in relation to policy implications.

LAND EAST OF NEWARK

5.4.2 As previously stated, Land East of Newark (122 ha) has been set aside for a proposed 1,600 residential units. The site will also include local retail, service and community facilities including primary schools and doctors surgery, on land between Clay Lane and Barnby Road. Potential access points will be provided onto the site from Beacon Hill Road to the north. A large amount of the site will be Green Infrastructure.

5.4.3 As shown of the Flood Risk mapping for Land East of Newark in Appendix C, the flood plain of Sodbridge Drain extends outwards from the centre of the site. As part of this watercourse is an EA Main River it is likely that the EA will require a minimum of an 8m buffer of no development from the top of bank either side of this watercourse. The section of the watercourse east of the railway line that is maintained by the NAIDB will require a 9m buffer of no development. The vast majority of the site (approx. 85%) is located in Flood Zone 1. The remaining (approx. 15%) is located in Flood Zones 2 and 3 associated with Sodbridge Drain. Approximately 97% of Residential Area One is located entirely in Flood Zone 1, with the remaining 3% being located in Flood Zones 2 and 3. All of Residential Area Two is located in Flood Zone 1. The remaining areas that are impacted by the flood plain of Sodbridge Drain are the zones of Green Infrastructure and the Landscape Buffer.

5.4.4 In line with the requirements off PPS25 the extent of the Functional Floodplain (Flood Zone 3b), has been shown for this site. Climate change outlines have been provided for Flood Zone 3a. Table D.3 in PPS25 states that Highly Vulnerable, More Vulnerable and Less Vulnerable land uses are not permitted in Flood Zone 3b. More Vulnerable land uses in Flood Zone 3a are only justified once the Exception Test has been satisfied. The 1 in 100 year climate change outline is shown to impact on Residential Area One. In the event of extensive flooding within this residential area, dry access and egress can be achieved along Clay Lane to the North. The Local Centre is located entirely in Flood Zone 1.

5.4.5 The Flood Hazard maps in Appendix C illustrate the level of risk in relation to depth of water and velocity within the various flood zones for the various return periods. Depending on the return period certain parts of Residential Area One is classified as having a 'Significant' hazard rating.

5.4.6 Flood level, depth and flood velocity mapping has also been provided to illustrate the level of risk across the site.

5.4.7 Based on the Flood Depth mapping provided in Appendix C, the depth of flood water for the 1 in 100 year plus climate change flood event ranges from between approximately 0.1-0.5m (AOD) for Residential Area One.

5.4.8 The rate of onset of flooding for the 1 in 1000 year event (worst case), from initial rainfall to the maximum onsite flood level is 6-10 hrs.

LAND AROUND FERNWOOD

5.4.9 As previously stated, Land around Fernwood (248 ha) has been set aside for a proposed 3,200 homes and business park. The development will also include doctors surgeries and a primary school. The site will be connected to the proposed Southern Link Road to the North West. A large amount of the development has been set aside for Green Infrastructure.

5.4.10 As shown on the Flood Risk maps for Land Around Fernwood in Appendix C, the combined flood plain of the River Witham and Shire Dyke impact on the eastern edge of the site. However, (approx.70%) of the site is located in Flood Zone 1. Residential Areas One and Two are affected by Flood Zones 2 and 3 emanating from Shire Dyke/River Witham and Lowfield Drain. Approximately 10% of Residential Area One falls within Flood Zones 2 and 3 associated with Lowfield Drain, Shire Dyke and the River Witham. Approximately 10% of Residential Area Two falls within Flood Zones 2 and 3 emanating from Shire Dyke and the River Witham. All of Residential Area Three falls within Flood Zone 1. Approximately 80% of the land designated as Green Infrastructure is inundated by Flood Zones 2 and 3 emanating from Shire Dyke the River Witham and Lowfield Drain.

5.4.11 The Local Centre is located entirely in Flood Zone 1 as well as the area set aside for Proposed Business use.

5.4.12 Shire Dyke is maintained by the UWIDB and has a 6 m buffer either side of the watercourse from the top of the bank. Any works within this buffer will require consent from the IDB. Lowfield Drain is an EA watercourse and will require a 9m buffer either side from the top of bank.

5.4.13 The climate change extent associated with Flood Zone 3a for this site has been illustrated in Appendix C; this extent is shown to impact on Residential Area One. In the event of extensive flooding in this area, dry access and egress can be achieved via the existing settlement area in the centre of the site. The Functional Floodplain (Flood Zone 3b) as generated by the detailed hydraulic modelling, emanating from Shire Dyke and the River Witham, does not impact on this site. However, Residential Area 1 is affected by the Lowfield Drain Functional Floodplain.

5.4.14 Flood level, depth and flood velocity mapping has been provided to illustrate the level of risk across the sites.

5.4.15 The Flood Hazard maps in Appendix C illustrate the level of risk in relation to depth of water and velocity within the various flood zones for the various return periods. Residential Areas One and Two are impacted by the 'Significant' Hazard rating for the 1 in 1000 year event for Lowfield Drain and the River Witham/Shire Dyke.

5.4.16 Based on the Flood Depth mapping provided in Appendix C, the depth of flood water for the 1 in 100 year plus climate change flood event ranges from between approximately 0.1-1.0m (AOD) for Residential Area One.

5.4.17 The rate of onset of flooding for the 1 in 1000 year event (worst case), from initial rainfall to the maximum onsite flood level is 32-48 hrs.

