Strategic Flood Risk Assessment

Final Report

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South Oxfordshire District Council

JBA Project Manager

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Revision history

Revision Ref/Date	Amendments	Issued to
23/11/2018	Draft Report	Rebekah Knight
10/12/2018	Final Report – addressed comments from Rebekah Knight and Ben Davis	Rebekah Knight
13/12/2018	Final Report – addressed comments from Ben Davis	Rebekah Knight and Ben Davis
27/03/2019	Final Report – addressed comments from the Environment Agency	Rebekah Knight

Contract

This report describes work commissioned by Rebekah Knight, on behalf of South Oxfordshire District Council, by an email dated 25 July 2018. South Oxfordshire District Council's representative for the contract was Rebekah Knight of Planning Policy. Alistair Clark, Richard Pardoe, Fiona Hartland, Emily Jones and Jenny Hill of JBA Consulting carried out this work.

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Purpose

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Executive summary

This Strategic Flood Risk Assessment (SFRA) 2019 replaces (within South Oxfordshire) the South Oxfordshire District Council (SODC) SFRA, published in 2017. It forms part of the evidence base for the South Oxfordshire Local Plan 2011-2034 Final Publication Version2nd.

The SFRA is a planning tool that will assist the Council in its selection and development of sustainable development sites away from vulnerable flood risk areas in accordance with the NPPF and its associated Planning Practice Guidance on Flood Risk and Coastal Change.

The report has been prepared to replace the work that was included in the previous SFRA and to provide appropriate supporting evidence for the Local Plan which will set out a vision and framework for development in the Council to 2034 and will be used to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

SFRA objectives

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

- Level 1: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
- Level 2: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances, the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

Both a Level 1 and Level 2 SFRA has been prepared for SODC. The SFRA outputs include:

- Appraisal of all potential sources of flooding, including Main River, ordinary watercourse, surface water, groundwater and sewer flooding
- Updated review of historic flooding incidents
- Mapping of location and extent of functional floodplain
- Reporting on the standard of protection provided by existing flood risk management infrastructure
- An assessment of the potential increase in flood risk due to climate change
- Areas at risk from other sources of flooding, for example surface water or reservoir
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk

Summary of the Level 1 Assessment

The SFRA has considered all sources of flooding including fluvial, surface water, groundwater, sewers and reservoirs within the study area.

Fluvial flood risk is primarily from the River Thames, with tributaries to the River Thame also contributing to risk of property flooding. The River Thame itself also has a large flood plain but it predominantly rural.

Surface water flooding is shown to correlate with small watercourses and urban areas throughout the area. Groundwater flood risk is shown to vary across the district with areas of increased groundwater risk around Burcot, Dorchester, Wheatley and south west of Wallingford as well as a band from Lewknor to Chinnor.

The effect of climate change has been assessed. In most catchments, the extent of Flood Zone 3 is not likely to increase significantly with climate change. Climate change is predicted to result in more frequent and extreme rainfall events, increasing the frequency and severity (depth/hazard) of flooding from fluvial and surface water sources. Detail is provided in Section 4 on how we assess flood risk for planning using the Flood Zones and explains the Sequential Approach. It outlines the sources of national and local flood risk mapping data, information and evidence that has been available for use in this SFRA.

Summary of the Level 2 Assessment

In several of the strategic sites, a small percentage of the site is within Flood Zone 2 or 3. Therefore a Level 2 SFRA was required. The scale of the sites means that there is still an opportunity to sequentially design the site layout and ensure the most vulnerable development is located in the areas of lowest risk of flooding. Therefore, there must be an expectation that all built development is located within Flood Zone 1 and areas within Flood Zone 2 and 3 are preserved for biodiversity enhancements and green space. In these cases, detailed site-specific FRAs should ensure that the Flood Zones are well defined using hydraulic modelling, the effect of climate change is considered and that development is compliant with the NPPF.

Guidance for planners and developers

Sections 8 and 9 introduce guidance aimed at both planners and developers. The guidance should be read in conjunction with the NPPF and flood risk guidance from the Environment Agency. The guidance addresses requirements for development in each of the Flood Zones, making development safe, river restoration and enhancement as part of development, dealing with existing watercourses and assets, developer contributions to flood risk improvements, dealing with surface water runoff and drainage, wastewater, water quality and biodiversity.

Use of SFRA data

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The SFRA should be periodically updated as appropriate when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Oxfordshire County Council as the Lead Local Flood Authority and Highways Authority, Thames Water, and the Environment Agency.

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Abbreviations and Definitions

Term	Definition
AEP	Annual Exceedance Probability
AIMS	Asset Information Management System (Environment Agency GIS database of assets)
AStGWF	Areas Susceptible to Groundwater Flooding
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CDA	Critical Drainage Area - A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	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.
CIRIA	Construction Industry Research and Information Association
Defra	Department for Environment, Food and Rural Affairs
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
EA	Environment Agency
EU	European Union
FEH	Flood Estimation Handbook
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).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
FWMA	Flood and Water Management Act - Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRA	Flood Risk Assessment - A site specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRMP	Flood Risk Management Plan
FZ	Flood Zones
Ha	Hectare
HELAA	Housing and Economic Land Availability Assessment
IDB	Internal Drainage Board
Indicative Flood Risk Area	Nationally identified flood risk areas, based on the definition of 'significant' flood risk described by Defra and WAG.
JBA	Jeremy Benn Associates
LFRMS	Local Food Risk Management Strategy
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management. For South Oxfordshire, the Lead Local Flood Authority is Oxfordshire County Council.
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment

Term	Definition
	Agency has responsibilities and powers
NPPF	National Planning Policy Framework
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity.
PPG	National Planning Policy Guidance
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water (update to the uFMfSW)
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SHLAA	Strategic Housing Land Availability Assessment - a technical piece of evidence to support local plans and Sites & Policies Development Plan Documents (DPDs). Its purpose is to demonstrate that there is a supply of housing land in the District which is suitable and deliverable.
SFHD	Thames Water's Sewer Flooding History Database
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding from surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
uFMfSW	Updated Flood Map for Surface Water
WFD	Water Framework Directive

1 Introduction

South Oxfordshire District Council is preparing the South Oxfordshire Local Plan 2011-2034 Final Publication Version 2nd, which will identify areas of housing, economic and infrastructure growth within the district until 2034. The Local Plan also serves to provide the planning policy which underpins development management decisions in South Oxfordshire.

This Strategic Flood Risk Assessment (SFRA) 2019 replaces (within South Oxfordshire) the South Oxfordshire District Council (SODC) SFRA, published in 2017.

The report has been prepared to update the content included in the previous SFRA, and to provide appropriate supporting evidence for the South Oxfordshire Local Plan 2034. The SFRA update will be used to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk. The boundary of SODC and its relation to its neighbouring authorities is shown in Figure 1-1.

Figure 1-1: SODC area and neighbouring authorities

1.1 Purpose of this Strategic Flood Risk Assessment

1 To take into account the latest flood risk policy and available flood risk data

Since SODC published their previous SFRA in 2017, the National Planning Policy Framework (NPPF) has been updated. Therefore, this SFRA has developed that which was published in 2017 to comply with the update to national policy. In addition, the revision of the SODC local plan has introduced alternative sites and additional sites, which are considered in this version of the report.

The provision of flood risk mapping and data has also developed since the existing 2017 SFRA, with the following data available for the updated assessment:

- Environment Agency modelling of the River Thames between Sandford Lock and Reading Bridge (2018)

2 To provide a comprehensive analysis of flood risk in South Oxfordshire

The assessment needs to consider the risk of flooding from all sources (fluvial, surface water, groundwater, sewer and reservoir flood risk) and the implications of this risk. Where possible, the assessment should identify the functional floodplain areas within the district.

This information is required as part of the sustainability appraisal and land use planning process in full compliance with the guidance set out in the NPPF to inform the Council in identifying suitable sites for the emerging South Oxfordshire Local Plan 2034.

The assessment should also identify the types of measures which may be appropriate to manage the risk, taking account of location, site opportunities, constraints and geology.

3 To enable application of the Sequential Test

The Level 1 SFRA assessment for the district should enable the application of the Sequential Test to the locations of new development sites to be carried out and to identify whether development can be allocated outside high and medium flood risk areas, based on all sources of flooding, without application of the exception test.

The assessment should be based on the development options set out in the South Oxfordshire Local Plan 2011-2034 Final Publication Version 2nd and sites in Neighbourhood Plans.

1.2 SFRA Objectives

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1 Level One: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.

2 Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances, the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This document includes both a Level One and Level Two SFRA.

1.3 SFRA Outputs

The outputs will identify development areas at risk from the following sources and provide a comprehensive set of maps including,

- fluvial flood risk, including functional floodplain and climate change;
- surface water risk;
- groundwater risk;
- sewer risk; and
- reservoir risk

1.4 Approach

1.4.1 General assessment of flood risk

The flood risk management hierarchy underpins the risk-based approach and is the basis for making all decisions involving development and flood risk. When using the hierarchy, account should be taken of:

- the nature of the flood risk (the source of the flooding);
- the spatial distribution of the flood risk (the pathways and areas affected by flooding);
- climate change impacts; and
- the degree of vulnerability of different types of development (the receptors).

Developments should reflect the application of the Sequential Test using the maps produced for this SFRA. The information in this SFRA should be used as evidence and, where necessary, reference should also be made to relevant evidence in other documents referenced in this report. The Flood Zone maps and flood risk information on other sources of flooding contained in this SFRA should be used where appropriate to apply the Sequential Test.

Where other sustainability criteria outweigh flood risk issues, the decision-making process should be transparent. Information from this SFRA should be used to justify decisions to allocate land in areas at high risk of flooding.

The flood risk management hierarchy is summarised in Figure 1-2 below.

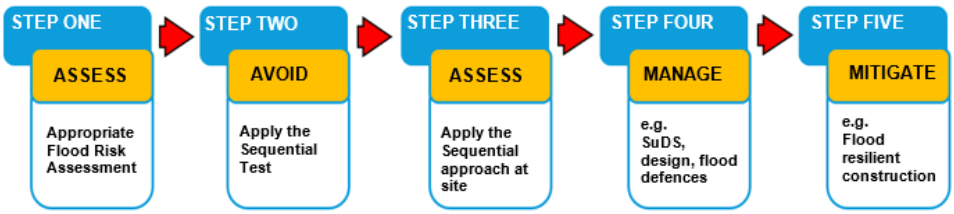


Figure 1-2: Flood risk management hierarchy

1.4.2 Technical assessment of hazards

Flood risk within the district has been assessed using results from computer models supplied by the Environment Agency and existing Environment Agency Flood Zone mapping.

The following models inform the flood risk information within the district:

- Environment Agency fluvial (river) models with year of production:
  - Lambourn, 2007
  - Pang and Sulham Brook, 2011
  - Kennet and Lambourn (Newbury), 2010

- Kennet (Newbury to Tyle Mill), 2007
- Kennet (Tyle Mill to Thames Confluence), 2007
- Thames (Mapledurham to Sonning), 2011
- Thames (Sandford to Reading Lock), 2018
- Thames (Whitchurch to Henley), 2000

- Environment Agency Risk of Flooding from Surface water map (2016)
- JBA Consulting Groundwater flood risk

The Environment Agency Flood Zones and models used are discussed in more detail in Section 3.3. Note that new national and local models may have been developed since preparation of this SFRA. Users should always consult the latest available modelling and mapping.

1.5 Consultation

There has been no formal consultation during the preparation of the 2019 SFRA update. However, the following parties (external to the Council) were consulted during the preparation of 2017 version of the SFRA:

- Monson Engineering Ltd. (SODC drainage engineers)
- Environment Agency
- Oxfordshire County Council (as Lead Local Flood Authority)
- Thames Water
- Neighbouring Authorities

1.6 User guide

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2. The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.
Level 1 Strategic Flood Risk Assessment	
3. How flood risk is assessed	Provides an overview of flooding and risk, Flood Zones, and what they mean.
4. The Sequential, risk based approach	Describes the Sequential approach and application of Sequential and Exception Tests. Describes the modelling and data used for the assessment. Outlines mapping that should be used for the Sequential and Exception Tests

Section	Contents
5. Understanding flood risk in the South Oxfordshire District	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting the districts. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered. Assessment of residual risk from flood defences, including future protection from climate change.
6. Assessment of flood risk in potential development areas	Summary of flood risk to strategic sites and designated Neighbourhood Plan Areas.
7. Opportunities for managing flood risk through the planning system	Advice on managing the risk of flooding for fluvial, surface water, groundwater and sewer flooding.
8. Flood risk guidance for planners and developers	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions set by the LLFA that should be followed.
9. Surface water run-off and drainage guidance for planners and developers	Advice on managing surface water run-off and flooding
Summary and recommendations	
10. Summary and conclusions	Reviews Level 1 SFRA and provides recommendations
Appendices	
Appendix A	Index of grid squares used for the Appendix mapping
Appendix B – Appendix J	Flood risk mapping for the South Oxfordshire District
Appendix K	SFRA Level 1 sites flood risk screening
Appendix L	SFRA Level 2 site summary sheets
Appendix M	Flood risk mapping for the Neighbourhood Development Plan areas
Appendix N	Cumulative impact assessment: Development and flood risk

2 The Planning Framework and Flood Risk Policy

2.1 Introduction

The overarching aim of development and flood risk planning policy in the UK is to ensure the potential risk of flooding is taken into account at every stage of the planning process.

The following section provides an overview of the current planning framework, flood risk policy and flood risk management responsibilities, which inform the subsequent sections of this updated SFRA.

2.2 Localism Act

The Localism Act (2011) provides local communities with greater control in local decision-making, such as deciding the location of new homes and businesses, through the preparation of neighbourhood development plans. It requires local authorities to *"engage constructively, actively and on an ongoing basis in any process by means of which development plan documents are prepared so far as relating to a strategic matter"*[1].

Neighbourhood Plans are the vehicle through which local communities are able to contribute to making decisions about the location and type of development, and the supporting infrastructure required to enable sustainable development within their areas. A Neighbourhood Plan is written by local people, and "made" or adopted by the LPA, becoming part of the development plan for that LPA. Neighbourhood Plans should take national guidance into account, and must be in general conformity with the LPA's strategic policies set out in the development plan.

The emerging South Oxfordshire Local Plan 2034 allocates strategic development site(s) and allocates other development sites through Neighbourhood Plans, which SODC has actively promoted. Details of ongoing and made plans are included in Section 6.

