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Mansfield District Council
Creating a District where People can Succeed

STRATEGIC FLOOD RISK ASSESSMENT

GUIDE FOR PLANNERS & DEVELOPERS

JUNE 2008

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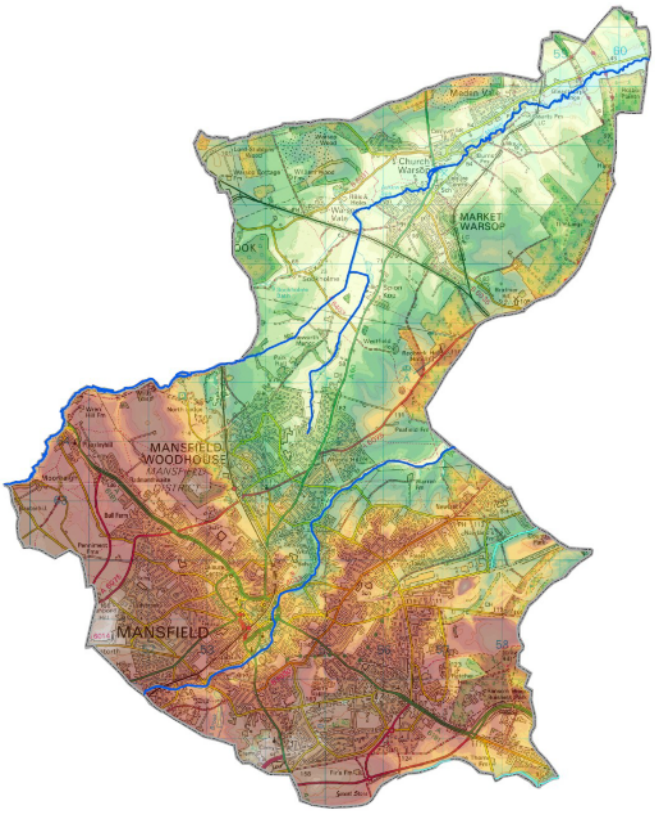

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Mansfield District

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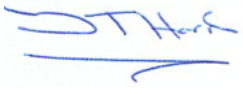
Prepared by:		J. Harris	*Principal Engineering Hydrologist*
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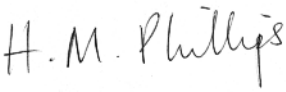
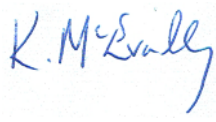
		H. Phillips	*Associate Planner*
Approved by:		K. McEvaddy	*Associate*

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GLOSSARY OF TERMS

Annual Excedence Probability	The annual probability that a rainfall or flood event will exceed a particular value (i.e. depth of rainfall or flood level). This is normally expressed as a percentage.
Attenuation	Reduction of peak flow and increased duration of a flow event.
Aquifer	An underground layer of earth, gravel, or porous rock that stores water.
BES	Biodiversity Enhancement Strategy.
bgl	Below Ground Level
CAMS	Catchment Abstraction Management Strategy
CFMP	Catchment Flood Management Plan.
DDF Modelling	A statistical model contained within the Flood Estimation Handbook which enables the derivation of rainfall depth, duration and frequency throughout the UK.
DEFRA	Department of Food, Environment and Rural Affairs.
Design Event	A historic or national flood event of a given annual flood probability, against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.
DCLG	Department for Communities and Local Government.
EA	Environment Agency.
Ephemeral Streams	Streams which flow for only a very short period.
FEH	Flood Estimation Handbook, Centre for Ecology and Hydrology.
Flood defence	Flood defence infrastructure, such as flood walls and embankment, intended to protect an area against flooding to a specified standard of protection.
Flood Risk Management Strategy	A long-term approach setting out the objectives and options for managing flood risk taking into account a broad range of technical, social, environmental and economic issues.
Floodplain	Area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defences where they exist.
FRA	Flood Risk Assessment. A study to assess the risk to an area or site from flooding, now and in the future, and to assess the impact that any changes or development on the site or area will have on flood risk to the site and elsewhere. It may also identify, particularly at more local levels, how to manage those changes to ensure that flood risk is not increased. PPS25

	differentiates between regional, sub-regional/strategic and site-specific flood risk assessments.
Flood Zone	A geographic area within which the flood risk is in a particular range as defined within PPS 25.
FZ 1	Flood Zone 1 Low Probability. 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%).
FZ 2	Flood Zone 2 Medium Probability. 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.
FZ3a	Flood Zone 3a High Probability. 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.
FZ3b	Flood Zone 3b The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood.
Fluvial flooding	Flooding from a river or other watercourse.
Greenfield land	Land that has not been previously developed.
Indicative Risk	The risk from flooding based on best available information and representing the influence of flood defences and the distribution of risk within the Flood Zones.
Local Development Framework	A non-statutory term used to describe a folder of documents which includes all the local planning authority's Local Development Documents. The Local Development Framework will also comprise the Statement of Community Involvement, the Local Development Scheme and the Annual Monitoring Report.
LDDs	All development plan documents which will form part of the statutory development plan, as well as supplementary planning documents which do not form part of the statutory development plan.
LDF	Local Development Framework.
LNR	Local Nature Reserve.
Main river	A watercourse designated on a statutory map of main rivers, maintained by Defra, on which the Environment Agency has permissive powers to construct and maintain flood defences.
mAOD	Metres above Ordnance Datum.
Ordinary Watercourse	All rivers, streams, ditches, drains, cuts, dykes, sluices, sewers (other than public sewer) and passages through which water flows which do not form part of a Main river. Local Authorities and, where relevant, Internal Drainage Boards have similar

	permissive powers on ordinary watercourses, as the Environment Agency has on Main Rivers.
PPS	A statement of policy issued by central Government to replace Planning Policy Guidance notes. Advice on practical implementation is not included in Planning Policy Statements.
PPS25	Planning Policy Statement 25. Development and Flood Risk Guidance, published in December 2006, outlining how flood risk should be considered at all stages of the development process.
Pluvial Flooding	Flooding from the public sewer or drainage network.
Residual Risk	A flood event more severe than that for which particular flood defences of structures have been designed to provide protection.
Return Period	The average time until the next occurrence of a defined event, normally considered in years.
Run-off	The flow of water along the surface as a result of rainfall falling onto the ground.
Sequential Test	An evidence-based exercise carried out by decision makers to appraise the reasonable availability of sites for development. This prioritises low flood risk areas, and then considers higher flood risk areas where alternative sites are reasonably available. This aims to match the vulnerability of proposed development / land use with severity of flood risk.
SFRA	Strategic Flood Risk Assessment.
SINC	Site of Importance for Nature Conservation.
SSSI	Site of Special Scientific Interest.
SUDS	Sustainable Urban Drainage Systems. A sequence of management practices and control structures, often referred to as SUDS, designed to drain water in a more sustainable manner than some conventional techniques. Typically these are used to reduce surface water run-off from new or existing development.
Sustainability Appraisal	An integral part of the plan-making process which seeks to appraise the economic, social and environmental effects of a plan in order to inform decision-making that aligns with sustainable development principles.
SW	Surface Water.
WFD	Water Framework Directive.

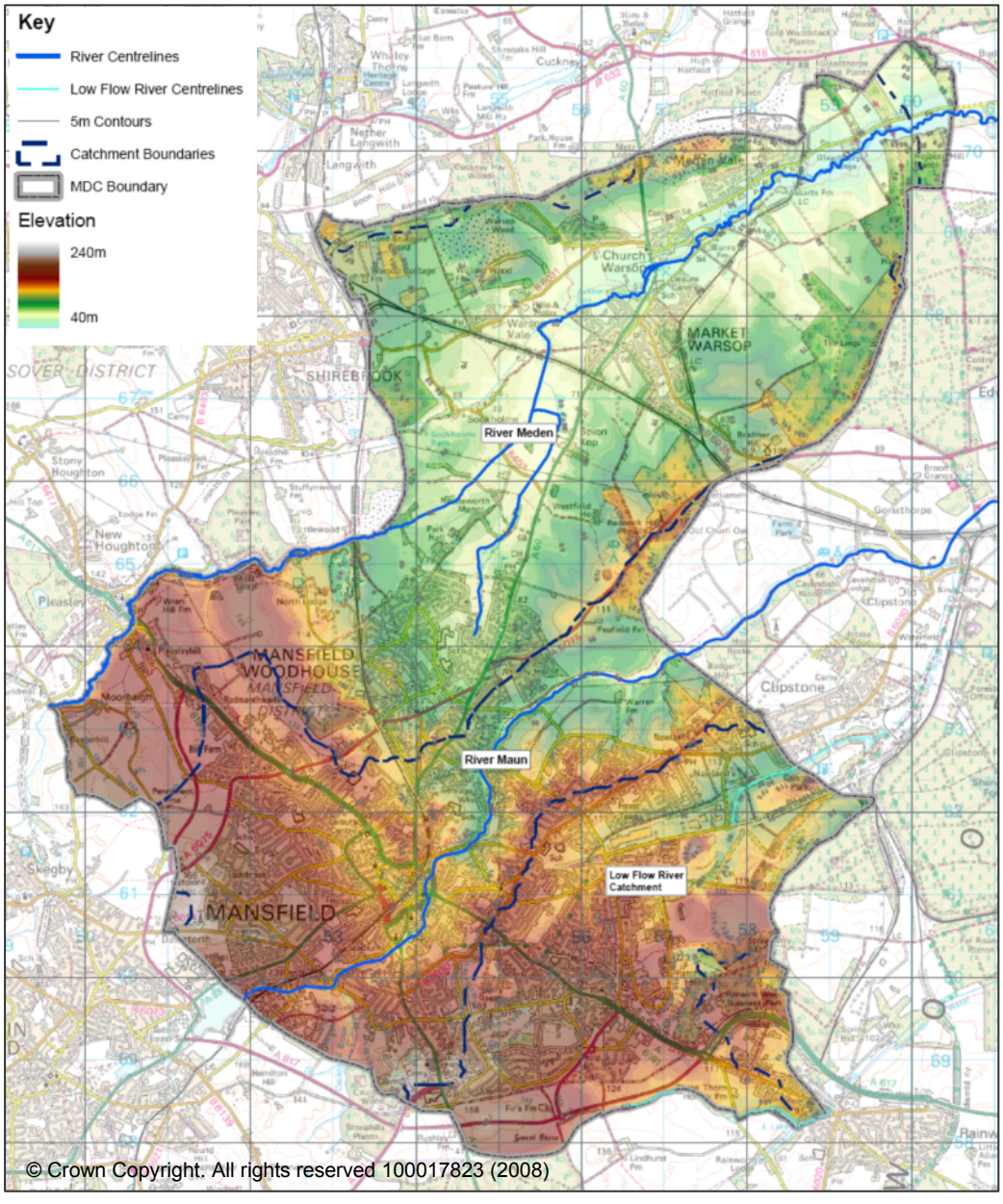
1 INTRODUCTION

1.1 Background

1.1.1 A Strategic Flood Risk Assessment provides a high level overview of flood risk issues within a district or borough. The Local Planning Authority is responsible for preparing SFRA's in consultation with the Environment Agency. The Mansfield SFRA therefore seeks to inform planning decisions within the Mansfield District in relation to flood risk issues.

1.1.2 The Mansfield District covers an area of 76.7km^2 as shown in Figure 1.1. The River Maun and River Meden flow across the district and later join the River Idle; the River Maun dissects Mansfield town centre and the River Meden flows to the north of Market Warsop. Lees Brook flows north from Mansfield Woodhouse and joins the River Meden. Other tributaries to the River Maun include Caudwell Brook, Vicar Water, Rainworth Water and Foul Evil Brook.

Figure 1.1 – Mansfield District



1.1.3 The southeast portion of Mansfield District drains into Vicar Water and Rainworth Water. These watercourses are characterised by low flow conditions, such that the demands placed on them through water abstraction and recreation can not be met due to insufficient water during normal conditions.

1.1.4 Despite their prominence within the study area, the relatively steep topography means that flooding from rivers and streams only impacts 3% of the district. Flooding from surface water run-off, sewers and groundwater are equally important factors and are therefore considered in this study.