LAND SOUTH OF NEWARK

5.4.18 As previously stated, Land South of Newark (598 ha) has been set aside for up to 3,100 homes and associated employment land uses. A health care centre and schools have also been proposed. A new Southern Link Road will also be provided, linking the A46 at Farndon to the south east of Newark. The land to the east of the Sustrans Route includes a large area set aside for Existing and Future Mineral Extraction works.

5.4.19 As shown on the Flood Risk maps for Land south of Newark in Appendix C, the flood plain emanating from Lowfield Drain is shown to impact on the northern part of the eastern half of the site around Balderton. This land lies to the east of the Sustrans Route. Approximately 5% of the Existing and Future Mineral Extraction land is affected by Flood Zones 2 and 3, emanating from Lowfield Drain. The floodplain also crosses over the southern link road route.

5.4.20 The land to the west of the Sustrans Route is impacted by the flood plain emanating from the River Trent/River Devon and Middle Beck. Approximately 60% of the land to the west of the Sustrans Route falls within Flood Zones 2 and 3. Residential Areas One, Two, Three and Four are affected by the floodplain of these three rivers. Approximately 15% of Residential Area One falls into Flood Zones 2 and 3 emanating from the Trent/Devon and Middle Beck. Approximately 15% of Residential Area Two falls into Flood Zones 2 and 3 associated with the Middle Beck. Approximately 15% of Residential Area Three falls within Flood Zones 2 and 3 emanating from Middle Beck. Approximately 5% of Residential Area Four falls within Flood Zones 2 and 3 emanating from Middle Beck. The Functional Floodplain and climate change outlines impact on all four of these residential areas. The proposed southern link road is impacted in parts by Flood Zones 2 and 3. In the event of extensive fluvial flooding, dry access and egress can be achieved to the north of the four residential areas via, the existing residential areas of Newark around Hawton Lane and Grange Road.

5.4.21 Middle Beck and the River Devon are EA watercourses and will require an 8m buffer either side from the top of bank. The remaining watercourses that impact on the site are maintained by the Newark Area IDB and will require a 9m buffer either side from the top of the bank.

5.4.22 Both the Local Centres are located in Flood Zone 1 as well as the area set aside for Proposed Industrial use. As highlighted in table D.3 in PPS25, Essential Infrastructure such as electricity substations, should not be located in Flood Zone 3.

5.4.23 Approximately 70% of the Green Infrastructure land to the south and west of the four residential areas is impacted by Flood Zones 2 and 3 emanating from Middle Beck, Car Dyke, and the River Devon/River Trent. Climate change extents and the Functional Floodplain also impact on the part of the site designated as Green Infrastructure.

5.4.24 The climate change extents associated with Flood Zone 3a for Lowfield Drain, have been shown in Appendix C. The Functional Floodplain for this watercourse has also been provided. Both these extents impact on the Existing and Future Mineral Extraction Areas and Southern Link Road.

5.4.25 The Flood Hazard maps in Appendix C illustrate the level of risk in relation to depth of water and velocity within the various flood zones for the various return periods. For the 1 in 1000 year event, residential areas One to Three are impacted by the 'Extreme' flood hazard event. The outline for this event, does not impact on residential area Four.

5.4.26 Flood level, depth and flood velocity mapping has also been provided to illustrate the level of risk across the sites.

5.4.27 Based on the Flood Depth mapping provided in Appendix C, the depth of flood water for the 1 in 100 year plus climate change flood event ranges from between approximately 0.1-1.5m (AOD) for Residential Areas One, Two, Three and Four.

5.4.28 The rate of onset of flooding for the 1 in 1000 year event (worst case), for the land east of the Sustrans Route from initial rainfall to the maximum onsite flood level is 6-10 hrs. For the same event, the rate of onset for the land to the west of the Sustrans Route is 48-78 hrs.

5.5 OTHER SOURCES

5.5.1 Potential sources of flooding from overland flow, sewers and water mains would need to be assessed in detail by developers as part of a site specific Flood Risk Assessment. For all three strategic sites, none of these were deemed to be a significant issue when assessing flood risk at a strategic level. The implementation of measures such as cut off drains and overland flow routes for example, can help mitigate against surface water flooding from on and off site areas.

5.5.2 For the purposes of this Level 2 study, incidents of pluvial and sewer flooding have been provided in Appendix B.

5.5.3 As stated in the Level 1 SFRA, the EA have no record of any groundwater flooding incidents within the Newark and Sherwood District. Limited historical records on groundwater flooding provided by NSDC and local residents do not relate to the three strategic sites.

5.5.4 Incidents of Pluvial (surface water flooding) are provided in Appendix B. As shown on these plans, there have been no recorded incidents of surface water flooding on any of the three strategic sites. The surface water/pluvial flooding noted at Jericho Road and Manners Road in Balderton, would have no impact on the north eastern part of the Land South of Newark site as surface water flows would be intercepted by Lowfield Drain. The NAIDB have advised, that the majority of flooding in Jericho Road emanates from Lowfield Drain. Due to its nature, incidents of pluvial flooding are difficult to differentiate between sewer flooding as both may occur in tandem.

5.5.5 Areas of Green Infrastructure and Landscape Buffers surrounding residential areas within each of the strategic sites will assist in mitigating against the effects of surface water flooding/runoff from adjacent off site areas.

