URS

Stratford-on-Avon DC, Warwickshire CC, North Warwickshire BC & Rugby BC Level 1 SFRA Report

Final Report

September 2013

UNITED KINGDOM & IRELAND

North Warwickshire Borough Council

Warwickshire County Council

REVISION SCHEDULE					
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EXECUTIVE SUMMARY

URS Infrastructure and Environment UK Ltd. were commissioned to prepare a Level 1 Strategic Flood Risk Assessment (SFRA) on behalf of Stratford-on-Avon District Council (DC), Warwickshire County Council (CC), Rugby Borough Council (BC) and North Warwickshire BC to undertake an update to their Level 1 SFRA produced in 2008. The aim is to inform the preparation of the Development Plan Documents of all the LPAs, Warwickshire CC's Surface Water Management Plan and Warwickshire CC's Minerals and Waste Development Documents.

A Level 1 SFRA was produced by Halcrow consultants for a sub-regional group in January 2008. The group comprised Coventry City Council, Solihull Metropolitan Borough Council and the County, Boroughs and District Councils of Warwickshire. Since that date, there have been a number of significant changes. These include the revocation of Regional Spatial Strategies, the introduction of the National Planning Policy Framework (NPPF)[1] and the Flood and Water Management Act (FWMA). In addition many of the data sets used to inform the 2008 SFRA have since been updated, and/or improved through the use of new modelling approaches. The availability of new policy guidance and improved flood risk data sets makes this an appropriate time at which to update the existing SFRA documents to ensure they are using the best available data.

The primary objective of the study was to enable the LPAs to undertake sequential testing in line with the Government's principles of flood risk and planning set out in the NPPF. The NPPF requires that all development is steered to areas of lowest flood risk where possible. Development is only permissible in areas at risk of flooding in exceptional circumstances where it can be demonstrated that there are no reasonable available sites in areas of lower risk and that the benefits of that development outweigh the risks from flooding. Such development is required to include mitigation/management measures to minimise risk to life and property should flooding occur.

The SFRA forms an essential reference tool providing the building blocks for future strategic planning. The core output of this study is a series of maps (included in Appendices A) which detail the flood risk from rivers, surface water, groundwater and artificial sources to the Study Area.

As the SFRA is likely to be used to inform planning and policy decisions into the future, it is imperative that it is adopted as a 'living document' to be reviewed regularly in light of emerging policy directives and an improved understanding of flood risk within the area. The period between reviews should be no more than 6 years but would ideally be every 3 years.

[1] Communities and Local Government. 2012. *National Planning Policy Framework*. Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.

ABBREVIATIONS

Acronym	Definition
AEP	Annual Exceedance Probability
CFMP	Catchment Flood Management Plan
CLG	Communities and Local Government
DEM	Digital Elevation Model
DPD	Development Plan Documents
EA	Environment Agency
FRR	Flood Risk Regulations
FWMA	Flood and Water Management Act
FRA	Flood Risk Assessment
GIS	Geographical Information Systems
LDDs	Local Development Documents
LDF	Local Development Framework
LDS	Local Development Scheme
LFRMS	Local Flood Risk Management Strategy
LiDAR	Light Detection And Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
mAOD	metres Above Ordnance Datum. Elevations use Ordnance Datum, Newlyn.
NPPF	National Planning Policy Framework
ODPM	Office of the Deputy Prime Minister
PFRA	Preliminary Flood Risk Assessment
PPS25	Planning Policy Statement 25: Development and Flood Risk
RBMP	River Basin Management Plan
RFRA	Regional Flood Risk Appraisal
RPG	Regional Planning Guidance
RSS	Regional Spatial Strategy
SAR	Synthetic Aperture Radar

Acronym	Definition
SAC	Special Area of Conservation
SA	Sustainability Appraisal
SDP	Strategic Development Plan
SFRA	Strategic Flood Risk Assessment
SPD	Supplementary Planning Document
SPG	Supplementary Planning Guidance
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan

GLOSSARY

Term	Definition
Alluvium	Sediments deposited by fluvial processes / flowing water.
Annual Exceedance Probability (AEP)	The probability of an event occurring within any one given year.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Breach	An opening – For example in the sea defences
Brownfield	Previously developed land, usually of industrial land use within inner city areas.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Culvert/culverted	A channel or pipe that carries water below the level of the ground.
Drift Geology	Sediments deposited by the action of ice and glacial processes
EA Flood Zone 1	Low probability of flooding
EA Flood Zone 2	Medium probability of flooding. Probability of fluvial flooding is 0.1 – 1%. Probability of tidal flooding is 0.1 – 0.5 %
EA Flood Zone 3a	High probability of flooding. Probability of fluvial flooding is 1% (1 in 100 years) or greater. Probability of tidal flooding is 0.5%(1 in 200 years)
EA Flood Zone 3b	Functional floodplain
Estuary	A tidal basin , where a river meets the sea, characterised by wide inlets
Exception Test	The exception test should be applied following the application of the Sequential Test. Conditions need to be met before the exception test can be applied.
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Resilience	Resistance strategies aimed at flood protection
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption)
Flood Risk Assessment	Considerations of the flood risks inherent in a project, leading to the development actions to control, mitigate or accept them.
Flood storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Flood Zone	The extent of how far flood waters are expected to reach.
Fluvial	Relating to the actions, processes and behaviour of a water course (river or stream)
Fluvial flooding	Flooding by a river or a watercourse.

Term	Definition
Freeboard	Height of flood defence crest level (or building level) above designed water level
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Freeboard	Height of flood defence crest level (or building level) above designed water level.
GIS	Geographic Information System – A mapping system that uses computers to store, manipulate, analyse and display data.
Greenfield	Previously undeveloped land.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Highly Vulnerable Developments	Developments that are at highest risk of flooding.
Hydraulic Modelling	A computerised model of a watercourse and floodplain to simulate water flows in rivers too estimate water levels and flood extents.
Hydrodynamic Modelling	The behaviour of water in terms of its velocity, depth and hazard that it presents.
Infiltration	The penetration of water through the grounds surface.
Infrastructure	Physical structures that form the foundation for development.
Inundation	Flooding.
LiDAR	Light Detection And Ranging – uses airborne scanning laser to map the terrain of the land.
Local Development Framework (LDF)	The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, site allocations and a proposals map.
Local Planning Authority	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'Main River Map' designated by DEFRA. The environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Overtopping	Water carried over the top of a defence structure due to the wave height exceeding the crest height of the defence.
Reach/ Upper reach	A river or stream segment of specific length. The upper reach refers to the upstream section of a river.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.

Term	Definition
Risk	The probability or likelihood of an event occurring.
River Catchment	The areas drained by a river.
SAR	Synthetic Aperture Radar - a high resolution ground mapping technique, which uses reflected radar pulses.
Sequential Test	Aims to steer development to areas of lowest flood risk.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Solid Geology	Solid rock that underlies loose material and superficial deposits on the earth's surface.
Source Protection Zone	Defined areas in which certain types of development are restricted to ensure that groundwater sources remain free from contaminants.
Standard of Protection	The flood event return period above which significant damage and possible failure of the flood defences could occur.
Storm surge	A high rise in sea level due to the winds of the storm and low atmospheric pressure.
Sustainability	To preserve /maintain a state or process for future generations.
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
Tidal	Relating to the actions or processes caused by tides.
Topographic survey	A survey of ground levels.
Tributary	A body of water, flowing into a larger body of water, such as a smaller stream joining a larger stream.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

1 INTRODUCTION

1.1 Background

A Level 1 Strategic Flood Risk Assessment (SFRA) was produced by Halcrow consultants for a sub-regional group in January 2008. The group comprised Coventry City Council, Solihull Metropolitan Borough Council and the County, Boroughs and District Councils of Warwickshire. Since that date, there have been a number of significant changes. These include the revocation of Regional Spatial Strategies, the introduction of the National Planning Policy Framework (NPPF)[2] and the Flood and Water Management Act (FWMA), the production of a national surface water map (Areas Susceptible to Surface Water Flooding (AStSWF) and Flood Map for Surface Water (FMfSW)) and a significant update of the Environment Agency's Flood Map in 2012.

In addition to the revised policy and guidance documents that have recently been released, many of the data sets used to inform the 2008 SFRA have since been updated, and/or improved through the use of new modelling approaches. The availability of new policy guidance and improved flood risk data sets makes this an appropriate time at which to update the existing SFRA documents to ensure they are using the best available data.

1.2 Planning Context

The NPPF and accompanying Technical Guidance[3] emphasise the responsibility of Local Planning Authorities (LPAs) to ensure that flood risk is understood and managed effectively using a risk-based approach throughout all stages of the planning process. The NPPF requires LPAs to undertake SFRAs to support the preparation of their Local Plan.

The NPPF and Technical Guidance were published in March 2012 and replace Planning Policy Statement 25 (PPS25) Development and Flood Risk[4], however they do not supersede the PPS25 Practice Guidance[5]. Accordingly, this SFRA has been prepared in accordance with the principles set out in the NPPF and supporting guidance.

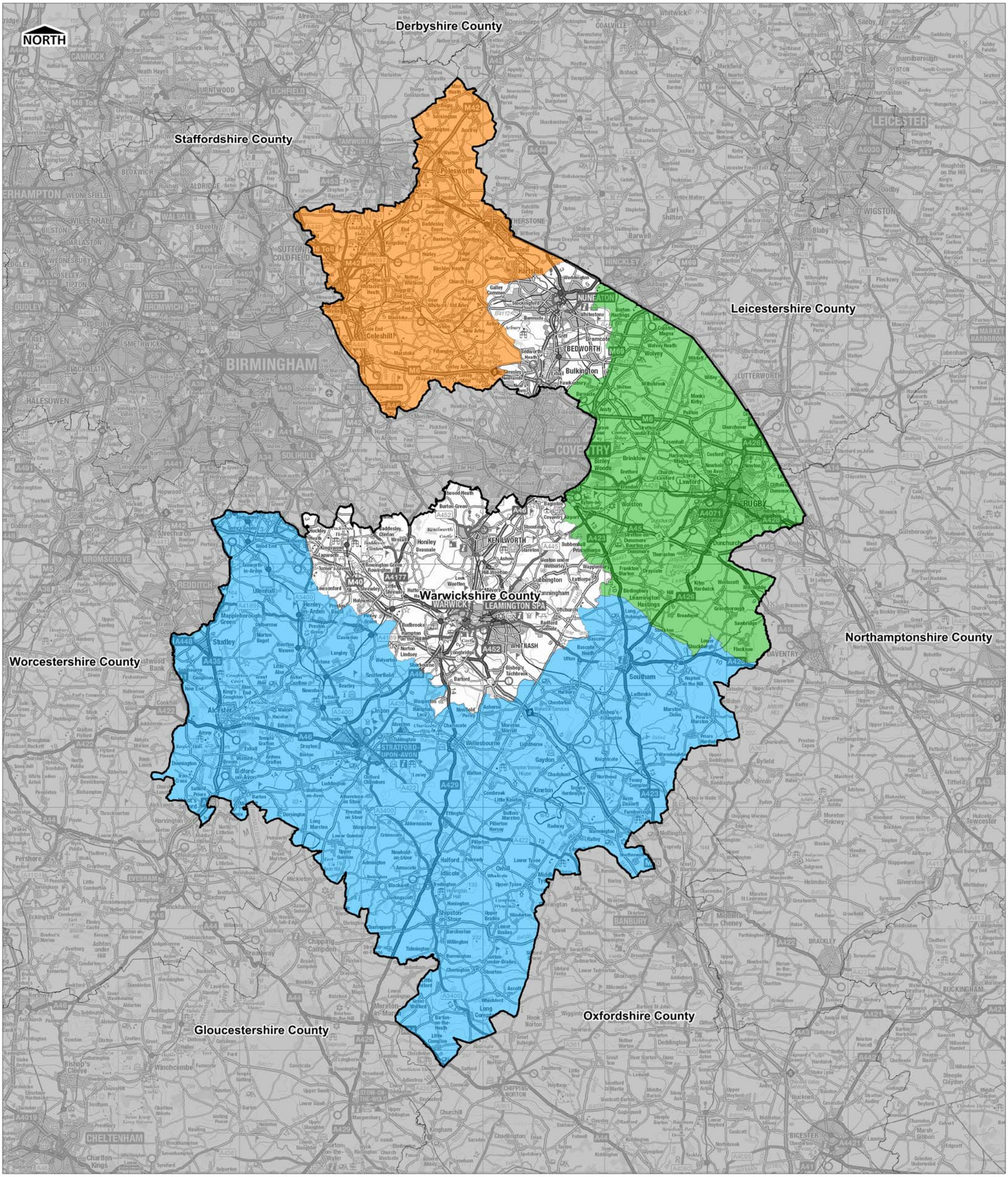
The NPPF and supporting guidance require LPAs to undertake SFRAs and to use their findings, and those of other studies, to inform strategic land use planning, including the application of the Sequential Test which seeks to steer development towards areas of lowest flood risk prior to consideration of areas of greater risk.

1.3 Study Area

Stratford-on-Avon District Council (DC) have commissioned URS Infrastructure and Environment UK Ltd ("URS") jointly with Warwickshire County Council (CC), North Warwickshire Borough Council (BC) and Rugby BC to undertake an update to their Level 1 SFRA produced in 2008 to inform the preparation of the LPA's Development Plan Documents, Warwickshire CC Surface Water Management Plan and Warwickshire CC Minerals and Waste Development Document. A Level 2 SFRA would be required once the LPA's determine their likely allocation sites.

[2] Communities and Local Government. 2012. *National Planning Policy Framework*. Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.
[3] Communities and Local Government. 2012. '*Technical Guidance to the National Planning Policy Framework*'. TSO: London. Available at: http://www.communities.gov.uk/publications/planningandbuilding/nppftechnicalguidance
[4] Communities and Local Government. 2010. *'Planning Policy Statement 25: Development and Flood Risk,* TSO: London.
[5] Communities and Local Government. 2009. *'Planning Policy Statement 25: Development and Flood Risk Practice Guide'*. TSO: London. Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/pps25guideupdate.pdf

Warwickshire County is located to the south and east of the West Midlands conurbation, having strong links with Coventry, Solihull and Birmingham. A significant part of Warwickshire is rural in nature, despite the focus of population being in the main towns of the county. Warwickshire CC is the Mineral Planning Authority (MPA) and Waste Planning Authority (WPA) for the area. Warwickshire CC is also the Lead Local Flood Authority (LLFA) for Warwickshire under the provisions of the FWMA (2010). Stratford-on-Avon DC, Rugby BC and North Warwickshire BC are component parts of Warwickshire County. They are situated to the south, east and north of county respectively. Figure 1-1 shows the Study Area location.



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Warwickshire CC
- North Warwickshire BC
- Rugby DC
- Stratford DC

Stratford-on-Avon DC, Warwickshire CC, North Warwickshire BC, Rugby BC

North Warwickshire Borough Council

Warwickshire County Council

Strategic Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:260,000	Sept 2013	DS	GH

Site Overview

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FIGURE 1-1

1.4 Aims and Objectives of the SFRA Update

The aim of this study is to provide an up to date Level 1 SFRA for Stratford-on-Avon DC, Warwickshire CC, North Warwickshire BC and Rugby BC, which will be used to inform planning and development policies within the county in accordance with the NPPF and supporting guidance.

The aim of the Level 1 SFRA update will be met through the following objectives:

- To provide an assessment of the impact of all potential sources of flooding in accordance with NPPF, including an assessment of any future impacts associated with climate change and sea level rise;
- Enable planning policies to be identified specific to local flooding issues;
- Provide information required to apply the Sequential Test for identification of land suitable for development in line with the principles of the NPPF;
- To provide baseline data to inform the Sustainability Appraisal of the Development Plan Documents (DPDs) with regard to catchment-wide flooding issues which affect the Study Area;
- Provide sufficient information to allow LPAs within the Study Area to assess the flood risk for specific development proposal sites, thereby setting out the requirements for site specific Flood Risk Assessments (FRAs);
- Provide recommendations of suitable mitigation measures including the objectives of Sustainable Drainage Systems (SuDS);
- Enable each of the LPAs within the Study Area to use the SFRA as a basis for decision making at the planning application stage;
- Where necessary, provide technical assessments to demonstrate that development located in flood risk areas are appropriate and in line with the requirements of the exception test; and,
- Present sufficient information to inform each of the LPAs within the Study Area of acceptable flood risk in relation to emergency planning capability.

2 POLICY CONTEXT

Since the 2008 Level 1 SFRA was completed, updates to national planning policy and flood risk have been implemented. This section highlights the main changes and the impacts they have on the SFRA.

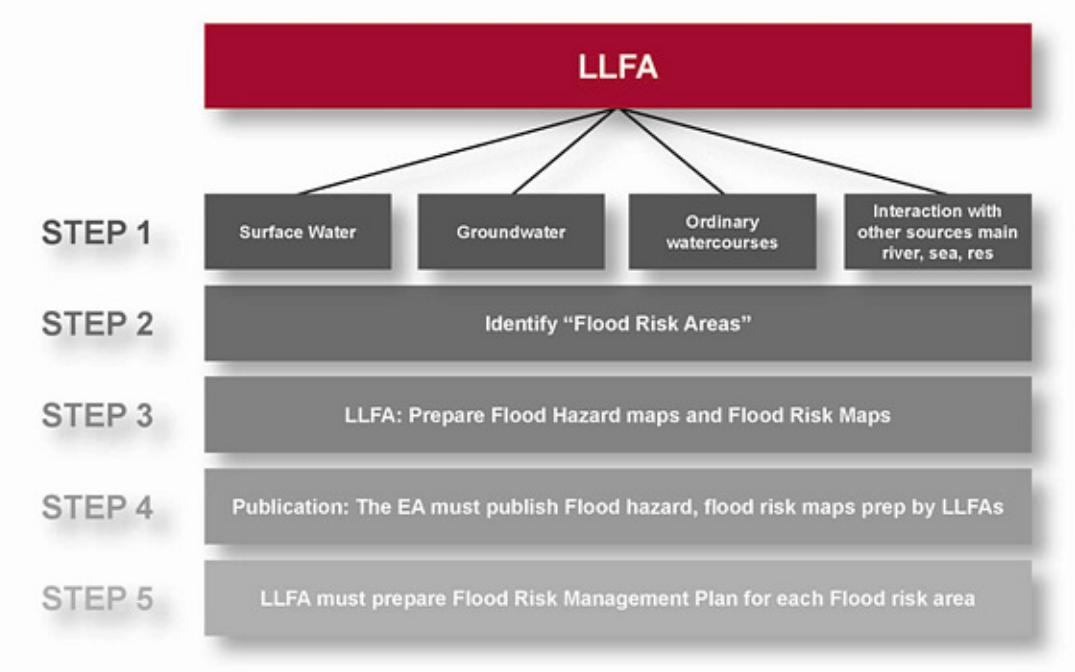
2.1 National Policy

2.1.1 The Flood Risk Regulations (December 2009)

The Flood Risk Regulations[6] came into force on the 10th December 2009 and sets out duties for the Environment Agency and LLFAs in the preparation of a range of reports and mapping outputs.