1.1.5 Due to the nature of river catchments and surface run-off, there are possible cross-boundary issues which will impact on flood risk to and from the Mansfield District. Broadly speaking, areas upstream of Mansfield or which form part of the Maun and Meden river catchments (namely Ashfield and Bolsover) may impact on the flood risk to Mansfield District. Similarly, development practice within Mansfield District may impact on areas downstream (namely Newark & Sherwood and Bassetlaw). The primary risk to Mansfield District is associated with development within Ashfield District, particularly adjacent to the Mansfield Ashfield Regeneration Route (MARR).

1.1.6 The Environment Agency publishes a Flood Zone Map for the whole of England and Wales. This map incorporates detailed flood risk mapping and historic flooding where this is more extensive. The Flood Zone Map generally considers the undefended flood extent, such that flood defences are considered ineffective. The Mansfield SFRA incorporates the River Maun Flood Risk Mapping but also considers the added benefit of existing flood defences, which are present along a short isolated reach of the River Maun, upstream of Bridge Street. The SFRA will therefore indicate some areas to be at a lower risk of flooding than is shown on the EA Flood Zone Map. Similarly, the Flood Zone Map only considers flooding from rivers. The SFRA considers additional flood risk associated with surface run-off, sewers and ground water.

1.1.7 This Strategic Flood Risk Assessment (SFRA) takes account of the guidance contained in the following documents:

- *Strategic Flood Risk Assessment: Midlands Region Interim Guidance (March 2006), Environment Agency;*
- *Planning Policy Statement 25: Development and Flood Risk (December 2006), DCLG;*
- *Planning Policy Statement 25: Development and Flood Risk Practice Guide (June 2008), DCLG;*
- *Maun Valley Action Plan (May 2000), Baker, Shepherd, Gillespie.*
- *River Trent Catchment Flood Management Plan – Final Draft (2007), Environment Agency*

1.2 Project Brief

1.2.1 Planning Policy Statement 25: Development and Flood Risk (PPS 25) requires Local Planning Authorities to demonstrate a risk-based approach to the preparation of local development plans and consideration of planning applications through the application of a Sequential Test and where appropriate the Exception Test.

1.2.2 The SFRA is intended to assist the LPA as follows:

- *Inform the preparation of the emergent Local Development Framework*
- *Assist in assessing the long-term development potential of the District*
- *To steer new development towards areas of the lowest risk of flooding and inform the application of the Sequential Test.*
- *Maximise the reuse of accessible brownfield land by understanding possible constraints imposed by flooding.*
- *Enable policies to be developed that aim to minimise and manage flood risk, enhance the biodiversity of the watercourse and address water quality and resource issues.*

1.2.3 Each of these objectives needs to be met within the principles defined by PPS 25 and associated guidance. It is vital that the adopted approach accounts for the Environment Agency's flood risk management strategy for the area, as outlined in the River Trent Catchment Flood Management Plan.

1.2.4 The key components of the Strategic Flood Risk Assessment brief are summarised below:

- *Consolidated flood maps detailing the fluvial flood risk associated with the River Maun, River Meden and tributaries indicating the flood outline for specific design events.*
- *Consolidated flood maps detailing all sources of flooding.*
- *An appraisal of the protection provided by natural and man-made flood defences, if any.*
- *Identify key locations where culverts could be reinstated as open channels for improved biodiversity.*
- *An appraisal and Code of Practice for sustainable surface water management including advice on the use of SUDS in agreement with Severn Trent Water and other relevant parties.*
- *An appraisal of areas where surface water run-off generated by new development may assist to replenish low flow watercourses for biodiversity and water quality benefits.*
- *Guidance on the required content of site-specific Flood Risk Assessments, based on the risks associated with the general location of the site.*

2 METHODOLOGY

2.1 SFRA Components

2.1.1 A strategic approach to flood risk assessment requires consideration of current and future flood risks within the study area. The precautionary risk based approach covered by the Sequential Test in PPS 25 encourages the allocation of land for development in sustainable locations. The Sequential Test is an evidence-based exercise carried out by decision makers to appraise the reasonable availability of sites for development. This prioritises low flood risk areas, and then considers higher flood risk areas where alternative sites are reasonably available. This aims to match the vulnerability of proposed development with severity of flood risk.

2.1.2 Completion of the SFRA is achieved through a four stage process. Stage 1 uses the Flood Zone Maps published by the Environment Agency as a starting point. Stage 2 reviews these Flood Zone Maps to establish whether they depict a realistic risk, based on the presence (or absence) of flood defences and other structures. This information is combined with other known sources of flooding to create the indicative flood risk maps. Stage 3 considers the residual risk of fluvial flooding. Stage 4 then considers appropriate practices for the management of surface water and opportunities to enhance the biodiversity. The full details of which are discussed below.

Stage 1: Identification of Flood Zones

2.1.3 The identification of sites in relation to Flood Zones 1, 2 and 3 enables the broad evaluation of sites based on the fluvial flooding risk, (Low, Moderate and High). The identification of appropriate development for each of the flood zones should be made with reference to Table D.1 and D.3 of PPS 25.

Stage 2: Determine Indicative Flood Risk

2.1.4 The indicative flood risk gives a more detailed assessment of the fluvial flood risks to a site, and includes the flood outlines generated from detailed modelling and enables identification of possible flood depths at broad locations and the likelihood of structures being overtopped.

2.1.5 Other possible flood risks are identified to enable a precautionary approach. In general, all land identified to be in Flood Zone 1 is appropriate for development. Where additional sources of flood risk are identified, development may still be acceptable, but must be accompanied by a detailed Flood Risk Assessment which addresses these risks in greater detail and where appropriate makes provision for suitable mitigation measures.

Stage 3: Review Residual Flood Risk

2.1.6 Within the Mansfield District, the Residual Risk is generally considered to be associated with extreme fluvial flooding with a 0.1% annual probability of occurrence (1 in 1000-year event).

Stage 4: Determine Best Practice for Surface Water Management and Enhancement of Biodiversity

2.1.7 With sites evaluated in terms of flood risk, the final stage considers opportunities for biodiversity enhancement. This includes the best practice for the management of surface run-off such as:

- *Priority sites for Green SUDS*
- *Priority sites for soakaways*
- *Priority sites for direct discharge to low flow areas*

2.1.8 In addition to the strategic flood risk component, this document also considers opportunities to improve the biodiversity of the river environment through opening up culverted sections of the rivers and streams and restoring the natural flow character of streams suffering from low flow conditions without increasing flood risk. This component is termed the Biodiversity Enhancement Strategy (BES) and is integral to the overall flood risk management strategy.

2.1.9 The holistic approach encompassed in this assessment enables land allocations to consider both the strategic impact on flood risk and the opportunity to enhance biodiversity.

2.2 Data Sources

2.2.1 The River Maun Flood Risk Mapping study was commissioned by the Environment Agency and was completed in March 2007. This document is the key source of information relating to fluvial flooding in the River Maun.

2.2.2 The River Meden Flood Risk Mapping study was commissioned by the Environment Agency and was available in Draft form in June 2008.

2.2.3 Channel Survey data for the River Maun helped to confirm the position and nature of flood defences. This was combined with aerial photography to establish the extent of defences.

2.2.4 The Severn Trent Water asset data was available for review of sewer types and the location of main sewers. There was no information available regarding the design standard of these sewers or the likelihood of flooding along individual sewer routes.

2.2.5 Digital Terrain Mapping and Aerial Photography were combined with data from the National Soil Research Institute, to evaluate issues related to surface water run-off.

2.2.6 The Institute of Hydrology's Flood Estimation Handbook (FEH) was used to provide statistical rainfall data and to help define the river catchments.

2.2.7 The Environment Agency provided river flow and rainfall data for the June 2007 flood event.

2.2.8 Groundwater issues were reviewed using the Institute of Geological Sciences, Hydrogeology Map of the Northern East Midlands, together with a range of data held by the Environment Agency, namely the EA Groundwater Vulnerability Map, Groundwater level hydrographs in boreholes within the Limestone and Sherwood Sandstone aquifers, and the Idle and Torne Catchment Abstraction Management Strategy.

2.2.9 Species records obtained from Nottinghamshire Wildlife Trust informed the ecological aspects of this study.

2.3 New Studies

2.3.1 Extensive site walkover visits were conducted throughout the Mansfield District to review the data described in Section 2.2 and assess areas which have encountered historic flooding or which are identified as being at a possible risk of flooding from rivers, surface run-off or other sources.

2.3.2 An analysis of the flood event in June 2007 was undertaken to review the cause and extent of flooding encountered. This included a review of hydrological data and reported incidents of flooding.

2.3.3 The susceptibility to blockage was reviewed at key structures together with the likely impact on flooding in the event of blockage.

2.3.4 In order to assess the possible improvements to biodiversity that might be achieved through the implementation of the SFRA, ecological studies have been undertaken to review the habitats of different species and possible opportunities to extend those habitats.

2.4 Participants

2.4.1 The Mansfield SFRA has been conducted in close consultation with the Environment Agency. Contributions from Severn Trent Water, Nottinghamshire Wildlife Trust and the Citizens Panel have also been incorporated into this SFRA.

2.4.2 Severn Trent Water was able to identify the location and general design standard of their infrastructure. They were not however able to comment on specific problems within the sewer network on account of their on-going maintenance programme which seeks to resolve problems within the lifetime of the SFRA document.

2.4.3 The Citizens Panel, enabled the collection of data from the public within Mansfield District. This data relates particularly to the June 2007 flooding and helped identify the cause and extent of flooding.

2.5 Project Limitations

2.5.1 Detailed flood risk mapping was only available for the River Maun. Consequently the flood outlines associated with the River Meden, Lees Brook, Vicar Water and Rainworth Water are based on the national flood model which has a reduced accuracy. The flood outlines associated with minor watercourses and ditches may be omitted from this study. The impact of blockages within small channels is not considered due to the unpredictability and relatively minor extent of possible flooding.

2.5.2 The River Maun flood risk mapping study provides a conservative representation of the fluvial flood risk along the River Maun. In accordance with the specification, the mapping ignores the benefit of flood defences and undertakes a particularly conservative modelling approach to the flow through key structures which is considered to result in elevated levels on the upstream face of structures. Consequently, the extent of flooding along individual reaches of the River Maun might otherwise be reduced slightly. Similarly it is possible that the inclusion of flood defences may increase the risk of flooding to areas which do not benefit from flood defences.

2.5.3 Limited access to data from Severn Trent Water means that the risk of flooding from sewers cannot be reliably established, particularly for lower return periods.

3 POLICY CONTEXT

3.1.1 A Strategic Flood Risk Assessment helps to inform the spatial planning process at a district level. In accordance with Planning Policy Statement 25: Development and Flood Risk, Mansfield District Council is required to prepare a Strategic Flood Risk Assessment (SFRA) as a freestanding document to contribute to the Sustainability Appraisal of Local Development Documents and to positively inform the planning process, including the application of the Sequential and Exception Tests as outlined in PPS 25, in deciding on locations for new development. The SFRA should be a single source document which considers the flood risk from all sources from the best available information.

3.1.2 The SFRA should therefore be used to inform the portfolio of documents contained within the Local Development Framework (LDF), and in particular the following:

- *Development Plan Documents (DPD's); including the Core Strategy, Site Specific Allocations, Development Control Policies, and the Mansfield Central Area Action Plan DPD's.*

- *Supplementary Planning Documents (SPD's).*

3.1.3 It will also be an important reference document for the Sustainability Appraisal of the local authority's strategies and policies, which is a statutory requirement that is integral to the plan-making process.

3.1.4 Planning Policy Statement 1: Delivering Sustainable Development is the overarching policy which complements PPS 25. In particular, PPS 1 establishes the Governments commitment to protecting and enhancing the quality of the environment. Planning Policy Statement: Planning and Climate Change is a supplement to PPS1. One of the key planning objectives is to conserve and enhance biodiversity and secure development that minimises vulnerability to and provides resilience to climate change. This feeds directly into the aims of this SFRA which seeks to encourage improved management of water resources through encouraging development in areas of low flood risk, the use of sustainable drainage systems and enhancement of the biodiversity within Mansfield District.

3.1.5 The requirement for SFRA's is outlined in Annex E of Planning Policy Statement 25: Development & Flood Risk with further detail on the preparation of SFRA's included in the accompanying Practice Guide, which was published as a draft in February 2007, with the final document published in June 2008.