5.5.6 Sewer flooding within the existing residential area of Newark to the north of the Land South of Newark site would not impact on this strategic site, as Severn Trent Water have advised that the sewers fall to the north in this area.

5.5.7 There is a risk of sewer flooding within the existing settlement area of Land around Fernwood, impacting on off site areas. This would need to be assessed in greater detail as part of a site specific FRA.

5.5.8 The potential of sewer flooding along Clay Lane impacting on residential areas to the south of Land East of Newark, would need to be assessed in greater detail as part of a site specific Flood Risk Assessment.

5.5.9 Hydraulic structures such as sluices and culverts have the potential to block or fail causing flooding to upstream or downstream areas. Where relevant this has been taken into consideration by WSP as part of the detailed hydraulic modelling for each of the strategic sites. This should be assessed in greater detail as part of a site specific Flood Risk Assessment. The extent of hydraulic structures adjacent to each site has been shown in Appendix B.

5.6 SURFACE WATER MANAGEMENT PLANS

5.6.1 A key reason for the production of the Level 2 SFRA is the identification for the need to undertake a Surface Water Management Plan (SWMP). As defined by DEFRA, a SWMP is a framework through which key local partners with responsibility for surface water drainage in their area work together to understand the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk. The overall purpose of a SWMP is to make sustainable urban surface water management decisions that are evidence based, risk based, future proofed and inclusive of stakeholder views and preferences.

5.6.2 PPS25 Practice Guidance states that SWMP should allow Local Planning Authorities to;

- Undertake a comprehensive assessment of surface water flooding as part of their SFRA and predict where it could happen;
- Make informed land use planning decisions on the basis of such an assessment;
- Clarify responsibilities and co-ordinate investment in drainage systems to manage the risk more effectively and with greater use of sustainable drainage systems;
- Improve emergency plans for surface water flooding; this approach is pro-active and risk-based, and therefore delivers resources where they are needed most.

5.6.3 As highlighted in the Detailed Water Cycle Strategy produced by JMP (2009), Nottinghamshire County Council, have advised that Newark and Sherwood District is one of the two areas within the county that are considered most in need for a SWMP.

5.6.4 The impact that the three strategic sites in exacerbating surface water flooding issues is assessed in greater detail as part of Section 7.

6 Assessment of the Impact of Climate Change

6.1 IMPACT OF CLIMATE CHANGE ON THREE STRATEGIC SITES

6.1.1 Annex B of PPS25 takes into account the impacts that climate change may have on flooding issues and sustainable development. Table B2 of this annex as shown in the Level 1 SFRA, provides indicative sensitivity ranges for different parameters affecting the likely severity of projected flooding.

6.1.2 Site specific climate change flood outlines have been provided for the 1 in 100 year event for each strategic site. In line with the requirements of PPS25, hydraulic modelling has taken into consideration an increase in peak river flows of 20% between the years 2025 to 2115. This timescale incorporates the proposed lifetime of a development which is 60 years for commercial and 100 years for residential.

6.1.3 NSDC have stated in their Publication Core Strategy Report that there is a need to minimise a future development's vulnerability to climate change through the design and construction of a new development.

6.1.4 Climate changes impacts will need to be taken into consideration as part of a detailed site specific Flood Risk Assessment at each of the three strategic sites. As stated in the Publication Core Strategy Report climate changes concerns should be addressed;

“the need to minimise future developments vulnerability to climate change is also particularly significant in the design and construction of new development, particularly in terms of reducing flood risk through its location and active management of surface water. Sustainable Drainage Systems (SuDS, dependent upon site specific characteristics, can aid the reduction of the rate and volume of surface water runoff and thus reduce flood risk.”

6.1.5 It is important to note that climate change parameters may change from those currently used. This will impact on climate change flood outlines by possibly increasing them. SuDs systems implemented now based on current climate change criteria may not meet the required standards as climate change parameters are altered in the future.

6.1.6 The Government's Flood and Water Management Act (2010), reinforces the need to adapt to climate change. The Act takes into consideration the recommendations made in the Pitt Review (2007). One of the principle aims of the Act is to deliver greater sustainability by helping people and their communities adapt to the increasing likelihood of severe weather events due to climate change. The Act also highlights that in order to respond to the challenges of climate change, bodies with direct responsibilities for managing flood and coastal erosion will need to work together to assess and manage these future risks.

6.1.7 Phase One of the Level 2 SFRA should be used by NSDC to assist in performing the Sequential and Exception Test. However, it is important to note that this study does not replace the need for these tests to be undertaken where necessary. The principle aim of the Sequential Test is to steer development towards sites of least flood risk (Flood Zone 1). The Exception Test is undertaken where more detailed information is provided and where there is deemed to be development pressure in areas that are at medium or high flood risk and there are no other suitable alternative areas for development after applying the Sequential Test. Section 7 of this study takes climate change outlines into consideration in relation to providing guidance on the above.

6.1.8 This SFRA is key in helping NSDC to understand the full impact of climate change on the three strategic sites.

7 Planning and Development Issues

7.1 FLOOD RISK MANAGEMENT HIERARCHY

7.1.1 When assessing a site's development potential, careful attention should be paid to the Flood Risk Management Hierarchy set out in the PPS25 Practice Guidance. This hierarchy emphasises the importance of assessing flood risk management in five steps;

- Step 1- Assess (appropriate flood risk assessment);
- Step 2- Avoid (apply the Sequential approach);
- Step 3- Substitute (apply the Sequential Test at site level);
- Step 4- Control (e.g.; SuDS design);
- Step 5- Mitigate (e.g. flood resilient construction).