2.3 National Planning Policy Framework

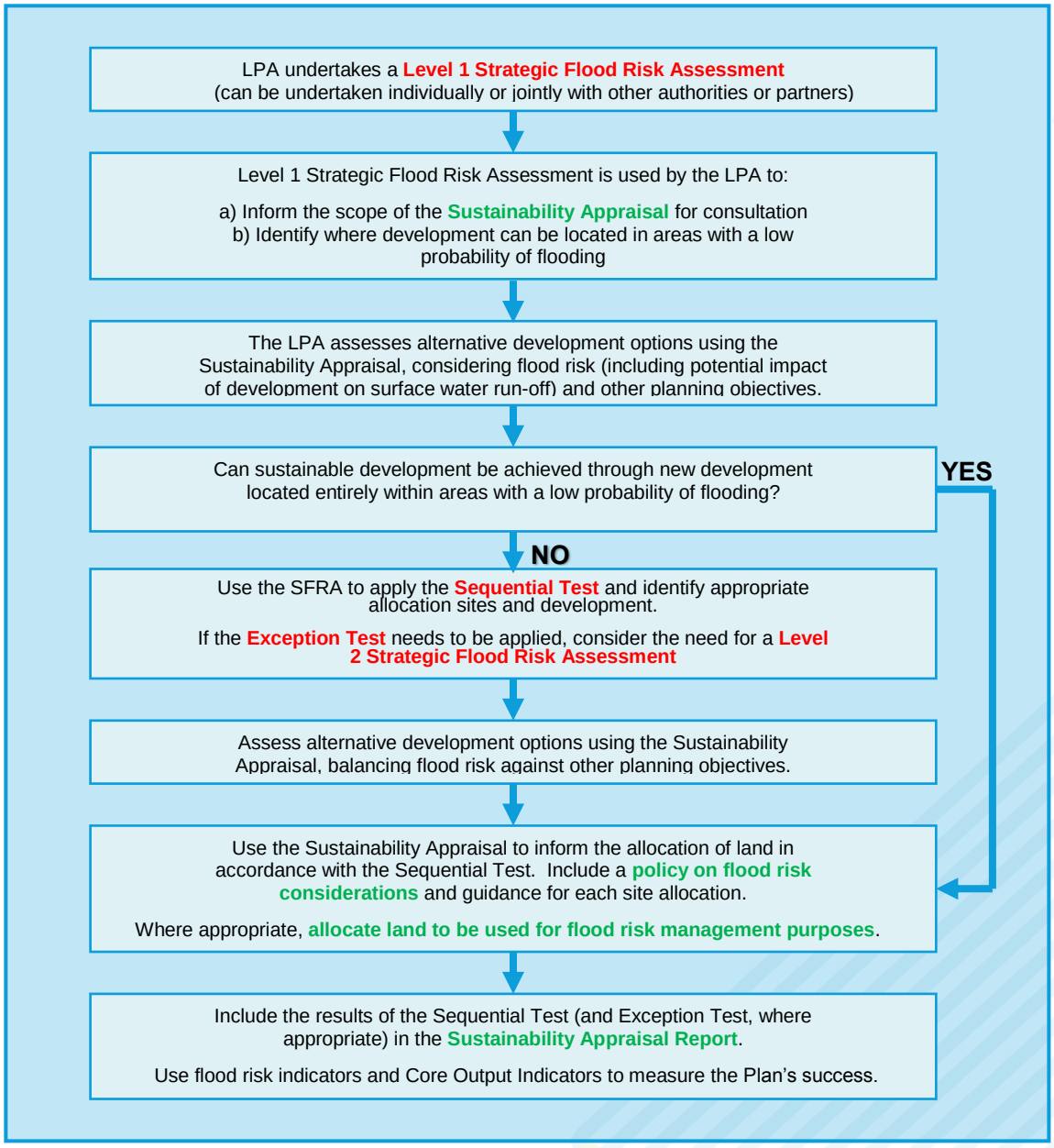
The National Planning Policy Framework (NPPF)[2] was issued on 27 March 2012 and updated on 24 July 2018 to, firstly, make the planning system less complex and more accessible, and secondly, to protect the environment, promote sustainable growth and replace most of the previously issued Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs). The NPPF is a source of guidance for local planning authorities to assist in preparation of Local Plans, as well as for applicants preparing planning applications.

Paragraphs 156 and 157 of the NPPF states that: "*Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to* flooding*, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards. All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change– so as to avoid, where possible, flood risk to people and property".*

The web-based Planning Practice Guidance on Flood Risk and Coastal Change[3] (henceforth referred to as 'the Planning Practice Guidance') was published alongside the NPPF and was most recently updated in November 2016. The guidance sets out

1 Localism Act 2011: Section 110, Department for Communities and Local Government (2011), Accessed online at: http://www.legislation.gov.uk/ukpga/2011/20/section/110 on: 27/06/17
2 National Planning Policy Framework Department for Communities and Local Government, (2012), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf on: 02/06/2017
3 Planning Practice Guidance: Flood Risk and Coastal Change, Department for Communities and Local Government (2015), Accessed online at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/ on 02/06/2017

how the policy should be implemented. A flow chart of how flood risk should be taken into account in the preparation of Local Plans is shown in Figure 2-1 below.



Based on Diagram 1 of the Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-021-20140306).

Figure 2-1: Flood risk and the preparation of Local Plans

2.3.1 Updates to the NPPF

The NPPF was revised in 2018 to implement the 2017 planning and housing market reforms introduced within the Housing White Paper[4]. Following public consultation on the draft revised NPPF between March and May 2018, the framework was published on 24 July 2018. Central to the reforms is the concept of 'planning for the right homes in the right places'. The key amendments with regards to development and flood risk, are as follows:

4 Department for Communities and Local Government (2017) Fixing our broken housing market. Available at: https://www.gov.uk/government/publications/fixing-our-broken-housing-market.

Clarification of the Exception Test (Paragraphs 157, 159-164)

Local Plans should not allocate land for development where it is not possible to meet the requirements of the Exception Test.

At the planning application stage, it may be necessary to reapply the Exception Test to individual allocated sites, which have undergone the Sequential Test. This may be due to the significant extent or nature of the flood risk identified to a site, or the age of the evidence base used to previously assess the site.

Minor Development and Changes of Use (Paragraph 164)

Minor development and change of use must still follow the Paragraph 103 of the NPPF, excluding the Sequential and Exception Tests, relating to the provision of a site-specific flood risk assessment, and ensuring that flood risk is not increased elsewhere.

Cumulative impact on flood risk (Paragraph 156)

Local Plans must be supported by a SFRA, and provide policies for managing all sources of flood risk.

Planning policy on flood risk should address the cumulative flood risks associated with separate new developments which are located within, or affect, areas susceptible to flooding.

The Impacts of Climate Change (Paragraph 148-150, 157)

Where climate change is expected to increase flood risk, and lead to development becoming unsustainable in the future, opportunities should be taken to relocate development to more sustainable locations.

The NPPF was then revised again in February 2019. There were no changes included in this update that would impact a SFRA.

2.4 Flood Risk Regulations (2009)

The Flood Risk Regulations (2009) were intended to translate the current EU Floods Directive into UK law and place responsibility upon Lead Local Flood Authorities (LLFAs) to manage local flood risk. Under the Regulations, the responsibility for managing flood risk from rivers, the sea and reservoirs lies with the Environment Agency; and responsibility for managing flood risk from local sources including; surface water, groundwater and ordinary watercourses, rests with LLFAs. The LLFA for South Oxfordshire is Oxfordshire County Council.

Figure 2-2 illustrates the steps that have / are being taken to implement the requirements of the EU Directive in the UK via the Flood Risk Regulations.

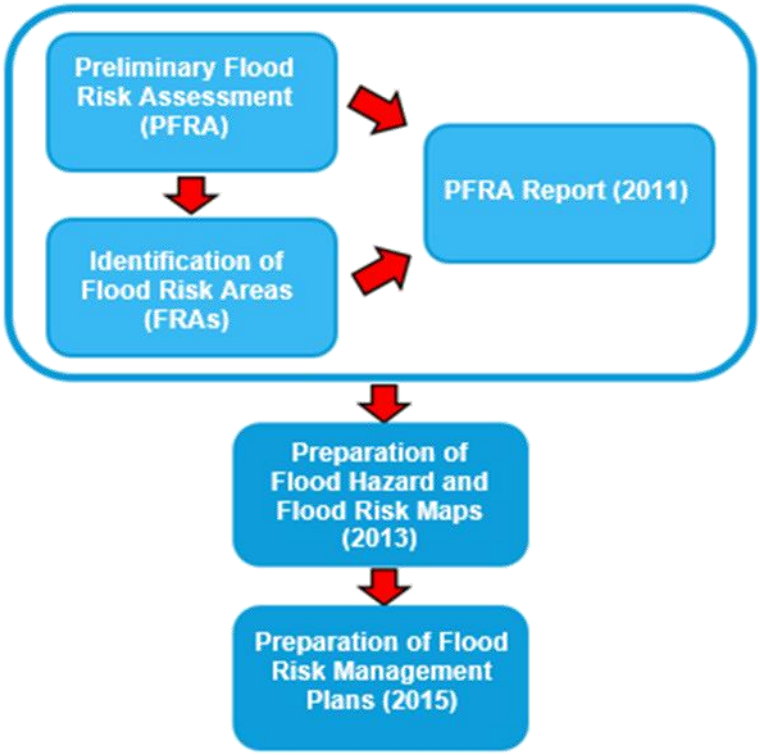


Figure 2-2: Flood Risk Regulations Requirements

Under this action plan in accordance with the Regulations, LLFAs are required to prepare a Preliminary Flood Risk Assessment (PFRA) report. This is a high-level report assessing historic flood incidents and the probability of future flooding within the administrative area. The Oxfordshire PRFA[5], produced in 2011, did not identify any indicative Flood Risk Areas following the definition of the Defra 2010 guidance.

In line with the Flood Risk Regulations (2009) each stage of the planning cycle must be reviewed every 6 years and updated if required. To this end, the Environment Agency and Defra issued guidance to the LLFAs in January 2017 which set out the approach to review and where required, update their PFRAs and flood risk areas. The Oxfordshire PRFA addendum, produced in 2017, concluded that there was no change to the assessment of risk from 2011[6].

2.4.1 Flood Risk Management Plans

Flood Risk Management Plans (FRMPs) are required under the Flood Risk Regulations and highlight the hazards and risks of flooding from rivers, the sea, surface water, groundwater and reservoirs. FRMPs provide catchment scale flood risk planning, and set out how Risk Management Authorities (RMA) work together with communities to manage flood risk.

The draft FRMPs were prepared by the Environment Agency in 2015, in partnership with LLFAs and other RMAs, and co-ordinated flood risk management planning with river basin management planning required under the Water Framework Directive[7]. South Oxfordshire is covered by the Thames River Basin District FRMP.

There are no specific measures in the FRMP which come under the ownership of SODC or Oxfordshire County Council in the Thames River Basin, however the Environment

[5] https://oxfordfloodalliance.files.wordpress.com/2014/12/oxfordshire-pfra_v1-2_apr11_version-for-scrutiny.pdf
[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698695/PFRA_Oxfordshire_County_Council_2017.pdf
[7] http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

Agency is responsible for several measures which fall within the district. The measures relating to planning and flood risk in South Oxfordshire are summarised in Table 2-1.

Table 2-1: FRMP specific measures

Measure ID	Location	Measure name	Measure details	Measure Owner
ACT3522	Along the River Thames from Sandford to Cookham	Short-term land use planning	Work with the relevant planning authority at both the strategic and planning application stages to steer development to areas at the least risk of flooding. Where practicable seek to re-establish, and enhance natural river corridors through new development in line with the Water Framework Directive	EA
ACT3523	Along the River Thames from Sandford to Cookham	Flood resilience adaptation	Work with developers to ensure any redevelopment reduces flood risk. Gain environmental improvements, where appropriate.	EA
ACT3527	Along the River Thame	Short-term land use planning actions	Work with the relevant planning authority at both the strategic and planning application stages to steer development to areas at the least risk of flooding. Where practicable seek to re-establish, and enhance natural river corridors through new development in line with the Water Framework Directive.	EA
ACT3528	Along the River Thame	Conveyance in urban locations	Continue with current regime of inspections and clearance set out in the system asset management plan (SAMP). Review the effectiveness of maintenance and seek to reduce costs where possible	EA

2.4.2 The Water Framework Directive

The Water Framework Directive (WFD) is a European Union directive for the protection of inland surface waters, groundwaters, estuaries and coastal waters. Its objectives include the aim to achieve good status for all water bodies, or good ecological potential and good surface water chemical status for heavily modified water bodies and artificial water bodies. Such considerations need to be accounted for when considering development proposals.

The WFD is delivered on a river basin scale across the UK, and South Oxfordshire lies within the Thames River Basin District.

2.4.3 River Basin Management Plans

River Basin Management Plans (RBMPs) provide a framework for protecting and enhancing the quality of the water environment. As water and land resources are closely linked, it also informs decisions of land use planning. It is critical that water is managed to ensure that the needs of society, economy and wildlife can be met and maintained over the long term. Sections of particular importance are baseline classification of water bodies, statutory objectives for protected areas, statutory objectives for water bodies, and the programme of measures to achieve statutory objectives. The RBMP fulfils the requirements of the Water Framework Directive (WFD).

South Oxfordshire district is covered by the Thame and South Chilterns catchment plan for the Thames River Basin District[8]. Measures for the Lower Thame involve reducing point and diffuse source pollution, providing habitat improvement, and increasing clean water ponds and wetland habitats.

The full RBMPs are all available to download online at:

http://www.gov.uk/government/collections/river-basin-management-plans-2015

2.4.4 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMP) are high level policy documents covering large river basin catchments. They aim to set policies for sustainable flood risk management for the whole catchment covering the next 50 to 100 years.

South Oxfordshire is covered by the Thames CFMP[9]. The CFMP catchments are split into sub areas with similar flood risk management types, with one of six policies assigned to each sub area. Table 2-2 below summarises the related policy statements:

Table 2-2: CFMP Policies in SODC

CFMP	Sub Area	Policy
Thames	4 - Chalk and down land catchments	Policy 3 - Areas of low to moderate flood risk where we are generally managing existing flood risk effectively.
Thames	2 - Towns and villages in open flood plain (central)	Policy 4 - Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.

South Oxfordshire is split between two policy sub areas. These actions identified for each sub area are summarised in Table 2-3. The actions focus on maintaining the capacity of the river system, increasing public awareness of flood risk, and improving flood warning and response.

Table 2-3: CFMP Actions

CFMP	Policy	Summary of Main Actions
Thames	Policy 3	Maintain the existing capacity of river systems. Work with LPAs to retain the floodplain for flood storage and adapt the urban environment to flood risk. Continue to increase public awareness.
Thames	Policy 4	Maintain existing flood defences, and investigate opportunities for new defences. Review maintenance to ensure maintenance of channel capacity. Promote greater awareness of flood risk. Build on flood warning work. Develop emergency response planning for extreme floods.

8 Thames River Basin Management Plan, Environment Agency (2016), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/500548/Thames_RBD_Part_1_river_basin_management_plan.pdf on: 25/10/2016.
9. Thames Catchment Flood Management Plan Summary Report, Environment Agency (2009), Accessed online at: https://www.gov.uk/government/publications/thames-catchment-flood-management-plan on: 02/06/2017

2.5 Flood and Water Management Act (2010)

The Flood and Water Management Act (FWMA) (2010)[10] aimed to create a simpler and more effective means of managing both flood risk and coastal erosion and implement Sir Michaels Pitt's recommendations following his review of the 2007 floods. The FWMA received Royal Assent in April 2010.