3.1.6 With the increasing uncertainty surrounding the nature and severity of climate change, such an approach will serve to reduce the overall risk, by placing new development in locations considered to be at low risk from flooding. Annex B of PPS 25 sets out guidelines on the consideration of Climate Change. This relates in particular to the predicted sea level rises and predicted increase in rainfall intensity and peak river flow. The impact of climate change should be considered for the design life of a particular development. This approach will minimise the flooding risk to new developments from the outset, which in turn will alleviate the requirement for long-term engineered flood defences.

3.1.7 There are also a number of policies in the draft Regional Spatial Strategy for the East Midlands (RSS8), published in September 2006. This addresses the issues of water resources and flood risk within the region and with which the LDF should comply. These include:

- *Policy 32 – A Regional Approach to the Water Resources and Water Quality*
- *Policy 33 – Regional Priorities for Strategic River Corridors*

- *Policy 35 – A Regional Approach to Managing Flood Risk*

3.1.8 Policy 35 of the RSS is particularly relevant to the Strategic Flood Risk Assessment and is summarised below.

- Local Development Frameworks and the strategies of relevant public bodies should:
  - *be informed by Strategic Flood Risk Assessments in order to evaluate actual flood risk. Priority areas for assessment include the built up areas of Derby, Nottingham and Newark;*
  - *include policies which prevent inappropriate development either in, or where there would be an adverse impact on, the coastal and fluvial floodplain areas;*
  - *deliver a programme of flood management schemes that also maximise biodiversity;*
  - *seek to enhance the townscape and achieve other public benefits; and*
  - *require sustainable drainage in all new developments where practicable.*
- Development should not be permitted if, alone or in conjunction with other new development, it would:
  - *be at unacceptable risk from flooding or create such an unacceptable risk elsewhere;*
  - *inhibit the capacity of the floodplain to store water;*
  - *impede the flow of floodwater in a way which would create an unacceptable risk elsewhere;*
  - *have a detrimental impact upon infiltration of rainfall to ground water storage;*
  - *otherwise unacceptably increase flood risk; and*
  - *interfere with coastal processes.*

3.1.9 The Panel Report of the Examination in Public of the draft Regional Spatial Strategy for the East Midlands was published in November 2007. In particular the following relevant recommendations are made:

R8.2- That the relevant part of policy 32 be strengthened to read: "promote improvements in water efficiency in new development and in regeneration to achieve a regional target of 25%"

R8.4 – That a clause in Policy 35: "Development should not be permitted if… it would… create… an unacceptable risk (of flooding) elsewhere:" should be supported by a suitable explanation in the supporting text.

Para 15.26 - …some loss of Greenfield land is, in our opinion justifiable… It should, of course, be at least matched by the 'greening' of isolated former colliery and industrial sites the re-use of which would be unsustainable."

3.1.10 In accordance with the above policies, the SFRA will therefore be an essential element in developing a sustainable spatial strategy for the district and in deciding on the best locations for further growth and development.

3.1.11 The final draft of the CFMP was published in October 2007, and sets out the future policy for investment in flood defence within the River Trent catchment. Mansfield District lies within the Policy Unit 2 - Sherwood. The selected policy for this unit is as follows:

"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)."

3.1.12 Table 3.1 below provides a summary of the action plan for the Sherwood Policy Unit. The CFMP Policy and proposed actions are to be supported by the proposals within this SFRA document. Mansfield District Council has already anticipated some of the actions identified in the CFMP, such as restoring rivers to their natural state.

Table 3.1 – Extract from the River Trent CFMP

Sherwood					
Policy unit	**Policy**	**Action**	**Principal Organisations**	**Priority and timescale**	**Consequence**
Policy unit 2	**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).	Investigate locations and ways to return river channel to more natural state – particularly Retford, Mansfield, Worksop, and the middle Idle where the channel has been heavily engineered through mining activities.	Environment Agency/ Natural England/ land owners/ local authorities	Medium 3 - 8 years	Development of a strategy for river restoration aimed at returning the river to a natural state.
		Identify opportunities to maximise the use and benefits of SuDS, particularly in areas where the sandstone geology will support extensive use, and where a strategy for retro-fitting SuDS may be developed.	Environment Agency / Local Authorities	Medium 0 – 3 years	Clear guidance for planners, developers and home owners regarding best practice for drainage, and a practical guide for implementation.
		Identify areas where efficiencies can be achieved, such as reduced channel maintenance and removal of structures.	Environment Agency	Medium 5 – 10 years	Cost savings whilst maintaining appropriate levels of protection.
		Investigate the effectiveness of current flood risk management and develop a prioritised maintenance plan for of the existing flood protection infrastructure, and a the viability of future levels of protection.	Environment Agency	Medium 3 – 8 years	Direction for works programmes and the asset review.
		Develop a strategy for implementing measures and schemes that will encourage land management practices and land drainage that will reduce run-off.	Environment Agency/ Natural England/ land owners/ local authorities	Medium 2 – 5 years	Clear guidance to drive appropriate land management, and encourage collaborative schemes.
		Review and agree the role of the IDBs within the area.	Environment Agency/IDB	Medium 0 –5 years	Clarity in roles and responsibilities for the future.
		Review hydrometric monitoring networks in relation to flood warning, and revise flood warning areas and trigger levels to improve accuracy and resolution of flood warning.	Environment Agency	High 0 - 3 years	Improved ability to provide accurate and timely flood warnings. Refine flood warning areas and allow more targeted warnings.

4 SFRA ANALYSIS AND FINDINGS

4.1 Introduction

4.1.1 The full details of the Strategic Flood Risk Assessment analysis is included in the accompanying Technical Report. This analysis separates out the flood risk and biodiversity issues which are combined in this chapter to aid the planning process.

4.1.2 Mansfield District is defined into three distinct areas in accordance with the river catchment boundaries. These boundaries can be seen on Figure 1.1 and in more detail in the overview map given in Appendix B.

- **River Meden Catchment** *(broadly Mansfield Woodhouse & Market Warsop)*
- **River Maun Catchment** *(broadly Mansfield central and western areas)*
- **Low Flow Catchment** *(south-eastern area of Mansfield)*

4.1.3 The SFRA analysis and findings specific to each catchment are summarised in Sections 4.4 to 4.6. District wide issues are discussed separately in Section 4.7. The Mansfield SFRA incorporates a dedicated Code of Practice in Figure 5.2, designed to help the user navigate through the findings of the SFRA and identify the site specific Flood Risk Assessment requirements and appropriate Drainage Strategy in order to make informed planning decisions.

4.2 Source of Flood Risk

4.2.1 The flood risks defined within this chapter are categorised in accordance with the source of flooding. Four primary sources of flood risk are considered:

Table 4.1: Possible Sources of Flooding

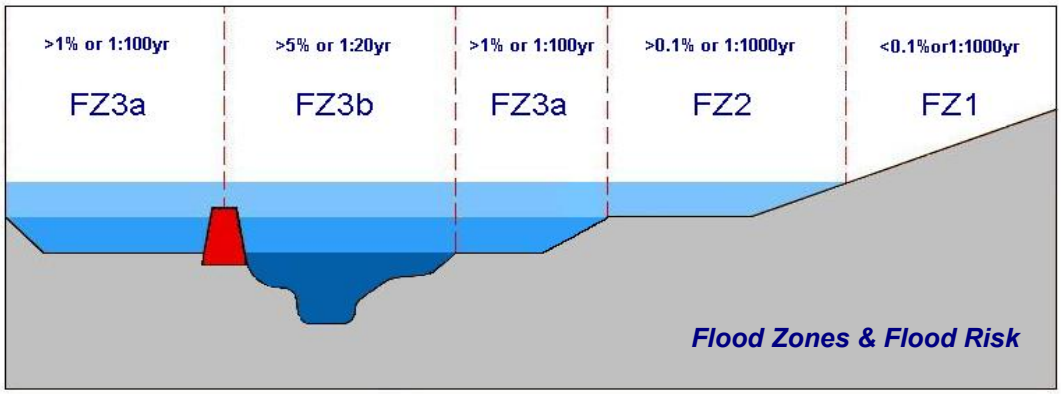
Source of Flooding	Description
Fluvial Flooding	From rivers and streams following periods of high intensity rainfall. Blockage or failure of defences may contribute to elevated risk.
Pluvial Flooding	Directly from the sewer network as a result of insufficient sewer capacity. Sewage can back up into properties or exit via manholes & gullies.
Surface Run-off Flooding	The overland flow of water resulting from rain falling on low permeability surfaces. The severity of flooding is increased where topography concentrates flow.
Groundwater Flooding	Elevated water table which leads to shallow groundwater conditions or seepage to the surface level.

4.2.2 Flood Zones classify the fluvial flood risk based on the annual probability of flooding. Broadly speaking, these Flood Zones are derived from computational models based on statistical rainfall events with a specific probability of occurrence. The definition and detail of these flood zones depends on the detail of the hydraulic modelling. PPS25 identifies distinct areas of flood risk as follows:

Table 4.2: Flood Zone Definition

Flood Zone	Risk Description	Return Period	Annual Excedence Probability
1	Little or no risk	< 1000 year	< 0.1%
2	Low to medium risk	100 – 1000 year	0.1% – 1.0%
3a	High risk	20 – 100 year	1.0% – 5.0%
3b	The Functional Floodplain	> 20 year	> 5%

Figure 4.1 – Flood Zone Schematic



4.2.3 The Flood Zones ignore the effect of flood defences, in order to identify those areas which are not dependent on the upkeep of flood defences and are therefore more sustainable. Consequently, where areas do benefit from defences, the zones will show an outline that is not necessarily associated with the real level of flood risk. The details of the Flood Zones within Mansfield District are shown in Appendix D.

4.3 Biodiversity Enhancement

4.3.1 Within the context of this SFRA, biodiversity enhancement opportunities are considered to be management practices related to the river system and surface water run-off which will improve the environment. In accordance with the project brief, the following practices were considered as potential biodiversity enhancement opportunities within the Mansfield District, full details are given in Chapter 4 of the Technical Report:

- *Removal of Culverts*
- *Restoration of Low Flows*
- *Introduction of Sustainable Urban Drainage Systems (SUDS)*

4.3.2 The removal of culverts considers the ecological benefit of restoring open watercourses where the culvert structure may present a barrier to the extension of habitats of endangered species. Feasibility in engineering terms and in relation to flood risk was also considered. This is discussed further in Section 4.5, with particular reference to Table 4.8.

4.3.3 A number of watercourses within the district are suffering from particularly low flow conditions as a result of high abstraction and low inflow. The restoration of normal flow conditions has a number biodiversity benefits including habitat creation and

enhancement, water quality and public amenity. The opportunity to restore flows is considered in terms of practicality and flood risk.

4.3.4 Sustainable Urban Drainage Systems provide the opportunity to control surface water at source and mitigate the impact of increased run-off from new development. In accordance with CIRIA 697, SUDS should aim to achieve three main benefits:

- *Quantity – reduce the discharge rate and total run-off volume that would otherwise enter the public sewer or watercourse.*
- *Quality – improve the quality of water leaving a site in terms of sediment load and contaminants.*
- *Amenity – provide an improved environment in human and ecological terms.*

Typical SUDS are summarised below in accordance with the above aims.

Table 4.3 –Potential Benefits of Different SUDS

SUDS feature	Description	Quantity	Quality	Amenity	Green SUDS?
Sub-surface attenuation	Sub-surface storage with controlled discharge	Moderate	Low	Low	N
Retention Pond	Storage facility with permanent water	Moderate	High	High	Y
Wetland	Retention basin with significant numbers of water-purifying plants	Moderate	High	High	Y
Soakaway	Trench or pit filled with a large void ratio allowing water storage and infiltration	High	High	Low	N
Infiltration Basin	Similar to a pond but all stored water infiltrates into the underlying soil	High	High	Moderate	Y
Grassed Swale	Shallow, flat grassed ditch allowing storage and infiltration	Moderate	High	Moderate	Y

4.3.5 Green SUDS is considered here to be systems which have a notable ecological benefit through the creation of wildlife habitats. This therefore excludes sub-surface systems such as soakaways and storage tanks which have a low ecological significance. Retention Ponds and Wetlands would be prioritised with a lesser benefit achieved through Infiltration Basins and Swales.