7.2 SEQUENTIAL AND EXCEPTION TEST

7.2.1 As previously stated, the primary reason for the completion of Phase One of the Level 2 SFRA is to provide guidance on undertaking the Sequential and Exception Test for the three strategic sites. The flood maps produced for this Level 2 SFRA, provide the basis for providing guidance on the Sequential and Exception Test within the various development areas. It is important to note that this SFRA should be used as a guidance to undertake both these tests and does not replace the need for NSDC to complete them as a separate process. Both the Sequential and Exception Test help contribute towards the process of Sustainable Development.

7.2.2 Table D.1, Annex D of PPS25 (below) provides definitions for the flood zones, referring to the probability of fluvial and tidal flooding, ignoring the presence of defences.

PPS25 Table D.1: Flood Zones & Appropriate Land Uses

Zone 1 Low Probability

Definition

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%).

Appropriate uses

All uses of land are appropriate in this zone.

FRA requirements

For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Zone 2 Medium Probability**Definition**

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.

Appropriate uses

The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone.

Subject to the Sequential Test being applied, the highly vulnerable uses in Table D.2 are only appropriate in this zone if the Exception Test (see para. D.9.) is passed.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Zone 3a High Probability

Definition

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.

Appropriate uses

The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone.

The highly vulnerable uses in Table D.2 should not be permitted in this zone.

The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.9) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to:

- i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques;
- ii. relocate existing development to land in zones with a lower probability of flooding; and
- iii. create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Zone 3b The Functional Floodplain

Definition

This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But 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, should provide a starting point for consideration and discussions to identify the functional floodplain.

Appropriate uses

Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows; and
- not increase flood risk elsewhere.

Essential infrastructure in this zone should pass the Exception Test.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to:

- i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and
- ii. relocate existing development to land with a lower probability of flooding.

7.2.3 The principle aim of the Sequential Test is to steer new development to areas at the lowest probability of flooding. If there are no reasonably available sites in Flood Zone 1, then the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3. Reference should be made to table D2 (PPS25) Flood Risk Vulnerability classification in relation to the vulnerability of various land uses. Reference should also be made to the Flood Risk Vulnerability and Flood Zone Compatibility classifications as set out in Annex D of PPS25. Both these tables are provided below;




PPS25 Table D.2: Flood Risk Vulnerability Classification

<p>Essential Infrastructure</p>	<ul style="list-style-type: none"> • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
<p>Highly Vulnerable</p>	<ul style="list-style-type: none"> • Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').
<p>More Vulnerable</p>	<ul style="list-style-type: none"> • Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Less Vulnerable	<ul style="list-style-type: none"> • Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment plants (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water-compatible Development	<ul style="list-style-type: none"> • Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

PPS25 Table D.3. Flood Risk Vulnerability and Flood Zone ‘Compatibility’

Flood Risk Vulnerability Classification (see Table D.2)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (See Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	X	Exception Test required	✓
	Zone 3b ‘Functional Floodplain’	Exception Test required	✓	X	X	X

	Development Type is permitted under PPS25. A Site based FRA is required in accordance with the SFRA.
	Development Type is permissible under PPS25, only if the Exception Test is passed. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk. A Site based FRA is required in accordance with the SFRA.
	Development Type is not permitted under PPS25

7.2.4 As previously highlighted in section 1.5, PPS25 expands on the Sequential Test by incorporating the Exception Test. If following the application of the Sequential Test, it is not possible or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding then the Exception Test can be applied.

7.2.5 The Exception Test provides a mechanism for managing flood risk whilst still allowing necessary development to occur. However, it should not be used to justify ‘highly’ vulnerable development in Flood Zone 3a, or ‘less vulnerable’, ‘more vulnerable’ and ‘highly vulnerable’ development in Flood Zone 3b.

7.3 SUSTAINABLE DRAINAGE SYSTEMS

7.3.1 As set out in the PPS25 Practice Guidance, SFRA should be used as an initial stage to producing guidance to developers on how surface water should be managed and on the potential for using sustainable drainage measures. As taken from paragraph F10 of Annex F of PPS25;

“The surface water drainage arrangements from any new development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.”

7.3.2 Where possible, a SuDs technique should seek to contribute to each of the three goals identified below with the favoured system contributing significantly to each objective;

- Reduce flood risk (to the site and neighbouring areas);
- Reduce pollution, and;
- Provide landscape and biodiversity benefit.

7.3.3 PPS25 highlights the importance of Local Authorities working closely with other stakeholders to enable surface water run-off to be managed as near to its source as possible. The recently passed Flood and Water Management Act (2010) highlights the imminent release of national SuDs design standards and that Local Authorities will be responsible for approving and adopting SuDs schemes.

7.3.4 PPS25 and documents such as the Pitt Review emphasise, the importance of controlling and reducing surface water surface water flows. This helps reduce the level of flood risk to the subject site and surrounding areas.

7.3.5 The detailed Water Cycle Study produced by JMP consultants, highlighted that historically areas around Balderton have had the dyke systems in-filled by urban expansion. As a result, future growth within these areas is likely to worsen the situation and exacerbate surface water flooding issues. SuDs systems implemented at the Land South of Newark and Land around Fernwood need to take this into consideration and not exacerbate the risk of flooding along Lowfield Drain.