The Flood Risk Regulations (2009) transpose the EU Floods Directive (2007/60/EC) into UK Law. One of the main impacts on LLFAs in the England and Wales is that they are required to complete Preliminary Flood Risk Assessment (PFRAs). Where Flood Risk Areas were defined within the PFRA Flood Risk Maps showing the extents and hazards of flooding are required to be produced alongside Flood Risk Management Plans (see Figure 2-1).

Figure 2-1: LLFA PFRAs



Warwickshire CC is the Lead Local Flood Authority for Stratford-on-Avon DC, Rugby BC and North Warwickshire BC and is responsible for preparing the following. It should be noted that Warwickshire CC has not been identified as being located within a Flood Risk Area.

- A PFRA report for flooding from sources other than that from the sea, main rivers and reservoirs (March 2011);

[6] The Flood Risk Regulations. 2009. http://www.legislation.gov.uk/uksi/2009/3042/contents/made

- Determine whether, in the opinion of the LLFA, there is a significant flood risk in its area and identify the part of the area, if any, where this risk exists (for sources other than that from sea, main rivers and reservoirs); and

- Where LLFA identify a relevant flood risk area there is a requirement to prepare flood hazard and flood risk maps for these areas for publication by the Environment Agency before 22nd December 2013. In addition, for these areas, a flood risk management plan must be prepared for publication by the Environment Agency by 22nd December 2015.

2.1.2 The Flood and Water Management Act (2010)

Following the devastating national floods of 2007, one of the recommendations from Sir Michael Pitt's review[7] was that "*the role of local authorities should be enhanced so that they take on responsibility for leading the co-ordination of flood risk management in their areas*".

The Flood and Water Management Act (FWMA) (2010)[8] brings in new roles and responsibilities for local authorities. In particular, the Act defines the role of the LLFA, which includes Unitary Authorities or County Councils. LLFAs are encouraged to bring together relevant bodies and stakeholders to effectively manage local flood risk, which may include County, City and District/Borough Councils, Internal Drainage Boards (IDBs), highways authorities, water companies and the Environment Agency.

The new responsibilities that the Act assigns to LLFAs include:

- Coordinated management of flooding from surface water, ground water and ordinary watercourses;

- Development and maintenance and implementation of Flood Risk Management Strategies;

- Investigation and recording of local flood events; and

- Establishment and maintenance of a Flood Risk Asset Register.

The Act gives LLFAs the role of SuDS Approval Body (SAB) where the LLFA is responsible for adopting and maintaining SuDS. This means that planning applications which have drainage implications will need to be approved by the SAB before work can commence.

2.1.3 Draft National Standards for Sustainable Drainage Systems (SuDS) – Designing, constructing, operating and maintaining drainage for surface runoff (2011)

Schedule 3 (Sustainable Drainage) of the Flood and Water Management Act 2010 contains new regulations which have implications on the design, approval and adoption of sustainable drainage. The Draft National Standards for SuDS were published for consultation[9] in December 2011. Further to the consultation, the Government plans to implement the sustainable drainage provisions i.e. publish the National Standards for SuDS and associated guidance with a commencement of the statutory instruments by the end of 2014.

[7] Sir Michael Pitt. June 2008. The Pitt Review: Lessons learned from the 2007 floods. http://www.environment-agency.gov.uk/research/library/publications/33889.aspx
[8] The National Archives. HM Government. 2010. The Flood and Water Management Act. http://www.legislation.gov.uk/ukpga/2010/29/contents
[9] The consultation on the *Implementation of the Sustainable Drainage Systems provisions in Schedule 3 – Flood and Water Management Act 2010* closed on 13th March 2012.

Future developments will have to comply with new measures with a requirement for the submission of a separate drainage application to the LLFA who also act as the SuDS Approval Body (SAB). It is the intention that where SuDS systems serve more than 1 property and are designed to new national standards, the LLFA will adopt the approved drainage system provided that three conditions are met, these are:

- The drainage system is constructed in pursuance of approval;
- The drainage system is constructed and functions in accordance with approval; and
- The drainage system is a sustainable drainage system.

The draft National Standards define SuDS for adoption as those parts of a drainage system that are not vested in a sewage undertaker pursuant to an agreement under section 104 of the Water Industry Act 1991. A developer can therefore request that the SAB adopts drainage systems which serve more than one property and cannot be adopted by the sewage undertaker. It should also be noted that the draft proposal still require the Highways Authorities to adopt drainage associated with publically maintained roads.

The principle strategy for the management of surface water runoff contained within the draft National Standards for SuDS follows existing legislation (such as Building Regulations Part H3).

2.1.4 National Planning Policy Framework (2012)

The NPPF was published on 27th March 2012 together with accompanying Technical Guidance. The NPPF revokes most of the previous Planning Policy Statements (PPS) and Planning Policy Guidance, including PPS25: Development and Flood Risk. However, NPPF does not revoke the PPS25 Practice Guide.

The NPPF consists of a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities.

The overall approach to flood risk is broadly summarised in NPPF paragraph 103:

"When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- *within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and*
- *development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems."*

The NPPF Technical Guide includes statements on policy aims, and reaffirms the need for developers and Local Planning Authorities to seek opportunities to:

- *"Reduce the overall level of flood risk in the area and beyond through the layout and form of the development,*
- *Relocate existing development to land with a lower probability of flooding,*

- *Create space for flooding, and*
- *Apply appropriate sustainable drainage systems."*

Minerals and Waste Policy

The majority of Minerals Planning Guidance (MPG) Notes and Minerals Policy Statements were cancelled with the publication of the NPPF. In addition the NPPF indicated that detailed waste policies will form part of the National Waste Management Plan (expected to be published by end of 2013). The following documents remain in force until they are cancelled or replaced:

- PPS10 Planning for Sustainable Waste Management;
- Planning for sustainable waste management: a companion guide to PPS10;
- Minerals Planning Guidance (MPG)4 Revocation, modification, discontinuance, prohibition and suspension orders;
- MPG8 Planning and Compensation Act 1991 – Interim Development Order Permissions: Statutory Provisions and Procedures;
- MPG 9: Planning and Compensation Act 1991 – Interim development order permissions (IDOS): conditions;
- MPG14: Environment Act 1995 - Review of Mineral Planning Permissions;
- National and regional guidelines for aggregates provision in England 2005-2020;
- Letter to Chief Planning Officers: National and regional guidelines for aggregates provision in England - 2005-2020.

To assist MPAs and WPAs in their strategic land use planning, SFRAs should present sufficient information to enable them to apply the sequential approach where possible to the allocation of sites. It is acknowledged within the NPPF that minerals have to be extracted and processed where the minerals are located but that the operational workings 'should not increase flood risk elsewhere and need to be designed, worked and restored accordingly'. Furthermore, PPS10 outlines that in searching for sites and areas for new or enhanced waste management facilities, the suitability of locations subject to flooding should be taken into consideration.

2.2 Additional Guidance and Strategy Documents

2.2.1 National Flood and Coastal Erosion Risk Management (FCERM) Strategy

In accordance with the FWMA, the Environment Agency have developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England[10]. This strategy provides a framework for the work of all flood and coastal erosion risk management authorities.

The National FCERM Strategy sets out the long-term objectives for managing flood and coastal erosion risks and the measures proposed to achieve them. It sets the context for, and informs the production of local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage

[10] Defra, Environment Agency (2011) The National Flood and Coastal Erosion Risk Management Strategy for England.

local flood risk. It also aims to encourage more effective risk management by enabling people, communities, business and the public sector to work together to:

- establish aims and principles for others to be consistent with;
- ensure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risks;
- encourage innovative management of risks taking account of the needs of communities and the environment;
- ensure that emergency responses to flood incidents are effective and that communities are able to respond properly to flood warnings; and,
- ensure informed decisions are made on land use planning.

2.2.2 Catchment Flood Management Plan (CFMP)

A CFMP is a high-level strategic planning document that provides an overview of the main sources of flood risk and how these can be managed in a sustainable framework for the next 50 to 100 years. The Environment Agency engages stakeholders within the catchment to produce policies in terms of sustainable flood management solutions whilst also considering local land use changes and effects of climate change.

The CFMPs also inform and support planning policies, statutory land use plans and implementation of the Water Framework Directive, so that future development in the catchment is sustainable in terms of flood risk. Awareness of the role of CFMPs among land-use planners is in its infancy as these plans, along with SFRAs, are a relatively new requirement.

The approach that the Environment Agency would like to see taken to flood risk management within the Study Area is outlined in three separate CFMPs, the Severn CFMP (2009), the River Thames CFMP (2009) and the River Trent CFMP (2010).

Each of the CFMPs aims to identify flood risk management policies for the catchments and sets out the preferred plan for sustainable flood risk management over the next 50 to 100 years. The Severn CFMP includes the catchment of the River Avon which dominates the southern part of the Warwickshire CC area. The Trent CFMP covers the northern part of the Study Area including the River Tame. The Thames CFMP covers the southern and western extents of Stratford-on-Avon BC with the Sor Brook and Hanwell Brook draining to the Thames catchment.

The following policies for the approach to flood risk management are the same across the CFMPs and are as follows:

- Policy 1 – No active intervention (including Flood Warning and Maintenance). Continue to monitor and advise.
- Policy 2 – Reduce existing flood risk management actions (accepting that flood risk will increase over time)

- Policy 3 – Continue with existing or alternative actions to management flood risk at current level.
- Policy 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).
- Policy 5 – Take further action to reduce flood risk.
- Policy 6 – Take action with others to store water or manage runoff in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

The policies for each of the CFMPs and sub regions are summarised in the table below:

Table 2-1: CFMP Regions and policy areas

CFMP	Sub Region	Policy	LPA
Severn	Middle Avon, Tributaries, Arrow & Alne, Redditch, Rugby & Teme.	Policy 3	Stratford-on-Avon DC & Rugby BC
	Upper Avon	Policy 6	Stratford-on-Avon DC & Rugby BC
	Coventry	Policy 5	Warwickshire CC
Thames	Upper Thames	Policy 6	Stratford-on-Avon DC
Trent	Mid Staffordshire and Lower Tame	Policy 6	Stratford-on-Avon DC & North Warwickshire BC
	Upper Soar & Upper Anker	Policy 4	North Warwickshire BC
	Birmingham and Black Country	Policy 5	North Warwickshire BC

2.2.3 River Basin Management Plans

In December 2009, the Environment Agency published river basin management plans (RBMPs) covering all the water environments of England and Wales. The plans outlined what would be done to protect and improve the water environment, including mitigating the effects of floods. The plans are produced in a series of six year planning cycles. The Study Area is covered by the River Severn, River Thames and River Humber RBMP. The Environment Agency is now reviewing and updating these RBMPs, and will publish the revised documents in December 2015.

3 DATA COLLECTION AND REVIEW

As outlined in Section 1, one of the objectives of the Level 1 SFRA update is to collect, collate and review available information relating to flooding in the Study Area. The information is then presented in a format to enable each of the Council's within the Study Area to apply the NPPF Sequential Test to their preferred sites for future development and to identify potential development sites which require the application of the Exception Test through a Level 2 SFRA.

3.1 Tasks

The sequence of tasks undertaken in the preparation of the Level 1 SFRA update was, in order:

- Inception meeting with the key project stakeholders;
- Contacted stakeholders requesting data/information;
- Collated and reviewed data and populated data register;
- Identified data gaps;
- Reviewed received data against the SFRA objectives; and,
- Presentation of available relevant information on flood sources and flood risk.

3.2 Stakeholder Consultation

In the preparation of this Level 1 SFRA update, the following stakeholders were contacted to provide data and information:

- Stratford-on-Avon DC;
- Warwickshire CC;
- North Warwickshire BC;
- Rugby BC;
- Severn Trent Water;
- Thames Water Utilities;
- Canal and River Trust; and,
- Environment Agency, Midlands - Central.

The Study Area falls entirely in the Environment Agency's Midlands - Central Region. The Environment Agency has discretionary powers under the Water Resources Act (1991) for all Main Rivers and their associated flood defences within the Study Area.

Severn Trent Water is responsible for the majority of storm water and foul water management across the Study Area, with a small area in the south east of Stratford-on-Avon DC which is the responsibility of Thames Water Utilities. In addition, private individuals may be responsible for drainage systems that operate prior to discharge either into a watercourse or into a public sewer.

3.3 Data/Information Requested

Information and data requested from the stakeholders was integrated in a GIS system to facilitate a review of the datasets. The information and data requested from the identified stakeholders was based on the following categories:

- Terrain Information e.g. LiDAR;
- Hydrology e.g. the main and ordinary watercourses;
- Flood Defence e.g. flood banks;
- Areas benefiting from flood defences;
- Flood Storage Areas;
- Flood Warning Areas and Flood Alert Areas;
- Environment Agency Flood Zone Maps and hydraulic models;
- Geology and groundwater flooding susceptibility;
- Surface water flooding;
- Local Authority Information e.g. Local Development Schemes and allocation sites;
- Artificial sources e.g. Canal network and reservoirs;
- Sewer network; and,
- Historical flood records from all sources of flooding.

Appendix B provides a full data register. The data collected has been used to inform the discussion of flood risk sources in each of the Study Areas (Sections 5 – 8).

Figures have been produced for each of the sources of flooding and cover the entire Study Area. These can be found in Appendix A.

4 LEVEL 1 SFRA DATA

This section describes the available data and methodology used in the production of mapping deliverables for the project.

4.1 Requirements of National Planning Policy Framework

NPPF and its accompanying Technical Documents require SFRAs to present sufficient information on all flood sources to enable the LPAs and the MPA within the Study Area to apply the Sequential Test in their administrative areas. In order to apply the Sequential Test information is required on the probability (High, Medium and Low) of flooding associated with different flood sources. This information should be presented graphically where possible as a series of figures and/or maps. This information has been presented in Appendix A.

In addition, the assessment of probability should also account for the effects of climate change on a flood source for the lifetime of any development that would be approved through each of the Council's emerging Local Plans.

For all but fluvial flood sources the current lack of data makes definition of robust classifications of probability unreliable. For example to define high, medium and low probabilities for groundwater flooding within the Study Area based on one reported incident (with no corresponding record of the severity of that flood) is not robust. Consequently for flood sources other than fluvial and tidal, where only anecdotal evidence of flooding is available, subjective assessments of probability have been made where the data allows.

However in some cases, definitions of probability are not practical or are unreliable; in these situations the flood risk from a particular source should be considered as 'medium' until proven otherwise and should be investigated through a site specific assessment of flood risk submitted as part of a planning application. Details of the requirements for flood risk assessments are presented in Section 9.5.

4.2 Tidal Flooding

Warwickshire CC is located inland and at its closest point, is approximately 110km from the Sea. Therefore there is considered to be no risk of tidal flooding to the Study Area.

As there is no risk of tidal flooding no further mention has been made**.**

4.3 Fluvial Flooding

A GIS layer of the Detailed River Network has been supplied by the Environment Agency to show the locations of all main rivers and other watercourses within the Study Area. The risk of fluvial flooding will be discussed taking into account a range of additional GIS datasets including, the Environment Agency Flood Map, hydraulic models for the main rivers, flood defence locations, flood storage areas and areas benefiting from flood defences. Each of these components is discussed in the following sections.

4.3.1 Environment Agency Flood Map

The Environment Agency provided an extract of their Flood Map for the Study Area (Appendix A, Figures A1i to A1xvi). The Flood Map shows the estimated extent of Flood Zones 2, 3a and 3b for all main rivers. Table 4-1 provides the NPPF definition of the Flood Zones, extracted from Table 1 of the Technical Guidance to the NPPF. The Flood Map provides an indication

of areas at risk of fluvial flooding within the Study Area at a strategic level. However, it does not provide detail on individual properties.

Table 4-1: Definition of Flood Zones

Flood Zone	Definition
Flood Zone 1	Low probability – Defined as zone where there is a less than 0.1% Annual Exceedance Probability (AEP) (1 in 1000 year) of flooding in any year.
Flood Zone 2	Medium probability – Defined as having between 0.1% and 1% AEP (between 1 in 1000 and 1 in 100 year) of fluvial flooding in any year.
Flood Zone 3a	High probability – Defined as having a 1% AEP (1 in 100 year) of fluvial flooding in any year.
Flood Zone 3b	Functional floodplain – Defined as land where water has to flow or be stored in times of flood. Defined as the 5% AEP (1 in 20 year) floodplain or an area designed to flood in an extreme (0.1% AEP) flood, or another probability agreed between the LPA and the Environment Agency. (The Environment Agency do not currently produce Flood Zone 3b mapping for England and Wales).

The Flood Map has been developed by the Environment Agency using a combination of detailed hydraulic modelling information which also utilises detailed LiDAR topography and outputs from the Environment Agency's National Generalised Model. The National Generalised Model outputs are derived from less accurate topographic data (Synthetic Aperture Radar (SAR) or LiDAR data) and national data for river flows.

The Flood Map does not provide information on flood depth, speed or volume of flow. It also does not show flooding from other sources, such as ordinary watercourses, groundwater, direct runoff from fields or parkland, or overflowing sewers.

4.3.2 Flood Zone 3b – Functional Floodplain

Functional floodplains have the highest probability of flooding of all the Flood Zones defined within Table 1 of the NPPF Technical Guidance and Table 4-1 above. A functional floodplain is defined as an area of land where water has to flow or be stored at times of flood. This has been defined by the Environment Agency to be the land which floods during a 5% AEP (1 in 20 year) flood event.

Hydraulic modelling of the functional floodplain has been undertaken on a number of watercourses in the Study Area as part of the Environment Agency Strategic Flood Risk Mapping programme, or as part of SFRAs for individual local authorities. Models greater than four years old are likely to require review prior to use in FRAs due to changes in input data that may alter the flood outlines.

Where available, the Environment Agency has supplied modelled flood outlines for the functional floodplain for the watercourses shown in Table 4-2. The return periods used to map the functional floodplain are predominantly the 5% AEP (1 in 20 year) flood event, or the 4% AEP (1 in 25 year) flood event, both of which are considered suitable to define the Flood Zone 3b Functional Floodplain.

4.3.3 Flood Zone 3a with Climate Change

To ensure sustainable development now and in the future, the NPPF requires that the effects of climate change should be taken into account in an SFRA. The flood outlines delineating climate change have been presented in Appendix A, Figures A1i to A1xvi.

The NPPF suggests that when completing an SFRA, planning bodies will need to agree how to factor climate change and over what time frame. The standard approach adopted by the Environment Agency in their Strategic Flood Risk Mapping is to include a net increase of 20% over and above peak flows, which is added to the 1% AEP (1 in 100 year) flood event to account for climate change. This approach has been adopted for the watercourses used in Table 4-2, and GIS outlines of these flood extent have been supplied for this Level 1 SFRA.

In areas where climate change has not been modelled or mapped it has been agreed with the Council and the Environment Agency that Flood Zone 2 should be used as a surrogate for Flood Zone 3 plus climate change until such time that more detailed information is available, such as a Level 2 SFRA, an Environment Agency Strategic Flood Risk Mapping (SFRM) study or a site-specific FRA.