4.4 River Meden Catchment

Flood Risk Issues

4.4.1 The River Meden predominantly flows through countryside, passing between the built-up areas of Market Warsop, Church Warsop, and Meden Vale in the northern part of the district. Even in these areas, a natural floodplain is retained alongside the majority of the watercourse. Consequently, the River Meden has a relatively low impact on existing development with the exception of the road infrastructure which is affected at several river crossings as described below. Lees Brook flows north from Mansfield Woodhouse and joins the River Meden near Spion Kop; there is understood to be no significant floodplain associated with Lees Brook. Table 4.4 provides a summary of the flood risks along different sections of the river.

Table 4.4a: Flood Risk Summary of the River Meden Catchment (Pleasley)

General Location	Potential Flood Risks	Possible Development Constraints
Pleasley	Properties in the vicinity of Pleasley Square are considered to be at a high risk of fluvial flooding due to insufficient capacity of the structure at the pond outfall. Flood water flows across Pleasley Square before rejoining the main river channel. An additional surface run-off risk is evident in this area although this would normally be mitigated by the storm drainage in the Square which will discharge surface water into the River Meden.	New development should be avoided in this area.

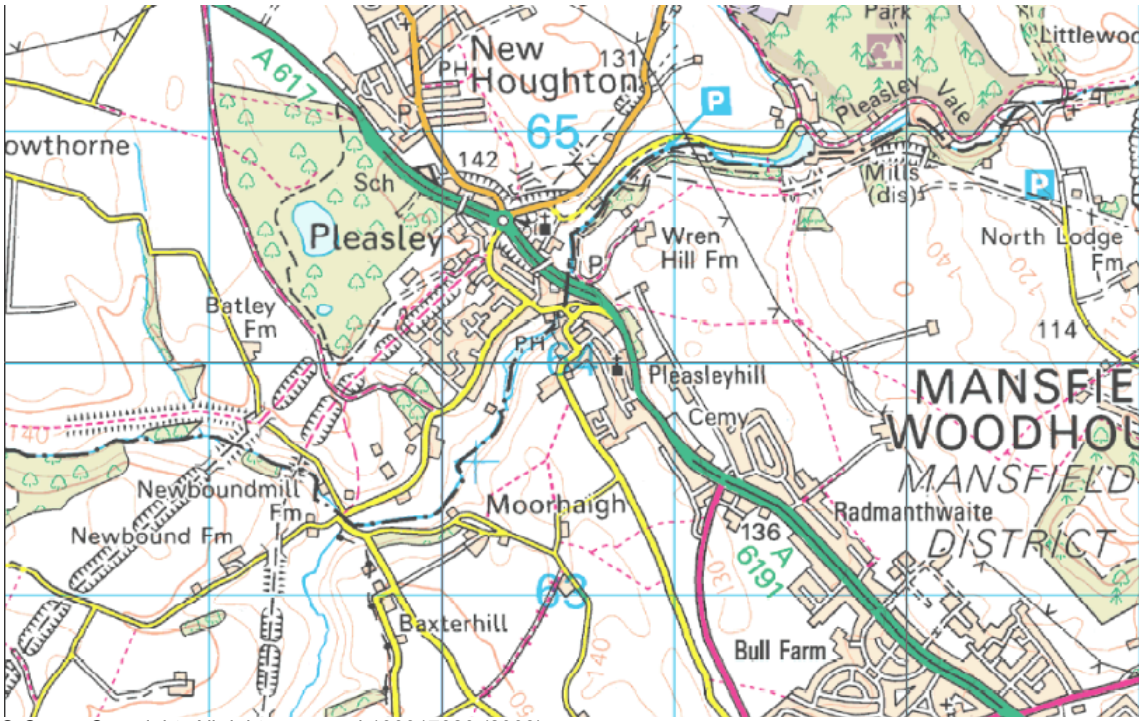


Table 4.4b: Flood Risk Summary of the River Meden Catchment
(Mansfield Woodhouse)

General Location	Potential Flood Risks	Possible Development Constraints
Mansfield Woodhouse	There are considered to be no significant flood risks in this general location. The fluvial floodplain is characterised by fields approximately 1km from the north of Mansfield Woodhouse. The combination of dense urbanisation and low permeability soils will contribute to an increased risk of surface run-off, although no significant flow concentrations have been identified	None identified.

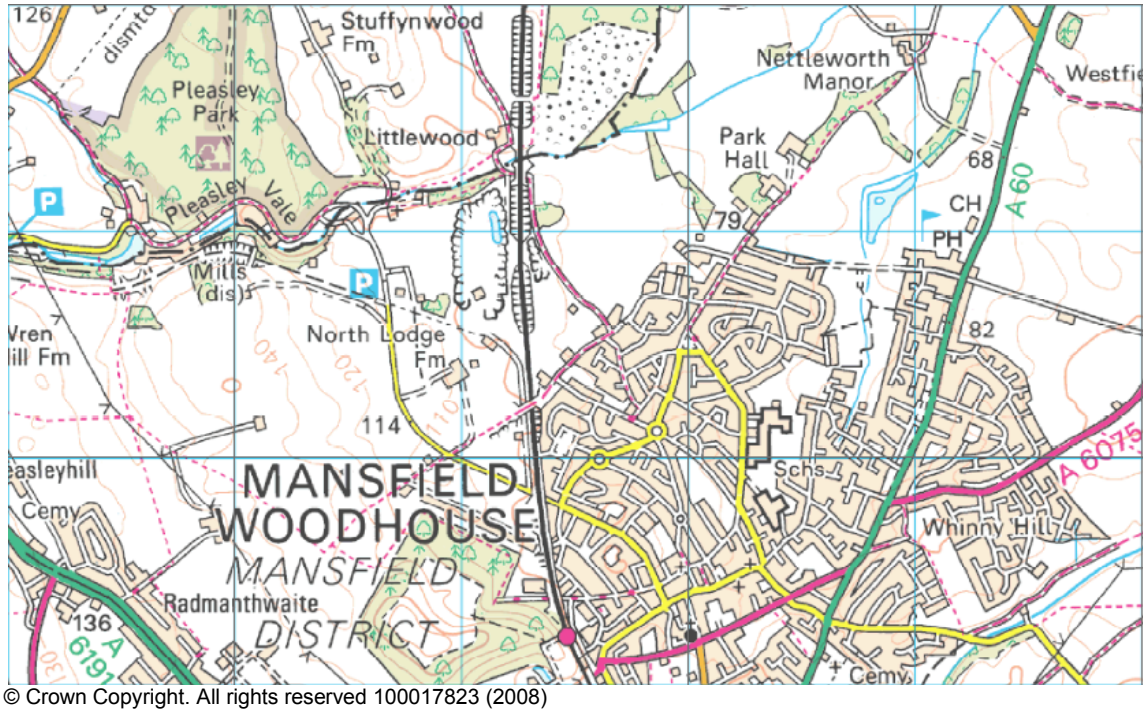


Table 4.4c: Flood Risk Summary of the River Meden Catchment
(Sookholme, Spion Kop & Market Warsop)

General Location	Potential Flood Risks	Possible Development Constraints
Sookholme & Spion Kop	Historic Fluvial flooding has affected properties and access routes in this area. The prevalence of springs is associated with shallow groundwater in this area. Extensive areas of low permeability soils will contribute to an increased risk of surface run-off, although no significant flow concentrations have been identified.	Development should avoid areas defined as Flood Zone 2 and 3 due to the availability of land elsewhere at lower flood risk.
Market Warsop	The north of Market Warsop is adjacent to the River Meden and has experienced historic flooding, in particular on the A60 and Church Road. Some existing properties and roads are within Flood Zone 3 at a high risk of fluvial flooding The area of low permeability soil at the northern end of the Market Warsop will contribute to an increased risk of surface run-off, although for the most part this is already characterised by urbanised areas.	Development should avoid areas to the north of Market Warsop defined as Flood Zone 2 and 3 due to the availability of land elsewhere at lower flood risk.

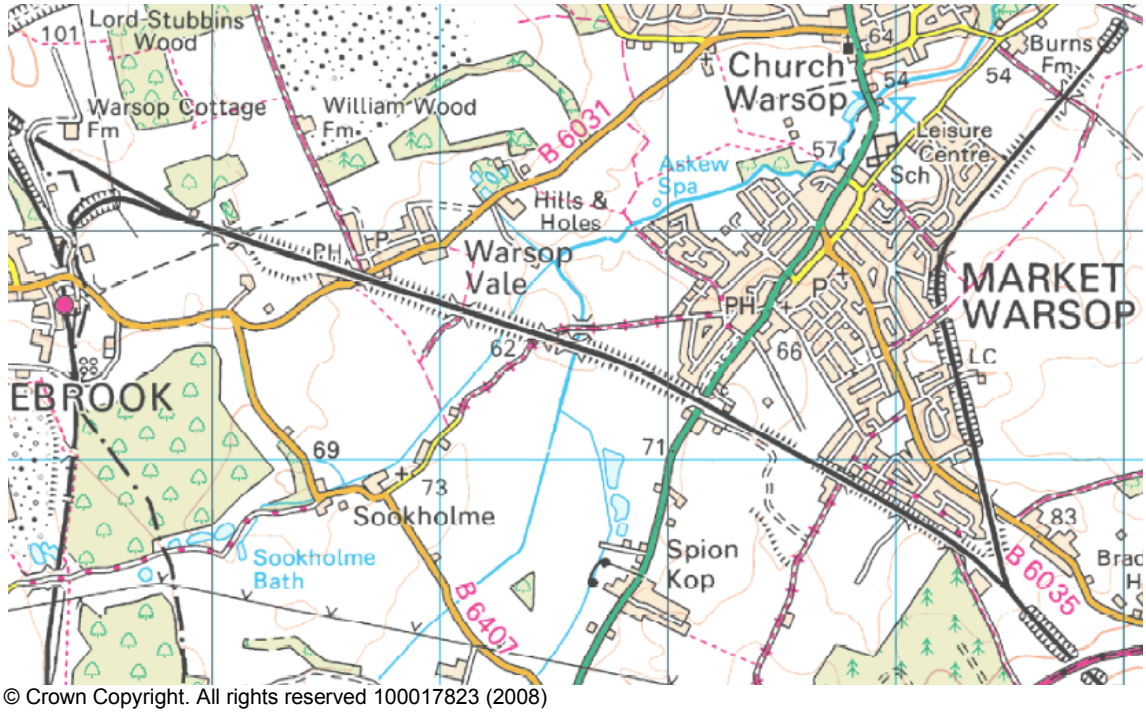
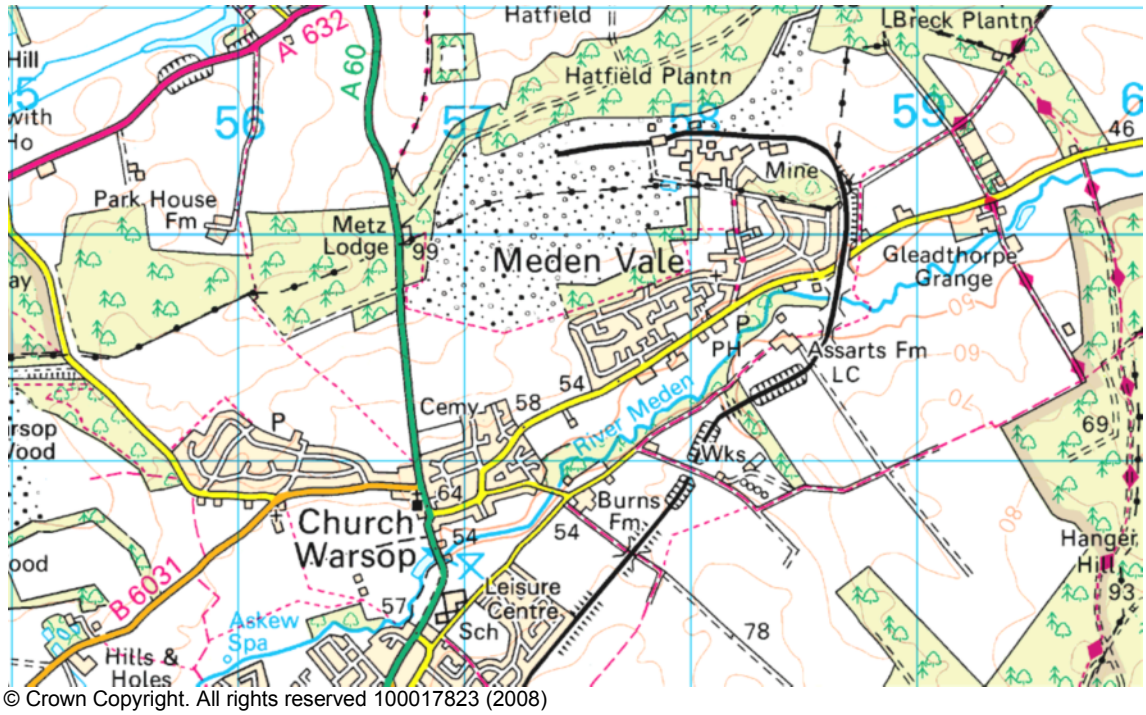


Table 4.4d: Flood Risk Summary of the River Meden Catchment
(Church Warsop & Meden Vale)

General Location	Potential Flood Risks	Possible Development Constraints
Church Warsop	The majority of Church Warsop is unaffected by flooding, except for a small area in the south east which is adjacent to the River Meden.	Development should avoid areas defined as Flood Zone 2 and 3 due to the availability of land elsewhere at lower flood risk.
Meden Vale	Parts of Meden Vale are subject to a high risk of flooding from surface run-off. Rain falling on the low permeability surface of the coal tip is known to exceed the capacity of the drainage system and flow towards the western side of Meden Vale. The land to the south of Netherfield Lane is characterised by low permeability soils, the increased run-off from these areas would however discharge directly into the River Meden without directly affecting properties. The River Meden meanders through this area with an associated floodplain approximately 100m in width.	There are no grounds to preclude development in the high run-off risk area; however development proposals must consider opportunities to fully mitigate flooding from this source. Development to the south of Netherfield Lane should avoid land identified to be within Flood Zone 3 due to the availability of land elsewhere at lower risk.