7.3.6 Source Protection Zone Maps (Appendix B), SuDs Infiltration Feasibility Plans (Appendix B) and sewer records have been reviewed to provide general recommendations on the implementation of SuDs on a site specific basis. Section 8 of the Level 1 SFRA provides a detailed explanation of the geological conditions within the study area and definition of infiltration and attenuation techniques. As previously stated, the general recommendations made in this SFRA in relation to the implementation of SuDs, do not substitute the need for detailed analysis of ground conditions as part of a site specific Flood Risk Assessment.

7.3.7 Information on groundwater levels has not been provided on a site specific basis. The information provided in the Level 1 SFRA was unable to yield any results relating to the three strategic sites.

Site Geology and SuDs Infiltration

7.3.8 Based on the SuDs Infiltration Feasibility Plans shown in Appendix B, the following can be inferred about the suitability of infiltration techniques on each of the three sites;

-
- **Land East of Newark;** The majority of the site is classified as uncertain in terms of infiltration suitability. There is also a band of the Mercia Mudstone Group running through the centre of the site in a south east to north west direction that has a low potential for infiltration techniques.
 - **Land around Fernwood;** The entire site has a low potential for SuDs infiltration methods.
 - **Land South of Newark;** The majority of the site has a low potential for SuDs infiltration methods. A small amount of areas along the northern boundary of the site are classified as uncertain.

7.3.9 Detailed ground investigation studies and site specific studies should be used to augment the findings of this initial analysis. For areas where it is recommended that infiltration techniques are not suitable, it may be preferential to apply techniques such as attenuation and source control.

Source Protection Zones

7.3.10 As stated in section 2.3, Source Protection Zone Maps were obtained from the Environment Agency. As previously stated, these need to be taken into consideration when assessing the suitability of infiltration SuDs techniques at each site. An analysis has been provided below;

- **Land East of Newark;** An Inner Protection Zone is located in the north west corner of the site. According to EA requirements an Inner Protection Zone has a minimum of a 50m protection radius around the borehole, which means that infiltration techniques would not be permitted in this area. The construction of foul sewerage in an Inner Protection Zone can be constrained. This would need to be discussed with the EA in greater detail.
- **Land around Fernwood;** There are no source protection zones on this site.
- **Land South of Newark;** A small part of the west half of the site, west of Balderton and the Sustrans Route, is located in an Outer Protection Zone and Total Catchment. The Total Catchment is the total area needed to support removal of water from the borehole. There maybe the potential to use infiltration techniques in both these areas; however this would need to be discussed with the EA as part of a detailed drainage strategy.

7.3.11 Quantitive risk assessments should be undertaken for assessing the suitability of SuDs infiltration techniques in relation to SPZs. These should be carried out in accordance with EA Groundwater Protection Policy.

Ground Contamination

7.3.12 Information relating to land contamination issues has been provided by NSDC Environmental Health Proactive Team for each of the three strategic areas. The information provided contains data on statutorily determined sites (contaminated land and special sites) and sites where potentially contaminative activities have occurred (former industrial uses). Land contamination issues have the potential to impact on the ability to use infiltration SuDs techniques for example. In order to reduce the risk of spreading contamination to wider areas, ground conditions need to be taken into consideration when implementing SuDs.

7.3.13 Due to the sensitive nature of site contamination, the SFRA does not provide specific details on the location and nature of contaminated areas within a strategic area. Contaminated sites scoring Medium/High or High are subject to a further assessment by NSDC in relation to their contamination potential. This further investigation could be undertaken in the form of desktop studies, intrusive investigations or ultimately remediation.

- **Land East of Newark;** One site located along the western boundary is classified as having a Medium/High Priority. This is in close proximity to the Inner SPZ previously mentioned.
- **Land South of Newark;** There are five sites classified as having Medium/High to High status. All of these are located within the central areas of the site in close proximity to the Sustrans Route.
- **Land around Fernwood;** There are no sites classified as having Medium/High or High status.

7.3.14 Detailed ground investigations would need to be undertaken as part of a site specific FRA in order to establish further details on contamination issues and the application of SuDs infiltration techniques.

7.3.15 PPS25's Flood Risk Management Hierarchy can be applied to surface water management as it is important to consider both flood risk to the proposed development as well as the potential impacts on areas adjacent to and downstream of the development. The management hierarchy in relation to surface water is given below;

- **Assess-** risk associated with surface water through regional, strategic and site specific Flood Risk Assessments and Surface Water Management Plans where completed;
- **Avoid-** risks from surface water by controlling water at sources using SuDs and locating development away from risk areas;
- **Substitute-** apply the sequential approach to locate more vulnerable developments in lowest risk areas;
- **Control-** use SuDs and implement Surface Water Management Plans to manage and reduce risk within the development and downstream.

7.3.16 Based on the information provided in this SFRA, guidance on the application of various SuDs techniques at each strategic site has been provided in Appendix E.