2.5.1 Lead Local Flood Authorities

The duties of Oxfordshire County Council (OCC), the LLFA for South Oxfordshire, include:

- Lead responsibility for managing the risk of flooding from surface water, groundwater and Ordinary Watercourses (often described as 'local flood risk').
- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor an LFRMS to outline how to manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.
- Flood investigations: when appropriate and necessary LLFAs must investigate and report on flooding incidents.
- Register of flood risk features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: Where appropriate, LLFAs will perform consenting of works on Ordinary Watercourses.

On 18 December 2014, a Written Ministerial Statement laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply to major development from 6 April 2015. In considering planning applications, planning authorities should consult the LLFA on the management of surface water, and ensure, through use of planning conditions or obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

In March 2015, the LLFA was made a statutory consultee to the planning system, which came into effect on 15 April 2015. As a result, Oxfordshire County Council are required to provide technical advice on surface water drainage strategies and designs put forward for new major developments[11].

Within South Oxfordshire, the council's drainage team comment upon the drainage proposals for applications for minor development.

2.5.2 Oxfordshire Preliminary Flood Risk Assessment (PFRA)

The Oxfordshire PFRA was published by Oxfordshire County Council in 2011[12], and gives an overview of local flood risk in the county. The PFRA investigated past flooding incidents which affected properties, infrastructure and services, and assessed the consequences of future flooding, considering climate change and future development.

The greatest flood risk in the county was concentrated around Oxford city and the towns of Banbury, Witney and Abingdon, which lie outside the South Oxfordshire

10 Flood and Water Management Act 2010, UK government (2010), Accessed online at: http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf on 02/06/2017

11 as defined by the Development Management Procedure Order 2010

12 Preliminary Flood Risk Assessment, Oxfordshire County Council (2011), Accessed online at: https://www.oxfordshire.gov.uk/cms/content/oxfordshire-preliminary-flood-risk-assessment-pfra on: 02/06/2017

district. The PFRA did not identify any Flood Risk Areas in Oxfordshire of national flood risk significance (with a total of more than 30,000 people affected by flooding) however the evidence collected was used to inform the Local Flood Risk Management Strategy.

In accordance with the 6-year planning cycle required by the Flood Risk Regulations, the Oxfordshire PFRA has been reviewed. The PFRA addendum published in 2017 concluded there was no change from the risk assessment from 2011.

2.5.3 Oxfordshire Local Flood Risk Management Strategy

The Oxfordshire Local Flood Risk Management Strategy[13] was produced in 2015, and sets out OCC's approach to managing flood risk and increasing community resilience within Oxfordshire. There is a strong focus within the strategy on collaboration between authorities and communities, to share knowledge, which is apparent in the objectives for managing flood risk in the county:

- Improving understanding
- Taking a collaborative approach
- Preventing an increase in flood risk
- Taking a sustainable and holistic approach

The strategy provides a series of actions which Risk Management Authorities (RMAs) will undertake to achieve these objectives, which are supported by details of funding mechanisms available for flood risk management schemes, how schemes will be prioritised, and commitments for communication with residents. The Flood Risk Strategy highlighted a need for the LLFA to provide greater communication about Flood Risk in Oxfordshire. To this end, OCC has prepared the Oxfordshire Flood Toolkit (www.oxfordshirefloodtoolkit.com), which provides a considerable amount of information for individuals, partner organisations and developers.

2.5.4 Surface Water Management Plans (SWMPs)

SWMPs outline surface water issues in a given location, and the preferred options for managing the flood risk. SWMPs are undertaken, when required, by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water, and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

There are currently no SWMPs which have been undertaken in South Oxfordshire, however any future SWMPs carried out in the district must be considered by the Local Plan.

2.6 Water Cycle Studies

Future changes in climate and increases in new development can be expected to exert greater pressure on the existing waste water supply and infrastructure within a settlement. A large number of new homes, for instance, may cause the existing water supply infrastructure to become overwhelmed, which would result in adverse effects on the environment both locally and in wider catchments. Planning for water management therefore needs to take these potential challenges into account.

Water Cycle Studies (WCS) assist local authorities in selecting and developing sustainable development allocations, so that there is minimal impact on the environment, water quality, water resources, infrastructure and flood risk. In areas where there may be conflict between any proposed development and environmental

13 Local Flood Risk Management Strategy, Oxfordshire County Council (2015) Accessed online at: https://www.oxfordshire.gov.uk/cms/content/oxfordshire-local-flood-risk-management-strategy on: 02/06/2017

requirements, this can be achieved through the recommendation of potential sustainable solutions.

South Oxfordshire has prepared an updated Phase 1 WCS[14], to support the Emerging Local Plan. The document highlighted some potential infrastructure and water quality constraints to developments in the district, with restrictions in sewer network capacity at most settlements, and improvements required at all wastewater treatment works (except Goring) to prevent deterioration of watercourses. This document is currently under review as part of the general evidence update. An addendum is expected to be published in January 2019.

2.7 Infrastructure Delivery Plan

The South Oxfordshire Infrastructure Delivery Plan[15] assesses the existing and planned infrastructure in the district, and identifies any requirements for planned growth. The document informs strategic planning policies within the Local Plan.

The following strategic infrastructure projects are planned within the timescale of the Local Plan:

- Crossrail
- Thames road crossing between Culham and Didcot
- Didcot Northern Perimeter Road Phase 3
- East West Rail
- Jubilee Way roundabout
- Oxford to Cambridge Expressway
- Didcot Science Bridge and A4130 Capacity Improvements

Several of these routes, in particular the Culham river crossings schemes, cross flood risk areas or may have an impact on flood risk. However, their construction also presents opportunities for flood risk improvements to be achieved.

Association of British Insurers Guidance, The Association of British Insurers (ABI) and the National Flood Forum have published guidance to assist local authorities in England in producing local plans and reviewing planning applications in flood risk areas[16]. The guidance complements the National Planning Policy Framework, and provides the following key recommendations:

- Ensure strong relationships with technical experts on flood risk
- Consider flooding from all sources, taking account of climate change
- Take potential impacts on drainage infrastructure seriously
- Ensure that flood risk is mitigated to acceptable levels for proposed developments
- Make sure Local Plans take account of all relevant costs are regularly reviewed

The insurance companies and the government have been working together to develop a new flood re-insurance scheme known as FloodRe. It was launched in April 2016, and is designed to:

14 Phase 1 Water Cycle Study, South Oxfordshire District Council (2016), Available at: http://www.southoxon.gov.uk/services-and-advice/planning-and-building/planning-policy/evidence-studies, on: 27/06/17
15 Infrastructure Delivery Plan - Stage 1, South Oxfordshire District Council (2017), Available at: http://www.southoxon.gov.uk/services-and-advice/planning-and-building/planning-policy/evidence-studies, on: 27/06/17
16 Guidance on Insurance and Planning in Flood Risk Areas for Local Planning Authorities in England (Association of British Insurers and National Flood Forum, April 2012)

- Enable flood cover to be affordable for those households at highest risk of flooding;
- Increase availability and choice of insurers for customers;
- Allow time for government, local authorities, insurers and communities to become better prepared for flooding;
- Create a 'level playing field' for new entrants and existing insurers in the UK home insurance market.

Further details are available on the FloodRe website at www.floodre.co.uk.

2.8 Roles and responsibility in the South Oxfordshire District Council

Responsibilities under the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009 are summarised in Table 2-4.

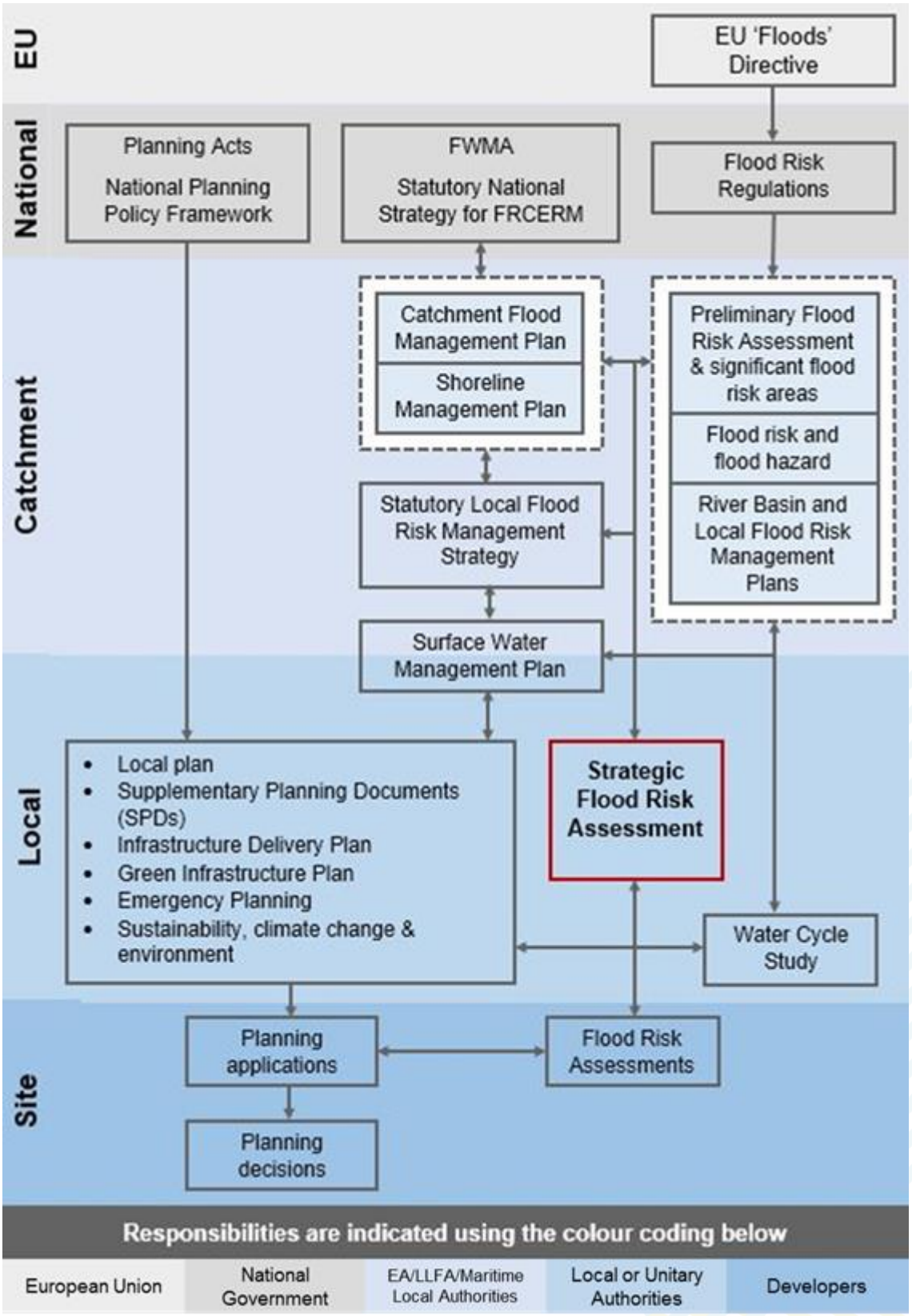
Table 2-4: Roles and responsibilities in South Oxfordshire

Risk Management Authority (RMA)	Strategic Level	Operational Level
Environment Agency	National Statutory Strategy Reporting and supervision (overview role)	Preliminary Flood Risk Assessment (per River Basin District) (the Environment Agency exercised an exception to the regulations and instead prepared Flood Hazard and Risk mapping and Flood Risk Management Plans) Managing flooding from main rivers and reservoirs and communication of flood risk warnings to the public, media and partner organisations. Identifying Significant Flood Risk Area Preparation of Flood Risk and Hazard Maps Preparation of Flood Risk Management Plan Enforcement authority for Reservoirs Act 1975 Managing Regional Flood and Coastal Committees (RFCCs) and supporting funding decisions, working with LLFAs and communities. Emergency planning and multi-agency flood plans, developed by local resilience forums
Lead Local Flood Authority (Oxfordshire County Council)	Input to national strategy Formulate and implement local flood risk management strategy	Responsible for enforcing and consenting works for Ordinary Watercourses, risk assessing Ordinary Watercourses. Managing local sources of flooding from surface water runoff and groundwater and carrying out practical works to manage flood risk from these sources where necessary. Preparing and publishing a PFRA Identifying Flood Risk Areas Preparing Flood Hazard and Flood Risk Maps Preparing Flood Risk Management Plans (where local flood risk is significant) Investigating certain incidents of flooding in Section 19 Flood Investigations Statutory roles in planning for surface water drainage. Keeping asset registers of structures and features which have a significant effect on local flood risk.

Risk Management Authority (RMA)	Strategic Level	Operational Level
District Council (South Oxfordshire District Council)	Input to National and Local Authority Plans and Strategy	Preparation of a Local Plan to guide development. The competent determining authority for planning applications and have the ultimate decision on the suitability of a site in relation to flood risk and management of surface water run-off. Responsibilities for emergency planning as a responder to a flood event. Own and manage public spaces which can potentially be used for flood risk management.

Figure 2-3 outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and the Flood and Water Management Act, in conjunction with the Localism Act's "duty to cooperate", introduce a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and plans. SFRAs are also linked to the preparation of Catchment Flood Management Plans (CFMPs), Shoreline Management Plans (SMPs), Surface Water Management Plans (SWMPs) and Water Cycle Studies (WCSs).



† See Table 2-4 for roles and responsibilities for the preparation of information

Figure 2-3: Strategic planning links and key documents for flood risk

3 How flood risk is assessed

3.1 Introduction

This section describes how we define and assess flood risk, and the main sources of information, data and mapping we have used to assess flood risk for this SFRA.

Planners and developers should use the evidence and maps presented in this SFRA, along with any other available evidence to identify any risk of flooding from all sources for a particular site.

3.2 Definitions

3.2.1 Flood

Section 1 (subsection 1) of the Flood and Water Management Act (FWMA) (2010)[17] defines a flood as:

'any case where land not normally covered by water becomes covered by water'

Section 1 (subsection 2) states that 'it does not matter for the purposes of subsection (1)' whether a flood is caused by:

A heavy rainfall;

B a river overflowing or its banks being breached;

C a dam overflowing or being breached;

D tidal waters;

E groundwater; or

F anything else (including any combination of factors).

Note: Sources of flooding under this definition do not include excess surface water from any part of a sewerage system, unless caused by an increase in the volume of rainwater entering or affecting the system, or a flood caused by a burst water main.

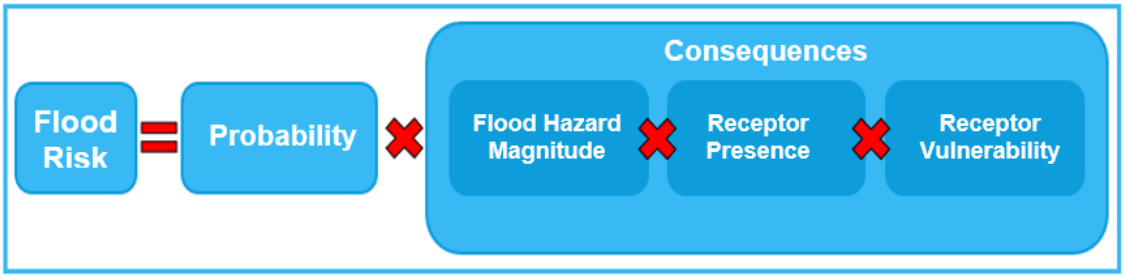
3.2.2 Flood risk

Section 3 (subsection 1) of the FWMA defines the risk of a potentially harmful event (such as flooding) as:

'a risk in respect of an occurrence is assessed and expressed (as for insurance and scientific purposes) as a combination of the probability of the occurrence with its potential consequences.'