4.4.2 There have been a number of historic incidents of flooding within the Meden catchment as described in Table 4.5. These are known to be recurrent flood issues and as such particular care should be exercised when considering development proximate to these locations.

Table 4.5: Meden Catchment Historic Flooding

Location	Primary Cause
Pleasley Square, Pleasley	River Meden
Water Lane, Pleasley	River Meden
MAR Route	Surface run-off
Carter Lane, near Shirebrook	Meden Tributary
Sookeholme Road, near Spion Kop	River Meden
The Carrs, A60 Road Bridge	River Meden
Church Road Warsop	River Meden
Meden Vale	Surface run-off

4.4.3 The flow area of key structures has been reviewed throughout the River Meden, However limited availability of survey data for structures on the River Meden means that the flow areas are approximate only. A comparative approach was used to identify the structures most at risk if overtopping. The bridges at Pleasley Square and The Carrs Local Nature Reserve are identified to be at the greatest risk of overtopping, as confirmed by the historic flooding incidents. A full summary of these structures is provided in **Appendix G.**

4.4.4 There are a number of natural springs within the Meden catchment that are not generally found elsewhere in the district. In particular springs at Market Warsop, Sookholme and Spion Kop signify shallow groundwater. Low lying ground in this area may see the emergence of new springs or temporary streams when groundwater levels are elevated in the underlying Limestone aquifer.

4.4.5 The flooding at Meden Vale is caused by surface run-off which flows from the old coal tip towards the River Meden. The coal tip has a particularly low permeability such that a high proportion of rain falling on this site is likely to lead to surface run-off. This is a particular problem in the western end of Meden Vale where the natural topography channels the surface run-off towards the rear of properties in Egmanton Road.

Biodiversity Enhancement Opportunities

4.4.6 Enhancement opportunities specific to the Meden catchment include the introduction of Green SUDS between Hills and Holes and Sookholme Brook SSSI and The Carrs LNR as shown on **Appendix J**. The introduction of appropriate SUDS might provide a link between existing fragmented water vole populations in this area.

4.5 River Maun Catchment

Flood Risk Issues

4.5.1 The River Maun flows through the centre of Mansfield in a northeast direction from Kings Mill Reservoir. Cauldwell Brook is a tributary of the River Maun and joins the main river at Bleak Hills. The River Maun flows through the urban centre of Mansfield and consequently has a number of structures enabling the river to pass under road and railway infrastructure. The natural river has been modified for much of its length, incorporating culverts, weirs, channel reinforcement and flood defences. The River Maun poses a flood risk to isolated low lying areas adjacent to the river.

Table 4.6a: Flood Risk Summary of the River Maun Catchment
(Kings Mill Reservoir to Field Mill Pond)

General Location	Potential Flood Risks	Possible Development Constraints
Kings Mill reservoir to Hermitage Ponds	Kings Mill reservoir provides some attenuation of peak flows. The water level in Hermitage Pond, upstream of the railway may be significantly elevated due to insufficient capacity of the railway culverts.	New development should generally be avoided on the downstream toe of the reservoir embankment.
Bleak Hills	Peak flow through this section of the River Maun is regulated by the culvert under the railway at the Hermitage Ponds. The fluvial flood risk is generally considered to be low. Insufficient capacity of the culvert between Cauldwell Brook and the River Maun results in an increased fluvial flood risk at this location.	Development in the vicinity of the culverted section of Cauldwell Brook must appropriately consider the risk of flooding from Cauldwell Brook.
Sheepbridge Lane to Field Mill pond	The gradient of the river and its embankments is relatively steep along this reach such that the floodplain is narrow, and the flood risks are low. The normal water level in Field Mill Pond is close to the crest level of the embankment, such that a small rise in water level may result in overtopping of the embankment and will not lead to significantly elevated levels upstream of the pond. The extent of flooding upstream of field mill pond is therefore considered to be minor.	None

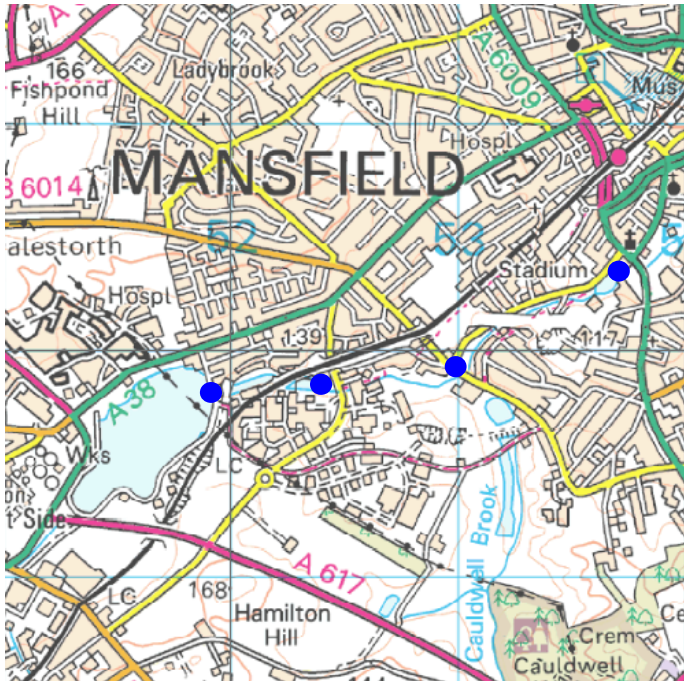


Table 4.6b: Flood Risk Summary of the River Maun Catchment
(Field Mill Pond to Bridge Street)

General Location	Potential Flood Risks	Possible Development Constraints
Field Mill pond to Bath Street	Insufficient capacity of the outlet structure at Field Mill Pond results in a high risk of the embankment overtopping, as was observed in 2007. This results in significant flooding of the properties immediately downstream of the pond and Nottingham Road. Titchfield Park is considered to be floodplain and is therefore at a high risk of flooding. After Titchfield Park the river returns to a relatively deep channel with a reduced risk of flooding	Development immediately downstream of Field Mill Pond must be appropriate to the high flood risk at this location, unless works are undertaken to mitigate the risk of overtopping.
Bath Street to St Peters Way	The river in this location has a steep gradient and flows through a relatively deep channel with no significant risk of fluvial flooding. Both the east and west sides of the river may however be subject to flooding during an extreme event.	Development within the extreme flood outline should undertake a detailed assessment of the flood risk from the River Maun and should incorporate appropriate mitigation measures.
St Peters Way to Bridge Street	The river in this location flows through a relatively deep channel which partially benefits from flood defences. There is no significant risk of flooding at this location, except where flood water can enter properties through unprotected surface water outfalls or gaps in the defences. Both the east and west sides of the river may however be subject to flooding during an extreme event.	Development within the extreme flood outline should undertake a detailed assessment of the flood risk from the River Maun and should incorporate appropriate mitigation measures.

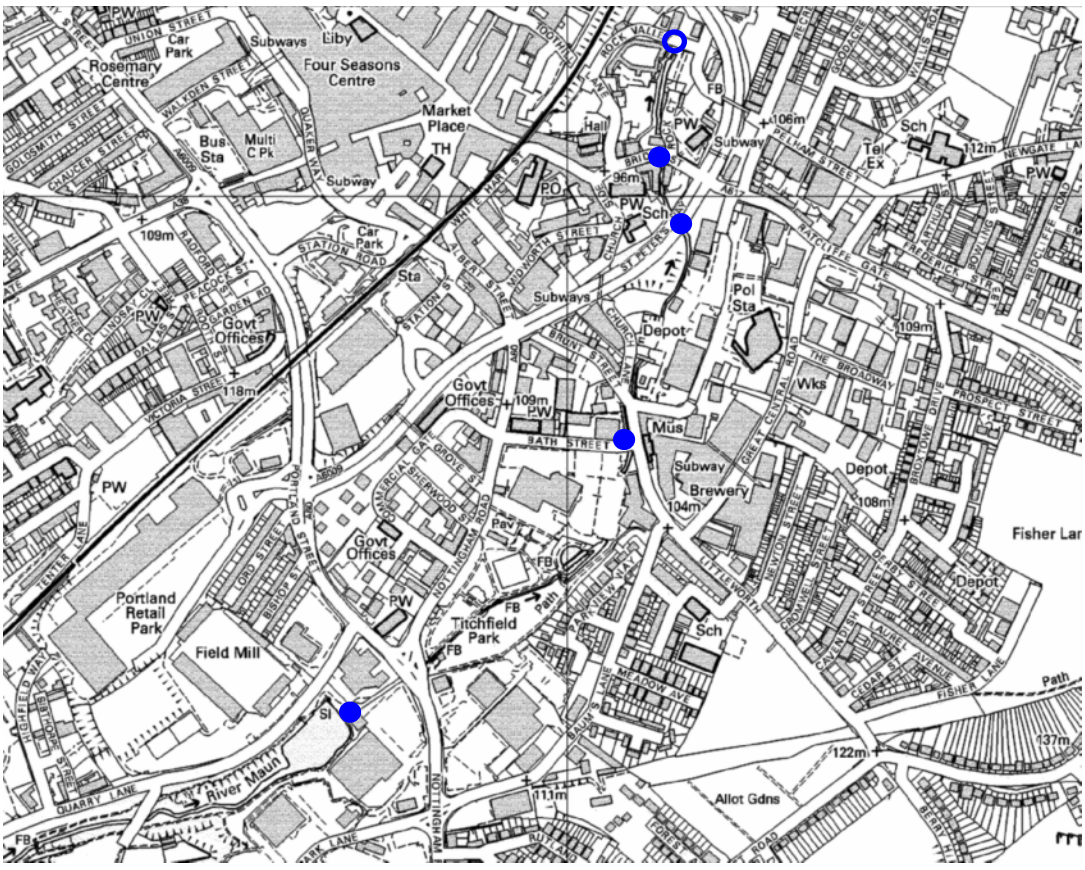


Table 4.6c: Flood Risk Summary of the River Maun Catchment
(Bridge Street to Snake Hill)

General Location	Potential Flood Risks	Possible Development Constraints
Bridge Street to Rock Valley culvert	The area to the west of the river is subject to a high risk of flooding from surface run-off and the sewer network, as has been observed historically. The river at this location is at an increased risk of flooding due to capacity limitations within the Rock Valley culvert. This results in a localised high risk of flooding, predominantly on the western side of the River Maun. Both sides of the river are also subject to flooding during an extreme event.	Development within the 100-year indicative outline should be avoided where possible. Where development is proposed flood resilient construction methods should be employed, floor levels must be situated appropriately above the 100-year flood level flood level, and floodplain compensation provided as appropriate.
Rock Valley culvert to Bath Lane	The Rock Valley culvert will limit the flow and subsequently reduce the risk of flooding along this canalised reach. The west side of the river will however be subject to flooding during an extreme event.	Development within the extreme flood outline should undertake an assessment of the flood risk from the River Maun.
Bath Lane to Old Mill Lane	The river continues in a canalised channel for this reach and there is generally considered to be no significant fluvial flooding in this area. The east and west sides of the river will however be subject to flooding during an extreme event.	Development within the extreme flood outline should undertake an assessment of the flood risk from the River Maun.
Old Mill Lane to Snake Hill	The river flows through a natural channel along this reach with the floodplain confined to the open grassland.	No development should be permitted within the floodplain. Grassland between Old Mill Lane and New Mill Lane could be opened up to provide enhanced flood storage function.