7.4 APPROPRIATENESS OF LAND USES WITHIN THE THREE STRATEGIC SITES

7.4.1 This section seeks to provide a policy direction in relation to flood risk and allow NSDC to make informed judgements in allocating land using the Sequential Test. Advice is also provided where necessary on the Exception Test for areas that are in medium and high flood risk and where there may be no other suitable alternative areas for development, after applying the Sequential Test. It is important to note that the flood outlines used within this SFRA, have been provided to guide land use allocations for the three strategic sites as set out in the Council's Publication Core Strategy. The land use diagrams are indicative and therefore boundaries are not precise; it is the Council's intention that More Vulnerable land uses such as residential development are not normally located in Flood Zone 3. Reference should be made to table D.3 (Flood Risk Vulnerability and Flood Zone Compatibility) as given in section 7.2.3 of this study. This level 2 SFRA is a strategic level appraisal of flood risk and does not replace the need for PPS25 compliant FRA's (which may require detailed hydraulic modelling), based around a detailed masterplan.

7.4.2 The highest flood hazard rating has been provided for each development area based on the highest recorded within the 1 in 20, 1 in 100, 1 in 100 plus climate change and 1 in 1000 year events. It is imperative that these hazard ratings should be taken into consideration when undertaking the Exception Test for the following land uses; More Vulnerable in Flood Zone 3a; Highly Vulnerable in Flood Zone 2; Essential Infrastructure in Flood Zone 3a and 3b.

7.4.3 The following is a detailed site specific summary of each strategic site and the classification of each land use;

Land use and PPS25 Flood Risk Vulnerability classification (table D.3)	Land East of Newark (Flood Zone and Flood Hazard)	Land around Fernwood (Flood Zone and Flood Hazard)	Land South of Newark (Flood Zone and Flood Hazard)
Residential Area 1- (More Vulnerable)	FZ1, FZ2, FZ3a and 3b (Significant Flood Hazard)	FZ1, FZ2 and FZ3a and 3b (Significant Flood Hazard)	FZ1, FZ2 and FZ3a and 3b (Significant Flood Hazard)

Residential Area 2 -(More Vulnerable)	FZ1 (Low Flood Hazard)	FZ2 (Significant Flood Hazard)	FZ1, FZ2, FZ3a and FZ3b (Significant Flood Hazard)
Residential Area 3- (More Vulnerable)		FZ1(Low Flood Hazard)	FZ1, FZ2, FZ3a and FZ3b (Significant Flood Hazard)
Residential Area 4 -(More Vulnerable)			FZ1, FZ2, FZ3a and 3b (Significant Flood Hazard)
Landscape Buffer-(Water Compatible)	FZ1, FZ2, FZ3a and FZ3b (Significant Flood Hazard)	FZ1, FZ2, FZ3a and FZ3b (Extreme Flood Hazard)	FZ1,FZ2,FZ3a and FZ3b (Significant Flood Hazard)
Green Infrastructure-(Water Compatible)	FZ1, FZ2, FZ3a and FZ3b (Extreme Flood Hazard)	FZ1, FZ2 and FZ3a and 3b (Extreme Flood Hazard)	FZ1, FZ2 and FZ3a and 3b (Extreme Flood Hazard)

Local Centre (More Vulnerable)	FZ1 (Low Flood Hazard)	FZ1(Low Flood Hazard)	FZ1(Low Flood Hazard)
Proposed Business Use (Less Vulnerable)		FZ1(Low Flood Hazard)	
Proposed Industrial Use (Less Vulnerable)			FZ1(Low Flood Hazard)
Existing and Future Minerals Extraction (Less Vulnerable)			FZ1,FZ2,FZ3a and FZ3b (Significant Flood Hazard)

7.5 LAND EAST OF NEWARK

7.5.1 The detailed Flood Risk and Flood Hazard mapping (Appendix C) illustrates that Residential Area 1 is the most vulnerable part of the site. However, the vast majority of the site is located in Flood Zone 1. Where relevant, strategic mitigation measures such as land raising and floodplain compensation should be implemented. Residential, health service facilities and educational establishment land uses are classified within PPS25 as 'More Vulnerable'. More Vulnerable land uses are not permitted within the Functional Floodplain. Essential Infrastructure such as grid and primary substations are permitted in Flood Zone 3 providing the Exception Test is satisfied. In all instances the highest Flood Hazard rating needs to be taken into consideration when assessing the level of risk within each development area for each return period. The table below provides an overall assessment of the site in relation to its suitability for development based on the modelled flood zone and its flood risk vulnerability classification;

East of Newark-Land Use	Flood Zone Compatibility (table D3. PPS25)
Residential Area 1	Exception Test is required for 'More Vulnerable' land uses that fall within Flood Zone 3a and 'Highly Vulnerable' land uses in Flood Zone 2. Mitigation measures should be implemented.
Residential Area 2	Suitable land uses
Local Centre	Suitable land use.
Landscape Buffer	Suitable land use.
Green Infrastructure	Suitable land use.

7.6 LAND AROUND FERNWOOD

7.6.1 The detailed Flood Risk and Flood Hazard mapping (Appendix C) illustrate that Residential Areas One and Two are the most vulnerable parts of the site. Residential, health service facilities and educational establishment land uses are classified within PPS25 as 'More Vulnerable'. Where relevant, strategic mitigation measures such as land raising and floodplain compensation should be implemented. The Functional Floodplain associated with Lowfield Drain impacts on Residential Area One. More Vulnerable land uses are not permitted within the Functional Floodplain. Essential Infrastructure such as grid and primary substations are permitted in Flood Zone 3 providing the Exception Test is satisfied. In all instances the highest Flood Hazard rating needs to be taken into consideration when assessing the level of risk within each development area. The table below provides an overall assessment of the site in relation to its suitability for development based on the modelled flood zone and its flood risk vulnerability classification;

Land around Fernwood-Land Use	Flood Zone Compatibility (table D3. PPS25)
Residential Area 1	Exception Test is required for 'More Vulnerable' land uses that fall within Flood Zone 3a and 'Highly Vulnerable' land uses in Flood Zone 2. Mitigation measures should be implemented.
Residential Area 2	Exception Test is required for 'More Vulnerable' land uses that fall within Flood Zone 3a and 'Highly Vulnerable' land uses in Flood Zone 2. Mitigation measures should be implemented.
Residential Area 3	Suitable land uses.
Proposed Business Use	Suitable land uses.
Local Centre	Suitable land uses.
Landscape Buffer	Suitable land uses.
Green Infrastructure	Suitable land uses.