Thus, it is possible to summarise flood risk as:

Flood Risk = (Probability of a flood) x (Scale of the consequences)



Using this definition, it can be seen that:

- **Increasing the probability or chance of a flood being experienced increases the flood risk:** In situations where the probability of a flood

17 Flood and Water Management Act (2010): http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

being experienced increases gradually over time, for example due to the effects of climate change, then the flood risk will increase.

- **The potential scale of the consequences in a given location can increase the flood risk:**
  - **Flood Hazard Magnitude:** If the direct hazard posed by the depth of flooding, velocity of flow, the speed of onset, rate of risk in flood water or duration of inundation is increased, then the consequences of flooding, and therefore risk, is increased.
  - **Receptor Presence:** The consequences of a flood will be increased if there are more receptors affected, for example with an increase in extent or frequency of flooding. Additionally, if there is new development that increases the probability of flooding (for example, increase in volume of runoff due to increased impermeable surfaces) or increased density of infrastructure then consequences will also be increased.
  - **Receptor Vulnerability:** If the vulnerability of the people, property or infrastructure is increased then the consequences are increased. For example, old or young people are more vulnerable in the event of a flood.

3.3 Flood risk data in the SFRA

This SFRA contains information that can be used at strategic, operational and tactical levels as shown by Figure 3-1.

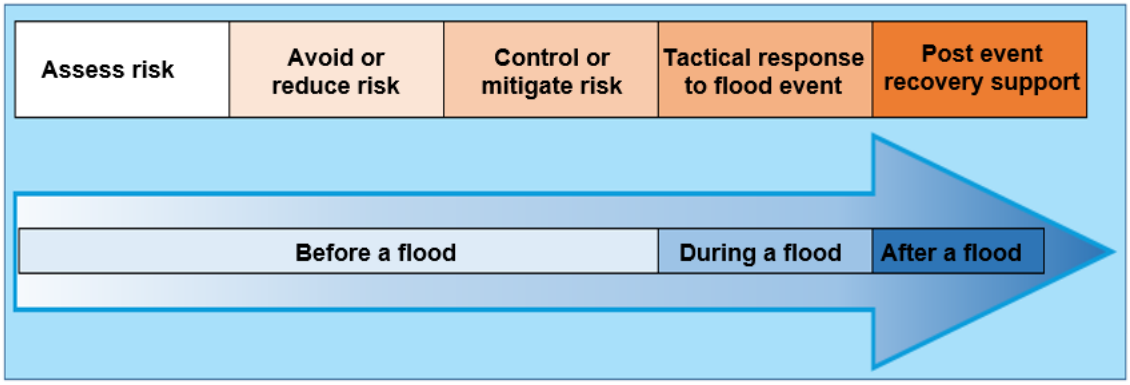


Figure 3-1: Use of SFRA information

The assessment of flood risk in the SFRA is primarily based on the following three types of information:

1 Flood Zones (undefended flood risk)
2 Actual flood risk (defended flood risk)
3 Residual risk (if flood mitigation measures were to fail)

3.4 Flood risk mapping

3.4.1 Flood zone definition

A concept diagram showing the classification of NPPF Flood Zones graphically, is included in Figure 3-2. Table 3-1 includes a description and discussion of appropriate development. A fuller discussion of Flood Zones and their relationship to planning policy can be found in the NPPF and the Planning Policy Guidance.

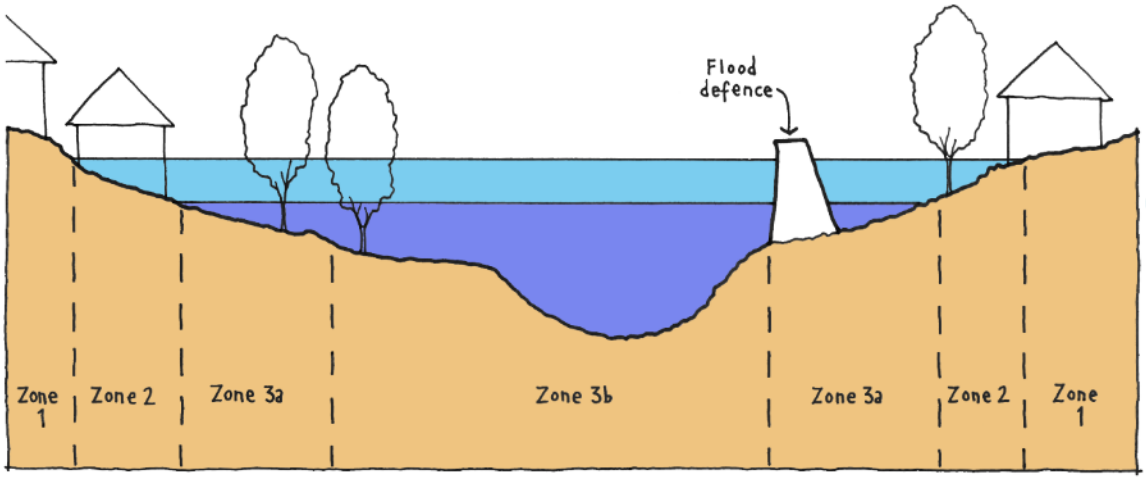


Figure 3-2: Definition of Flood Zones

The preference when allocating land is, whenever possible, to place all new development on land in Zone 1, see Section 4 of this report for more information on the sequential risk based approach. Since the Flood Zones identify locations that are not reliant on flood defences, placing development on Zone 1 land means there is no future commitment to spending money on flood banks or flood alleviation measures. It also does not commit future generations to costly long-term expenditure that would become increasingly unsustainable as the effects of climate change increase.

Table 3-1: Flood Zone description

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
		Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) as appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.
		Developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems.

Zone	Probability	Description
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year developers and the local authorities should seek to reduce the overall level of flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
		Developers and local authorities should seek opportunities to: • Reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems. • Relocate existing development to land in lower risk zones. • Create space for flooding by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open spaces for flood storage.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone in discussion with the LPA and the Environment Agency. The identification of functional floodplain should take account of local circumstances, for example whether or not the floodplain is currently developed.
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. Infrastructure must also not increase flood risk elsewhere.
		All developments in this zone require an FRA.
		Developers and local authorities should seek opportunities to: • Reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems. • Relocate existing development to land in lower risk zones.

3.4.2 Flood Map for Planning (Rivers and Sea) (Flood Zone 2 and 3a)

The NPPF sets out a Sequential Test to steer new development to areas with the lowest probability of flooding. This is initially based on the Flood Map for Planning (Rivers and Sea), as provided by the Environment Agency, but should be refined by the SFRA to take into account the probability of flooding, other sources of flooding and the impact of climate change.

The Flood Map for Planning (Rivers and Sea) is made up of a suite of map layers, including Flood Zone 2 and 3a, Defences, Areas Benefiting from Defences, and Flood Storage Areas. The Flood Map for Planning in South Oxfordshire is shown in **Appendix C**.

The Flood Zones describe the land that would flood from rivers if there were no defences present. They are based on broad scale modelling that has been refined with

detailed hydraulic models in areas of higher risk. Areas Benefiting from Defences can be identified using the accompanying layers.

Where outlines are not informed by detailed hydraulic modelling, the Flood Map for Planning is based on generalised modelling to provide an indication of flood risk. Whilst the generalised modelling is mostly accurate on a large scale, they are not provided for specific sites or for land where the catchment area of the watercourse falls below 3km^2. For this reason, the Flood Map for Planning is not of a resolution for use as application evidence to provide details for flooding of individual properties or sites, and for any sites with watercourses on, or adjacent to the site. Accordingly, for site specific assessments it will be necessary to perform more detailed studies in circumstances where flood risk is an issue. Where the Flood Map for Planning is based on generalised modelling, developers should undertake a more detailed analysis and assessment of the flood risk at the planning application stage.

The most up to date version of the Flood Map for Planning (Rivers and Sea) should always be used, and can be viewed on the Environment Agency's website[18].

For planning purposes under the NPPF, a more detailed breakdown of risk within the Flood Zones is required and the SFRA is required to define Flood Zone 3b (also known as a Functional Floodplain) and Flood Zone 3a with climate change, using more detailed data from hydraulic models where available. This information is included in the detailed mapping which accompanies this report and encompasses all the local authority's currently identified sites.

3.4.3 Updating the Flood Zone mapping

The Environment Agency's Flood Zone 3a and 2 are updated quarterly with any new detailed hydraulic modelling information, and planners and developers should always refer to the most up to date issue. These data sets are now freely available on the Government open data website[19][20].

The Flood Zone 3b and 3a plus climate change provided by the SFRA will not be automatically updated. However, users should be aware that if Flood Zone 3a and 2 have changed, this is an indication that new modelled information is also available which could be used to refine Flood Zone 3b and 3a plus climate change.

3.4.4 Functional Floodplain (Flood Zone 3b)

The 'functional floodplain' is defined as an area of land where water flows or is stored in times of flood. This forms Flood Zone 3b within the NPPF. Following discussion between the Council and Environment Agency, the following definition of the functional floodplain was agreed:

- Use the 1 in 20-year modelled flood extent wherever suitable hydraulic models are available.
- Elsewhere, take a precautionary approach and assume that Flood Zone 3a (1 in 100-year flood extent) represents the functional floodplain

3.4.5 Climate Change (Flood Zone 3a plus climate change)

The Flood Map supplied by the Environment Agency does not provide any allowance or indication of the impact of climate change on the Flood Zones.

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18 Flood Map for Planning (Rivers and Sea), Environment Agency (2017), Accessed online at: https://flood-map-for-planning.service.gov.uk/ on: 02/06/2017

19 Flood Map for Planning (Rivers and Sea) – Flood Zone 2, Environment Agency (2018). Accessed online at: https://data.gov.uk/dataset/bed63fc1-dd26-4685-b143-2941088923b3/flood-map-for-planning-rivers-and-sea-flood-zone-2

20 Flood Map for Planning (Rivers and Sea) – Flood Zone 3, Environment Agency (2018). Accessed online at: https://data.gov.uk/dataset/bed63fc1-dd26-4685-b143-2941088923b3/flood-map-for-planning-rivers-and-sea-flood-zone-3

Updated government guidance on assessing the impact of climate change on flooding in line with the UKCP09 Climate Change Projections[21] was released in February 2016[22]. The guidance provides a range of climate change allowances which are dependent on location (by river basin) and timescale of development (epoch). It also provides several bands (termed 'central', 'higher central' and 'upper end') to test depending on the vulnerability of the development and the Flood Zone within which it is located. For example, for 'more vulnerable' development in Flood Zone 3a, FRAs should use the higher central and upper end estimates to assess a range of allowances.

For the purposes of strategic planning, the key period considered is 2070-2115 as this reflects the lifetime of development; and the key vulnerability is 'more vulnerable' as this represents a conservative classification incorporating all vulnerabilities. The key allowances to consider for Flood Zone 3a are therefore the higher central and upper end (35% and 70% in the Thames river basin respectively) as shown in Figure 3-2.

Table 3-2: Climate change allowances

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

3.4.6 Surface water

Mapping of surface water flood risk in South Oxfordshire has been taken from the Risk of Flooding from Surface Water (RoFSW) map published online by the Environment Agency. This information is based on a national scale map identifying those areas where surface water flooding poses a risk. Surface water flood risk is subdivided into the following four categories:

- High: An area has a change of flooding greater than the 1 in 30 (3.3%) each year;
- Medium: An area has a chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%) each year;
- Low: An area has a chance of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%) each year;
- Very Low: An area has a chance of flooding of less than 1 in 1000 (0.1%) each year.

3.4.7 Identification of Flood Risk from other Sources

Planners and developers should use the evidence and maps presented in this SFRA, along with any other available evidence to identify any risk of flooding from all sources for a particular site. Table 3-3 below gives some guidelines on sources of evidence for identifying a significant level of risk.

21 UK Climate Projections (UKCP09), Met Office (2015), Accessed online at: http://ukclimateprojections.metoffice.gov.uk/21678 on: 02/06/2017
22 Climate change allowances, Environment Agency (2016) Accessed online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances on 02/06/2017

Table 3-3: Identifying areas at risk of flooding from all sources

Source of Flooding	Source of Evidence	Criteria for identifying risk
Ordinary Watercourses (not included in Flood Zone maps)	Detailed River Network SODC/OCC records Anecdotal evidence	Within 10m of the watercourse Local evidence of historic flooding from the watercourse.
Surface water	Environment Agency Risk of flooding from Surface Water map SODC/OCC records Anecdotal evidence	Within the high, medium or low categories on the RoFSW Local evidence of surface water flooding in the area.
Groundwater	Environment Agency Areas Susceptible to Groundwater Flooding (AStGWF) SODC/ OCC records Anecdotal evidence JBA Consulting Groundwater Flood Map	Risk in highest category on AStGWF, however the JBA Consulting Groundwater Flood Map has been used in preference in this study. Local evidence of groundwater flooding problems in the area. 5m resolution groundwater flood risk mapping.
Sewer	SFRA Sewer Flooding Map SODC/OCC records Anecdotal evidence	Local evidence of sewer flooding to existing properties on or near the site Sewer flooding records provided by Thames Water are not detailed enough to identify site-specific risks. However, Thames Water will comment on larger planning applications, and on Local Plans.
Flooding from reservoirs, canals and other artificial sources	Environment Agency reservoir flood plans - can be viewed on the Environment Agency website[23]	Within flood envelope on Environment Agency reservoir flooding maps within 100m of a canal or other waterbody.

3.5 Flood risk modelling

3.5.1 Residual risk

The residual risk refers to the risks that remain in circumstances after measures have been taken to alleviate flooding (such as flood defences). It is important that these

23 Long term flood risk, Environment Agency (2017), Accessed online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk, on: 27/06/2017

risks are quantified to confirm that the consequences can be safely managed. The residual risk can be:

- The effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges.
- Or failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner or failure of pumping stations.

The assessment of residual risk demands that attention be given to the vulnerability of the receptors and the response to managing the resultant flood emergency. In this instance, attention should be paid to the characteristics of flood emergencies and the roles and responsibilities during such events. Additionally, in the cases of breach or overtopping events, consideration should be given to the structural safety of the dwellings or structures that could be adversely affected by significant high flows or flood depths.

3.6 Planning responses to flood risk

Planning responses to flood risk should be in line with the Flood Risk Management Hierarchy (see Figure 1-2):

3.6.1 Assess

The first response to flooding must be to understand the nature and frequency of the risk. The assessment of risk is not just performed as a "one off" during the process, but rather the assessment of risk should be performed during all subsequent stages of responding to flooding.