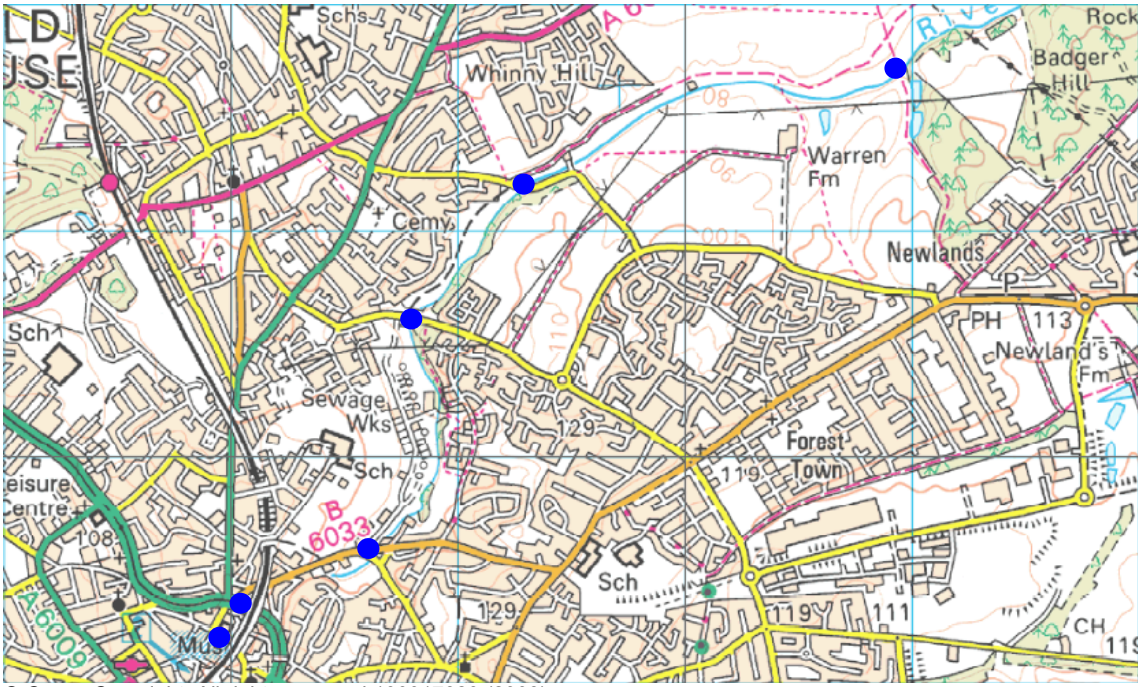
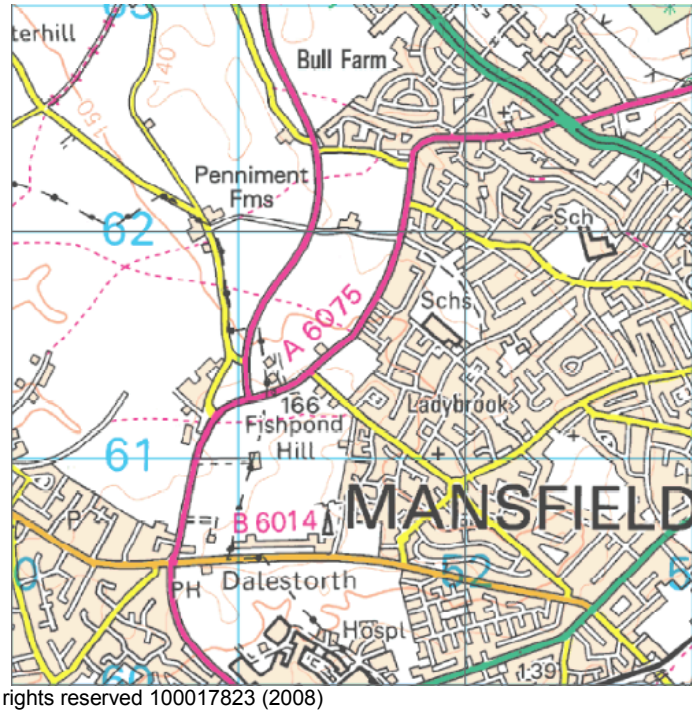


Table 4.6d: Flood Risk Summary of the River Maun Catchment
(West Mansfield)

General Location	Potential Flood Risks	Possible Development Constraints
West Mansfield	An extensive area of low permeability soil on the western boundary is considered to contribute to a high risk of surface-run off in this area. This surface run-off has historically affected parts of the MAR Route further north. The risk of flooding from surface run-off is considered high in this area, particularly where topography and infrastructure leads to a concentration of flows.	There are no grounds to preclude development in the high run-off risk area; however development proposals must consider opportunities to fully mitigate flooding from this source.



4.5.2 The River Maun Flood Risk Mapping report, considers two different modelling techniques to model the flow through the Rock Valley culvert. The two models produced very different 100-year design flood levels upstream of the culvert, being 100mAOD and 96.83mAOD. The Flood Risk Mapping uses the higher value, however, the technical findings of this SFRA considers that the peak 100-year flood level will be lower than indicated in the River Maun Flood Risk Mapping. For the purposes of the SFRA, the 100-year peak level at the upstream end of the Rock Valley culvert is considered to be 97.75mAOD, this is deemed to be an appropriate value which leans toward the lower estimate of the two modelling techniques.

4.5.3 At the 100-year design flood level the general area between Bridge Street and St Peters Way is considered to be protected against fluvial flooding. However, the Environment Agency does not have flood defences between Bridge Street and the Rock Valley culvert; it is therefore considered that there is a considerable flood risk in this confined area.

4.5.4 There are two significant reservoirs within the River Maun Catchment, namely Kings Mill Reservoir and Field Mill Pond. A dam which retains more than 25,000m^3 of water above the adjacent ground level is subject to the Reservoirs Act, 1975. Kings Mill Reservoir is

therefore subject to the Act. Field Mill Pond has recently been surveyed to assess whether it is subject to the Act. Assuming both reservoirs are indeed subject to the Reservoirs Act, they would be categorised as shown in Table 4.7. Kings Mill reservoir is understood to be the responsibility of Ashfield District, while Field Mill Dam is property of Mansfield District. All water bodies under the Reservoirs Act are subject to regular inspection by an appointed Inspecting Engineer and Panel Engineer. The purpose of these inspections is to minimise the risk of a breach which could endanger lives and properties. In terms of planning, it may be inappropriate to allocate land for development which is either at the toe of these embankments which would be subject to rapid and hazardous flooding in the event of an embankment breach.

Table 4.7: Reservoirs

Reservoir	Category	Description
Kings Mill Reservoir	A	Where a breach could endanger lives in a community
Field Mill Dam	B	Where a breach could endanger lives not in a community or could result in extensive damage.

4.5.5 There have been a number of historic incidents of flooding within the Maun catchment as described in Table 4.8. These are known to be recurrent flood issues and as such particular care should be exercised when considering development proximate to these locations.

Table 4.8: Maun Catchment Historic Flooding

Location	Primary Cause
Field Mill Dam	River Maun
Nottingham Road	River Maun
Tichfield Park	River Maun
Bridge Street	Sewer Flooding
MAR Route	Surface run-off

4.5.6 The flow area of key structures has been reviewed throughout the River Maun. A full summary of these structures is provided in **Appendix G.** It is noted that many of the structures with capacity limitations were subject to overtopping during the June 2007 flooding. The main structures considered to have capacity limitations are given in Table 4.9.

Table 4.9: River Maun Structures liable to overtopping

Location	Structure	Watercourse
Access Bridge at Quarry Lane	Culvert	River Maun
Field Mill Pond Main Culvert	Culvert	River Maun
Bath Street Road Bridge	Arch Bridge	River Maun
Culvert at Church Lane	Culvert	River Maun
Access Bridge at New Mill Lane	Rectangular road bridge	River Maun
Spa Lane Road Bridge	Arch road bridge	River Maun
Bridge Street Culvert	Culvert	River Maun
Rock Valley Culvert	Culvert	River Maun

4.5.7 The embankment of Field Mill Pond was overtopped during the June 2007 flooding.

4.5.8 The presence of flood defences in Mansfield reduces the risk of flooding to sites that the River Maun Flood Mapping Study considers to be within Flood Zone 3. In particular:

- *Embankments and walls to the south of Field Mill Pond will provide some protection to the industrial units in this area.*
- *Between Bath Street and Rock Valley, the majority of the river is defended against flooding from events up to the 1 in 100-year event.*

4.5.9 The 100-year flood outline given in **Appendix F** takes the added benefit of defences into account and considers the Rock Valley culvert to have a greater conveyance capacity than is represented through the River Maun Flood Mapping Study. The 100-year flood outline is therefore reduced in the town centre.

4.5.10 The sewers in Bridge Street are prone to flooding during extreme rainfall events. Floodwater exits manholes and gullies at the lower end of Bridge Street to the west of River Maun. The sewer flooding ponds in Bridge Street, impacting on vehicular access and adjacent properties.

Biodiversity Enhancement Opportunities

4.5.11 Priority areas for Green SUDS within Mansfield District should include areas adjacent to Caudwell Brook since the habitats described above are likely to be of significant value to white-clawed crayfish and the systems could help to protect or enhance the quality of run-off entering the brook which is essential for the survival of the crayfish population.

4.5.12 Enhancement opportunities specific to the Maun catchment include the introduction of Green SUDS along the stretch of the River Maun between Kings Mill Reservoir and Caudwell Brook and within Maun Valley Local Nature Reserve, shown on **Appendix J**. The introduction of appropriate SUDS might provide a link between existing fragmented water vole populations in this area.

4.5.13 There are four particular culverts which may present biodiversity enhancement opportunity through their removal in part or along the whole length. These culverts are shown in Table 4.10 and on **Appendix J**.

4.5.14 Culverts **C7, C13 and C14** may present realistic opportunities for restoring natural channel conditions. The impact on diversity may only be minor since the restoration of the channel at these locations will not lead to the linkage of significant habitats. However, the naturalisation of the channel at these locations could potentially lead to the establishment of new habitats and could lead to the enhancement of the urban area through the creation of open space and a significant public amenity.

Table 4.10: Possible Culverts for removal

Culvert ID	Location	Potential biodiversity benefits of reinstatement to open watercourse
C5	Cauldwell Brook	**High**: Restoration in whole or part could link water vole populations and increase habitat for white-clawed crayfish
C7	Field Mill Pond Outfall	**Moderate**: Culvert may act as a barrier to water vole and crayfish passage. Not feasible to link to suitable habitat or other populations
C13	Rock Valley	**Moderate**: Minor benefit to diversity. Restoration of natural channel will improve general amenity and quality of environment.
C14	D/S of Rock Valley	**Moderate**: Minor benefit to diversity. Restoration of natural channel will improve general amenity and quality of environment.

4.5.15 Culvert **C5** connects Caudwell Brook and the River Maun which poses a significant barrier to water vole and white-clawed crayfish passage. The culvert runs parallel to a factory fence line with dense scrub and then enters the factory compound. Restoration of the culvert in whole or part could increase the habitat of water voles and white clawed crayfish within Caudwell Brook and provide greater connectivity with the River Maun, potentially linking existing water vole and crayfish populations.

4.5.16 The removal of sections of culverts is likely to reduce the risk of flooding upstream, and with the exception of Field Mill Pond could increase the risk of flooding downstream. The risk of flooding downstream could be mitigated through the incorporation of increased flood storage and carefully designed flow control structures. With this in mind, the restoration of the channel could provide opportunity to mitigate the fluvial flood risk in Mansfield and provide a long term solution for the sustainability of development within these areas.