Table 4-2 Watercourses with Functional Floodplain & Climate Change Flood Zones

Hydraulic Model	Modelled Return Period for Flood Zone 3b Functional Floodplain	Modelled Return Period for Flood Zone 3a with Climate Change
River Swift (1999)	✓ (4% AEP (1 in 25 year))	×
River Anker (2006)	✓ (4% AEP (1 in 25 year))	✓
River Dene (2008 & 2010)	×	×
Shottery Brook (2008)	✓ (5% AEP (1 in 20 year))	✓
River Arrow & Alne (2009)	✓ (5% AEP (1 in 20 year))	✓
River Leam, Itchen, Pingle (2009)	✓ (5% AEP (1 in 20 year))	✓
River Cole (2009)	✓ (5% AEP (1 in 20 year))	×
River Tame (2009)	✓ (5% AEP (1 in 20 year))	✓
River Avon (2010)	✓ (5% AEP (1 in 20 year))	✓
River Kenilworth (2010)	✓ (5% AEP (1 in 20 year))	✓
River Sowe & Sherbourne (2009)	✓ (5% AEP (1 in 20 year))	✓
River Stour (2010)	✓ (5% AEP (1 in 20 year))	✓
Warwick Tributaries (2012)	✓ (5% AEP (1 in 20 year))	✓

4.3.4 Flood Defences

Flood defences are typically engineered structures designed to limit the impact of flooding. Flood defences take several forms including bunds/embankments, canalised channels, culverts and flood storage areas.

Information on flood defences throughout the Study Area has been requested from the Environment Agency as a GIS layer of the National Flood and Coastal Defence Database (NFCDD), listing details of structures and flood defences. The locations of flood defences in the NFCDD are illustrated in the Flood Map figures presented in Appendix A, Figures A1i to A1xvi. The NFCDD aims to provide the following information:

- The location, composition and condition of fluvial and tidal defences and watercourses referenced to identified risk areas;
- The types of asset (i.e. property, infrastructure, environmental) at risk within identified risk areas and including those protected by fluvial, tidal and coastal defences;
- The extent of floods related to different flooding scenarios (e.g. different return periods and different types of flood event such as overtopping or embankment failure).

The Environment Agency Flood Zone Map defines the extent of flooding ignoring the presence of defences. The reason for this approach is to make an allowance for residual flood risk in the event of a failure or breach/blockage/overtopping of the flood defences. This conservative approach over time will reduce reliance on flood defences and raise the awareness of flood risk in defended areas to help ensure that it is managed appropriately as part of development proposals.

4.3.5 Areas Benefiting from Flood Defences

A GIS layer of the Areas Benefiting from Flood Defences has been provided by the Environment Agency and is presented in Appendix A Figure A1, tiles i to xvi. This shows the areas where land benefits from the presence of flood defences up to the 1% AEP (1 in 100 year) chance flood event. If the defences were not there, these areas would potentially flood.

Flood defences do not completely remove the chance of flooding. The risk of flooding to these areas should therefore be considered to be residual, accounting for the possibility of overtopping or a breach of the defences.

The Environment Agency has identified a number of locations where flood alleviation works may provide benefit for local communities. These have been discussed in more detail in the following chapters for each LPA. The Environment Agency will look for opportunities to work in partnership with developers and communities. Details of these schemes should be used to inform Infrastructure Delivery Plans and Community Infrastructure Levy proposals for each LPA.

4.3.6 Flood Storage Areas

A GIS layer of the Flood Storage Areas has been provided by the Environment Agency and is presented in Appendix A, Figure A1, tiles i to xvi. This shows areas where land is designated as an area for temporary storage of excess runoff or river flow.

4.3.7 Flood Warning Areas

The Civil Contingencies Act[11] requires that the Environment Agency 'maintain arrangements to warn the public of emergencies'. As a Category 1 responder, the Environment Agency has a duty to maintain arrangements to warn, inform and advise the public in relation to particular emergencies.

Warwickshire CC also has a duty under the Civil Contingencies Act to warn and inform the public and that is done mainly through the Communications Unit.

The Environment Agency have provided details of areas benefiting from an Environment Agency flood warning system which should be used by emergency planners in conjunction with the Flood Zone maps and flood defence information to assist in developing emergency plans for areas at risk of flooding with the Study Area. The flood warning and flood alert areas are provided at the county level on Appendix A, Figure A7.

4.4 Surface Water Flooding

The Environment Agency Flood Map for Surface Water (FMfSW) gives an indication of the broad areas across the Study Area that are likely to be at risk of surface water flooding. This is the preferred source of surface water mapping (see Appendix A Figure A3i to A3xvi). The document entitled 'Using Surface Water Flood Risk Information' explains how Environment Agency Surface Water Flood Risk Information can be used by planning authorities to help fulfil their planning role as well as local resilience forums (LRFs) and regional resilience teams (RRTs) to help plan their emergency response to surface water flooding; and LLFAs to help fulfil their local flood risk management role.

The FMfSW maps are not suitable for identifying whether an individual property will flood, neither is the intended to be definitive. Rather the FMfSW provides information to support local flood risk management in the absence of any better information.

4.4.1 Mapping

The FMfSW has been prepared for two return periods: the 0.5% AEP (1 in 200 year) and the 3.3% AEP (1 in 30 year). For the purpose of this Level 1 SFRA, the dataset for the 0.5% AEP rainfall event has been mapped and is presented in Appendix A, Figure A3i to A3xvi.

Two categories have been used; shallow, relating to flood depths between 0.1m and 0.3m, and deep, which refers to depths >0.3m.

Figure 4-1 Legend for FMfSW

	Shallow >0.1m
	Deep >0.3m

4.4.2 Limitations

When using the FMfSW, the Environment Agency have stated that planning authorities should not:

- Use the Environment Agency surface water flood maps as the sole evidence for any specific planning decision at any scale without further supporting studies or evidence;

[11] HMSO (2004) Civil Contingencies Act

- Use the Environment Agency surface water flood maps to identify individual properties at risk of surface water flooding;
- Rely on the Environment Agency surface water flood maps alone to show expected areas of surface water flooding;
- Interpret the Environment Agency surface water flood maps as defining the flood extent for a specific probability;
- Use the Environment Agency surface water flood maps for screening planning applications for consulting with the Environment Agency;
- With respect to mapping, the FMfSW layers should only be published or provided externally with an OS base map scale of 1:25,000 or smaller (i.e. 1:50,000 is ok, 1:10,000 is not) and with a zoom scale of 1:10,000 or smaller (i.e. 1:50,000 is ok, 1:5,000 is not).

In the light of these recommendations, this mapping has been used purely as an initial high-level overview of pluvial flood risk across the Study Area.

The Flood Map for Surface Water is currently being updated and is due to be published in December 2013. The updated flood map will assess the flood risk from 0.1 AEP (1 in 1000 year), 1% AEP (1 in 100 year) and 3.3% AEP (1 in 30 year) flood events. Figures in Appendix A Figure A3i to A3xvi will be updated as required when this data is provided.

4.5 Groundwater Flooding

As part of the SFRA, an assessment of the risk of groundwater flooding needs to be considered; however, a quantified assessment of risk from groundwater flooding is difficult to undertake, especially on a strategic scale. This is due to lack of groundwater level records, the variability in geological conditions and the lack of predictive tools (such as modelling) that can be used to make assessments of groundwater flow and risk of groundwater flooding following rainfall events.

The Environment Agency's Areas Susceptible to Groundwater Flooding (AStGWF) dataset is a strategic scale map showing groundwater flood areas on a 1km square grid. This can be seen in Appendix A, Figure A4i to xvi. The Environment Agency has provided information with the data and guidance for using it, which is summarised below.

The AStGWF dataset has been prepared primarily as part of the PFRA process, to allow LLFAs across England and Wales to obtain a broad feel for the wider areas which might be susceptible to groundwater flooding.

The data has used the top two susceptibility bands of the BGS 1:50,000 Groundwater Flood Susceptibility Map therefore covers consolidated aquifers and superficial deposits. It does not take account of the chance of flooding from groundwater rebound. It shows the proportion of each 1km square where geological and hydrogeological conditions show that groundwater might emerge i.e. between 25% - 50% of the 1km square has geological and hydrogeological conditions that may result in groundwater emerging. The susceptible areas are represented by one of four area categories showing the proportion of each 1km square that is susceptible to groundwater emergence. It does not show the likelihood of groundwater flooding occurring.

The dataset covers a large area, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

4.5.1 Limitations

The AStGWF dataset has not been formally assessed as appropriate for any other use than the PFRA.

The data should not be interpreted as identifying areas where groundwater is actually likely to flow or pond, thus causing flooding, but may be of use to LLFAs in identifying, where, for example, further studies may be useful.

The AStGWF should not be used as the sole evidence for any specific flood risk management, land use planning or other decision at any scale. The data may however help to identify areas for assessment at a local scale where finer resolution datasets exist.

4.6 Sewer Flooding

Areas at risk from sewer flooding have been determined through review of records from DG5 registers provided by Severn Trent Water and Thames Water Utilities. In order to fulfil statutory commitments set by OFWAT, water companies must maintain verifiable records of reported sewer flooding, which is achieved through their DG5 registers. Water companies are required to record flooding arising from public foul, combined or surface water sewers and identify where properties have suffered internal or external flooding.

The data provided by each water company is limited to postcodes, resulting in the coverage of relatively large areas by comparatively limited and isolated recorded flood events. . It should be noted that the flood records provided could underestimate the scale as they may not provide a complete and accurate record of flood events in the Study Area as some minor flooding incidents may go unreported, particularly if no properties are affected by internal flooding. Water Companies prioritise investment for potential alleviation schemes depending on the severity and frequency of flooding.

Available data has been mapped showing the areas that have been most and least affected by sewer flooding. For this study, data has been mapped as total sewer flooding incidents which include data for both foul and surface water flooding incidents. This is shown in Appendix A, Figure A5.

As outlined previously, data provided by Water Companies is limited and does not represent a comprehensive record of instances of sewer flooding as some events may not have been recorded and remedial works may have subsequently been undertaken.

4.7 Artificial Sources - Canals and Reservoirs

Artificial sources include any water bodies not covered by the previous categories. This typically includes canals, lakes, reservoirs etc. Appendix A, Figure A6 illustrates the locations of the artificial sources of flooding (canals and reservoirs), historic records of flooding and modelled flood outlines.

The Canal and River Trust provided the location of canals which run through the Study Area as well as locations of overtopping and breach incidents. Water levels within canals are generally maintained to control the risk of flooding to adjacent areas. However they are susceptible to overtopping when they experience high inflows from the wider catchment or from overflow from adjacent watercourses. The breach and overtopping records provided by the Canal and River Trust show that the majority of the incidents occurred in rural areas affecting adjacent towpaths and farmland. Overtopping incidents are generally associated within high inflows resulting from the intense rainfall of the July 2007 event. Breach records

are generally associated with embankment works. The flood records for each Council are discussed in more detail in the following sections.

The Environment Agency has provided information on the location of statutory reservoirs across the Study Area. The outlines of the modelled breach extent for the reservoirs have also been provided. The risk of flooding from reservoirs is considered to be residual as it would only occur with a failure of the reservoir walls.

5 STRATFORD-ON-AVON DISTRICT COUNCIL

5.1 Area Overview

Stratford-on-Avon DC lies in the southern half of Warwickshire and covers an area approximately 978km^2. Stratford-on-Avon DC borders the districts of Solihull, Warwick and Rugby to the north, Wychavon, Cotswold, Redditch and West Oxfordshire to the south-west and Cherwell, South Northamptonshire and Daventry to the east. The district is mainly rural with the main town being Stratford-upon-Avon. The total estimated population in 2011 was 120,800, with a population density of 120/km^2.

Appendix A provides the mapped outputs for all sources of flood risk to the Stratford-on-Avon DC administrative area. Within Appendix A, Figures A1 to A4 tiles viii to xvi cover the Stratford-on-Avon DC administrative area.

5.2 Local Policy

5.2.1 Intended Proposed Submission Core Strategy (2013)

Policy CS.3 – Water Environment and Flood Risk

All development proposals should take into account the predicted impact of climate change on the district's water environment. Measures should include sustainable use of water resources, minimising water consumption, protecting and improving water quality, and minimising flood risk from all sources as set out in the most up-to-date Strategic Flood Risk Assessment.

Flood Risk Areas

All development proposals should be located in Flood Risk Zone 1 (Low Probability Flood Risk).

There is a presumption against development in flood risk areas as shown on the Proposals Map and identified in the most up to date Strategic Flood Risk Assessment.

Development within the Environment Agency's flood risk zones 2, 3a and 3b will only be acceptable when it is compatible with national policy and when the sequential test and the exception test, where applicable, as set out in National Planning Policy Framework, have been satisfied.

The extent of flood risk zones 2, 3a and 3b (as at 2013) is shown on the Policies Map.

The flood plain will be maintained and, where opportunities arise, restored in order to maximise natural storage of flood water, reduce flooding problems and increase landscape and conservation value.

Surface Water Run-off and Sustainable Urban Drainage Systems

Development which increases the risk of flooding elsewhere will not be permitted unless satisfactory mitigation measures accompany the proposal.

As a minimum, run off rates and volumes from development sites should not be greater than the existing run off rates and volumes prior to development. On brownfield development sites, a reduction in the run off rates and volumes should be achieved compared to existing rates and volumes. The run-off requirements for a development site should be agreed with the Environment Agency at an early stage in the planning process.

In greenfield development, there should be no flooding (from all sources) on properties up to the 100 year flood event with an allowance for climate change.

Sustainable Urban Drainage Systems (SuDS) should be proportionately incorporated in all scales of development. Infiltration SuDS should be promoted where it is practical. Where infiltration SuDS are not applicable, surface water should be discharged to a watercourse in agreement with the Environment Agency. Where SuDS are provided arrangements must be put in place for their whole life management and maintenance. Making space for water should be incorporated into the design layout to allow for a full range of SuDS measures.

Applicants should ensure foul and surface water from new development and redevelopment are kept separate where possible. Where sites which currently connect to combined sewers are redeveloped, the opportunity to disconnect surface water and highway drainage from combined sewers must be taken.

Where feasible, all development proposals should seek to control and discharge 100% of surface water runoff generated on site using above ground sustainable drainage systems, such as swales, ponds and other water based ecological features. Where it can be demonstrated that it is not practicable, development proposals should maximise opportunities to use SuDS measures which require no additional land take, i.e. green roofs, permeable surfaces and water butts.

Applicants should ensure that the design of SuDS support the findings and recommendations of the Warwickshire Surface Water Management Plan, the Warwickshire Sustainable Urban Drainage Manual and the District Council's Strategic Flood Risk Assessment.

Development should ensure the linkage of SuDS to green infrastructure to provide environmental enhancement and amenity, social and recreational value, as well as balancing storm flows and improving water quality. The design of SuDS should maximise the opportunity to create amenity, enhance biodiversity and contribute to a network of green (and blue) open space.

5.3 Flood Risk

5.3.1 Historic Flooding

The Environment Agency has provided historic flood outlines for a number of events across the Stratford-on-Avon DC administrative area.

Table 5-1 Historical Flood Events in Stratford-on-Avon DC

Year	Source	Description
March 1947	Main River – Exceedance of channel capacity (no raised defences)	Widespread flooding along the Middle Avon through Stratford-upon-Avon
January 1960	Main River – Exceedance of channel capacity (no raised defences)	Flooding of the River Arrow and River Alne at confluence at Alcester
July 1968	Main River – Exceedance of channel capacity (no raised defences)	Widespread along the Middle Avon, River Dene and River Stour
1979	Main River – Exceedance of channel capacity (no raised defences)	Flooding of River Avon at Hampton Lucy

Year	Source	Description
1985	Main River – Exceedance of channel capacity (no raised defences)	Flooding along the Avon
April 1998	Main River – Exceedance of channel capacity (no raised defences)	Flooding along the Avon
September 1992	Main River – Exceedance of channel capacity (no raised defences)	More localised flooding along the Middle Avon to the north of Stratford-on-Avon
July 2007	Main River – Exceedance of channel capacity (no raised defences)	Widespread flooding along the Middle Avon, River Stour, River Alne, Bell Brook, River Arrow, River Dene

In addition, the council hold records of flooding across the district for events on the 21st of July 2007 and from the 21st to 23rd of November 2012. The records from these two events show the tendency for flooding to result from both heavy rainfall and then resulting fluvial flooding. Incidences of surcharging sewers also occur. The distribution of the flooding can be seen in Appendix A2 Figure viii to xvi. The majority of flooding incidents for both events are associated with the urban areas around the River Avon and its associated tributaries.

5.3.2 Fluvial Flooding

There are a number of Environment Agency designated Main Rivers, and numerous ordinary watercourses with the Stratford-on-Avon DC administrative area. These can be seen, along with the Environment Agency Flood Zones in Appendix A, Figure A1 viii to xvi. The main rivers include the following:

- River Avon
- River Dene
- Shottery Brook
- River Stour
- Marchfont Brook
- Noleham Brook
- River Arrow
- River Alne
- River Itchen
- River Stowe
- Racecourse Brook
- Bell Brook
- Hanwell Brook
- Sor Brook

The River Avon is the predominate river flowing through the administrative area. The section of the River Avon at this point is referred to as the Middle Avon and flows in a south direction across the administrative area. The Middle Avon passes alongside and through several urban areas including Stratford-upon-Avon, Welford-on-Avon and Bidford-on-Avon. There are a number of tributaries to the River Avon including the Bell Brook, River Dene, Racecourse Brook, River Stour, Marchfont Brook, Noleham Brook and River Arrow.

The River Arrow and River Alne flow across the western part of the administrative area. The River Arrow flows in a southerly direction before joining the River Avon just to the south of Bidford-on-Avon. The River Alne flows in a south westerly direction and is a tributary of the Arrow, joining to the south of Alcester.

The River Stowe and River Itchen flow within the north eastern part of the administrative area in an approximate northerly direction. These pass through the urban areas of Southam and Long Itchington before joining the River Leam at Marton.

In the east of the administrative area, the Hanwell Brook and Sor Brook originate before flowing in a south easterly direction out of the district before joining the River Cherwell at Banbury.

Hydraulic Models

Hydraulic models enable the estimation of floodplain extents and flood depths based on detailed topographic data of river channels including structures (bridges, culverts etc.) and flood defences.

Hydraulic modelling has been completed for the following Rivers with the Stratford-on-Avon DC administrative area. The model outputs determine Flood Zone 3b (functional floodplain) 3a and 2 as well as modelling the impacts of climate change on the 1 % AEP (1 in 100 year) flood event. The following hydraulic models have been completed:

- River Dene (2008 & 2010)
- Shottery Brook (2010
- Rivers Arrow & Alne (2009)
- Rivers Leam, Itchen and Pingle (2009)
- River Avon (2010)
- River Stour (2010

Flood Defences

The Environment Agency's NFCDD details the type and location of flood defence assets maintained by the Environment Agency. The presence of formal flood defences across the Stratford-on-Avon DC administrative area is minimal. The location of flood defences can be seen in Appendix A, Figure A1 viii to xvi:

- Raised earth embankment defences located in Alcester at the confluence of the River Arrow and River Alne,
- Raised earth embankment defence along the River Alne, in two locations, south and north of Henley-in-Arden
- Earth embankment along the River Avon at Barton
- Raised Defence to private property at Clifford Chambers
- Embankment along the River Dene at Wellesbourne.