3.6.2 Avoid

The Sequential Test requires that the first requirement is to avoid the hazard. If it is possible to place all new growth in areas at a low probability of flooding, then the flood risk management considerations will relate solely to ensuring that proposed development does not increase the probability of flooding to others. This can be achieved by implementing Sustainable Drainage Systems (SuDS) and other measures to control and manage runoff.

In some circumstances, it might be possible to include measures within proposed growth areas that reduce the probability of flooding to others and assist existing communities to adapt to the effects of climate change. In such circumstances, the growth proposals should include features that can deliver the necessary levels of mitigation so that the standards of protection and probability of flooding are not reduced by the effects of climate change. In South Oxfordshire, consideration should be given not only to the peak flows generated by new development but also to the volumes generated during longer duration storm events.

3.6.3 Substitute, Control and Mitigate

These responses all involve management of the flood risk and thus require an understanding of the consequences (the magnitude of the flood hazard and the vulnerability of the receptor).

There are opportunities to reduce the flood risk by lowering the vulnerability of the proposed development. For instance, changing existing residential land to commercial uses will reduce the risk, provided that the residential land can then be located on land in a lower risk Flood Zone.

Flood risk management responses in circumstances where there is a need to consider growth, or regeneration in areas that are affected by a medium or high probability, will include:

- Strategic measures to maintain or improve the standard of flood protection so that the growth can be implemented safely for the lifetime of the development (must include provisions to invest in infrastructure that can adapt to the increased chance and severity of flooding presented by climate change).
- Design and implement measures so that the proposed development includes features that enables the infrastructure to adapt to the increased probability and severity of flooding whilst ensuring that new communities are safe and that the risk to others is not increased (preferably reduced).
- Flood resilient measures that reduce the consequences of flooding to infrastructure so that the magnitude of the consequences is reduced. Such measures would need to be considered alongside improved flood warning, evacuation and welfare procedures so that occupants affected by flooding could be safe for the duration of a flood event and rapidly return to properties after an event had been experienced.

It should be noted that the Flood and Coastal Risk Management Grant in Aid (FCRMGiA) funding arrangements (introduced in 2011) do not make government funds available for any new development implemented after 2012. Accordingly, it is essential that appropriate funding arrangements are established for new development proposed in locations where a long-term investment commitment is required to sustain Flood Risk Management (FRM) measures. The strategic investment commitment is required so that in future the FRM measures can be maintained and afforded for the lifetime of the development, since the available funds from FCRMGiA will potentially not reflect the scale of development that is benefitting. The policy statement 'Flood and Coastal Resilience Partnership Funding' (2013)[24] sets out the arrangements that will apply for the allocation of capital Flood Defence Grant-in-Aid (FDGiA) to flood and coastal erosion risk management projects. Flood and Coastal Resilience Partnership Funding will form part of the Environment Agency's overall capital allocation projects until the end of the 2014/2015 financial year. Under this system, central government contributions will cover the full cost of a scheme if it has high benefits – such as if a high number of homes are protected. However, where the benefits are not high enough for central government contributions to cover the costs, local contributions may be available to top up the funding.

24 Flood and Coastal Resilience Partnership Funding, Defra (2013), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221094/pb13896-flood-coastal-resilience-policy.pdf on 22/06/2017

The National Flood and Coastal Erosion Management Strategy[25] summarises the new system:

> **"In essence, instead of meeting the full cost of a limited number of schemes, a new partnership approach to funding could make government money available to pay a share of any worthwhile scheme. The amount in each case will depend on the level of benefits the scheme provides. For example, the number of households protected, or the amount of damage that can be prevented. The level of government funding potentially available towards each scheme can be easily calculated. Local authorities and communities can then decide on priorities and what to do if full funding isn't available. Projects can still go ahead if costs can be reduced or other funding can be found locally."**

There are a number of potential impacts of this change in funding. The Government stated that its proposals will help to:

- Encourage total investment in Flood and Coastal Erosion Risk Management by operating authorities to increase beyond what is affordable to national budgets alone;
- Enable more local choice within the system and encourage innovative, cost-effective options to come forward in which civil society may play a greater role;
- Maintain widespread uptake of flood insurance.

25 The national flood and coastal erosion risk management strategy for England, Defra (2011), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf on: 22/06/2017

4 The sequential risk-based approach

4.1 Introduction

This approach is established to ensure development occurs in areas with little or no risk of flooding (from any source) in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible.

It is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances, the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic. A greater understanding of the scale and nature of the flood risks is required.

When deciding on the ability to manage flood risk for new development located in Flood Zones 2 and 3, consideration must be given to a wide range of issues. These include how any evacuation of the occupants would be handled, how the new development fits in with the existing flood management provision and, in circumstances where flooding is experienced, how quickly the wider area would recover and return to normal. At some locations, it could be found that Flood Risk Management (FRM) measures are more easily integrated alongside proposed new development to address the flood risk issues, usually as a consequence of the prevailing natural or artificial topography. In these circumstances, the FRM proposals could be deployed without causing a significant alteration to the design and its place setting. However, even in these circumstances it should be recognised that FRM measures at one location can have the potential to cause an alteration to the flood risk to adjacent property or in flood cells on the opposite bank.

4.2 Sequential test

The Sequential Test must be performed when considering the placement of future development and for planning application proposals. The sequential approach to locating development should be followed for all sources of flooding. The Flooding and Coastal Change Planning Practice Guidance to the NPPF gives detailed instructions on how to perform the test.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the Sequential Test.
- Applications for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site).

It is normally reasonable to presume and state that individual sites that lie in Flood Zone 1 satisfy the requirements of the Sequential Test; however, consideration should be given to risks from all sources, areas with critical drainage problems and critical drainage areas (as defined in SWMPs).

For developments that do not fall under the above categories, local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other Local Plan policies[26]. A pragmatic approach should be taken when applying the Sequential Test. It is recommended that the Sequential Test be applied

26 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 033, Reference ID: 7-056-20140306), DCLG (2014)

to all potential development sites, including sites already rejected for other planning or practical reasons.

The Council, with advice from the Environment Agency, is responsible for considering the extent to which Sequential Test considerations have been satisfied, and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

The information provided in this SFRA can be used to:

- Identify the area to be assessed (including alternatives) on the Flood Zone maps that are provided with this assessment.
- Establish the risk of flooding from other sources.
- Follow the instructions given in the Planning Practice Guidance.

4.3 Exception test

If, following application of the Sequential Test, it is not possible for the development to be located in areas with a lower probability of flooding the Exception Test must then be applied if deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable property types, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the Test to be satisfied, both of the following elements have to be accepted for development to be allocated or permitted:

1 *It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.*

Local Planning Authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied, and give advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused[27].

2 *A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

The site-specific Flood Risk Assessment should demonstrate that the site will be safe and the people will not be exposed to hazardous flooding from any source. The following should be considered[28]:

- The design of any flood defence infrastructure.
- Access and egress.
- Operation and maintenance.
- Design of the development to manage and reduce flood risk wherever possible
- Resident awareness.
- Flood warning and evacuation procedures.
- Any funding arrangements required for implementing measures.

The NPPF and Planning Practice Guidance provide detailed information on how the Test can be applied.

[27] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306), DCLG, (2014)
[28] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306), DCLG, (2014)

4.4 Applying the Sequential Test and Exception Test in the preparation of a Local Plan

When preparing a Local Plan, the Local Planning Authority should demonstrate it has considered a range of site allocations, using Strategic Flood Risk Assessments to apply the Sequential and Exception Tests where necessary.

The Sequential Test should be applied to the whole Local Planning Authority area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. Whether as a stand-alone document or as part of another document, the Sequential Test must be clearly presented to demonstrate, to statutory consultees and the planning inspector, that the process has been followed. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan.

The Environment Agency will, as a statutory consultee, review the application of the Sequential Test through the formal Local Plan consultations. It is recommended that the Environment Agency be involved during the development of the Sequential Test, in order to demonstrate Duty to Co-operate, and to address any concerns with the application of the Sequential Test before the Local Plan is fully developed. The Environment Agency may charge for non-statutory consultations.

The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPF Planning Practice Guidance: Flood Risk and Coastal Change. NPPF Planning Practice Guidance: Flood Risk and Coastal Change describes how the Exception Test should be applied in the preparation of a Local Plan.

The Sequential Test should take into account flood risk from other sources, as well as fluvial risk. The working definition of low risk of flooding from other sources is considered to be:

- in Flood Zone 1 and not identified as being at risk from fluvial flooding with climate change, ordinary watercourses, reservoirs, sewer flooding or critical drainage issues, AND
- with less than 10% of their area within the RoFSW 1 in 1000-year extent, AND
- with less than 10% of their area within zones where the 1 in 100-year groundwater levels (as defined by the JBA Groundwater Flood Map) are estimated to reach the ground surface.

4.5 Applying the Sequential Test and Exception Test in the preparation of a Neighbourhood Plan

Neighbourhood Development Plans (NDPs) are subject to the same NPPF flood risk policies as Local Plans. As a result, the sequential, risk-based approach used to allocate sites within the preparation of a Local Plan (outlined in Section 4.2) should also be applied when allocating sites in the preparation of a Neighbourhood Plan. Advice on managing flood risk in NDPs is included within the NPPF Practice Guidance on Flood Risk and Coastal Change. This states that *"local planning authorities should provide advice to qualifying bodies on where and how they should demonstrate that policies and any site allocations in Neighbourhood Plans and Orders would satisfy the Sequential Test and, if necessary, the Exception Test, including the appropriate area to apply the Sequential Test."*

The process of applying the Sequential and Exceptions Tests to allocate development within a NDP is summarised in Figure 4-1 and detailed in the following sections.

4.5.1 Compiling potential sites within a Neighbourhood Plan Area

To assist in the screening process, the Neighbourhood Plan site boundaries should be in a digital format, which may involve digitising maps of site locations using a GIS system. All sites within the designated Neighbourhood Plan area should be included.

The existing and proposed land uses of each Neighbourhood Plan site should be identified, to inform the flood vulnerability classification of the site. This determines whether the type of development is suitable within a particular Flood Zone.

4.5.2 Assessing the flood risk to potential Neighbourhood Plan sites

Before the Sequential or Exception Tests can be applied, the potential Neighbourhood Plan sites will need to be screened, to assess the relative flood risk to each site from rivers, surface water, reservoirs and groundwater.

An initial, high level assessment of flood risk to each of the Neighbourhood Plan sites should be undertaken using the datasets outlined in Table 4-1 below. Identifying the proportion of each site which lies within a Flood Zone or area of other potential flood risk event will determine whether development needs can be met within the proposed sites.

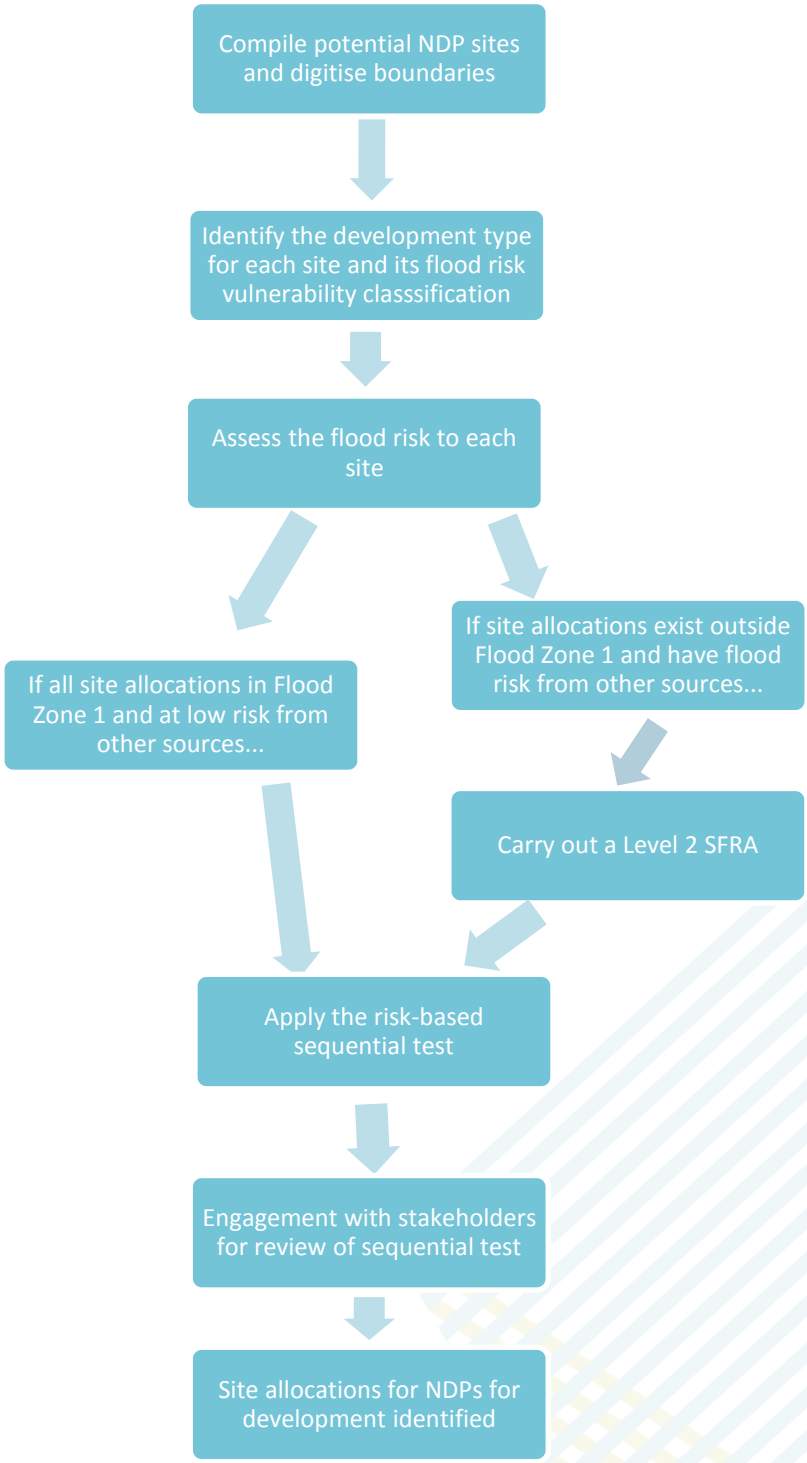


Figure 4-1: Overview of screening sites and applying the Sequential Test within a Neighbourhood Development Plan

Table 4-1: Datasets used in site screening assessment for Neighbourhood Development Plans

Source of flood risk	Dataset required in analysis	Source of data
Fluvial (rivers)	Flood Zone 1	Data.gov.uk
	Flood Zone 2	Data.gov.uk
	Flood Zone 3a	Calculated from EA Flood Zones and results from detailed hydraulic models
	Flood Zone 3a plus climate change	
	Flood Zone 3b	
Surface water	Risk of Flooding from Surface Water Map 1 in 30-year return period	Data.gov.uk
	Risk of Flooding from Surface Water Map 1 in 100-year return period	Data.gov.uk
	Risk of Flooding from Surface Water Map 1 in 1,000-year return period	Data.gov.uk
Reservoirs	Risk of Flooding from Reservoirs Map	Environment Agency (via data request)
Groundwater	Any available groundwater risk mapping.	Environment Agency, British Geological Survey[29], Oxfordshire County Council, JBA Consulting Groundwater Flood Map (as shown in SFRA **Appendix F**).
Historic Flooding	Historic Flood Map	Environment Agency[30]

4.5.3 Applying the Sequential Test within a Neighbourhood Plan

The Sequential Test should be applied to the Neighbourhood Plan area, to assess the suitability of proposed site allocations (Figure 4-2).