7.7 LAND SOUTH OF NEWARK

7.7.1 The detailed Flood Risk and Flood Hazard mapping (Appendix C) illustrate that the most vulnerable parts of the site are Residential Areas One to Four. Residential, health service facilities and educational establishment land uses are classified within PPS25 as 'More Vulnerable'. The Functional Floodplain is shown to impact on all four residential areas. More Vulnerable land uses are not permitted within the Functional Floodplain. Essential Infrastructure such as grid and primary substations are permitted in Flood Zone 3 providing the Exception Test is satisfied. Where relevant, strategic mitigation measures such as land raising and floodplain compensation should be implemented. In all instances the highest Flood Hazard rating needs to be taken into consideration when assessing the level of risk within each development area. The table below provides an overall assessment of the site in relation to its suitability for development based on the modelled flood zone and its flood risk vulnerability classification;

Land South of Newark-Land Use	Flood Zone Compatibility (table D3. PPS25)
Residential Area 1	Exception Test is required for 'More Vulnerable' land uses that fall within Flood Zone 3a and 'Highly Vulnerable' land uses in Flood Zone 2. Mitigation measures should be implemented.
Residential Area 2	Exception Test is required for 'More Vulnerable' land uses that fall within Flood Zone 3a and 'Highly Vulnerable' land uses in Flood Zone 2. Mitigation measures should be implemented.
Residential Area 3	Exception Test is required for 'More Vulnerable' land uses that fall within Flood Zone 3a and 'Highly Vulnerable' land uses in Flood Zone 2. Mitigation measures should be implemented.

Residential Area 4	Exception Test is required for 'More Vulnerable' land uses that fall within Flood Zone 3a and 'Highly Vulnerable' land uses in Flood Zone 2. Mitigation measures should be implemented.
Proposed Industrial Use	Suitable land uses
Existing and Future Minerals Extraction	Less Vulnerable development is suitable outside of the Functional Floodplain.
Local Centre	Suitable Land Use
Landscape Buffer	Suitable Land Use
Green Infrastructure	Suitable Land Use

7.7.2 A site specific Flood Risk Assessment toolkit has been provided in Appendix E for each of the three strategic sites based on the findings of this Level 2 SFRA. Guidance on the appropriate treatment of climate change impacts, control of surface water runoff, implementation of appropriate SuDs techniques and consideration of residual risks have been offered to assist NSDC and future developers of the three strategic sites in the study area.

7.7.3 The table below provides a summary of the extent and reduction of area within each strategic site that is inundated by Flood Zones 2 and 3:

	Land East of Newark (Newark and Sherwood Publication Core Strategy Report)	Inundated Area Land East of Newark	Reduced Area Land East of Newark
Residential Area 1 (ha)	32.93	2.28	30.65
Residential Area 2 (ha)	19.62	0.00	19.62
Σ	52.55	2.28	50.27
Local Centre (ha)	0.79	0.00	0.79
Σ	0.79	0.00	0.79
Landscape Buffer (ha)	14.31	0.31	14.00
Green Infrastructure (ha)	54.15	12.52	41.63
Σ	68.46	12.83	55.63
Total Σ	121.80	15.11	106.69
Strategic Site Boundary Area	122.4		

	Land South of Newark (Newark and Sherwood Publication Core Strategy Report)	Inundated Area Land South of Newark	Reduced Area Land South of Newark
Residential Area 1 (ha)	19.54	3.64	15.90
Residential Area 2 (ha)	17.88	1.38	16.50
Residential Area 3 (ha)	20.94	3.54	17.40
Residential Area 4 (ha)	24.93	0.33	24.60
Σ	83.29	8.89	74.40
Proposed Industrial Use (ha)	44.31	0.00	44.31
Existing and Future Minerals Extraction (ha)	273.89	8.57	265.32
Σ	318.20	8.57	309.63
Local Centre (ha)	3.80	0.00	3.80
Σ	3.80	0.00	3.80
Landscape Buffer (ha)	18.89	3.64	15.25
Green Infrastructure (ha)	169.73	119.11	50.62
Σ	188.62	122.75	65.87
Total Σ	593.91	140.21	453.70
Strategic Site Boundary Area	598.7		

	Land around Fernwood (Newark and Sherwood Publication Core Strategy Report)	Inundated Area Land around Fernwood	Reduced Area Land around Fernwood
Residential Area 1 (ha)	37.43	3.97	33.46
Residential Area 2 (ha)	41.50	4.21	37.29
Residential Area 3 (ha)	53.53	0.00	53.53
Σ	132.46	8.18	124.28
Proposed Business Use (ha)	13.30	0.00	13.30
Σ	13.30	0.00	13.30
Local Centre (ha)	3.10	0.00	3.10
Σ	3.10	0.00	3.10
Landscape Buffer (ha)	40.74	20.84	19.90
Green Infrastructure (ha)	58.58	43.98	14.60
Σ	99.32	64.82	34.50
Total Σ	248.18	73.00	175.18
Strategic Site Boundary Area	248.5		