Flood Storage Areas

No flood storage areas have been identified within the Stratford-on-Avon administrative area.

Potential Future Flood Alleviation Schemes

The Environment Agency has identified a number of locations where flood alleviation works may provide benefits to local communities. Within Stratford-on-Avon this includes fluvial flood alleviation schemes at:

- Bell Brook, Snitterfield;
- Lot Brook, Southam;
- Cherington, Shipston-on-Stour; and,
- Fenny Compton.

Planning

- Any planning application for a site within Flood Zones 2, 3a or 3b will require an FRA appropriate to the site and complexity of development;
- Any development proposal greater than 1ha in size within Flood Zone 1 will require an FRA;
- The FRA should explore the risk to the development from all sources of flooding;
- During preparation of a FRA, consultation with the Environment Agency is likely to identify whether hydraulic modelling will be required as part of the assessment. As a minimum the FRA should confirm the extent of Flood Zones 3a and 3b relative to the development. Further planning considerations are included in Section 2;
- Refer to http://www.environment-agency.gov.uk/research/planning/33098.aspx for Environment Agency standing advice on flood risk.

5.3.3 Sewer Flooding

Sewer flooding generally results in localised short term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage, poor maintenance or structural failure.

The majority of the Stratford-on-Avon DC administrative area is serviced by Severn Trent Water. Thames Water Utilities provide the drainage service to a small part of the southern and the eastern part of the administrative area. Severn Trent Water and Thames Water Utilities have supplied data based on a four figure post code to show sewer flooding instances. Appendix A, Figure A5 illustrates these sewer flooding records.

The records show the greatest number of historical sewer flooding incidents (between 10 and 20 records) to have occurred in the post code areas of CV37 9 and CV36 4, associated with Stratford-upon-Avon, Ilmington and Shipston-on-Stour respectively.

Modern sewer systems are typically designed to accommodate rainfall events with a 3.3% AEP (1 in 30 year) return period. Older sewer systems were often constructed without consideration of a design standard therefore some areas may be served by sewers with an effective design standard of less than 3.3% AEP (1 in 30 years). Due to the nature of sewer flooding, the scale of flooding events is generally small.

In future climate change will increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination will increase the pressure on existing sewer systems effectively reducing their design standard, leading to more frequent localised flooding incidents.

Planning

- Future development if not adequately planned can increase the flood risk from sewer flooding and in some cases cause new flood problems to occur. Potential increases in surface water or sewage discharge from new development must be adequately managed and mitigation measures introduced where required.

5.3.4 Surface Water Flooding

Surface water flooding typically arises as a result of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. There is therefore an inherent link between sewer flooding and overland flow/surface water flooding.

Surface water flooding can be compounded when combined with impermeable sub-soils, significant areas of development with associated hard standing areas or areas of open grassland. As the majority of the Study Area is rural, the risk of surface water flooding will be greatest in the urban areas.

The Environment Agency Flood Map for Surface Water (shown in Appendix A, Figure A3 tiles viii to xvi), details the likely extent of shallow (>0.1m) and deep (>0.3m) of surface water flooding resulting from a 0.5% AEP (1 in 200 year) rainfall event.

Surface water flooding is largely driven by the topography of the area, and therefore tends to be associated with the river channels across the administrative area. Within urban areas, the tendency for surface water flooding will be influenced at a local scale by the presence of buildings and structures (bridges) etc. that would impede the flow of surface water.

Potential Future Flood Alleviation Schemes

The Environment Agency has identified a number of locations where flood alleviation works may provide benefits to local communities. Within Stratford-on-Avon DC this includes surface water flood alleviation schemes at Gaydon.

Planning

- Surface water flow paths should be taken into account in spatial planning for urban developments. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this.

- Where an area is identified as being at risk from surface water flooding, site specific flood risk assessments should consider localised flow paths to establish the risks to the site.

- Surface water runoff from all new developments should be attenuated to the greenfield runoff rate for equivalent rainfall events, up to and including, the 1% AEP (1 in 100 year) plus climate change return period event.

- Developments should aim to use SuDS, wherever practicably possible, in order to achieve surface water runoff requirements for all developments. Infiltration measures should be the preferred means of surface water disposal where ground conditions are appropriate.

5.3.5 Groundwater Flooding

Groundwater flooding can occur when the water table rises after prolonged rainfall and emerges above ground level. This is most likely to occur in low-lying areas that are underlain by permeable bedrock and superficial geology.

Figure A4 viii to xvi in Appendix A shows the Environment Agency's AStGWF mapping. This indicates that across the Stratford-on-Avon administrative area, there is generally a low susceptibility to groundwater flooding, with the exception of the land adjacent to the main rivers.

The presence of Mudstone bedrock throughout the Study Area suggests that the risk of groundwater flooding should typically be relatively low. However groundwater flooding risks are often highly localised, and dependent upon geological interfaces between permeable and impermeable subsoils. It is therefore essential that an understanding of site specific ground conditions is achieved through site survey and/or review of detailed borehole data.

The areas of higher susceptibility to groundwater flooding area associated with the superficial deposits of sand & gravel and river terrace deposits. The superficial deposits have the potential to act as Secondary A aquifers (or Minor Aquifers), which are described as permeable layers capable of supporting groundwater supplies at local scales.

Planning

- Where an area is identified as being susceptible to groundwater flooding, site specific flood risk assessments should consider localised groundwater levels and geology to establish the risks to the site.

5.3.6 Artificial Sources

Figure A6 in Appendix A shows the locations of the canals and reservoirs in the Stratford-on-Avon administrative area. The South Stratford Canal, the Grand Union Canal and the Oxford Canal pass through the Stratford-on-Avon DC area. Records from the Canal and River Trust show that there have been a number of historic flooding incidents resulting from breaches and/or overtopping of the canal banks.

There are 16 records of overtopping within Stratford-upon Avon DC. 12 of these are associated with the Oxford Canal. Most of the records are associated with excessive inflows of water during the heavy rainfall event on the 21st of July 2007. The records of flooding are mainly in rural areas, with the exception of one record in the urban area of Stratford-upon-Avon. There are 6 records of flooding from breaches, all of which occurred in rural areas. 5 of these records are associated with the Grand Union Canal at Long Itchington and are attributed to embankment instability post construction.

There are a number of reservoirs present with the Stratford-on-Avon DC area, Earlswood Lakes, Lower Compton, Napton, Upper Compton, Ragley Hall Lake, Warren Chase Water, Wormleighton, Edstone Lake and Walton Hall Lake. There is a residual risk of flooding from these reservoirs which would affect the urban areas of Alcester, Stratford-upon-Avon, Wellesbourne, Southam, Long Itchington, Studely, Bidford-on-Avon and Welford-on-Avon.

Planning

- Where an area is identified as being at risk from flooding from an artificial source, a site specific FRA should consider the risk to the development and potential mitigation measures to account for this flood source.

6 NORTH WARWICKSHIRE BOROUGH COUNCIL

6.1 Area Overview

North Warwickshire BC lies in the north of Warwickshire and covers an area approximately 285km^2. North Warwickshire BC borders the districts of Nuneaton and Bedworth and Hinckley and Bosworth to the east, Coventry, Solihull to the south, Birmingham to the west and Tamworth to the north. The borough is mainly rural with the main town being Atherstone. The total estimated population in 2011 was 62,014.

Appendix A provides the mapped outputs for all sources of flood risk to the North Warwickshire BC area. Within Appendix A, Figures A1 to A4 tiles i to iv cover the North Warwickshire BC administrative area.

6.2 Local Policy

6.2.1 Core Strategy (2013)

Policy NW8 – Sustainable Development

Development should meet the needs of residents and businesses without compromising the ability of future generations to enjoy the same quality of life that the present generation aspires to. Development should…:

- *manage the impacts of climate change through the design and location of development, including sustainable drainage, water efficiency measures , use of trees and natural vegetation and ensuring no net loss of flood storage capacity;*
- *protect the quality and hydrology of ground or surface water sources so as to reduce the risk of pollution and flooding, on site or elsewhere*

6.3 Flood Risk

6.3.1 Historic Flooding

The Environment Agency has provided historic flood outlines for the fluvial flooding event on the 1st of December 1992 which resulted in flooding along the tributaries of the River Trent, including the River Tame, River Anker and River Blythe. The distribution of the flooding can be seen in Appendix A, Figure A2 i to A1iv.

The flood extents of more recent events, including the July 2007 and 2012 events have not yet been produced by the Environment Agency.

6.3.2 Fluvial Flooding

There are a number of Environment Agency designated Main Rivers, and numerous ordinary watercourses within the North Warwickshire BC administrative area. These can be seen, along with the Environment Agency Flood Zones in Appendix A, Figure A1 i to A1iv. The main rivers include the following:

- River Anker
- Bramcote Brook
- Penmire Brook
- River Tame
- River Bourne
- River Cole
- River Blythe
- Hollywell Brook
- Coleshill Hall Brook

The River Tame flows in the western part of the North Warwickshire BC area. The River Blythe flows in a northerly direction across the western extent of the administrative area and is a tributary of the River Tame. The River Cole, flowing form the west, joins the River Blythe at Coleshill Parkway. Shortly after, the Blythe and then the River Bourne (from the east) join the River Tame. This series of rivers flow alongside a number of urban areas, including the periphery of the West Midland urban area, Curdworth, Whitacre Heath and Kingsbury.

The River Anker dominates the northern and eastern part of the borough, flowing in a north westerly direction. The Penmire Brook and Bramcote Brook form tributaries to the River Anker. The River Anker passes through the urban area of Dordon & Polesworth.

Hydraulic Models

Hydraulic models enable the estimation of floodplain extents and flood depths based on detailed topographic data of river channels including structures (bridges, culverts etc.) and flood defences.

Hydraulic modelling has been completed for the following Rivers with the North Warwickshire administrative area. The model outputs determine Flood Zone 3b (functional floodplain) 3a and 2 as well as modelling the impacts of climate change on the 1 % AEP (1 in 100 year) flood event. The River Cole and The River Blythe have not been modelled within the North Warwickshire BC area.

- River Anker (2006)
- River Tame (2009)

Flood Defences

The Environment Agency's NFCDD details the type and location of flood defence assets maintained by the Environment Agency. The presence of formal flood defences across the North Warwickshire BC is minimal and is concentrated in the Coleshill Area where the River Tame, Cole, Blythe and Bourne converge:

- Raised flood embankment along the River Tame at Whitacre Heath (River Tame)
- Concrete revetment at the confluence of the River Blythe and River Tame

- Stone revetment opposite Hams Hall Power Station (River Tame)
- Natural Earth at Minworth Confluence (River Tame)
- Stone revetment opposite Coleshill Sewage Treatment Works (River Tame)
- Marsh Lane Embankment opposite March Lane (River Tame)
- Earth bank alongside flood relief channel (of River Tame)
- Flood bank at rear of factories on Station Road (River Cole)

Flood Storage Areas

No flood storage areas have been identified within the North Warwickshire BC area.

Planning

- Any planning application for a site within Flood Zones 2, 3a or 3b will require an FRA appropriate to the site and complexity of development;
- Any development proposal greater than 1ha in size within Flood Zone 1 will require an FRA;
- The FRA should explore the risk to the development from all sources of flooding;
- During preparation of a FRA, consultation with the Environment Agency is likely to identify whether hydraulic modelling will be required as part of the assessment. As a minimum the FRA should confirm the extent of Flood Zones 3a and 3b relative to the development. Further planning considerations are included in Section 2;
- Refer to http://www.environment-agency.gov.uk/research/planning/33098.aspx for Environment Agency standing advice on flood risk.

6.3.3 Sewer Flooding

Sewer flooding generally results in localised short term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage, poor maintenance or structural failure.

The North Warwickshire BC administrative area is served by Severn Trent Water. Severn Trent Water has supplied data based on a four figure post code to show sewer flooding instances. Appendix A Figure A5 illustrates these sewer flooding records.

The records show the greatest number of historical sewer flooding incidents (between 10 and 20 records) to have occurred in the post code areas of CV9 2 associated with urban areas of Hurley, Baddesley Ensor and Atherstone. Across the rest of the North Warwickshire BC post code areas, there are either no records or between 1 – 5.

Modern sewer systems are typically designed to accommodate rainfall events with a 3.3% AEP (1 in 30 year) return period. Older sewer systems were often constructed without consideration of a design standard therefore some areas may be served by sewers with an effective design standard of less than 3.3% AEP (1 in 30 years). Due to the nature of sewer flooding, the scale of flooding events is generally small.

In future climate change will increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination will increase the pressure on existing sewer systems effectively reducing their design standard, leading to more frequent localised flooding incidents.

Planning

- Future development if not adequately planned can increase the flood risk from sewer flooding and in some cases cause new flood problems to occur. Potential increases in surface water or sewage discharge from new development must be adequately managed and mitigation measures introduced where required.

6.3.4 Surface Water Flooding

Surface water flooding typically arises as a result of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. There is therefore an inherent link between sewer flooding and overland flow/surface water flooding.

Surface water flooding can be compounded when combined with impermeable sub-soils, significant areas of development with associated hard standing areas or areas of open grassland. As the majority of the Study Area is rural, the risk of surface water flooding will be greatest in the urban areas.

The Environment Agency Flood Map for Surface Water (shown in Appendix A, Figure A3), details the likely extent of shallow (>0.1m) and deep (>0.3m) of surface water flooding resulting from an extreme, 0.5% AEP (1 in 200 year) rainfall event.

Surface water flooding is largely driven by the topography of the area, and therefore tends to be associated with the river channels across the administrative area. Within urban areas, the tendency for surface water flooding will be influenced at a local scale by the presence of buildings and structures (bridges) etc. that would impede the flow of surface water.

Potential Future Flood Alleviation Schemes

The Environment Agency has identified a number of locations where flood alleviation works may provide benefits to local communities. Within North Warwickshire BC this includes surface water flood alleviation schemes at Polesworth, Tamworth.

Planning

- Surface water flow paths should be taken into account in spatial planning for urban developments. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this.

- Where an area is identified as being at risk from surface water flooding, site specific flood risk assessments should consider localised flow paths to establish the risks to the site.

- Surface water runoff from all new developments should be attenuated to the greenfield runoff rate for equivalent rainfall events, up to and including, the 1% AEP (1 in 100 year) plus climate change return period event.

- Developments should aim to use SuDS, wherever practicably possible, in order to achieve surface water runoff requirements for all developments. Infiltration measures should be the preferred means of surface water disposal where ground conditions are appropriate.

6.3.5 Groundwater Flooding

Groundwater flooding can occur when the water table rises after prolonged rainfall and emerges above ground level. This is most likely to occur in low-lying areas that are underlain by permeable bedrock and superficial geology.

Figure A4i to iv in Appendix A shows the Environment Agency's AStGWF mapping. This indicates that across the North Warwickshire BC area, there is generally a low susceptibility to groundwater flooding, with the exception of the land adjacent to the main river channels.

Alluvium and River Terrace deposits are the predominant superficial deposits within the North Warwickshire administrative area and are associated with the presence of rivers. These superficial deposits have the potential to act as Secondary A aquifers (or Minor Aquifers), which are described as permeable layers capable of supporting groundwater supplies at local scales.

The bedrock geology within the area supports principal aquifers, as well as Secondary A and B aquifers. The Principal Aquifers are designated as major aquifers and are able to support water supply at a strategic scale.

Groundwater flooding risks are often highly localised, and dependent upon geological interfaces between permeable and impermeable subsoils. It is therefore essential that an understanding of site specific ground conditions is achieved through site survey and/or review of detailed borehole data.

Planning

- Where an area is identified as being susceptible to groundwater flooding, site specific flood risk assessments should consider localised groundwater levels and geology to establish the risks to the site.

6.3.6 Artificial Sources

Figure A6 in Appendix A shows the locations of the canals and reservoirs in the North Warwickshire administrative area. The Coventry Canal and the Birmingham & Fazeley Canal pass through the North Warwickshire BC area. Records from the Canal and River Trust show that there has been one incident of overtopping of the Birmingham & Fazeley Canal within the area. This is occurred in July 2007 and is attributed to overtopping from a water park into the Canal causing flooding of the towpath.

There are 11 reservoirs present with the North Warwickshire BC area, Shustoke Lower, Shustoke Upper, Belfry, Great Pool, Merevale Park Estate, Middleton Hall Lake, Park Meadow, Whitacre, Broadwater, Geary's, Hall Pool, Molands, Oldbury No.1 and Oldbury No. 2. There is a residual risk of flooding from these reservoirs which would affect the urban areas of Atherstone, Dordon/Polesworth, Kingsbury and Whitacre Heath.

Planning

- Where an area is identified as being at risk from flooding from an artificial source, a site specific FRA should consider the risk to the development and potential mitigation measures to account for this flood source.

7 RUGBY BOROUGH COUNCIL

7.1 Area Overview

Rugby BC lies to the east of Warwickshire and covers an area approximately 135km^2. Rugby BC borders the districts of Nuneaton and Bedworth to the north, Harborough and Daventry to the west, Stratford-on-Avon and Warwick to the south and Coventry to the west. The borough is mainly rural with the main town being Rugby. The total estimated population in 2011 was 100,100 and has a population density of 290/km^2.

Appendix A provides the mapped outputs for all sources of flood risk to the Rugby BC administrative area. Within Appendix A, Figures A1 to A4 tiles v to vii and xi to xii cover the North Warwickshire BC area.

7.2 Local Policy

7.2.1 Core Strategy (2011)

Policy CS16 – Sustainable Design

Sustainable drainage systems (SuDS) should be proportionately incorporated in all new scales of developments. Infiltration SuDS should be promoted where it is practical. Where infiltration SuDS are not applicable surface water should be discharged to a watercourse in agreement with the Environment Agency.

7.2.2 Local Plan DPD

The Local Plan DPD for Rugby BC is currently being prepared and will supplement the Core Strategy in guiding development up to 2026. This document will provide flood risk policy specific for the borough and should be referred to for all site specific FRAs.

7.3 Flood Risk

The Environment Agency has provided historic flood outlines for a number of events across the Rugby BC administrative area. The distribution of the flooding can be seen in Appendix A, Figure A2 v, vi, vii, xi and xii.

Table 7-1 Historical Flood Events in Rugby BC

Year	Source	Description
1985	Main River – Exceedance of channel capacity (no raised defences)	Flooding along the Wolston Brook, Sow Brook South, Clifton Brook, River Swift, River Leam, Millholme Brook, Birdingbury Brook and Upper Avon
April 1998	Main River – Exceedance of channel capacity (no raised defences)	Flooding along the Upper Avon along its extent through Rugby BC.
September 1992	Main River – Exceedance of channel capacity (no raised defences)	More localised flooding along the Upper Avon at Bretford, Long Lawford and east of rugby. Along the River Swift and sections along the Clifton Brook (east of Rugby).

Additionally, Rugby BC have 23 records of flooding resulting from heavy rainfall between the 22nd and 25th of November 2012. The records indicate flooding resulting from surface water

runoff, fluvial, sewer and groundwater sources. Consequences of flooding include disruption to roads and some internal flooding of properties.