In the first instance, all sites which are located entirely within Flood Zone 1 should be identified. This will determine whether development needs can be fully accommodated within this area of lowest flood risk. Where this is the case, and the sites are not at risk from any other sources of flooding, the Sequential Test has been passed and no further action needs to be taken.

If all potential sites are situated in Flood Zone 1, but are at risk from other sources, the Sequential Test should be carried out for these sites, in line with the NPPF.

[29] Susceptibility to Groundwater, British Geological Survey (2018). Accessed online at: https://www.bgs.ac.uk/research/groundwater/datainfo/GFSD.html

[30] Historic Flood Map, Environment Agency (2018). Accessed online at: https://data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map

If development needs cannot be fully accommodated in Flood Zone 1, sites within Flood Zone 2 should be assessed. Sites at low risk from other sources of flooding, such as surface water or groundwater, can also be considered.

Neighbourhood Planning Groups are required to complete the Sequential Test to explain the reasons for including site allocations in the NDP. Particular justification will be required where sites at low flood risk, which could have contributed towards allocations, are excluded from the NDP in place of higher risk sites.

It is recommended that Neighbourhood Planning Groups submit a draft Sequential Test to South Oxfordshire District Council, Oxfordshire County Council and the Environment Agency for review. The Environment Agency may charge for informal consultations. NPPF Practice Guidance states that: *"in providing advice, local planning authorities should have regard to flood risk across the whole of their areas. In particular, there may be places outside the neighbourhood planning area at lower flood risk which are suitable and reasonably available for the development proposed."* In other words, if a Neighbourhood Plan is proposing to allocate a site at risk of flooding, the LPA should consider whether it may be more appropriate to develop alternative sites at lower flood risk but located outside of the NDP area. This would need to be balanced against the need to provide housing or employment development within a settlement, and the distance to alternative sites at a lower risk of flooding.

4.5.4 Applying the Exception Test within a Neighbourhood Plan

In the instance where proposed NDP sites exist outside Flood Zone 1, or are at risk from other sources of flooding, a Level 2 Strategic Flood Risk Assessment (SFRA) would be required. As an initial guide, the sites should be assessed at a Level 2 SFRA level where they:

- are located within fluvial Flood Zones 2 or 3, or
- 10% or more of the site area is at risk of surface water flooding, as defined by the RoFSW 1 in 1000-year extents, or
- 10% or more of the site area is at risk of flooding from groundwater, as defined by the JBA Groundwater Flood Map where groundwater levels between 0.0 and 0.025m below ground level are predicted.

The Exception Test (Figure 4-3) should then be applied to the Level 2 SFRA sites, to identify whether the sites are suitable for allocation within the NDP.

4.6 Applying the Sequential Test and the Exception Test to individual planning applications

The Planning Practice Guidance[31] sets out how developers and planners need to consider flood risk to, and from, the development site, following the broad approach of assessing, avoiding, managing and mitigating flood risk. A checklist for site-specific Flood Risk Assessments is provided in Paragraph 68 of this Guidance.

A site-specific Flood Risk Assessment should be carried out to assess flood risk to, and from, a development. The assessment should demonstrate how flood risk will be managed over a development's lifetime, taking climate change and the user vulnerability into account.

[31] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 033, Reference ID: 7-056-20140306), DCLG, (2014)

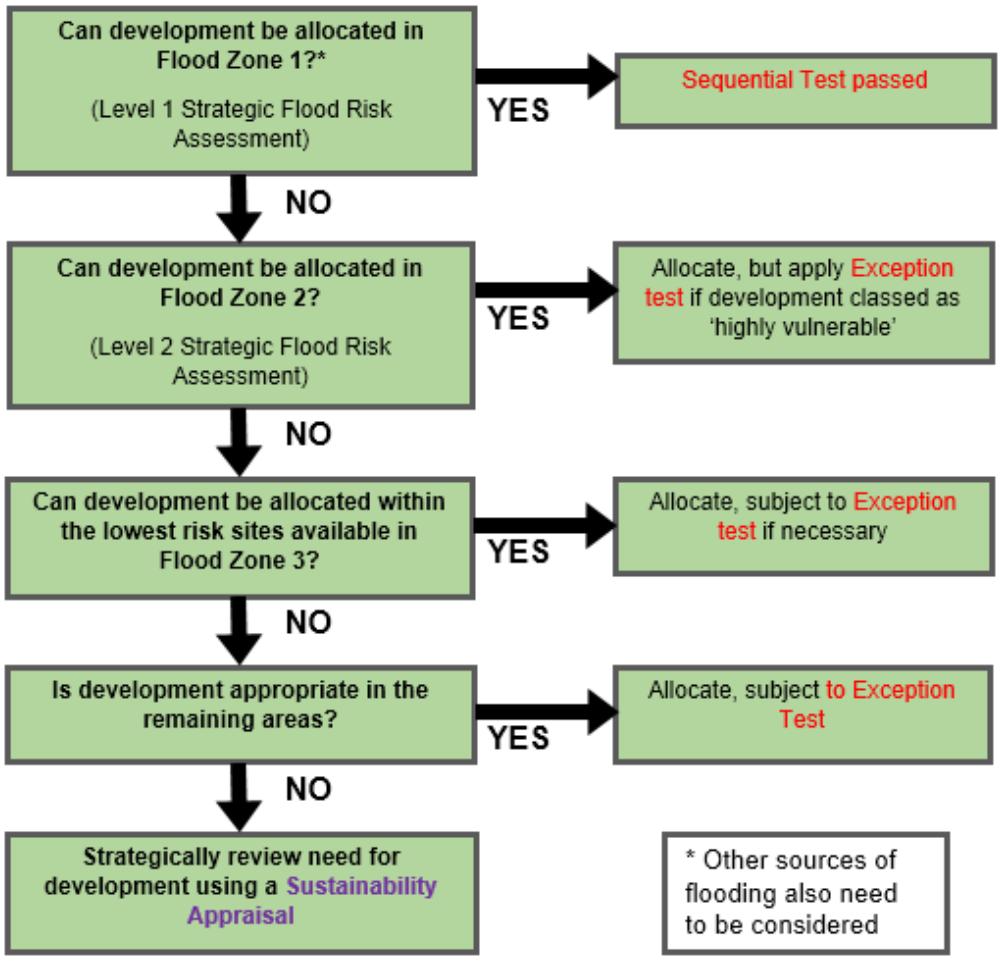
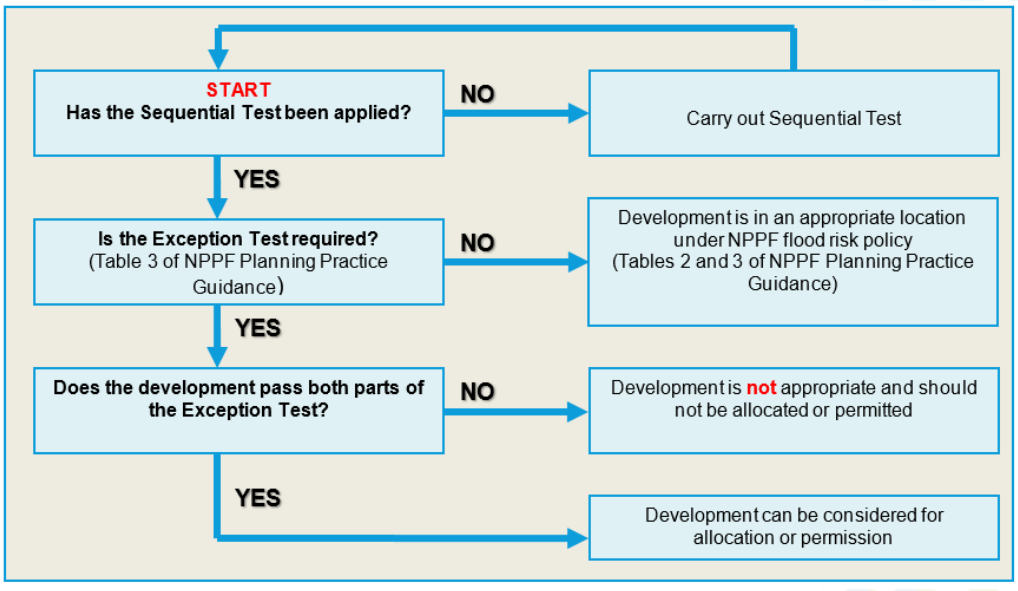


Figure 4-2: Applying the Sequential Test in the preparation of a Local Plan or Neighbourhood Plan



† Based on Diagram 3 of NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 028, Reference ID: 7-021-20140306) March 2014

Figure 4-3: Applying the Exception Test in the preparation of a Local Plan or Neighbourhood Plan

The Planning Practice Guidance sets out the following objectives for a site-specific Flood Risk Assessment (FRA) and states it should establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for the local planning authority to apply (if required) the Sequential Test; and
- whether the development will be safe and pass the Exception Test (where applicable).

5 Understanding flood risk in South Oxfordshire

5.1 Topography, geology, soils and hydrology

5.2 Study area

The study area is approximately 679km^2, and has a population of 134,257 according to the 2011 census[32]. Didcot is the largest population centre in the district (25,140), with Henley-on-Thames (11,619), Wallingford (11,600), and Thame (11,561) the other large towns.

5.3 Topography

Figure 5-1 shows the topography of the SODC area which is dominated by the ridge of the Chiltern Hills between Wallingford and Henley, that rises to 250m close to the M40. Elsewhere the land is mostly lower lying (60-80m) and relatively flat, with the exception of the area around Wheatley east of Oxford.

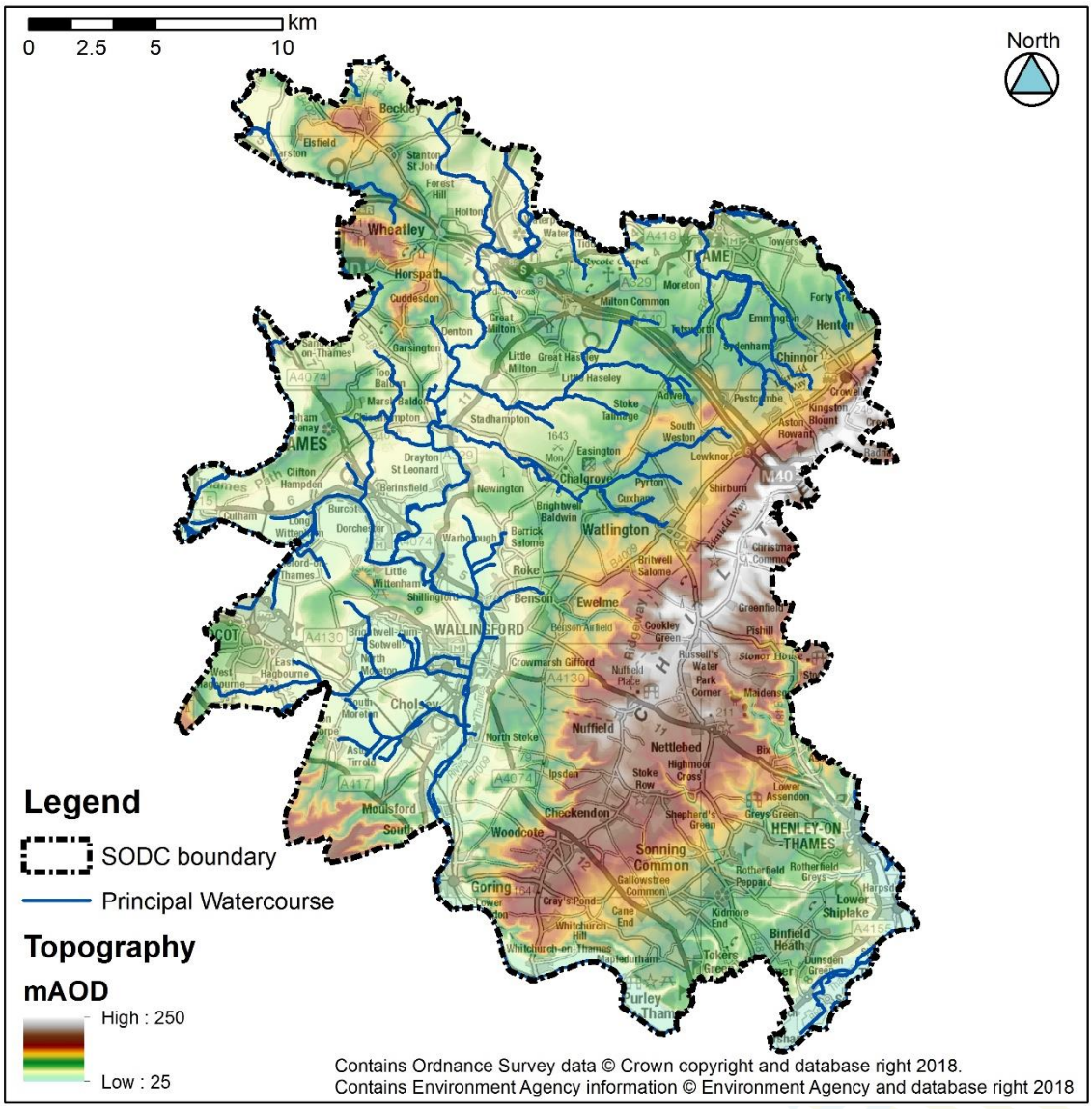


Figure 5-1: District topography

32 Census 2011 Summary, SODC (2014), Accessed online at: http://www.southoxon.gov.uk/node/13571 on 30-05-17

The most significant watercourse in the South Oxfordshire district is the River Thames which forms the western and southern boundary of much of the district as it flows to the east of Abingdon, north of Reading and east of Henley. Between Dorchester and Shillingford the Thames is joined by the River Thame.

5.3.1 Geology

Catchment geology can be an important influencing factor in the way that water interacts and flows over the landscape with variations in the permeability of the surface material and the bedrock stratigraphy affecting infiltration and movement of water. The geology of the SODC area is shown in Figure 5-2 and Figure 5-3 below. Superficial deposits of clay, slit and sand are present along the flood plain of the Thames and Thame, and with sand and gravel more widely spread. Clay with flints (Diamicton) is present on the north-eastern edge of the Chiltern Hills as they cross the district.

Bedrock geology varies considerably with location. The south east is characterised by the White Chalk Subgroup with small pockets of Lambeth Group (clay, silt, sand, gravel). Above this is a band of Grey Chalk Subgroup running through Cholsey, Wallingford, Watlington and Chinnor.