8 Recommendations

8.1 RECOMMENDATIONS

8.1.1 Newark and Sherwood District Council are required to carry out the Sequential Test for allocating land for future development within the three strategic sites, based upon supporting evidence provided in Phase One of the Level 2 SFRA. The Sequential Test should be undertaken in relation to the test criteria set out in section 7.2. Guidance has also been provided on appropriate policies for sites which satisfy parts a) and b) of the Exception Test and requirements to consider the planning application stage to pass part c) of the Exception Test as set out in PPS25 (see Appendix E). The following recommendations should be taken into consideration;

- NSDC should ensure developers and their consultants make reference to this SFRA study prior to the formulation of development proposals and planning applications for the three strategic sites. This is to ensure that the key requirements of PPS25 (supplemented by recommendations within the SFRA) are met.
- NSDC should ensure developers carry out site specific FRA's for their proposals in line with the EA's latest standing advice on flood risk and the requirements of a site specific FRA. Specific reference is made to the FRA 'Toolkit' for each strategic site provided in Appendix E. The generic recommendations made in the Level 1 SFRA FRA 'Toolkit' should also be taken into consideration.
- NSDC should seek to ensure that flood mitigation measures are implemented on a site specific basis where necessary.
- Areas shown as Green Infrastructure (adjacent to watercourses) on each of the three sites, could be considered as strategic flood mitigation/flood storage areas that provide relief to both upstream and downstream areas. These areas also provide biodiversity benefits which help enhance the natural environment and provide community benefits.
- NSDC investigate the need to undertake a Surface Water Management Plan for Newark which would incorporate an analysis of the three strategic sites. As highlighted in the Water Cycle Study produced by JMP, Nottinghamshire County Council have advised that Newark and Sherwood District is one of the two areas within the County that are considered most in need of a SWMP. A SWMP in Newark, would be key in assessing the surface water drainage issues that affect the Balderton area for example. It is crucial that surface water drainage schemes proposed at each of the strategic sites do not exacerbate these issues.
- NSDC should support the implementation of SuDs by way of robust planning conditions and or Section 106 agreements.
- NSDC should support intrusive site investigations at each of the three strategic sites to test for the presence of onsite contamination. These tests should focus on areas where infiltration SuDS techniques may be viable.
- NSDC Emergency Planners should take into consideration the findings presented within this SFRA. This will help assist in the preparation of evacuation routes and emergency planning procedures in the event of extensive fluvial flooding in and around Newark.

8.1.2 As stated in the Level 1 SFRA, NSDC should investigate the application of a 'roof tax', to supplement flood defence and strategic flood alleviation schemes proposed for each of the three strategic sites.

8.2 AREAS FOR FURTHER INVESTIGATION

8.2.1 Areas for further investigation following the completion of Phase One of the Level 2 SFRA, relate to the need to complete Phase Two of the Level 2 SFRA for the remainder of the District.

8.2.2 Ongoing consultation should be undertaken with the EA with regards to future delivery of Flood Alleviation Schemes in relation to the three strategic sites.

8.2.3 As stated in the Trent CFMP, the EA are currently undertaking technical studies to assess the potential for upgrading the flood defences in Newark (Newark Flood Alleviation Scheme). The EA have advised that the initial results of these studies are due out in 2010. The implications of such upgrades should be assessed in relation to the Land South of Newark site.

8.2.4 Further discussions need to be held with Severn Trent Water on the ability of the sewage treatment works at Balderton and Crankley Point to cope with additional foul flows from each of the strategic sites.

9 Conclusion

9.1 SUMMARY

9.1.1 A Level 2 strategic assessment of flood risk has been carried out to assist NSDC with the allocation of three strategic sites in Newark within their Core Strategy. The study area is shown in Appendix A.

9.1.2 Particular reference should be made to the Fluvial Flood Risk and Hazard Constraints plans for each strategic site in Appendix C. Maps showing the extent of flood depths and flood velocities within Appendix C should also be reviewed in relation to the sustainable development of each site.

9.1.3 Areas shown as Green Infrastructure adjacent to watercourses within each of the three strategic site boundaries, could be viewed as strategic flood storage areas. These provide strategic flood mitigation opportunities for upstream and downstream areas potentially reducing the impact of flooding.

9.1.4 Land allocations within each of the three strategic sites must be made with reference to the Sequential and Exception Tests, as set out within PPS25. A sequential approach should be adopted to areas that fall within Flood Zones 2 and 3. The amount of area within each strategic site that is inundated by Flood Zones 2 and 3 is shown in section 7.7.3.

9.1.5 A site specific FRA 'toolkit' (Appendix E) has been provided to assist NSDC, the EA and future developers in identifying the key flood risk issues within the study area. This toolkit is designed to assist with the formulation of policies and solutions to the management of flood risk and surface water runoff that are of benefit strategically rather than locally.

9.1.6 This SFRA has been based on government guidance and information available at the time of report issues (June 2010). Flood risk classifications may be subject to change in line with future government guidance. Flood zoning may also change within each of the strategic sites following consideration of detailed topographical information, and investigation of flood risk issues within site specific FRAs accompanying planning applications.