4.5.17 The grassland between Old Mill Lane and New Mill Lane could be utilised as additional flood alleviation storage to compensate for the removal of culverts upstream on the River Maun. The utilisation of this grassland is unlikely to benefit Mansfield directly, but could prevent an increased risk of flooding to downstream areas as a consequence of culvert removal.

4.6 Low Flow Catchment

Flood Risk Issues

4.6.1 The Low Flow Catchment includes the ordinary watercourses Vicar Water, Rainworth Water and Foul Evil Brook. These watercourses join the River Maun downstream of the Mansfield District. Vicar Water flows to the south of Forest Town while Foul Evil Brook flows through a predominantly rural area. These watercourses have not been subject to detailed modelling, however the indicative floodplain is narrow and is generally situated away from existing properties.

4.6.2 There are no known historic flood incidents within the Low Flows catchment.

Biodiversity Enhancement Opportunities

4.6.3 Restoration of flows to Vicar Water, Rainworth Water and Foul Evil Brook presents a significant opportunity to enhance the biodiversity at these locations. It is critical that the restoration of low flows be managed in a fashion that does not lead to rapid fluctuations in water depth. The restoration of flows could be achieved through the following:

- *Prioritise the use of soakaways throughout the Low Flow catchment.*
- *Minimise surface water discharge into public sewers which drain surface water away from its natural catchment.*
- *Maximise opportunities for controlled discharge into Vicar Water, Rainworth Water and Foul Evil Brook.*

4.6.4 To maximise the environmental benefit of the restored flows sensitive engineering to re-profile banks, remove excess silt and clear excessive scrub from the dry bed should be included. This will encourage the recovery of aquatic vegetation and maintenance of water depth.

4.7 District Wide

Flood Risk Issues

4.7.1 A summary of the indicative flood risk to Mansfield District, relative to the severity of flooding and area affected is presented in Table 4.11.

Table 4.11: Summary of Spatial Extent of Flood Risk within Mansfield District

Source of Flooding	Potential			Comments
	High	*Med*	*Low*	
Fluvial *(Rivers)*	☐	☐	☒	Extent of flooding generally localised and minor. High risk is apparent near structures with limited capacity.
Pluvial (drainage system)	☐	☒	☐	Expected that capacity exceedance will occur during moderate rainfall events.
Surface Run-off	☐	☒	☐	Isolated incidents of high risk, while overall risk remains moderate due to topography and dense urbanisation
Groundwater	☐	☐	☒	Risk of GW flooding generally low, with the risk increasing proximate to streams and spring lines.

4.7.2 Due to the high proportion of land at low risk of flooding within Mansfield District, land allocations should generally avoid areas considered to be at high risk of indicative flooding. These areas are identified using **Appendix F**, with reference to the following:

- *All development within Flood Zones 2 and 3*
- *All development adjacent to the recorded historic flood incidents*
- *Development prone to a high risk of surface run-off*

Sewer Flooding

4.7.3 Severn Trent Water is responsible for the operation and maintenance of the sewers within the Mansfield District. The sewer network comprises a system of combined foul and surface water sewers with a design capacity ranging from the 1 in 5-year return period rainfall event for the older sewers to an optimum capacity of 1 in 40-year return period rainfall event for some of the newer sewers.

4.7.4 There was no access to Severn Trent's network analysis; it is therefore difficult to identify the primary locations at which sewers will flood. Urban flooding would be expected when the sewer capacity is exceeded (i.e. for events greater than the 5-year to 40-year return period design standard). In this instance the following flooding mechanisms would be expected:

- ***Pluvial Flooding*** *– flooding is caused directly from the surcharging of sewers which results in surface water flowing out of the sewer network and which may back up inside properties.*
- ***Ponding*** *– rain water collects in depressions in the ground unable to drain into the sewer system due to insufficient capacity.*
- ***Surface Run-off*** *– rain water flows overland in accordance with the slope of the ground. The surface water run-off will bypass the drainage gullies due to insufficient capacity in the sewer network.*

Surface Run-off

4.7.5 The risk of surface water run-off is generally associated with large areas of impermeable or low permeability surfaces. The likelihood and severity of surface run-off is increased where topography tends to concentrate flows, such as natural valleys or at the base of hills. Even areas that are considered to be positively drained through the sewer network may be subject to a risk of surface run-off if the sewer capacity is exceeded.

4.7.6 The Mansfield District has steep topography such that the risk of flooding from surface run-off requires due consideration. There are several sources within Mansfield District which contribute to an increased risk of flooding from surface run-off, namely; densely urbanised areas, highways, disused coal tips and low permeability soils. These are discussed in more detail in Section 3.3 of the Technical Guide. A methodology for properly addressing surface run-off is included in the SUDS Code of Practice.

Groundwater Flooding

4.7.7 The potential impact of flooding from groundwater includes flooding of residential or commercial properties located in typically dry valley areas, low lying areas near to rivers or potential spring lines. In addition, where there is no obvious signs of flooding on the surface, rising groundwater levels may impact basement structures leading to potential property damage.

4.7.8 Groundwater conditions can vary significantly even on a local scale depending on the hydro geological conditions and in accordance with PPS 25 a site specific assessment should always be made of the potential for groundwater flooding.

Biodiversity Enhancement Opportunities

4.7.9 The incorporation of SUDS and in particular soakaways should be promoted throughout the district where soil permeability and the absence of a groundwater contamination risk permits. Where the use of Green SUDS is prioritised, the use of subsurface devices should be discouraged in favour of Retention Ponds and Wetlands and to a lesser extent Infiltration Basins and Swales. All SUDS should be designed in accordance with CIRIA C697 and should meet the approval of the Environment Agency.

4.7.10 While the creation of Green SUDS is considered an important enhancement opportunity, it is imperative that this be complemented by maintaining the existing areas of natural and semi-natural habitats within the Mansfield District. This, combined with Green SUDS will help maintain a sustainable floodplain.

4.7.11 The Biodiversity Enhancement Strategy enables resources to be targeted so as to achieve a cost effective strategic approach to watercourse reinstatement, and will contribute to the Nottinghamshire Local Biodiversity Action Plan 'Habitat Action Plan for Rivers and Streams'.

4.8 Consideration of Climate Change

4.8.1 Annex B of PPS 25, provides detailed guidance on how climate change should be considered within the context of new development. Planning has an important role to steer development towards sustainable sites which avoid unnecessary risk to people and property with consideration of the future impact of climate change. Flood Risk Assessments must consider climate change for the design life of the proposed development. Table 4.12 is an extract from PPS 25 and should be applied to all proposed development to ensure that drainage schemes take appropriate account of increased rainfall intensity, and that sites are elevated outside the future floodplain.

Table 4.12: Consideration of the Impact of Climate Change (PPS 25)

Parameter	1990-2025	2025-2055	2055-2085	2085-2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
Peak River Flow	+10%	+20%		

4.8.2 The River Maun Flood Mapping Study, considers the impact of climate change as an increased flow on the 1 in 100-year flood event, which denotes the boundary of Flood Zone 3a (see Table 4.2 and Figure 4.1). The modelled impact of climate change on the River Maun is presented in Appendix E. It should be noted that, while climate change will result in an increase in flood depth, the steep incline of the watercourse and its embankments, means that this generally results in a minor increase in the flood extent, which is not apparent at the scale of the produced mapping.

4.8.3 Where proposed developments are considering the impact of surface water run-off, it is important that they consider an appropriate increase in rainfall intensity, based on the design life of the proposed development. This percentage increase should be applied to the design rainfall obtained from the Flood Estimation Handbook.

5 APPLICATION OF THE MANSFIELD SFRA

5.1 Introduction

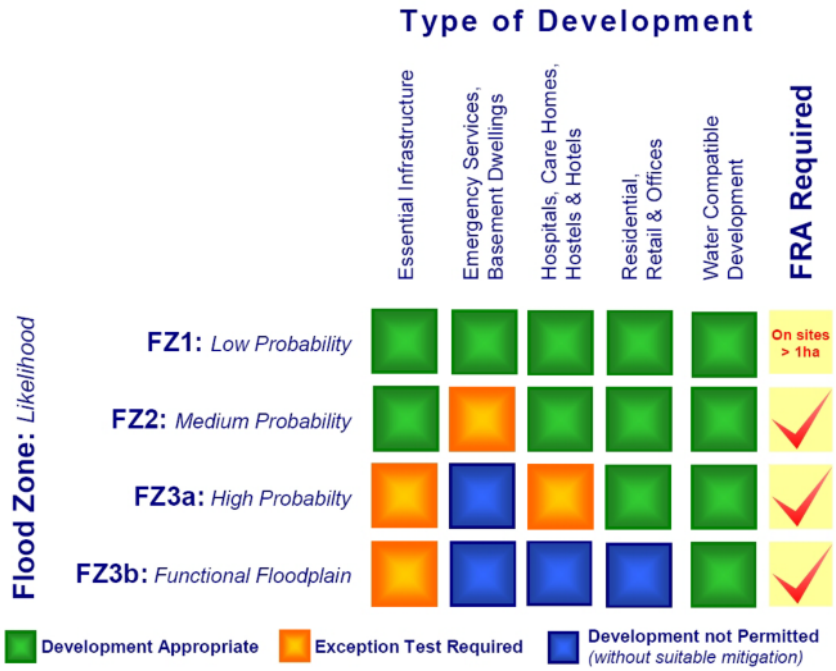
5.1.1 This section provides guidance on the application of the Strategic Flood Risk Assessment.

5.1.2 Flooding must be addressed as a material planning consideration for all major developments greater than 1 Ha and for all development within Flood Zones 2 and 3. This guidance should be read in conjunction with PPS 25, application of the practice codes included below will help planners ensure that flood risk is properly addressed.

5.2 Sequential and Exception Test

5.2.1 The Mansfield SFRA identifies areas at risk of flooding. This information should inform the Sequential Test which seeks to steer development towards areas at a low risk of flooding. The Sequential Test is primarily concerned with the flood risk associated with rivers in order to secure sustainable development and make space for flood water within the natural floodplain. Flood risks from other sources such as surface run-off, may be considered as avoidable risks with the appropriate mitigation measures in place; this should be addressed through a site specific Flood Risk Assessment as described in Section 5.4.

Figure 5.1: FRA Requirements in Accordance with the Sequential Test



5.2.2 The Strategic Evaluation Procedure comprises a four stage process to identify the flood risk to a site, confirm the best flood risk management practices and where appropriate take advantage of opportunities to enhance the biodiversity.

5.2.3 The indicative flood risks within the Mansfield District are generally considered to be low and in accordance with the Sequential Test, should not impact greatly on the LDF allocations. The areas of high risk are localised and will generally affect only small pockets of land.

5.3 Flood Risk Assessment Code of Practice

5.3.1 Flood Risk Assessments are required for all development within Flood Zones 2 and 3 and for all major development. Flood Risk Assessments must be in accordance with PPS 25 and should address any particular concerns held by the Local Authority and the Environment Agency. The Code of Practice given in Figure 5.2 seeks to guide the FRA process.

5.4 SUDS Code of Practice

5.4.1 Drainage assessments are required for all major developments regardless of the flood zone. All development should make appropriate consideration of surface water attenuation and storage. Where appropriate, SUDS should be incorporated, with a general requirement to reduce the discharge rate and preferably total volume from the site. Given the generally permeable nature of the majority of the soils throughout the Mansfield District, the use of infiltration techniques should be explored in the first instance as the preferred means of surface water disposal; the efficacy of infiltration techniques will need to be demonstrated through the application of site-specific FRA's. Exceptions to this rule are where greater biodiversity benefits can be achieved through alternative SUDS techniques. The SUDS Code of Practice given in Figure 5.3 guides the user through a process to help select an appropriate SUDS device. The design of all SUDS will require the approval of the Environment Agency and Local Planning Authority as appropriate.

5.4.2 To aid the design of SUDS, Table 5.1 provides indicative run-off values for different types of surface within the district. Where the design of SUDS refers to the 2-year Greenfield Run-off rate, this will typically be between 2-6 litres/sec/hectare, depending on the soil type. This information is intended for comparison with the peak discharge rates calculated in the detailed drainage design for proposed developments. **These rates should not be relied upon for design purposes.**

5.4.3 Greenfield run-off should normally be calculated in accordance with the Institute of Hydrology Report 124 (IOH124) – Flood Estimation for Small Catchments, 1994. Run-off from brownfield sites should be calculated with appropriate consideration of the capacity of the existing surface water drainage network on the site and within the public sewer into which it discharges. Where attenuation storage is required, this must consider the storage requirement during the critical rainfall event, based on the design rainfall for different intensity storms, obtained using parameters from the Flood Estimation Handbook (FEH).