Through Didcot, Chalgrove to Chinnor is a wider band of Gault Formation and Upper Greensand Formation (undifferentiated).

The north of the area has a complex mix of bedrock with the following groups present:

- Great Oolite group
- Corallian Group (limestone, sandstone, siltstone and mudstone)
- Kellaways Formation and Oxford Clay Formation (undifferentiated)
- West Walton formation, Ampthill Clay Formation and Kimmeridge Clay Formation (undifferentiated)
- Lower Greensand group
- Wealden Group (sandstone and siltstone, interbedded)
- Portland Group

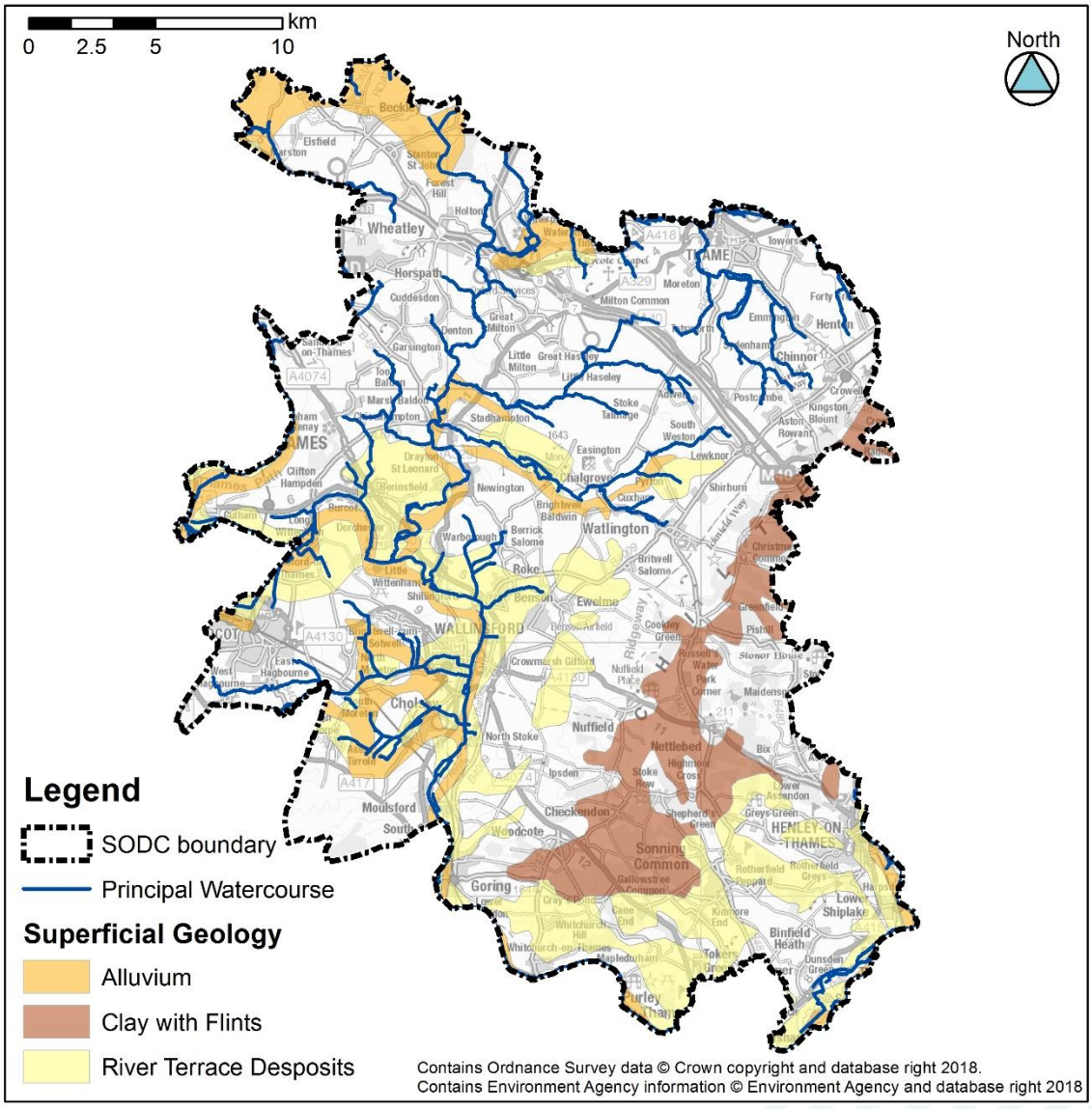


Figure 5-2: Superficial geology in SODC area

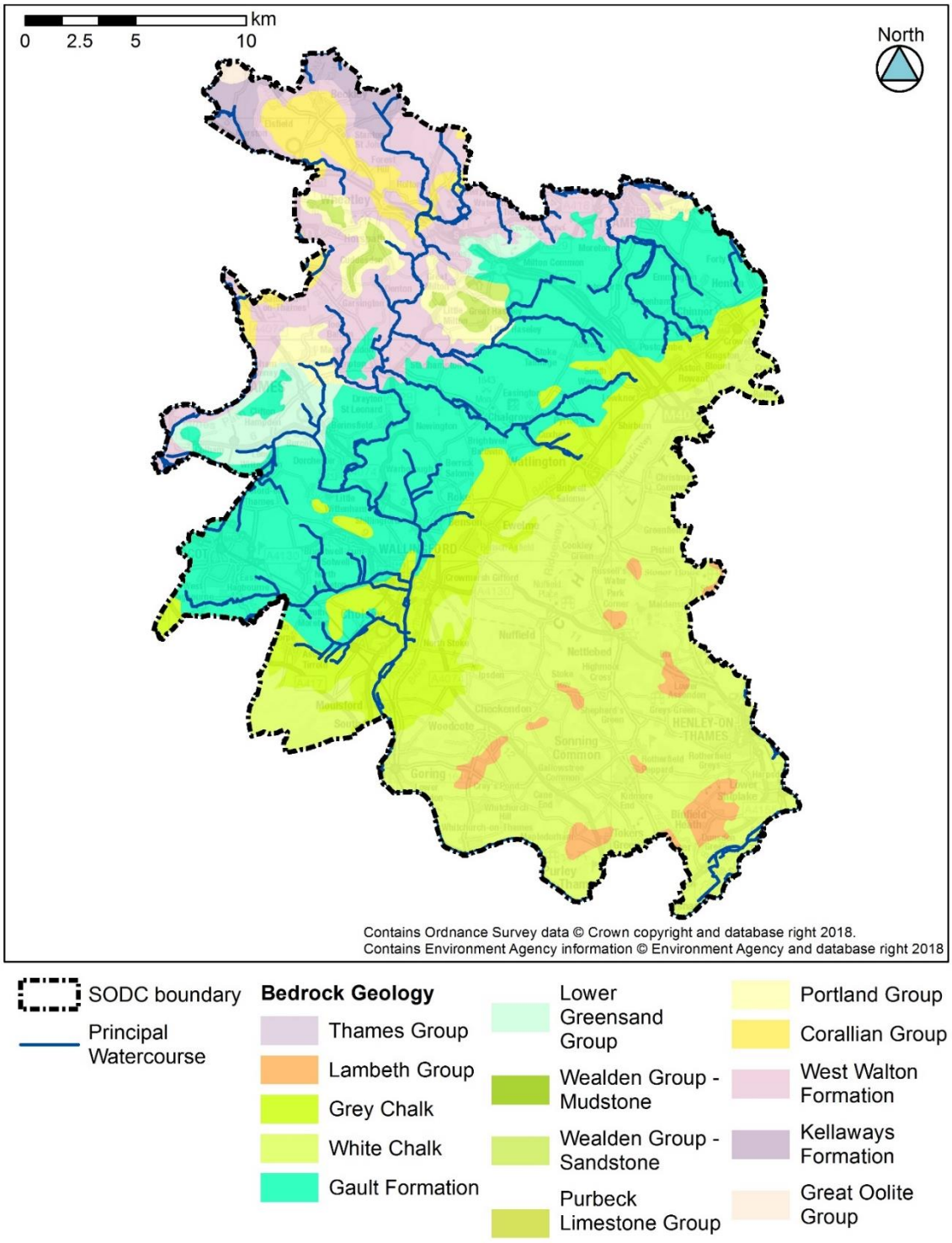


Figure 5-3: Bedrock geology in SODC area

5.4 Flood history

The district has a history of documented flood events based on the information from the Environment Agency, SODC, Thames Water and Oxfordshire County Council. The extents of all recorded events are provided in **Appendix I** and significant historic flood events between 1947 and 2017 can be summarised as follows:

Table 5-1: Significant flood events between 1947 and 2017

Date	Area / Description
March 1947	Extensive along length of Thames and Isolated surface water / drainage incident near Mapledurham
November 1974	Thames near Henley
August 1977	Extensive along length of Thames and some local drainage / surface water flooding near Dorchester
February 1979	Thames as far as Moulsford
February 1990	Thames around Henley
September 1992	River Thame and isolated local drainage / surface water flooding by Aston Upthorpe and North Moreton
October 1993	Lower Thame and Wallingford River Cherwell by Marston
April 1998	River Cherwell
December 2000	Thames at Abingdon and Culham, and at Reading and Henley
January 2003	Extensive along length of Thames and lower Thame
July 2007	Entire length of Thames and isolated surface water at North Moreton
February 2009	Chalgrove, Henley, Wargrave, and Drayton St Leonard
November 2013	Extensive along length of Thames
January 2014	The River Thames at Crowmarsh, Henley and Shiplake. Flooding from tributaries and surface water runoff at Chalgrove, East and West Hagbourne, North Moreton and Henton. Sewage flooding in unspecified locations.
February 2014	Lower reaches of the River Thames at Shiplake and Henley. Flooding from tributaries and surface water runoff at Chalgrove, Stadhampton, Cholsey, Brightwell-cum-Sotwell and West Hagbourne. Spring flows at Assendon, Benson, Ewelme and Watlington.

5.4.1 2013-14 floods

In the winter of 2013/2014 a succession of storms hit the UK bringing significant disruption to infrastructure and property damage from both wind and flood. The individual storms themselves were not remarkable, but their combined affect; including the wettest January on record for parts of the UK; lead to widespread flooding[33]. Total economic damages for England and Wales due to flooding were estimated to be between £1,000 million and £1,500 million[34].

The River Thames was particularly affected with several gauges showing their highest levels since being installed in the 1990s[35] and flooding occurring along most of its length. In many cases surface water flooding from significant rainfall increased the number of properties flooded, with sewer flooding also an issue in some areas.

33 Winter storms, December 2013 to January 2014, Met Office (2014), Accessed online at: http://www.metoffice.gov.uk/climate/uk/interesting/2013-decwind on: 22-06-17
34 The costs and impacts of the winter 2013 to 2014 floods, Environment Agency, (2016), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/501783/The_costs_and_impacts_of_the_winter_2013_to_2014_floods_-_summary.pdf on: 22-06-17
35 UK floods: Homes evacuated as swollen Thames keeps rising, BBC News, (2014), Accessed online at: http://www.bbc.co.uk/news/uk-26111598 on: 22-06-17

5.5 Fluvial flood risk

Fluvial flooding is caused by high flows in rivers or streams exceeding the capacity of the river channel and spilling onto the floodplain, usually after a period of heavy rainfall.

Fluvial risk is present on both main rivers (which are the responsibility of the Environment Agency) and ordinary watercourses (which are the responsibility of the local authority and riparian owners).

5.5.1 Fluvial flood risk by watercourse

There are several main rivers in the district, all of which form part of River Thames catchment. Fluvial flood risk for each of these is described in more detail below. Principle watercourses are shown in Figure 5-4 below and **Appendix B**.

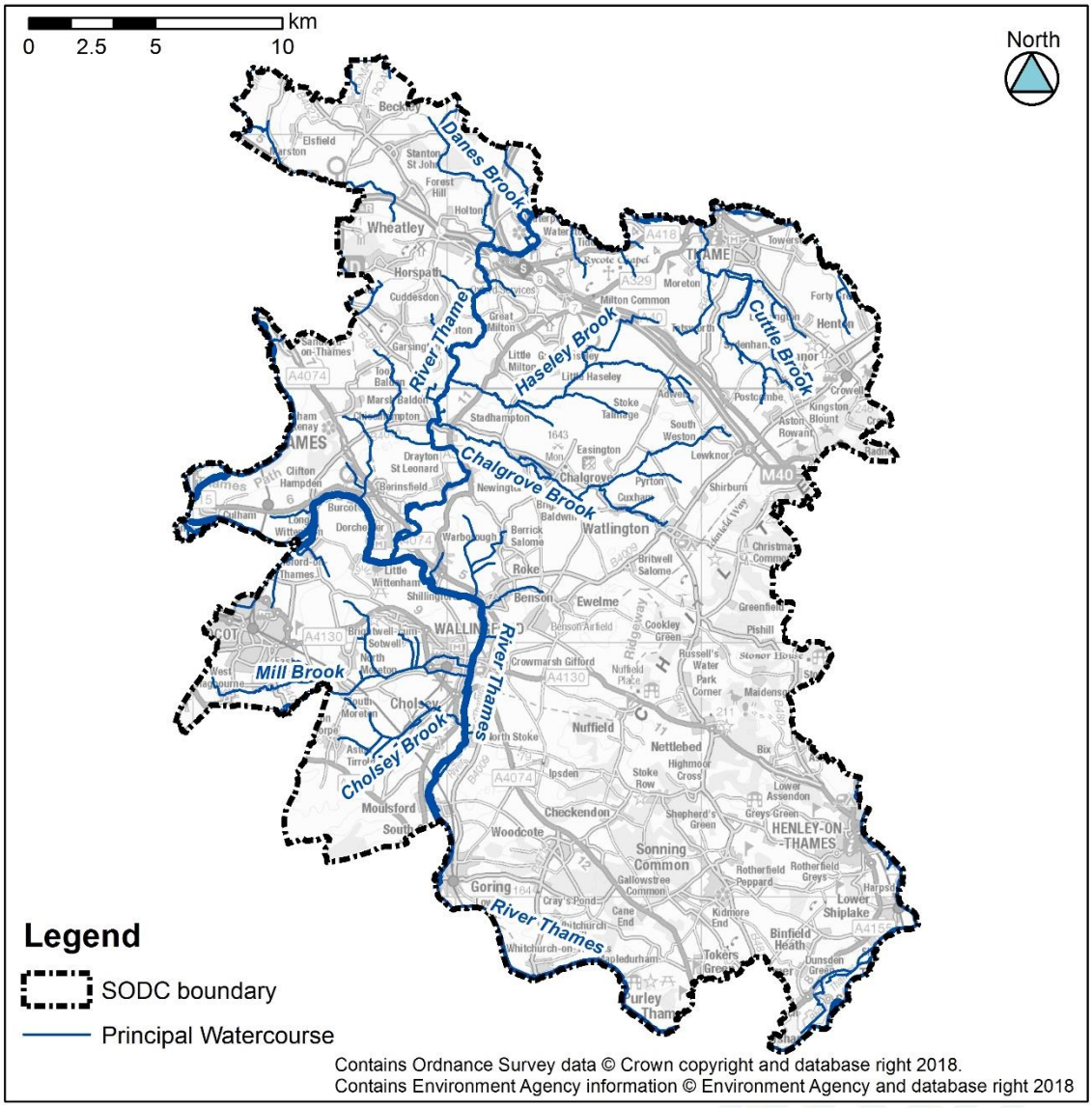


Figure 5-4: Principal watercourse in SODC

River Thames

As one of the largest catchments in the UK, the River Thames dominates the SODC area and has a well-documented history of flooding along its length. The Thames enters the SODC area south of Oxford at Sandford on Thames, and forms the district boundary as it flows south to Abingdon. Whilst the Thames frequently floods along this

stretch there are few properties within the SODC area at risk, (most being within Abingdon). Several settlements lie within the flood plain of the Thames between Abingdon and Wallingford; Culham, Clifton Hampden, Long Wittenham, Burcot, Dorchester, Benson and Shillingford. Wallingford itself has experienced fluvial flooding to a relatively small number of properties in 1894, 1947, 1968, 2003, 2007 and 2012.