7.3.1 Fluvial Flooding

There are a number of Environment Agency designated Main Rivers, and numerous ordinary watercourses with the Rugby BC administrative area. These can be seen, along with the Environment Agency Flood Zones in Appendix A (Figure 1A v, vi, vii, xi and xii). The main rivers include the following:

- River Avon (upper)
- River Swift
- Clifton Brook
- Sow Brook
- Wolston Brook
- River Leam
- Hillholm Brook
- Birdingbury Brook
- River Itchin
- Withy Brook
- River Anker
- Sketchley Brook
- Harrow Brook

The River Avon (Upper Avon) flows in a westerly direction across the central area of the Rugby BC administrative area. There are a number of tributaries to the River Avon through the Rugby BC administrative area including the Clifton Brook, River Swift, Sow Brook and Wolston Brook. The Upper River Avon, Clifton Brook, River Swift and Sow Brook pass through the urban area of Rugby. Downstream of Rugby, the River Avon flows alongside the urban areas of Long Lawford, Wolston and Ryton-on-Dunsmore.

The River Leam flows in a westerly direction across the southern part of the Rugby BC administrative area. The Birdingbury Brook is a tributary of the River Leam. The River Itchin flows along the administrative border and joins the River Leam at Marton.

The Withy Brook originates in the rural area to the west of Coventry and flows in a westerly direction out of the borough. The Withy Brook is a tributary of the Sow Brook.

The River Anker originates in the northern part of the Rugby BC administrative area. The Harrow Brook is a tributary of the River Anker and flows in a westerly direction from Hinckley before joining the River Anker. The Sketchley Brook is a tributary of the Harrow Brook and flows across the northern part of the borough in a westerly direction.

Hydraulic Models

Hydraulic models enable the estimation of accurate floodplain extents and flood depths based on detailed topographic data of river channels including structures (bridges, culverts etc.) and flood defences.

Hydraulic modelling has been completed for the following Rivers with the Rugby BC administrative area. The model outputs determine Flood Zone 3b (functional floodplain), 3a and 2 as well as modelling the impacts of climate change on the 1% AEP (1 in 100 year) flood event. The following hydraulic models have been completed:

- River Anker (2006)

- River Avon (2009)
- Rivers Leam, Itchen, Pingle (2009)

Flood Defences

The Environment Agency's NFCDD details the type and location of flood defence assets maintained by the Environment Agency. The presence of formal flood defences across the Rugby BC area is minimal:

- Earth embankment along the left and right banks of the River Swift before the confluence with the Upper Avon.
- Flood wall defence (Upper Avon at Rugby)
- Raised defence forming boundary to flood storage area. (Upper Avon)
- Two Earth Embankments at Newbold-on-Avon (Upper Avon)

Flood Storage Areas

There are a number of flood storage areas along the Upper Avon and Clifton Brook, predominately locate within the Rugby urban area as part of the River Avon Flood Relief Scheme. These are maintained by the Environment Agency:

- Butlers Leap (Flood storage area alongside Clifton Brook)
- Boughton Road (Flood Plain alongside Clifton Brook)
- Avon Mill Recreation Ground (Flood storage area alongside the Upper Avon)
- Newbold Recreation Ground (Flood storage area alongside the Upper Avon)

Planning

- Any planning application for a site within Flood Zones 2, 3a or 3b will require an FRA appropriate to the site and complexity of development;
- Any development proposal greater than 1ha in size within Flood Zone 1 will require an FRA;
- The FRA should explore the risk to the development from all sources of flooding;
- During preparation of a FRA, consultation with the Environment Agency is likely to identify whether hydraulic modelling will be required as part of the assessment. As a minimum the FRA should confirm the extent of Flood Zones 3a and 3b relative to the development. Further planning considerations are included in Section 2;
- Refer to http://www.environment-agency.gov.uk/research/planning/33098.aspx for Environment Agency standing advice on flood risk.

7.3.2 Sewer Flooding

Sewer flooding generally results in localised short term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage, poor maintenance or structural failure.

The Rugby BC administrative area is served by Severn Trent Water. Severn Trent Water has supplied data based on a four figure post code to show sewer flooding instances. Appendix A Figure A5 illustrates these sewer flooding records.

The records show the greatest number of historical sewer flooding incidents (between 10 and 20 records) to have occurred in the post code areas of CV22 5 associated with the southern part of the Rugby urban area. The post code areas of CV22 7, CV22 6 and CV23 8 have a moderate level of sewer flooding records (6 – 10).

Modern sewer systems are typically designed to accommodate rainfall events with a 3.3% AEP (1 in 30 year) return period. Older sewer systems were often constructed without consideration of a design standard therefore some areas may be served by sewers with an effective design standard of less than 3.3% AEP (1 in 30 years). Due to the nature of sewer flooding, the scale of flooding events is generally small.

In future climate change will increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination will increase the pressure on existing sewer systems effectively reducing their design standard, leading to more frequent localised flooding incidents.

Planning

- Future development if not adequately planned can increase the flood risk from sewer flooding and in some cases cause new flood problems to occur. Potential increases in surface water or sewage discharge from new development must be adequately managed and mitigation measures introduced where required.

7.3.3 Surface Water Flooding

Surface water flooding typically arises as a result of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. There is therefore an inherent link between sewer flooding and overland flow/surface water flooding.

Surface water flooding can be compounded when combined with impermeable sub-soils, significant areas of development with associated hard standing areas or areas of open grassland. As the majority of the Study Area is rural, the risk of surface water flooding will be greatest in the urban areas.

The Environment Agency Flood Map for Surface Water (shown in Appendix A, Figure A3 (tiles v to vii and xi to xii), details the likely extent of shallow (>0.1m) and deep (>0.3m) of surface water flooding resulting from an extreme, 0.5% AEP (1 in 200 year) rainfall event.

Surface water flooding is largely driven by the topography of the area, and therefore tends to be associated with the river channels across the administrative area. Within urban areas, the tendency for surface water flooding will be influenced at a local scale by the presence of buildings and structures (bridges) etc. that would impede the flow of surface water.

Potential Future Flood Alleviation Schemes

The Environment Agency has identified a number of locations where flood alleviation works may provide benefits to local communities. Within Rugby BC this includes surface water flood alleviation schemes at Broadwell and Pailton.

Planning

- Surface water flow paths should be taken into account in spatial planning for urban developments. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this.
- Where an area is identified as being at risk from surface water flooding, site specific flood risk assessments should consider localised flow paths to establish the risks to the site.
- Surface water runoff from all new developments should be attenuated to the greenfield runoff rate for equivalent rainfall events, up to and including, the 1% AEP (1 in 100 year) plus climate change return period event.
- Developments should aim to use SuDS, wherever practicably possible, in order to achieve surface water runoff requirements for all developments. Infiltration measures should be the preferred means of surface water disposal where ground conditions are appropriate.

7.3.4 Groundwater Flooding

Groundwater flooding can occur when the water table rises after prolonged rainfall and emerges above ground level. This is most likely to occur in low-lying areas that are underlain by permeable bedrock and superficial geology.

Figure A4 (tiles v to vii and xi to xii) in Appendix A shows the Environment Agency's AStGWF mapping. This indicates that across the Rugby BC area, there is generally a moderate susceptibility to groundwater flooding, associated with the superficial deposits across the area.

Till and Glacial Sand and Gravel deposits for the predominant superficial deposits across the Rugby BC administrative area. There is some river terrace deposit and alluvium associated within the river channels of the area. These superficial deposits have the potential to act as Secondary A aquifers (or Minor Aquifers), which are described as permeable layers capable of supporting groundwater supplies at local scales.

The bedrock geology of the administrative area is made predominantly of mudstone, siltstone limestone and sandstone. The bedrock geology within the area supports Secondary A and B aquifers.

Groundwater flooding risks are often highly localised, and dependent upon geological interfaces between permeable and impermeable subsoils. It is therefore essential that an understanding of site specific ground conditions is achieved through site survey and/or review of detailed borehole data.

Planning

- Where an area is identified as being at risk from groundwater flooding, site specific flood risk assessments should consider localised groundwater levels and geology to establish the risks to the site.

7.3.5 Artificial Sources

Figure A6 in Appendix A shows the locations of the canals and reservoirs in the Rugby administrative area. The Oxford Canal, Stretton Arm of the Oxford Canal and Grand Union Canal pass through Rugby BC administrative area. Records from the Canal and River Trust show that there have been five incidents of overtopping and one breach event along the Oxford Canal within the administrative area. These have all occurred within rural areas of the borough. The overtopping incidents are recorded to have occurred as a result of excessive inflows to the canals and resulted in flooding of adjacent towpaths. The breach event is described as embankment failure from leakage and has been subsequently repaired.

There are a number of reservoirs within the Rugby BC area, Draycote Water, Makin Fisheries, Brinklow Marina (under construction), Coombe Pool and Ventnor Farm Marina (under Construction).There is a residual risk of flooding from these reservoirs which would affect the urban areas of Rugby, Wolston and Ryton-on-Dunsmore

Planning

- Where an area is identified as being at risk from flooding from an artificial source, a site specific FRA should consider the risk to the development and potential mitigation measures to account for this flood source.

8 WARWICKSHIRE COUNTY COUNCIL

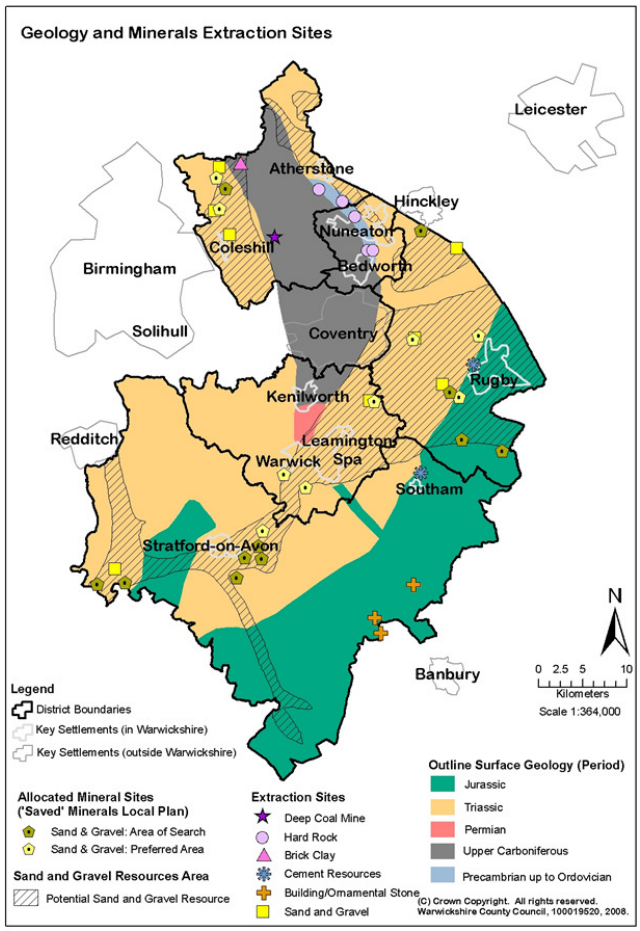
8.1 Area Overview

Warwickshire CC is located in the West Midlands region of England. Five districts/boroughs are located within the county of Warwickshire; North Warwickshire, Nuneaton and Bedworth, Rugby, Warwick and Stratford-on-Avon. The major towns within the county include Atherstone, Bedworth, Nuneaton, Rugby, Royal Leamington Spa, Stratford-upon-Avon and Warwick. The total estimated population in 2011 for the county was 545,474 and has a population density of 720/km^2. Warwickshire CC is the MPA and WPA for all district and borough councils within its administrative area. Warwickshire CC is also the LLFA for Warwickshire.

8.1.1 Minerals

Warwickshire CC has a diverse range of mineral resources available with the main extracts including coal, sand & gravel, crushed rock, brick clay and ironstone. The locations of the existing mineral sites are shown below in Figure 8-1.

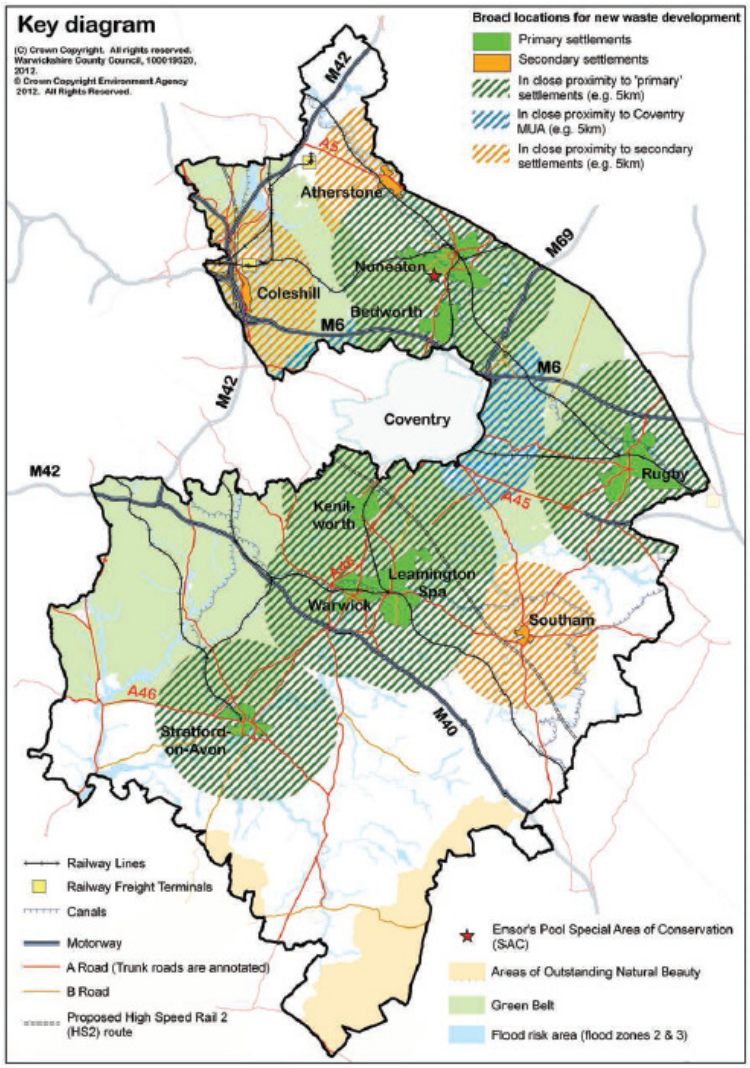
Figure 8-1: Warwickshire CC geology and Minerals Extraction Sites *(Source: Warwickshire CC Minerals Core Strategy – revised Spatial Options)*



8.1.2 Waste

Warwickshire CC has four main waste streams including municipal waste, commercial & industrial, construction & demolition and hazardous. Figure 8-2 below outlines the broad locations for new development of waste sites within Warwickshire CC.

Figure 8-2: Broad locations for new waste development *(Source: Warwickshire CC Waste Development Framework Core Strategy)*



8.2 Local Policy

8.2.1 Warwickshire Minerals and Waste Development Framework

The Minerals and Waste DPDs form part of the statutory Minerals and Waste Development Framework for Warwickshire which delivers the spatial planning strategy for the area. SFRAs are one of the documents used as the evidence base for planning decisions. The Minerals and Waste Core Strategies provide the strategy and policies for minerals and waste planning in Warwickshire for a 15 year plan period.

The Waste Core Strategy was adopted by Warwickshire CC on 9th July 2013. The Waste Core Strategy did not include specific site allocations as it was concluded that there was sufficient capacity already permitted to meet the County's waste management and treatment requirements over the plan period. However, the plan will be subject to annual review through the Authority Monitoring Report process. If permitted treatment capacity is 'lost' to the extent that the County is unable to meet its capacity requirements, then there may be a formal Plan Review and/or a Site Allocations DPD. The SFRA will provide an evidence base for underpinning any decisions on future waste allocations if required.

Warwickshire CC is in the process of producing a Minerals Plan (formerly referred to as the 'Minerals Core Strategy') in order to meet its obligations as a Minerals Planning Authority. Once adopted, the Minerals Plan will replace the current Minerals Local Plan adopted in February 1995.

Warwickshire CC is currently preparing the Minerals Plan – 'Preferred Option and Policies' for a public consultation in early 2014. This is likely to include preferred allocations for sand and gravel – all other minerals will be addressed through policies. The SFRA will inform decision making on which sand and gravel sites are allocated in the plan. The plan will then be published for a 6 week consultation (the 'Publication' stage) before it is submitted to the Secretary of State for independent examination. Once adopted by the Council, the document will be reviewed through the Annual Monitoring Review thereafter.

8.2.2 Warwickshire County Council Preliminary Flood Risk Assessment

The PFRA is a high level screening exercise to locate flood risk areas in which the risk of surface water and groundwater flooding is significant and warrants further examination through the production of maps and management plans. The PFRA prepared for Warwickshire CC was published in March 2011.

8.2.3 Warwickshire County Council Local Flood Risk Management Strategy (LFRMS)

The National FCERM Strategy, prepared by the Environment Agency to meet the requirements of the FWMA, sets out the guiding principles for flood and coastal erosion risk management across England. Warwickshire CC is considering how the principles apply to their authority, and will prepare a LFRMS. The LFRMS should:

- Demonstrate understanding of the current and future flood risk from all sources, a baseline assessment of which will be available through the PFRA, as well as SFRAs and SWMPs for lower tier authorities.
- Use the principles of the National Strategy to consider what the main objectives and measures are to manage flood risk, for example development control, emergency planning, and what measures should be used over different timescales.
- Involve communities and work in collaboration with other risk management authorities to achieve objectives.
- Put in place mechanisms for reviewing the development and implementation of the Local Strategy as well as reporting back to Government.

Warwickshire CC is committed to completing the LFRMS by 2015.

8.3 Flood Risk

8.3.1 Historic Flooding

The Environment Agency has provided historic flood outlines for a number of events across the Warwickshire CC area. Historical flooding events recorded below do not include those already listed in Table 5-1 and Table 7-1.

Table 8-1 Historical Flood Events in Warwickshire CC

Year	Source	Description
May 1932	Main River	Flooding of the River Anker at confluence of Wem Brook at Nuneaton
January 1939	Main River	Middle Avon at Warwick
1985	Main River – Exceedance of channel capacity (no raised defences)	Flooding through Warwickshire along the River Avon
January 1992	Main River – Exceedance of channel capacity (no raised defences)	Flooding along the River Leam at Royal Leamington Spa, and Barford, along the Middle Avon
April 1998	Main River – Exceedance of channel capacity (no raised defences)	Flooding through Warwickshire
December 2008	Drainage channel	Drainage Channel running along the A444 and ending behind 67 Delamere Road at River Sowe

8.3.2 Fluvial Flooding

There are a number of Environment Agency designated Main Rivers, and numerous ordinary watercourses with Warwickshire CC. These can be seen, along with the Environment Agency Flood Zones in Appendix A (Figure A1i to xvi). The main rivers include the following:

- River Arrow
- River Avon
- River Learn
- River Sowe
- River Stour
- River Stowe
- River Alne
- River Dene
- River Anker
- River Blythe
- River Tame
- River Cole

Mineral extraction in the floodplain can have two opposite impacts:

- Increase the level of flood risk through the reduction of storage capacity due to stockpiling and associated infrastructure; or,
- Reduce the level of flood risk by providing additional capacity for floodwater storage during its operation phase.