Table 5.1: Indicative Peak Surface Water Run-off rates

Surface	2-year peak run-off	30-year peak run-off	100-year peak run-off
	l/s/ha	*l/s/ha*	*l/s/ha*
Urbanised Areas & Highways	190	340	440
Disused Coal Tips	6	12	17
Low Permeability Soils	4	9	13
High Permeability Soils	2	4	6

NB This table is for guidance only and must be verified by detailed calculations

Figure 5.2: FRA COP Decision Flow Chart

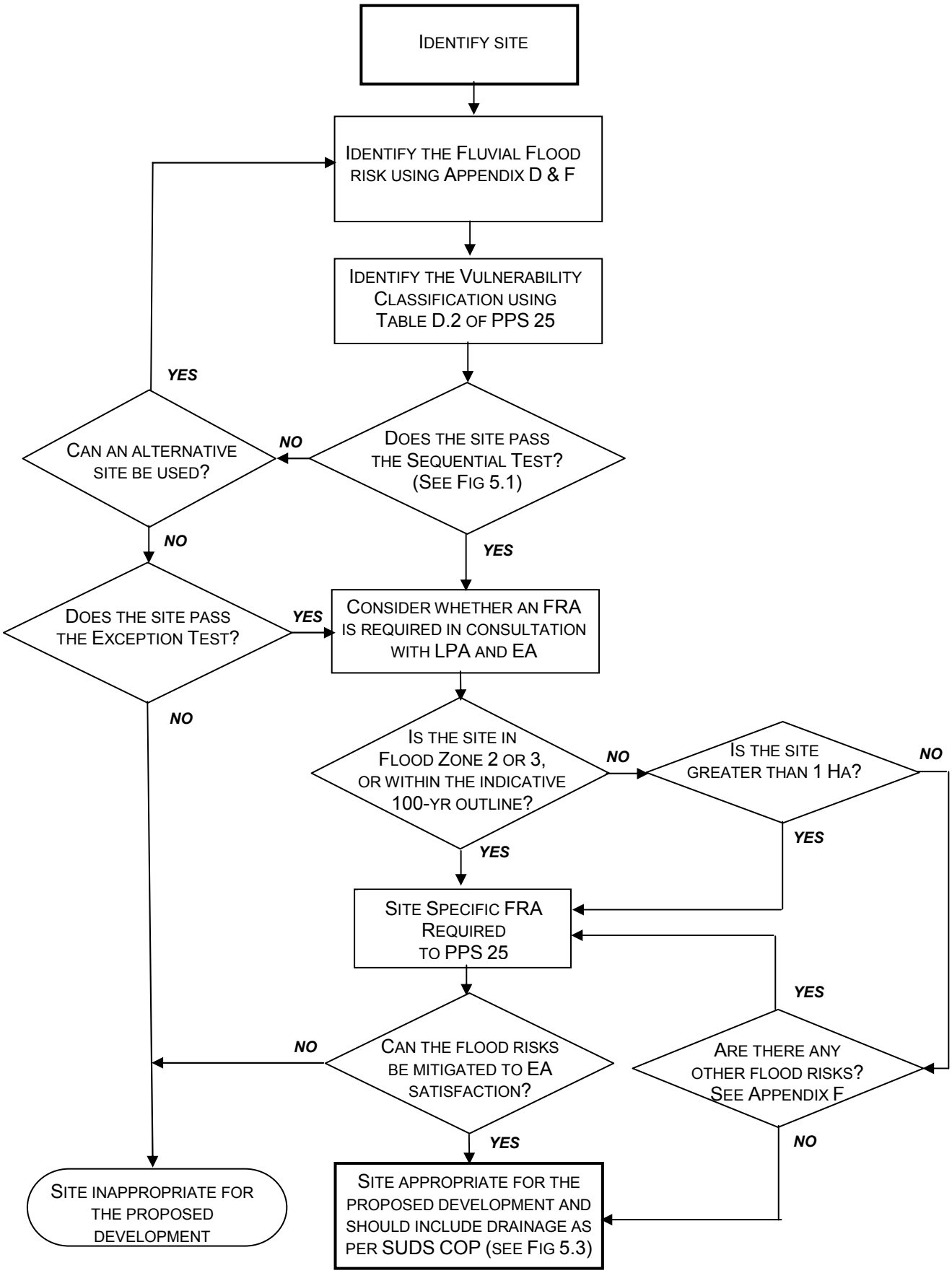
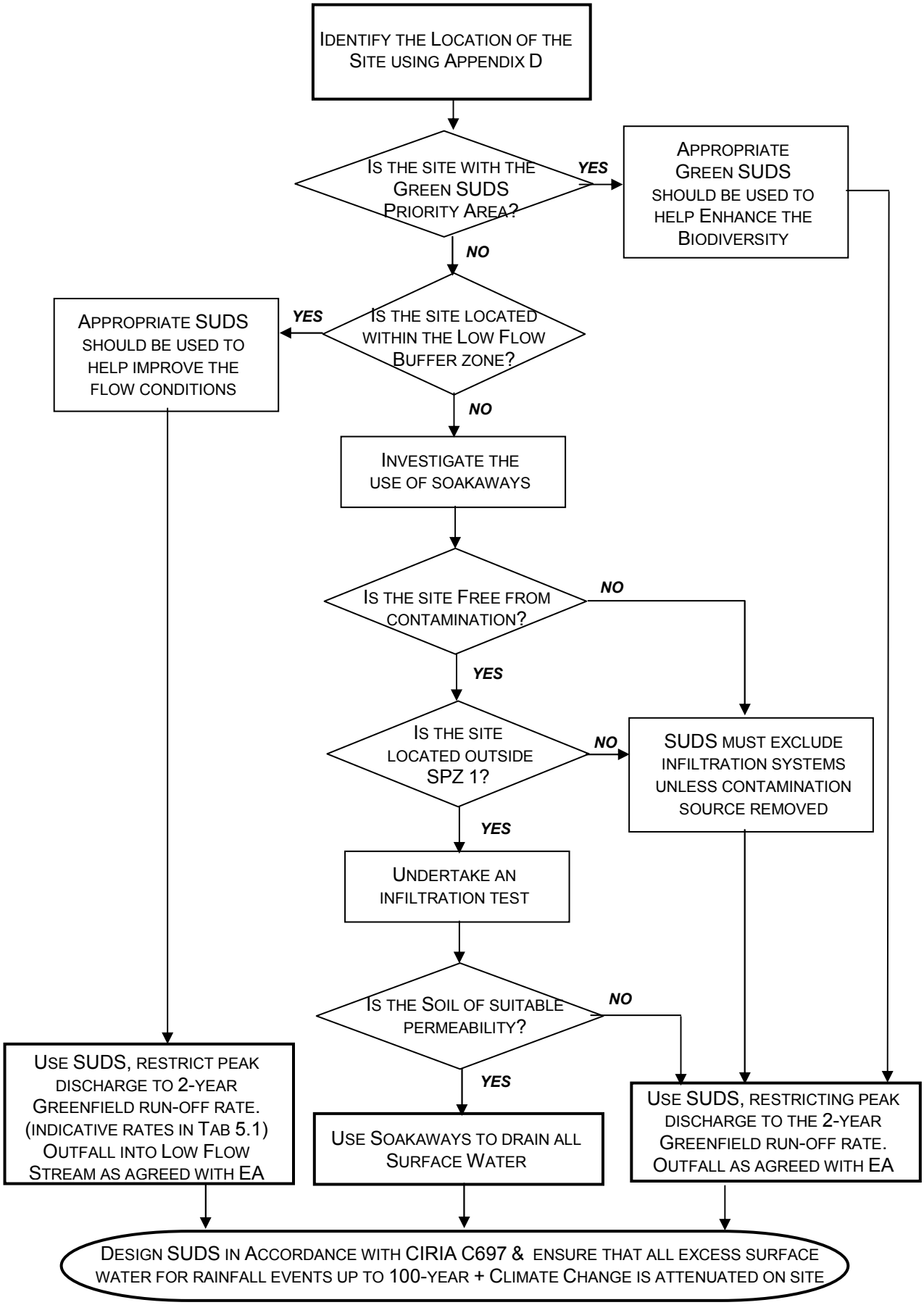


Figure 5.3: SUDS COP Decision Flow Chart



6 CONCLUSIONS

6.1.1 The Strategic Flood Risk Assessment is a co-ordinated response to the flood risk and biodiversity concerns within the Mansfield District. This Guide for Planners and Developers is accompanied by the Technical Report. This accompanying document provides guidance to help steer development away from areas of high risk in accordance with the Sequential Test in PPS 25. Key opportunities to enhance the biodiversity are highlighted through the Biodiversity Enhancement Strategy. Sustainable drainage systems (SUDS) are proposed to suit the local environment and to assist with the overall water management strategy.

6.1.2 In general the Mansfield District is considered to be at low risk of flooding with only 3% of the district at risk of fluvial flooding. There are however specific locations where flooding is a concern and should be addressed through appropriate LDF allocations and good surface water management practices.

6.1.3 The identified historic incidents of flooding from surface run-off and sewer flooding remain unresolved at the time of this assessment.

6.1.4 The River Maun Flood Mapping Study completed in March 2007 is considered to incorporate a conservative modelling approach. While this approach may overestimate the extent of flooding for a given return period, it does nonetheless identify bands of risk which should inform the Sequential Test. It is therefore considered that the mapping study does not materially affect the overall conclusions about flood risk.

6.1.5 The removal of culverts along sections of the River Maun will provide a significant opportunity to enhance the biodiversity and may also present an opportunity to reduce the flood risk to Mansfield and areas downstream.

6.1.6 The Biodiversity Enhancement Strategy enables resources to be targeted so as to achieve a cost effective strategic approach to watercourse reinstatement, with due regard being given to the potential for funding through development.

6.1.7 The current Low Flow conditions observed in Vicar Water, Foul Evil Brook and Rainworth Water could be alleviated through the appropriate regulation of surface water discharge from new developments into these watercourses. Soakaways should also be prioritised where reasonably practical. The widespread application of SUDS will help to cap and even reduce the risk of flooding from sewers and surface run-off.

6.1.8 The findings of the SFRA should be used to inform the Sequential Test and subsequently to inform sustainable management practices. This is described in the four stage process below:

Stage 1: Identification of Flood Zones (Appendix D)
Site allocations should prioritise land at a low risk of fluvial flooding. Appendix D provides an overview of the flood zones at the time of this report being published. It should be noted that these are periodically revised by the Environment Agency. The EA Flood Zone Maps should therefore be consulted in the first instance. The identification of appropriate development for each of the flood zones should be made with reference to Table D.1 and D.3 of PPS 25.

Stage 2: Determine Indicative Flood Risk (Appendix F)
The indicative flood risk gives a more detailed assessment of the fluvial flood risks to a site, and therefore the 100-year indicative flood outline may differ from Flood Zone 3. The indicative flood outline considers the benefit of formal and informal flood defences. Other flood risks should also be considered, in particular related to surface run-off and historic flood locations.

Stage 3: Review Residual Flood Risk (Appendix F)
The residual risk is generally considered to be associated with extreme fluvial flooding with a 0.1% annual probability of occurrence (1 in 1000-year event). The extreme flood outline should inform emergency planning to ensure that Highly Vulnerable development (as defined in Table D.2 of PPS25) is situated away from these areas where reasonably practical.

Stage 4: Surface Water Management and Biodiversity Enhancement (Appendix J)
The information contained in Appendix J should be used in combination with Figure 5.3 in order to maximise the biodiversity and water resource benefits that can potentially be achieved through new development schemes.

6.1.9 All proposed LDF allocations should be reviewed in accordance with the SFRA. It is considered that there is sufficient land available in areas of low risk to prevent the need for extensive development within areas of high or moderate flood risk. The generally steep sides of the river channel and associated floodplain means that in many areas, land adjacent to the rivers may be considered to be at a low risk of fluvial flooding.