Tables 1 and 2 of the NPPF Technical Guidance identify the types of development appropriate for each flood risk zone. Table 8-2 below expands on this for the different forms of minerals and waste developments that can be envisaged.

Table 8-2 Minerals and Waste Flood Vulnerability Classification

	Development Type	Vulnerability Classification	Flood Zone Compatibility
Waste	Landfill sites used for waste management facilities for hazardous waste[12]	More Vulnerable	Flood Zone 1 and 2 (and 3a if the Exception Test can also be passed)
	Waste Treatment (except landfill and hazardous waste facilities)	Less Vulnerable	Flood Zone 1, 2, and 3a
	Sewage Treatment Plants	Less Vulnerable	Flood Zones 1, 2 and 3a
	Waste recycling and composting uses (except hazardous waste)	Less Vulnerable	Flood Zones 1, 2 and 3a
Minerals	Minerals working and processing (except for sand and gravel working)	Less Vulnerable	Flood Zones 1, 2 and 3a
	Sand and Gravel Workings	Water Compatible	Flood Zone 1, 2, 3a, 3b
	Secondary aggregate re-cycling	Less Vulnerable	Flood Zones 1, 2 and 3a
	Concrete block manufacture	Less Vulnerable	Flood Zones 1, 2 and 3a
	Concrete batching plant	Less Vulnerable	Flood Zones 1, 2 and 3a

Mineral Sites

Minerals can only be worked where they naturally occur. This has implications when carrying out the Sequential Test (steering development to lowest flood risk) as reasonable alternative sites may not always be available. This is particularly the case with deposits of sand and gravel as many of the deposits are located within natural river floodplains which are often inundated during flood events, therefore would not be considered as 'preferred' in accordance with the Sequential Test.

In light of this, sand and gravel working (together with essential ancillary sleeping or residential accommodation for staff required by these uses[13] (subject to a specific flood warning and evacuation plan)) are classified as Water Compatible development. Although acknowledging that guidance on flood risk and mineral working could be open to interpretation, the Environment Agency advise that the Sequential Test should still be applied to sand and gravel working, notwithstanding that this is classified as Water Compatible development. The NPPF Technical Guidance suggests that the Sequential Test should still be applied to Water Compatible development, and it is recommended that this is the approach adopted by Warwickshire CC in formulating its minerals strategy.

Where processing plant form an integral part of a sand and gravel working, the Environment Agency takes the view that the development should not be classified as Water Compatible

[12] See Planning for Sustainable Waste Management: Companion Guide to PPS10 for definition
[13] Table 2 of the CLG (March 2012) National Planning Policy Framework Technical Guidance

development, and should be regarded as Less Vulnerable development (and therefore not allowed in Flood Zone 3b – as set out in Table 9-3. This is particularly likely to apply where a new working is opened (as distinct from an extension to an existing pit). Therefore, where a possible sand and gravel site includes land in Flood Zone 3b, unless classified as an extension site, Warwickshire CC is advised to treat the site with caution. At site allocation stage Warwickshire CC will need to be satisfied that any stockpiles and non-essential ancillary buildings are able to be accommodated outside of Flood Zone 3b if the site is to be considered further. At the planning application stage a site specific FRA will need to demonstrate that the development will not reduce the storage capacity of the floodplain, obstruct flow paths or increase flood risk to adjacent ground. Compensation or other mitigation measures may be needed in order to achieve this. A sequential approach to development layout should be adopted as a means of achieving this.

For those sites located within a range of Flood Zone classifications, the sequential approach should be applied within the site to ensure that stockpiles and ancillary buildings are located in areas of least flood risk to avoid being adversely affected by flooding or increasing flood risk elsewhere.

Further details regarding the Sequential Test are provided in Section 9.

Waste Sites

Historically landfill was the most common method of waste management throughout the UK. However, in order to conform to EU legislation and government targets, ways must be found to reduce the current dependence on landfill and move towards more sustainable methods of managing waste. These methods include recycling, composting and energy recovery through various technologies such as anaerobic digestion, combustion or gasification.

Table 2 in the NPPF Technical Guidance classifies landfill sites and sites used for waste management facilities for hazardous waste[14] as More Vulnerable developments, and are therefore restricted to Flood Zones 1 and 2 (subject to the application of the Sequential Test) or Flood Zone 3a following completion of both the Sequential and Exception Test. It is noted that the NPPF does not make a distinction between the vulnerability classifications for inert and non-inert landfill types; all landfill sites are classified as More Vulnerable. All other waste treatment sites are classified as Less Vulnerable and are permitted in Flood Zones 1, 2 and 3a (subject to application of the Sequential Test).

Flooding of waste sites can have serious impacts as debris from the site could be washed downstream causing blockages of infrastructure (bridges, culverts) or pollution of the floodwater.

In addition, for sites located within any Flood Zone, the sequential approach should be applied within the site boundary, to ensure that development is located in areas of lower flood risk first, and elements of the development with greater vulnerability are located in the areas of least flood risk.

8.3.3 Surface Water Flooding

Intense periods of rainfall over a short duration or periods of prolonged rainfall can lead to overland flow as rainwater may be unable to infiltrate into the ground or enter drainage systems.

[14] See planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10 for definition. www.communities.gov.uk/index.asp?id=1500757

The Environment Agency Flood Map for Surface Water (shown in Appendix A, Figure A3), details the likely extent of shallow (>0.1m) and deep (>0.3m) of surface water flooding resulting from an extreme, 0.5% AEP (1 in 200 year) rainfall event. These highlight areas where surface water flooding may be an issue and should be considered in more detail as part of a site specific FRA.

Surface water flooding is largely driven by the topography of the area, and therefore tends to be associated with the river channels found within the administrative area. Within urban areas, the tendency for surface water flooding will be influenced at a local scale by the presence of buildings and structures (bridges) etc. that would impede the flow of surface water.

One of the main issues with surface water flooding is that relatively small changes to hard surface and surface gradients can cause flooding. As a result, development for minerals sites including the stockpiles and ancillary buildings could lead to more frequent surface water flooding which can cause disruption to the site and surrounding land. Waste treatment plants may increase the percentage of impermeable surfaces increasing the risk of flooding from surface water to the site itself and to neighbouring areas, and contributing to flood risk in lower parts of the local catchment.

Due to the scale and permeable nature of the proposed mineral sites, it is considered that any problems encountered from surface water flooding are more likely to inconvenience the operator and are unlikely to be significant in assessing the suitability of sites providing sufficient drainage is incorporated within the site to ensure there is no increased risk of flooding elsewhere as a direct result of site activities.

8.3.4 Groundwater Flooding

Groundwater flooding can occur when the water table rises after prolonged rainfall and emerges above ground level. This is most likely to occur in low-lying areas that are underlain by permeable bedrock and superficial geology.

Figure A4 in Appendix A shows the Environment Agency's AStGWF mapping. This indicates that across the Warwickshire CC area, there is generally a low susceptibility to groundwater flooding, with the exception of the land adjacent to the main rivers.

The geology of Warwickshire CC is very varied ranging through many geological periods. The majority of the bedrock geology within the area is mudstone, siltstone limestone and sandstone. The majority of the bedrock across the area supports a Secondary B aquifer. To the north of the area a Principal Aquifer is present. The Principal Aquifers are designated as major aquifers and are able to support water supply at a strategic scale.

The superficial geology is dominated by a large area of Till between Rugby and Coventry. Along the valley of the River Avon and River Arrow, Alluvium and River Terrace Deposits are present. These superficial deposits have the potential to act as Secondary A aquifers (or Minor Aquifers), which are described as permeable layers capable of supporting groundwater supplies at local scales.

The areas of higher susceptibility to groundwater flooding area associated with the superficial deposits of sand & gravel and river terrace deposits. Minerals workings in most cases excavate below the natural water table, which during periods of heavy rainfall may rise. Mineral workings often operate a pumped system and can therefore interfere with groundwater flow. These issues would be most appropriately addressed in an FRA at the planning application stage for each site.

8.3.5 Sewer Flooding

Sewer flooding generally results in localised short term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage by debris or sediment poor maintenance, structural failure or surcharging of the system due to high water levels in the receiving fluvial system.

Severn Trent Water and Thames Water Utilities maintain a register of historical sewer flooding events (DG5 register), which has been provided as part of the SFRA study (Appendix A Figure A5).

Minerals sites are generally located in rural areas remote from settlements and scattered housing, therefore, sewer flooding is not thought to be a large issue with regard to flood risk at proposed minerals sites

8.3.6 Artificial Sources

Figure A6 in Appendix A shows the locations of the canals and reservoirs in the Warwickshire CC administrative area. Canals in Warwickshire include the following list below. Records from the Canal and River Trust indicate that there have been a number of overtopping incidents breach incidents across the Study Area.

- Grand Union Canal;
- Oxford Canal;
- South Stratford Canal;
- Coventry Canal;
- Ashby Canal;
- Stretton Arm (Oxford Canal);
- North Stratford Canal ;
- Kingswood Arm (North Stratford Canal);
- Engine Arm (Oxford Canal);
- Brinklow Arm (Oxford Canal);
- Rugby Arm (Oxford Canal);
- Clifton Arm (Oxford Canal);
- Brownsover Arm (Oxford Canal); and,
- Birmingham & Fazeley Canal.

In addition to the overtopping and breach flooding described in the separate sections for Stratford-on-Avon DC, North Warwickshire BC and Rugby BC administrative areas, there have been an additional 3 overtopping and 3 breach incidents in Warwickshire CC. Both the overtopping and breach incidents occurred on the Grand Union Canal within the Warwick and Leamington Spa areas.

All of these canals have the potential to cause flooding of potential mineral sites especially if they are in an elevated section. The risk posed by canals is reduced when compared to the risk posed by fluvial watercourses as canals are managed through ‘draw down’ if levels become dangerously high.

There are a number of reservoirs within the Warwickshire CC area, in addition to those listed in Sections 5.3.6, 6.3.6 and 7.3.5, Seeswood Pool, Park Farm, Willes Meadow and New Waters Warwick.

8.4 Restoration of Minerals Sites

Mineral extraction is a temporary use of land and the careful restoration of a site to beneficial after-use can avoid permanent adverse impacts on the local environment and provide opportunities for positive enhancement of the local area. The eventual after-use is therefore an important consideration when selecting sites.

Where appropriate, proposals shall demonstrate the best available techniques to ensure that flood risk is not increased, and proposals shall demonstrate that there will not be an unacceptable adverse impact on groundwater conditions, surface water drainage and the capacity of soils for future use.

Restoration covers any operations designed to return the land to an acceptable landform, environmental condition and beneficial after-use. The restoration of mineral sites in the past has predominantly been achieved through infilling with waste material and capping with clays and soils to enable a return to agricultural use, or alternatively the creation of water bodies. There has since been a decline in the need for agricultural land; changes in the way in which waste disposal is taxed and regulated have also led to less inert material being available for use as fill. Biodiversity and amenity uses have therefore become more common after uses for minerals sites.

There are a number of potential restoration uses for minerals sites as listed below, which can be beneficial to the management of flood risk.

- Flood Storage – Research carried out by Symonds Group on behalf of Defra, the Mineral Industry Sustainable Technology and the Mineral Industry Research Organisation looked into the influence of aggregate quarrying in floodplains on flood risk. The results showed that sand and gravel extraction in a floodplain will create a void that can be used to provide potential storage during a flood event, generally reducing flow and water levels in the vicinity of the extraction. However, long term benefits will only accrue where larger workings up-stream of a vulnerable settlement are restored to an open water environment; it is also thought that any benefits are diminished where workings are more than 2km upstream of a settlement.

- Habitat Creation – Mineral sites can be restored to create a variety of habitats including wetlands, wetland grassland, ponds, backwaters, marshes and wet woodland.

- Water Supply – Minerals sites can be restored and used for winter water storage for agricultural spray irrigation or potable water supply. These uses may also create a greater opportunity for boating, walking, cycling, camping etc.

9 NPPF SEQUENTIAL TEST GUIDANCE

9.1 Overview

The NPPF states that Local Plans should be supported by an SFRA, and that LPAs should use SFRA's to steer development towards low flood vulnerability areas by applying the Sequential Test and where necessary the Exception Test.

The NPPF and its Technical Guidance document retain key elements of PPS25 in relation to the application of the Sequential Test, but makes slight amendments to the Exception Test, by removing the requirement to pass 'part b' of the test, referring to previously developed land.

The sections below provide an overview of the Sequential Test and Exception Test as detailed within the NPPF. It has been highlighted within the text where elements of this decision-making tool differ from those previously published in PPS25.

9.2 Sequential Test

The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. The Flood Zones remain the starting point for this sequential approach. These are set out in Table 1 of the NPPF Technical Guidance (reproduced in Table 9-1 of this report). The Flood Zone definitions, appropriate types of development, FRA requirements and policy aims for each Flood Zone remain the same as those previously stated in PPS25.

Flood Zone 2 and Flood Zone 3 are shown on the Environment Agency Flood Map[15] (also in Appendix A, Figure A1i to A1xvi) with Flood Zone 1 being all the land falling outside Flood Zones 2 and 3. These Flood Zones refer to the probability of sea and river flooding, ignoring the presence of existing defences.

Table 9-1: NPPF Flood Zone definitions for tidal and river flooding (from NPPF Technical Guide, Table 1)

Flood Zone	Definition
Flood Zone 1	Low probability – Defined as zone where there is a less than 0.1% AEP (1 in 1000 year) of flooding in any year.
Flood Zone 2	Medium probability – Defined as having between 0.1% and 1% AEP (between 1 in 1000 and 1 in 100 year) of fluvial flooding in any year.
Flood Zone 3a	High probability – Defined as having a 1% (1 in 100 year) annual probability of fluvial flooding in any year.
Flood Zone 3b	Functional floodplain – Defined as land where water has to flow or be stored in times of flood. Defined as the 5% (1 in 20 year) annual probability floodplain or an area designed to flood in an extreme (0.1%) flood, or another probability agreed between the LPA and the Environment Agency. (The Environment Agency do not currently produce Flood Zone 3b mapping for England and Wales).

(Note: 1. These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. 2. The NPPF and its Technical Guidance do not provide Flood Zone definitions for groundwater, sewer, surface water or artificial sources of flooding).

[15] Available on Environment Agency website at: http://www.environment-agency.gov.uk/homeandleisure/floods/default.aspx

The aim of the Sequential Test, set out in the NPPF, is to steer new development to the areas with lowest probability of flooding (i.e. Flood Zone 1). Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding.

The Sequential Test can be applied at all levels and scales of the planning process, both between and within Flood Zones. All opportunities to locate new developments in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

Where there are no reasonably available sites in Flood Zone 1, the flood risk vulnerability (see Table 9-2) of the proposed development should be taken into account in locating development in Flood Zone 2, applying the Exception Test if required (see Table 9-3) and then Flood Zone 3 (applying the Exception Test if required (see Table 9-3).

The NPPF makes it clear that this Level 1 SFRA document will continue to provide the basis for applying the Sequential Test. SFRAs will continue to refine the probability of flooding (e.g. delineation of Flood Zone 3a and Flood Zone 3b) and take into account other sources of flooding and the impacts of climate change.

Within each Flood Zone new development should be directed to sites with lower flood risk (towards the adjacent zone of lower probability of flooding) from all sources as indicated by the SFRA. Other sources of flooding (not considered within the Flood Zones), which require consideration when considering the location of new development allocations include:

- Flooding from the surface water;
- Flooding from groundwater;
- Flooding from sewers; and,
- Flooding from artificial sources.

Table 9-2: NPPF Flood Risk Vulnerability Classification (from NPPF Technical Guide, Table 2)

Vulnerability	Development Type
Essential Infrastructure	• 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.
Highly Vulnerable	• 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”).
More Vulnerable	• 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	• 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 works (if adequate measures to control pollution and manage sewage during flooding events are in place).

Vulnerability	Development Type
Water Compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of 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.

Table 9-3: NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' (from NPPF Technical Guide, Table 3)

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

9.3 Recommended Stages for Application of the Sequential Test

The sequence of steps presented below is designed to guide each of the Councils and developers through the Sequential Test:

A. The developments (i.e. housing, hospitals, industrial etc.) that need to be accommodated should be assigned a vulnerability classification (Table 9-2). Where development is mixed, this should be moved to the higher classification.

B. The Flood Zone classification of all development sites should be determined based on a review of the Environment Agency Flood Zones for fluvial sources. This should consider the effects of climate change on Flood Zone definition for the design life of any development that the site may be suitable for. Where these span more than one Flood Zone, all zones should be noted.

C. Identify existing flood defences serving the potential development sites. However, it should be noted that for the purposes of the Sequential Test, Flood Zones ignoring defences should be used.

D. In the first instance the 'highly vulnerable' developments should be located in those sites identified as being within Flood Zone 1. If the 'highly vulnerable' developments cannot be

located in Flood Zone 1, because the identified sites are unsuitable or there are insufficient sites in Flood Zone 1 then sites in Flood Zone 2 can then be considered. If sites in Flood Zone 2 are inadequate then the LPA may have to identify additional sites in Flood Zones 1 or 2 to accommodate development, or seek opportunities to locate the development outside their administrative area. In Accordance with the NPPF 'highly vulnerable' uses would not be permitted in Flood Zone 3.

E. Once all 'highly vulnerable' developments have been allocated to a development site, the LPA can consider those development types defined as 'more vulnerable'. In the first instance 'more vulnerable' development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate the 'more vulnerable' development types, sites in Flood Zone 3a can be considered. However, any 'more vulnerable' developments in Flood Zone 3a will require application of the Exception Test (See 9.4). 'More vulnerable' developments are not appropriate in Flood Zone 3b – Functional Floodplain.

F. Once all 'more vulnerable' developments have been allocated to a development site, the LPA would consider those development types defined as 'less vulnerable'. In the first instance 'less vulnerable' development should be located in any remaining unallocated sites in Flood Zone 1, continuing sequentially with Flood Zone 2 then 3a. Less vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.

G. 'Essential infrastructure' developments should also be preferentially located in the lowest flood risk zones, however this type of development can be located in Flood Zones 3a and 3b, where necessary, through application of the Exception Test.

H. Water compatible development typically has the least flood risk constraints and it is therefore recommended to consider these types of development last when allocating development sites.

I. For decisions made through Stages D, E and F it will also be necessary to consider the risks posed to the site from other flood sources and where comparable development sites in the same Flood Zone may be more suitable due to:

   – flood risk management measures,

   – the rate of flooding,

   – flood water depth, or,

   – flood water velocity.

J. Where the development type is 'highly vulnerable', 'more vulnerable', 'less vulnerable' or 'essential infrastructure' and a site is found to be impacted by a recurrent flood source (other than fluvial), the site and flood sources should be investigated further irrespective of a requirement for the Exception Test. This should be discussed with the Environment Agency to establish the appropriate time for the assessment to be undertaken, (i.e. Exception Test through a Level 2 SFRA or through a site specific flood risk assessment).

9.4 Exception Test

The NPPF states that following the application of the Sequential Test, if it is not possible for the development to be located in zones with a lower probability of flooding, the Exception Test should be applied.

It should only be applied if appropriate to the type of development and Flood Zone (see Table 9-3) and if consistent with wider sustainability objectives.

In PPS25 there were three elements to the Exception Test, the NPPF has refined this to two elements, which both need to be passed for development to be allocated or permitted:

- *it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and*
- *a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

On completion of the Sequential Test, should any site be taken forward that is not possible to locate in a zone of lower probability of flooding, a Level 2 SFRA would be required to inform whether or not it would be possible for the sites to pass the Exception Test. A Level 2 SFRA should consider the risk posed to the site based on the following aspects of flood risk management and mapping to allow a more detailed comparison of sites located within the same Flood Zones:

- Flood risk management measures;
- The rate of flooding;
- Flood water depth; or,
- Flood water velocity.

Where the development type is 'highly vulnerable', 'more vulnerable', 'less vulnerable' or 'essential infrastructure' and a site is found to be impacted by a recurrent flood source (other than tidal of fluvial), the site and flood sources should be investigated further as part of an SFRA or site specific FRA, regardless of any requirement for the Exception Test.

9.5 Site Specific FRA Guidance

The requirement to undertake a site specific FRA to support applications for development proposed in flood risk areas or where proposed development may increase flood risk to third parties still applies under the NPPF.

The NPPF states that site-specific FRAs are required to accompany planning applications for sites:

- within Flood Zones 2 or 3;
- or where the site lies within Flood Zone 1 and is greater than 1 hectare in area,
- or is in an area in Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency).

The NPPF states that site-specific FRAs should be carried out to the appropriate degree, at all levels of the planning process and to inform the application of the sequential approach. They should assess the risks of all forms of flooding to and from development, taking climate change into account.

It is the responsibility of applicants to consider the flood risk to a site, as early as possible. Applicants should refer to the SFRA at the start of the pre-application stage, or if this is not carried out, at the earliest stage in the preparation of development proposals and a planning application.

The preparation of the SFRA does not remove the need for site-specific FRAs to be undertaken to support planning applications. A site-specific FRA will need to demonstrate that flood risk to the development can be managed now and over the lifetime of the development for all sources of flooding. It should show that the development is safe.

A site-specific FRA should demonstrate also that the development does not increase the risk of flooding to third parties from all sources and that the proposals are compliant with local planning policy. Where possible the development should aim to reduce flood risk overall, and the site-specific FRA should demonstrate this where it is the case.

The Environment Agency website[16] provides 'standing advice' on flood risk. Applicants for planning permission will find this advice helpful when preparing a site-specific FRA. The Agency also provides standing advice to enable LPAs to clearly identify the type of planning applications on which they should consult the Environment Agency.

9.6 Waste and Minerals Sites

The Exception Test is only required (in terms of minerals and waste development) where landfill sites or sites used for waste management facilities (more vulnerable development) are proposed in Flood Zone 3a or Flood Zone 3b in exceptional circumstances.

For sites located within a Flood Zone, the sequential approach should be applied within the site boundary, to ensure that development is located in areas of lower flood risk first, and elements of the development with greater vulnerability are located in the areas of least flood risk.

It is acknowledged within the NPPF that minerals have to be extracted where they are located but their operational workings 'should not increase flood risk elsewhere and need to be designed, worked and restored accordingly'. For this reason sand and gravel extraction sites are classified as Water Compatible development notwithstanding that such development can still give rise to flooding problems.

Where sand and gravel workings are located within the floodplain, steps should be taken to apply a sequential approach within the site itself to ensure that ancillary and supporting infrastructure and buildings are located in areas of least flood risk to reduce the risk of being adversely affected by flooding or increasing flood risk elsewhere.

It should also be noted that essential ancillary sleeping or residential accommodation for staff required by all Water Compatible development including sand and gravel workings are subject to a specific flood warning and evacuation plan. Warwickshire CC should assess whether the requirement for the mineral could first be met from areas at no risk of flooding and, if not, that there is justification for the level of development that may ultimately need to take place in areas that are at risk of flooding.

[16] Available online: http://www.environment-agency.gov.uk/research/planning/82584.aspx

10 EMERGENCY PLANNING AND FLOOD RISK MANAGEMENT

A key consideration for any new development is whether adequate flood warning systems and procedures are in place to ensure that occupants of the site are able to act upon the warnings and are equipped to take steps to remain safe in the event of a flood.

For sand and gravel workings, the NPPF Technical Guidance states that any essential ancillary sleeping or residential accommodation for staff required by the workings will only be permitted in areas of flood risk *subject to a specific warning and evacuation plan*.

10.1 Flood Warning

The Environment Agency operates a flood warning service in certain areas at risk of fluvial flooding.

The Environment Agency operate four types of flood warning to use when warning the public, media and partner organisations of impending flooding as described below. They are referred to as 'Flood Warning Codes' and are used as appropriate to indicate the impact of flooding in a given area.

Severe Flood Warning

Severe flooding. Danger to life.

Flood Warning

Flooding is expected. Immediate action required.

Flood Alert

Flooding is possible. Be prepared.

Warning no longer in force. Flood warnings and flood alerts that have been removed in the last 24 hours

The Environment Agency issue flood warnings to the public and professional partners including emergency services, local authorities, utility companies and the media. Warning messages are sent to people registered to receive flood warnings on the Environment Agency's Floodline Warnings Direct service via automated voice messages to land line and mobile phones, fax, pager, SMS, email. Warnings may also be broadcast by the media.

There is also an emergency Floodline number (0845 988 1188) and a quick dial number for specific areas.

The flood warning system helps residents in flood warning areas to prepare for flooding, through obtaining sand bags, moving valuables upstairs and where necessary evacuating the property to minimise the potential consequences of flooding.

It should be noted that flood warnings are not possible for Flood Defence failure. Appendix A2 illustrates the flood warning areas across the Study Area.

10.1.1 Lead Time

The greater the lead time, i.e. from when the Flood Warning is issued to the onset of property flooding, may mean there is increased preparation time to prepare for flooding and evacuation. The Environment Agency endeavour to give a 2 hour lead time when issuing Flood Warnings, however, this may not always be possible due to the characteristics of some rivers which react more quickly.

Should a defence structure breach or fail then inundation can be rapid, resulting in rapid inundation for areas local to the breach. On the other hand, during tidal events, should a breach occur early in the tidal cycle, the lead time could be a lot slower. Typically, areas immediately adjacent to a breach location will flood quicker than areas setback from the flood defence.

10.2 Residual Risk

Residual risks, as defined in the NPPF, are 'those remaining after applying the sequential approach and taking mitigating actions'. In a flood risk context, this residual risk pertains to the flood risk that remains after flood avoidance and alleviation measures have been put in place.

Residual risk management therefore aims to prevent or mitigate the consequences of flooding that can occur despite the presence of flood alleviation measures.

Application of the Sequential Test aims to preferentially develop or relocate potential development sites into areas with low flood risk. Where this is not realistically possible, some development sites may be located in higher flood risk areas, such as Flood Zones 2 and 3. As a result, such developments will require residual risk management to minimise the consequences of potential flooding, e.g. following a breach or overtopping of local defences.

Ensuring properties are defended to an appropriate design standard reduces flood risk. However, further options are also available should the residual risk to a development prove unacceptable. Details of potential residual risk management options are contained in Appendix C.

10.3 Emergency Planning

Emergency planning is the responsibility of the Warwickshire CC. Specific details of the emergency plans throughout the Study Area have not been made available during this study as they are highly confidential documents for security reasons. However, it is understood that emergency plans are in place to respond to any incident that occurs within their administrative area.

Emergency Planning can be broadly split into three phases:

- Before a flood – raising flood awareness, ensuring no inappropriate use of the floodplain, ensuring emergency access and egress routes are available, protecting vital infrastructure, ensuring adequate flood resilience measures are employed;

- During a flood – Flood warning, rescuing occupants, providing safe refuge and alternative accommodation;
- After the flood – providing support to help people recover and return to their homes and businesses.

During a flood the main function of each of the Councils would be to provide temporary accommodation to any displaced people until such time that they are in a position to return to their homes or their insurance companies can arrange temporary accommodation for them. This shelter is provided in the form of rest centres, and provides a warm dry place to sleep and basic facilities including shower, food, etc.

The NPPF classifies police stations, ambulance stations, fire stations and command centres as Highly Vulnerable buildings. It is essential that all establishments related to these services are located in the lowest flood risk zones to ensure that in the event of an emergency those services vital to the rescue operation are not impacted by flood water. In addition future development control policies should seek to locate 'more vulnerable' institutes such as schools and care homes in areas of the lowest risk to minimise the potential for flood casualties.

Allied to this, nominated rest and reception centres should also be identified within the Study Area and compared with the outputs of this SFRA to ensure that these allocated centres are not at high risk of flooding, so that evacuees will be safe during a flood event. Developments that would be suitable for such uses would include:

- Leisure centres;
- Churches;
- Schools; and
- Community Centres.

It is becoming increasingly important to manage the use of the floodplain and each of the Councils should encourage the construction of new facilities to be developed outside the floodplain. Floodplain management and emergency response activities must have a focus on key infrastructure.

Essential infrastructure located in Flood Zone 3a or 3b must be operational during a flood event to assist in the emergency evacuation process.

10.4 Potential Evacuation and Rescue Routes

In the event of a flood incident, it is essential that the evacuation and rescue routes to and from any proposed development remain safe.

Chapter 13 of Document FD2320 "FRA Guidance for New Development" produced by the Environment Agency and Defra concentrates on safe access and egress. The Environment Agency deems evacuation routes safe if they are above the depth and velocity for a 1% AEP (1 in 100 year) design event.

A key consideration in relation to the presence and use of evacuation routes is the vulnerability and mobility of those in danger of being inundated. Development for highly vulnerable users e.g. disabled or the elderly should be located away from high-risk areas. The Sequential Test does not however differentiate between the vulnerability of the end users of the site, only the vulnerability of the intended use of the site. A proposed residential

development for highly vulnerable end users (elderly, physically impaired etc.) will still fall under the 'more vulnerable' classification in Table 2 of the Technical Guidance to the NPPF and the Sequential and Exception Tests will apply accordingly. Where development for highly vulnerable end users cannot be avoided, safe and easy evacuation routes are essential.

Table 2 of the Technical Guidance to the NPPF Table 9-2 classifies 'highly vulnerable' developments, of those that should be taken into consideration in the event of an emergency are:

- Hospitals; Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels;
- Student halls of residence; and,
- Non-residential uses for health service, nurseries and educational establishments.

Situations may arise in an emergency where the occupants of the above institutions cannot be evacuated (such as prisons). Therefore particular significance must be given to these development types when looking to allocate them. These allocations should be assessed against the outputs of the SFRA to develop robust emergency plans.

Consideration needs to be made to basement only properties as they provide no means of escape from flood waters and no alternative dry accommodation after a flood. Their occupants will be at a high risk from even shallow flooding and means of escape is essential. Agreements should be made with occupants and emergency planning teams as to appropriate actions.

11 SUSTAINABLE DRAINAGE SYSTEMS

11.1 What are SuDS?

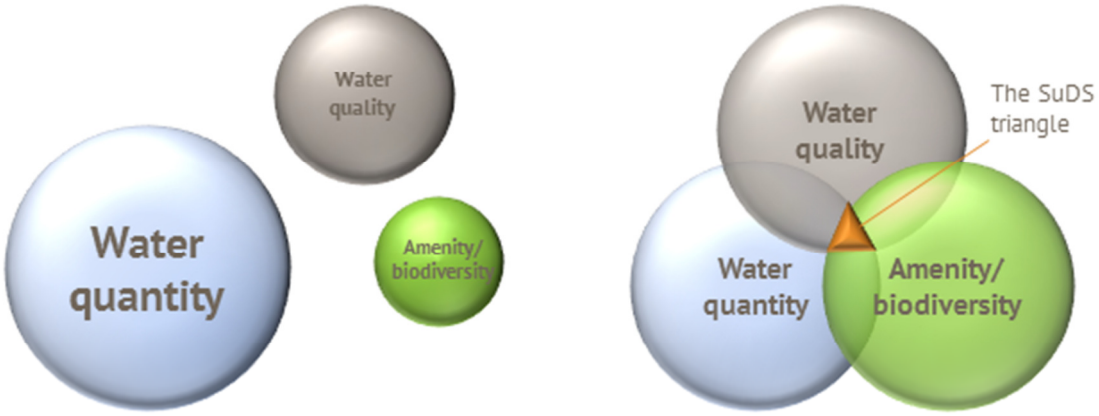
Drainage systems can contribute to sustainable development and improve urban design, by balancing the different issues that influence the development of communities. Approaches to manage surface water that take account of water quantity (flooding), water quality (pollution) and amenity issues are collectively referred to as Sustainable Drainage Systems (SuDS).

SuDS mimic nature and typically manage rainfall close to where it falls. SuDS can be designed to slow water down (attenuate) before it enters streams, rivers and other watercourses, they provide areas to store water in natural contours and can be used to allow water to soak (infiltrate) into the ground or evaporated from surface water and lost or transpired from vegetation (known as evapotranspiration).

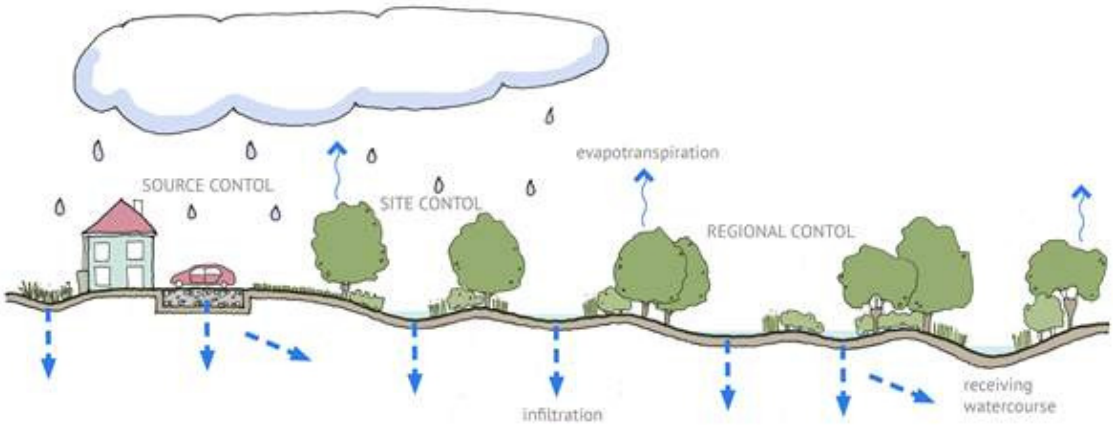
SUDS are technically regarded a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies.

SuDS are more sustainable than traditional drainage methods because they:

- Manage runoff volumes and flow rates from hard surfaces, reducing the impact of urbanisation on flooding
- Protect or enhance water quality (reducing pollution from runoff)
- Protect natural flow regimes in watercourses
- Are sympathetic to the environment and the needs of the local community
- Provide an attractive habitat for wildlife in urban watercourses
- Provide opportunities for evapotranspiration from vegetation and surface water
- Encourage natural groundwater/aquifer recharge (where appropriate)
- Create better places to live, work and play.



A useful concept used in the development of sustainable drainage systems is the SuDS management train (sometimes referred to as the treatment train), illustrated below. Just as in a natural catchment, drainage techniques can be used in series to change the flow and quality characteristics of the runoff in stages.



The management train starts with prevention (preventing runoff by reducing impermeable areas), or good housekeeping measures for reducing pollution; and progresses through local source controls to larger downstream site and regional controls.

Runoff need not pass through all the stages in the management train. It could flow straight to a site control, but as a general principle it is better to deal with runoff locally, returning the water to the natural drainage system as near to the source as possible.

Only if the water cannot be managed on site should it be (slowly) conveyed elsewhere. This may be due to the water requiring additional treatment before disposal or the quantities of runoff generated being greater than the capacity of the natural drainage system at that point. Excess flows would therefore need to be routed off site.

End of pipe solutions where runoff is directly discharged to a wetland or pond should be avoided. SuDS design requires a balancing of different options, often depending on the risks associated with each course of action. The risks of an area flooding have to be balanced with the costs of protecting the area from different levels of floods.

The management train concept promotes division of the area to be drained into sub-catchments with different drainage characteristics and land uses, each with its own drainage strategy. Dealing with the water locally not only reduces the quantity that has to be managed at any one point, but also reduces the need for conveying the water off the site.

When dividing catchments into small sections it is important to retain a perspective on how this affects the whole catchment management and the hydrological cycle.

11.2 Why use SuDS?

Traditionally, built developments have utilised piped drainage systems to manage surface water and convey surface water run-off away from developed areas as quickly as possible. Typically these systems connect to the public sewer system for treatment and/or disposal to local watercourses. Whilst this approach rapidly transfers surface water from developed areas, the alteration of natural drainage processes can potentially impact on downstream areas by increasing flood risk and reducing water quality.

Due to the difficulties associated with upgrading sewer systems it is uncommon for sewer and drainage systems to keep pace with the rate of development/re-development and the increasingly stringent drainage discharge restrictions that are being placed upon them. As development continues and/or urban areas expand these systems can become inadequate to deal with the volumes of surface water that is generated, resulting in increased flood risk and/or pollution to watercourses. Allied to this are the implications of climate change and increasing rainfall intensities.

SuDS also have wider sustainability advantages by creating opportunities for landscaping and incorporation of habitats for wildlife.

11.3 SuDS Techniques

SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourses or public sewers etc.). Various SuDS techniques are available and operate under two main principles:

- Infiltration;
- Attenuation.

The design of SuDS measures should be undertaken as part of the drainage strategy and design for a development site. A ground investigation will be required to assess the required volume of on-site storage. Hydrological analysis should be undertaken using industry approved procedures, to ensure robust design storage volume is obtained.

During the design process, liaison should take place with the Local Planning Authority, the Environment Agency and if necessary, the water undertaker to establish a satisfactory design methodology and permitted rate of discharge from the site.

The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS. It should be noted, each development site must offset its own increase in runoff and attenuation cannot be 'traded' between developments.

11.4 Where can SuDS be utilised?

SuDS can be used anywhere, though consideration needs to be given to the points below. As long as the basic principles of the SuDS management and treatment trains are applied there is no reason why they will not work, and successfully deliver the flood mitigation benefits alongside additional benefits such as amenity, bio-diversity and water quality.

- Land use characteristics;
- Site characteristics;
- Catchment characteristics;
- Quantity and quality performance requirements; and,
- Amenity and environmental requirements.

The underlying ground conditions of a development site can determine the type of SuDS approach to be used. This will need to be determined through ground investigations carried out on-site.

11.5 SuDS Approval Board

Under the FWMA, Warwickshire CC is designated the SuDS Approval Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new SuDS within the area.

The SAB will have responsibility for the approval of proposed drainage systems in new developments and redevelopments, subject to exemptions and thresholds, and approval must be granted before the developer can commence construction.

In order to be approved, proposed drainage systems will have to meet new National Standards for Sustainable Drainage Systems. Where planning permission is required, applications for drainage approval and planning permission may need to be lodged jointly with the planning authority but Warwickshire CC, as the SAB, will determine the drainage application. Regulations will set a timeframe for the decision so as not to hold up the planning process.

The SAB will also be responsible for adopting and maintaining SuDS which serve more than one property, where they have been approved. Highways authorities will be responsible for maintain SuDS in public roads, to National Standards.

The SAB must arrange for SuDS on private property, whether they are adopted or not, to be designated under Schedule 1 to the FWMA as features that affect flood risk. The SAB will also be required to arrange for all approved SuDS to be included on the register of structures and features (as a separate category).

The National Standards will set out the criteria by which the form of drainage appropriate to any particular site or development can be determined, as well as requirements for the design, construction, operation and maintenance of SuDS. Local authorities are represented on the Project Advisory Board for the development of these National Standards.

The FWMA, in response to Sir Michael Pitt's Review, also makes the right to connect surface water drainage from new development to the public sewerage system conditional on the surface water drainage system being approved by the SAB.

Defra has worked closely with key stakeholders and technical experts including the Environment Agency, Local Authorities, developers and water companies to develop National Standards. The National Standards will apply to construction work (domestic and commercial new developments and redevelopments) and will allow flexibility for local conditions.

The requirements for SuDS in England is yet to be implemented and in the interim period, the on-going requirement is to continue to seek advice from the Environment Agency regarding the design of SuDS and the management of surface water runoff from development sites.

12 POLICY AND PRACTICE

12.1 Overview

To ensure a holistic approach to flood risk management and ensure that flooding is taken into account at all stages of the planning process, the findings of this report need to be incorporated into each of the Council's Local Plans. This will help to ensure that flood risk is taken into account at all levels of the planning process.

In accordance with NPPF, a specific policy on flood risk should be included to ensure:

- Development is located in the lowest risk area where possible;
- Where required, new development is flood-proofed to a satisfactory degree and does not increase flood risk elsewhere; and,
- Surface water is managed effectively on site.

Application of the Sequential Test should ensure that 'more vulnerable' property types are not permitted in areas at high risk of flooding. Where there are valid reasons for a development type which is not entirely compatible with the level of flood risk the LPA or developer needs to demonstrate that both elements of the Exception Test are passed.

When proposing development behind flood defences, the impact on residual flood risk to other properties should be considered. New development behind flood defences can increase the residual flood risk should defences be breached or overtopped by disrupting flow paths and or the displacement of flood water. If conveyance routes that allow flood water to pass back into a river following failure of a flood defence are blocked, this may potentially increase flood risk to existing properties.

If development is to be constructed with 'less vulnerable' uses on the ground level, agreements need to be in place to prevent future alteration of these areas to 'more vulnerable' uses without further study into flood risk.

Single storey residential development should not normally be considered in high flood risk areas as they offer no opportunity for safe refuge areas on upper floors.

Developers and Local Authorities proposing to develop in Flood Zones 2 and 3 should seek opportunities to:

- Reduce flooding by considering the layout and the form of the development and the appropriate application of sustainable drainage techniques;
- Locate development to land in zones with a lower probability of flooding;
- Create space for flooding to occur by restoring functional floodplains and flood flow pathways and by identifying, allocating and safeguarding open space for storage; and
- Seek opportunities to improve flow conveyance through watercourse reprofilling and removal of structures.
- Developers and local authorities proposing to develop in Flood Zone 3 should provide floodplain compensation for the loss of floodplain resulting from the development, on a level-for-level basis. The volume of floodplain loss should be calculated using the 1 in 100 year plus climate change flood level at the site and that volume should be provided.

12.2 Flood Risk Recommendations

1. Ensure the Sequential Test is undertaken for all land allocations to reduce the flood risk to the allocation and ensure that the vulnerability classification of the proposed development is appropriate to the Flood Zone classification;

2. FRAs should be undertaken for all developments within Flood Zones 2 and 3 to assess the risk of flooding to the development and identify options to mitigate the flood risk to the development, site users and surrounding area;

3. FRAs are required for developments identified as at risk from other sources of flooding, proportionate to the nature and scale of the flood risk source and the type of development proposed;

4. To manage future flood risk, FRAs should look at opportunities to accommodate additional water as a result of climate change;

5. An 8m buffer strip must be maintained along fluvial river corridors respectively, to ensure that maintenance of the channel can be undertaken;

6. Promote flood resilience at the individual property level; and,

7. Continue to maintain those assets that are effective in managing current and future flood risk, and look to improve defences where they fall below the required standard of protection.

Finished floor levels of all residential and commercial development within Flood Zone 3 should be raised above the 1% AEP (1 in 100 year) plus climate change flood level (including a freeboard allowance of at least 600mm).

Potential access & egress routes should be identified and recommendations made for appropriate actions of future occupants in the event of flooding.

The groundwater, surface water and historic flood mapping should be reviewed to determine the risk of flooding from sources other than fluvial. When a proposed development is located within an area with an identified flood risk, then a flood risk assessment should determine the actual risk to the development and recommend appropriate mitigation measures. The flood risk assessment must demonstrate to the satisfaction of the Environment Agency that the development will not exacerbate the existing flooding situation, and improve existing conditions where possible.

12.3 Flood Mitigation Recommendations

General flood mitigation policies should address the following issues:

1. Where a development borders an area benefiting from flood defence, opportunities should be sought for the maintenance of these flood defences to be partly funded by the development for its lifetime;

2. Opportunities should be sought to de-culvert rivers, where possible, to return them to a natural system, reducing back up of flows and under capacity where this does not exacerbate the flooding elsewhere;

3. River channel restoration should be undertaken where possible to return the river to its natural state and restore floodplain to reduce the impact of flooding downstream;

4. Emergency planning strategies should be put in place in order to direct people to safety during times of flood;

5. Current emergency planning strategies should be reviewed to determine the suitability of refuge centres and evacuation routes based on the Flood Zone mapping produced in this study;

6. Opportunities should be sought to reduce the risk of flooding from the sewer network through consultation with Severn Trent Water and Thames Water Utilities to determine key areas for maintenance and flood alleviation schemes; and

7. Where development within flood risk areas is absolutely necessary flood proof construction methods should be utilised to reduce the impact of flooding.

12.4 SuDS Recommendations

1. Sustainable Drainage Systems must be included in new developments as a way to manage surface water;

2. For Greenfield development sites, the rate of surface water runoff generated as a result of the development must be equivalent to the rate of surface water runoff generated from the undeveloped site.;

3. For Brownfield development sites, developers are expected to deliver a substantial reduction in the existing rate of surface water runoff generated from the development and, where possible, limit the rate of surface water runoff to the equivalent Greenfield rate;

4. Where practicable, runoff rates should be restricted to greenfield runoff rates in areas known to have a history of sewer flooding;

5. Where practicable, the separation of surface water from sewers should be undertaken, through consultation with Severn Trent Water or Thames Water Utilities;

6. Sustainable Drainage Systems should be considered in line with the Management Train hierarchy set out in The SuDS Manual, C697, whereby 'Prevention' techniques are considered initially. Adopted techniques should also be located in accordance with the restrictions set out in Policy and Practice for the Protection of Groundwater.

12.5 Water Environment Recommendations

As populations increase and climate change leads to changes in weather patterns, the prospect of droughts may increase. New development can tackle this by incorporating water efficiency measures such as grey water recycling, rainwater harvesting and water use minimisation technologies. In doing so, knock-on benefits could be felt by the sewer system which will receive less wastewater from properties, potentially freeing up capacity during flood events.

In addition, increasing people's awareness of the water environment around them, its importance and its hazards, will contribute to their understanding of where floods come from and what individuals can do to limit the consequences of flooding and resource shortages.

1. Consult the Environment Agency regarding the potential for future management regime of the river catchments, including the potential for any flood alleviation schemes, upgrading and/or replacement of existing flood defences;

2. Consult the Environment Agency regarding any works to watercourses, floodplains or drainage systems to take into account the requirements of the Water Framework Directive and to make improvements that are viable.

3. Ensure that proposed developments can be accommodated by the existing resource provision. Where a development cannot be met by current resources, ensure that the phasing of development is in tandem with resource infrastructure investment;

4. Encourage new developments to adhere to the principles of water sensitive urban design by integrating surface water, groundwater, wastewater management and water supply designs in order to minimise environmental impacts whilst providing additional recreational and aesthetic benefits.

5. For large schemes suggest a water strategy is carried out to determine there is sufficient water resources for the proposed increase in demand.

12.6 Development Management Recommendations

1. If development is to be constructed with 'less vulnerable' uses on the ground level, agreements need to be in place to prevent future alteration of these areas to 'more vulnerable' uses without further study into flood risk;

2. Single storey residential development should not normally be considered in Flood Zone 3 as they offer no opportunity for safe refuge areas on upper floors;

3. Ensure new development in an area known to suffer surface water flooding does not increase the discharge to the existing drainage system either though restricting site discharge rates and/or through capital contributions to improvements works of the existing drainage infrastructure.

13 DISCUSSION AND CONCLUSIONS

13.1 Overview

The process of the Sequential Test outlined in the NPPF aims to steer vulnerable development to areas of lowest flood risk. The SFRA aims to facilitate this process by identifying the variation in flood risk across the Study Area allowing an area-wide comparison of future development sites with respect to flood risk considerations.

The SFRA presents Flood Zone Maps that delineate the Flood Zones outlined in the NPPF as Flood Zone 1 - Low Probability, Flood Zone 2 - Medium Probability and Flood Zone 3a - High Probability. In addition, Flood Zone 3b - Functional Floodplain, has also been mapped. The NPPF Technical Guidance provides information on which developments might be considered to be appropriate in each Flood Zone, subject to the application of the Sequential Test and either the Exception Test or a site-specific Flood Risk Assessment demonstrating safety.

The full SFRA report should be used to provide a more detailed overview of the flood risks to the Stratford-on-Avon DC, North Warwickshire BC, Rugby BC and Warwickshire CC to assist in the development of policies, strategic planning and flood risk management.

This SFRA recommends various policies associated to flood risk. Through completion of these recommendations each Council will be able to transparently manage flood risk and ensure risk to their development sites and communities, now and in the future are mitigated.

13.2 How to maintain and update the SFRA

For an SFRA to serve as a practical planning tool now and in the future, it is imperative that the SFRA is adopted as a 'living draft' and is reviewed periodically in light of emerging policy directives and an improving understanding of flood risk within the Study Area.

This section lists a series of recommendations ensuring that the SFRA is kept up-to-date and maintained. This will allow the SFRA to follow emerging best practice and developments in policy and climate change predications.

13.2.1 Flood Zones and GIS Layers

The GIS layers used in the SFRA have been created from a number of different sources, using the best and most suitable information available at the time of publishing. Prior to any amendments taking place, the GIS Layers supplied with this SFRA should be securely backed up.

Should new Flood Zone information become available, the data should be digitised and geo-referenced within a GIS system.

For other GIS layers such as the Historical Flood Records or the Sewer Flooding Information, it is likely that data will be added rather than be replaced. For example, where a new sewer flooding incident or flooding incident recorded by the LLFA is reported in the catchment, a point should be added to the relevant flooding GIS layer, rather than creating a new layer.

All GIS layers used in the SFRA have meta-data attached to them. When updating the GIS information, it is important that the meta-data is updated in the process. Meta-data is additional information that lies behind the GIS polygons, lines and points. For example, the information behind the SFRA Flood Zone Maps describes where the information came from, what the intended use was, together with a level of confidence.

For any new data or updated data, the data tables presented in Appendix B should be checked to ensure they are up-to-date.

13.2.2 Data Licensing Issues

Prior to any data being updated within the SFRA, it is important that the licensing information is also updated to ensure that the data used is not in breach of copyright. The principal licensing bodies relevant to the SFRA at the time of publishing were the Environment Agency (Midlands - Central), Ordnance Survey, Canal and River Trust, Severn Trent Water and Thames Water Utilities. Updated or new data may be based on datasets from other licensing authorities and may require additional licenses.

13.2.3 Flooding Policy Updates

This SFRA was created using guidance that was current in September 2013, principally the NPPF and the accompanying Technical Guidance.

Should new flooding policy be adopted nationally, regionally or locally, the SFRA should be checked to ensure it is still relevant and updates made if necessary.

13.2.4 Stakeholder Consultation and Notification

The key stakeholders consulted in the SFRA were the Stratford-on-Avon DC, Warwickshire CC, North Warwickshire BC, Rugby BC, Severn Trent Water, Thames Water Utilities, the Environment Agency and the Canal and River Trust. It is recommended that a periodic consultation exercise is carried out with the key stakeholders to check for updates to their datasets and any relevant additional or updated information they may hold. If the SFRA is updated, it is recommended that the Environment Agency and the Council's Emergency Planning Department are notified of the changes and instructed to refer to the new version of the SFRA for future reference.

13.2.5 Frequency of Updates and Maintenance

It is recommended that the SFRA is reviewed on an annual basis, in liaison with the Environment Agency, to assess any maintenance or update work. Should the Council's decide any significant changes are necessary; the SFRA should be updated and re-issued. Any subsequent reviews and updates should be recorded in a register.

APPENDIX A – FIGURES

Figure Number	Figure Title
A1i, ii,… xvi	Environment Agency Flood Zones and Rivers
A2i, ii, iii….xvi	Historic flood records
A3i, ii, iii… xvi	Flood Map for Surface Water
A4 i, ii, iii… xvi	Areas Susceptible to Groundwater Flooding
A5	Sewer Flooding Records
A6	Artificial Sources of Flooding: Canals and Reservoirs
A7	Environment Agency Flood Alert and Warning Areas

APPENDIX B – GIS DATA REGISTER

Council Requests

Data Set	Data Provided	Format	Quality of Data
Council boundaries	August 2013	GIS	Good
Development Sites	August 2013	GIS	Good
Historic flooding records	August 2013	GIS	Good
50k OS Mapping Tiles	August 2013	GIS	Good
Administrative Areas	August 2013	GIS	Good

Environment Agency Requests

Data Set	Data Provided	Format	Quality of Data
Flood Maps	August 2013	GIS	Good
Flood Warning/Alert Areas	August 2013	GIS	Good
Flood Storage Areas	August 2013	GIS	Good
NFCDD defence layers	August 2013	GIS	Good
Areas Benefitting from Flood Defences	August 2013	GIS	Good
LiDAR Data	August 2013	GIS	Good
River Model outputs	August 2013	GIS	Good
Main Rivers	August 2013	GIS	Good
Historic flood map	August 2013	GIS	Good
AStGWF	August 2013	GIS	Good
FMfSW	August 2013	GIS	Good
Reservoir locations and breach outlines	September 2013	GIS	Good

Severn Trent Water and Thames Water Utilities Requests

Data Set	Data Provided	Format	Quality of Data
DG5 flooding incidents	August 2013	GIS	Good
Sewer Plans	August 2013	GIS	Good

Canal and River Trust

Data Set	Data Provided	Format	Quality of Data
Canal Locations	August 2013	GIS	Good
Overtopping and Breach locations	August 2013	GIS	Good

APPENDIX C – METHODS OF MANAGING RESIDUAL FLOOD RISK

The following sub-sections outline various methods available for the management of residual flood risk. The methods outlined will not be appropriate for all development types or all geographical areas. Therefore, they should be considered on a site-by-site basis. In addition, it is important that the use of such techniques do not exacerbate flooding elsewhere.

Recreation, Amenity and Ecology

The inclusion of parks and open spaces or river restoration schemes have ecological, biodiversity and sustainability benefits as well as providing flood risk mitigation through the creation of increased flood storage areas and conveyance of rainwater.

Open spaces and the inclusion of ditches or small pools could be investigated as part of new developments. These all can have the added benefit of improving the ecological and amenity value of an area by providing attractive areas available for recreation as well as providing storm water attenuation.

Secondary Defences

Secondary defences are those that exist on the dry side of primary defences. Typically, their main function is to reduce the risk of residual flooding following a failure or overtopping of the primary defences.

Secondary defences can relocate floodwaters away from certain areas or reduce the rate of flood inundation following a residual event. Examples of secondary defences include embankments or raised areas behind flood defence walls, raised infrastructure e.g. railways or roads and, on a strategic level, canals, river and drainage networks. The latter are a form of secondary defence as they are able to convey or re-direct water away from flood prone areas even if this is not their primary function. The consequences of increasing water levels at other properties would need to be taken into account whether such a solution were implemented in the active or defended flood plains.

Land Raising

Land raising can have mixed results when used as a secondary flood alleviation measure. It can be an effective method of reducing flood inundation on certain areas or developments by raising the finished levels above the predicted flood level. However, it can also result in the reduction in flood storage volumes which may increase local floodwater levels and exacerbated flooding elsewhere.

The impact of residual risk on other properties should be considered, and where the potential increase of flood levels or potential disruption of flow routes as a result of development is significant, compensatory flood storage should be provided.

N.B. Building up land ‘adjacent’ to existing or primary flood defences must respect the byelaw margin: a strip of land kept free of obstructions, to enable maintenance and emergency repair of the primary flood defence.

Finished Floor Levels

Where developing in flood risk areas is unavoidable, the most common method of mitigating flood risk to people is to ensure habitable floor levels are raised above the maximum flood water level.

The Environment Agency suggest that a 600mm freeboard on the 1 in 100 year, plus 20% climate change flood level is used when setting finished floor levels (Where this cannot be achieved for practicality reasons flood proofing measures should be utilised up to the 1 in 100 year, plus 20% climate change flood level.

It is also necessary to ensure that proposed road levels are such that emergency access and evacuation routes are maintained where possible at the 1 in 1000 year flood level. This can significantly reduce the risk of the proposed development becoming inundated by flooding. As with the land raising option, it is imperative that any assessment takes into consideration the volume of floodwater potentially displaced and potential disruption to flow routes posed by such raising and provides appropriate compensation where the floodplain has been lost.

Flood Resilience

Flood resilient buildings are designed to reduce the consequences of flooding and facilitate recovery from the effects of flooding sooner than conventional buildings.

The Association of British Insurers in cooperation with the National Flood Forum has produced published guidance on how homeowners can improve the food resilience of their properties (ABI, 2004). Such measures should be encouraged for use on existing development subject to flooding, and not purely to justify new development.

The guidance identifies the key flood resistant measures as being:

- Replace timber floors with concrete and cover with tiles,
- Replace chipboard/MDF kitchen and bathroom units with plastic equivalents,
- Replace gypsum plaster with more water-resistant material, such as lime plaster or cement render, Move service meters, boilers, and electrical points well above likely flood levels, and,
- Put one-way valves into drainage pipes to prevent sewage backing up into the house.

In considering appropriate resilience measures, it will be necessary to plan for specific circumstances and have a clear understanding of the mechanisms that lead to flooding and the nature of flood risk by undertaking a FRA. Guidance on resilient construction is being prepares and will be placed on the Communities and Local Government and Planning Portal websites[17]

Advice on flood mitigation for homes and businesses is also given in the ODPM's 2003 report, 'Preparing for Floods' (ODPM) and CLG's 2007 report 'Improving The Flood Performance of New Buildings'.

[17] See www.communities.gov.uk or planningprotal.gov.uk