After Wallingford, the Thames flows to Reading where it once again forms the SODC boundary. On this stretch the settlements of North and South Stoke, Moulsford, Goring and Whitchurch on Thames are all on or adjacent to the floodplain.

Before leaving the SODC area at Henley on Thames, the flood plain takes in the settlements of Playhatch, Sonning Eye, Lower Shiplake and Shiplake, with flooding recorded in 1947, 2003, 2007 and 2014. In Henley on Thames itself, property flooding was recorded in 1947, 1990, 2000 and 2003, though not in the more recent floods of 2007 or 2012.

River Thame

The Thame originates north and east of Aylesbury, flowing into the SODC area immediately north of Thame. A flood event was recorded in 1992 but no serious property flooding resulted around Thame. It then flows through a largely rural flood plain with few properties at risk until it joins the Thames at Dorchester.

Chalgrove Brook and Haseley Brook

Chalgrove Brook originates in Watlington and flows through the villages of Cuxham, Chalgrove, and Stadhampton where it joins the Thame. In each of these villages a number of properties lie within Flood Zone 3. Watlington, Chalgrove and Stadhampton were affected by flooding from the Chalgrove Brook in Winter 2013/2014, with spring flows contributing to the flood risk at Watlington.

Haseley Brook joins the River Thame north of Stadhampton. Despite having a wide flood plain, few properties lie within it, with the exception of a number of homes at Little Milton.

Mill Brook / Bradford's Brook

Mill Brook originates in Blewbury south of Didcot, and just outside the SODC area, entering the study area at Hagbourne Mill Farm. The flat farmland leads to a wide flood plain before it reaches South Moreton where there flood plain narrows, before spreading out east of South Moreton, covering the area of the Airstrip. The brook bifurcates to the west of Wallingford, the northern branch, known as the Mill Brook, no longer receives flows due to sedimentation of its channel. The southern branch, known as the Bradford Brook, joins the Thames at Wallingford. Few properties are classified as at risk from this watercourse, although an unnamed tributary to it that flows through East Hagbourne has some properties within Flood Zone 3. East Hagbourne and West Hagbourne, North Moreton and South Moreton experienced flooding from the upper reaches of the Mill Brook in January 2014. Further flooding to the Main Road at East Hagbourne was recorded in Winter 2014/2015.

Ewelme Stream

This a relatively short watercourse that originates in Ewelme and joins the Thames at Benson, however Flood Zone 3 covers several properties as it passes through the middle of Benson and Ewelme, as well as the perimeter road of the airfield. The Street at Ewelme was flooded by the stream in Winter 2013/2014 and spring flows from the area raised water levels at Benson Brook in February 2014.

Berrick Stream and Lady Brook

Berrick Stream is raised on farmland south west of Brightwell Baldwin, and flows through the village of Roke, where much of the village is within Flood Zone 3, before joining the Thames just upstream of Benson. Roke experienced flooding in Winter 2013/2014, with the source of flooding thought to be the Berrick Stream.

Moor Ditch and Ladygrove Brook

Moor Ditch flows through the north of Didcot, and meets the Thames where it has an influence on flooding at Long Wittenham. An unnamed tributary of the Moor Ditch may have contributed to the flooding at Basil Hill Road in Didcot in the Winters of 2014/2015, 2015/2016 and 2016/2017. Just outside Didcot it is joined by Ladygrove Ditch, a small ordinary watercourse, but one that has a significant number of properties within its flood plain.

Other watercourses

Numerous smaller watercourses exist within the study area, and may pose a flood risk to a small number of properties. Where these impact upon individual SODC Strategic Sites they are discussed in the site summary sheets in **Appendix L**.

5.6 Fluvial defences, assets and structures

5.6.1 Flood defence structures and raised defences

The Flood Zone mapping does not take into account the effect of flood defences and assets on flood risk, therefore a high-level review of formal flood defences was carried out for this SFRA, including an assessment of their condition and standard of protection. Details of flood defence locations and conditions were obtained from the Environment Agency Spatial Flood Defence layer.

Formal structural defences are given a rating based on a grading system for their condition. A summary of the grading system used by the Environment Agency is provided below in Table 5-2.

Table 5-2: Defence asset condition rating

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce the performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation required.
5	Very Poor	Severe defects resulting in complete performance failure.

Source: Condition Assessment Manual – Environment Agency 2006

The condition of existing defences and whether they will continue to be maintained and/or improved in the future is an issue that should be considered as part of the risk based sequential approach and, in the light of this, whether possible site options for development are appropriate and sustainable. In addition, detailed Flood Risk Assessments (FRAs) will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired.

A review of key defences across the district, their condition and standard of protection is included below.

5.6.2 Flood defence structures and raised defences in SODC area

The Environment Agency's National Spatial Flood Defence layer identifies flood defences in the SODC area. They are located along most of the main rivers and their tributaries, and are recorded as either "high ground" or "embankment". Further

examination of the description of these assets shows that many are actually the natural bank of the river. Also, present are bank protection measures, and masonry walls.

The design Standard of Protection (SoP) for the majority of the assets is 0-5 years, with a few cases of a higher SoP (25-50 year) in the case of the concrete bank protection measures.

Three areas are designated as benefiting from capital defence schemes. One to the south of Abingdon (Oxford Short Term Measures 2), one at Pangbourne, and one at Watlington.

5.6.3 Culverts

Culverts can often increase flood risk due to physical blockages in the culvert itself or its trash screens, or because the capacity is insufficient to accommodate the additional flow (either through poor condition or under-capacity in design).

Responsibility for the maintenance of culverts can be difficult to determine between riparian owners, District and County Councils and the Environment Agency.

The Environment Agency's AIMS database contains the details of culverts on main rivers, and the SODC drainage team may be contacted for information on culverts on ordinary watercourses, however no formal record of culverts or other assets on ordinary watercourses is kept. Notable culverts in the districts include:

- Mill Brook at Wallingford. Flows into the head of this culvert were reversed in the 1970s, directing all flows into the Bradford's Brook. Only local surface water sewers and highway drainage connect into this culvert.
- Assendon Stream at Henley. The course of this ephemeral, groundwater fed stream enters a culvert along Fair Mile, but no detailed mapping of its course is available.

The risk posed by culverts needs to be assessed on a local basis, particularly where ordinary watercourses are concerned.

5.6.4 Local flood alleviation schemes

The Oxford Flood Alleviation Scheme is a major capital scheme aimed at reducing flood risk in the Hinksey / Abingdon Road area in the south of Oxford. This scheme is outside the SODC area, and its design remit includes a requirement not to increase flood risk further downstream on the River Thames. Providing full funding and approval is received, work is expected to commence in late 2018 at the earliest, with construction due to be completed in 2021.

A number of flood alleviation works have been undertaken in recent years and are summarised in Table 5-3.

Table 5-3: Recent flood alleviation works undertaken in South Oxfordshire District

Date of works	Location	Details of works
2012/2013	Berrick Salome (north)	N/A
	Wainhill	
	Chinnor	
	Church Lane, Sandford-on-Thames	
	Piton	
	Cedar Crescent/Maple Road, Thame	
2013/2014	Henton	N/A

Date of works	Location	Details of works
	Moor Lane, West Hagbourne	
2014/2015	South-east Wheatley, Wheatley	Attenuation installed
2015/2016	Mill Brook, Wallingford Sports Trust	N/A
2016/2017	Mill Lane (west), Chalgrove	N/A
	Moor Lane (west), West Hagbourne.	

The Environment Agency maintains a programme of flood and coastal erosion risk management schemes across England, which includes studies. Table 5-4 lists current projects (as of February 2017) in SODC and its neighbouring authorities. There is one ongoing scheme in SODC at Goring, which is aiming to provide an improved level of flood protection to 55 homes.

Table 5-4: Environment Agency programme of flood risk management schemes

Project Name	Local Authority	Lead Risk Management Authority Name	Project Stage	Forecast Completion Date
Bicester Town Centre Trash Screen Investigation	Cherwell	Environment Agency	Development	By April 2019
Bloxham Flood Alleviation Scheme	Cherwell	Environment Agency	Development	By April 2019
Wendlebury	Cherwell	Environment Agency	Development	By April 2019
Bloxham (Tadmarton Road) Flood Risk Management Scheme	Cherwell	Oxfordshire County Council	Development	By April 2019
Boundary Brook Catchment (Florence Park) Flood Alleviation	Oxford	Environment Agency	Development	By April 2019
Oxford Flood Alleviation Scheme	Oxford	Environment Agency	Development	By April 2021
Goring on Thames Flood Risk Management Scheme	South Oxfordshire	Environment Agency	Development	By April 2019
Abingdon River Ock Flood Storage Area	Vale of White Horse	Environment Agency	Development	By April 2019
Dunstan Park Flood Alleviation Scheme	West Berkshire	West Berkshire Council	Construction	By April 2019
Waller Drive, Newbury - PLP Scheme - Main scheme	West Berkshire	West Berkshire Council	Construction	By April 2019
Newbury & Thatcham Property Level	West Berkshire	West Berkshire Council	Development	Beyond 2021

Project Name	Local Authority	Lead Risk Management Authority Name	Project Stage	Forecast Completion Date
Protection				
West Ilsley	West Berkshire	West Berkshire Council	Development	By April 2021
Great Shefford Flood Mitigation	West Berkshire	Environment Agency	Development	Beyond 2021
Pangbourne Flood Alleviation	West Berkshire	Environment Agency	Development	By April 2021
Boxford Flood Alleviation Scheme	West Berkshire	West Berkshire Council	Development	By April 2019
Grazeley Green Flood Alleviation Scheme	West Berkshire	West Berkshire Council	Development	By April 2019
Hampstead Norreys	West Berkshire	West Berkshire Council	Development	By April 2019
Bisham - Flood Alleviation	Windsor and Maidenhead	Environment Agency	Development	By April 2021
Twyford Flood Mitigation	Wokingham	Environment Agency	Development	By April 2021
River Loddon Soft Engineering	Wokingham	Environment Agency	Pipeline	By April 2019
Marlow Flood Alleviation Scheme	Wycombe	Environment Agency	Construction	By April 2019
Sands (High Wycombe) Surface Water Flood Risk Management	Wycombe	Buckinghamshire County Council	Construction	By April 2019
Marlow Surface Water Drainage Pre-Feasibility Study	Wycombe	Buckinghamshire County Council	Construction	Beyond 2021
Hughenden Road and Coates Lane, High Wycombe Surface Water Management Scheme	Wycombe	Buckinghamshire County Council	Development	By April 2019

5.7 Surface water flood risk

Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours. Flooding usually occurs when rainfall fails to infiltrate to the ground or enter the drainage system and ponding generally occurs at low points in the topography. The likelihood of flooding is dependent on not only the rate of runoff but also saturation of the receiving soils, the groundwater levels and the condition of the surface water drainage system (i.e. surface water sewers, highway authority drains and gullies, open channels, Ordinary Watercourses and SuDS). Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding.

The Risk of Flooding from Surface Water (RoFSW) predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. Mapping of the RoFSW throughout the district is provided in **Appendix E**.

Reports of surface water flooding in the district identify a primary source being overland flows generated within saturated catchments, where no further rainfall is able to enter the ground. This contributed to flooding at Chalgrove, East and West Hagbourne, North Moreton, Henton, Stadhampton, Cholsey, Brightwell-cum-Sotwell and Watlington in Winter 2013/2014. In addition, flood incidents have been reported between 2014 and 2017 affecting the road network and urbanised residential areas of settlements including Didcot, Cholsey, Goring, Crowmarsh Gifford and Thame. The likely flood mechanisms in these locations are overland flow paths and areas of ponding generated on impermeable surfaces and exceedance of surface water drainage systems during heavy rainfall.

It should be noted that because of the broad-scale nature of surface water flooding, wherever possible, these mapped outlines should be used in conjunction with other sources of local flooding information to confirm the presence of a surface water risk. Any site-specific FRA would need to adequately assess the risk from surface water flooding; not only at the site but to also ensure there is not an increased risk of flooding to areas downstream.

5.8 Groundwater flood risk

Compared with other sources of flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Under the Flood and Water Management Act (2010), LLFAs have powers to undertake risk management functions in relation to groundwater flood risk. Groundwater level monitoring records are available for areas on major aquifers. However, for low lying valley areas, which can be susceptible to groundwater flooding caused by a high water-table in mudstones, clays and superficial alluvial deposits, very few records are available. Additionally, there is increased groundwater flooding where long reaches of watercourses are culverted as a result of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

As part of the SFRA deliverables, mapping of the whole district has been provided showing the Environment Agency and the JBA Consulting Groundwater Flood Map. This information is provided in Appendix F. The JBA Consulting Groundwater Flood Map is a high resolution dataset using 1:50,000 geological data and a 5m digital terrain model to provide a 5m resolution groundwater hazard map. It predicts the depth of groundwater below ground level in a 1 in 100-year event, covering both chalk aquifers and local superficial deposits. It is able to provide an indication of areas where a property or site-specific assessment of groundwater hazard is recommended.

The information indicates that susceptibility to groundwater flooding is greatest along the course of the River Thames between Abingdon and Wallingford, particularly around Burcot and Dorchester, with other significant areas at Wheatley, Watlington, and beneath the Chilton hills between Lewknor and Chinnor. Significant groundwater flooding was reported within the district in February 2014, in which prolonged rainfall led to spring flow inundation at Assendon, Watlington and Moulsford. Many properties in Moulsford were affected by flooding, resulting from saturated overland flows and groundwater infiltration into the sewer network.

The AStGWF data should be used only in combination with other information, for example local or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist. It should be noted that although an area may be designated as susceptible to groundwater flooding, this does not mean that groundwater flooding will definitely be a problem within these areas, rather it provides an indication of the risk.

It is often difficult to ascertain if the source of a flood event is from groundwater. This is because it may be a result of a combination of sources, or a culverted watercourse being mistaken for a spring or underground stream.

As a result, developers planning to build within any groundwater emergence zones should investigate whether groundwater flooding is likely to be a problem locally.

5.9 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge freely into watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration, entry of soil or groundwater into sewer systems via faults within the fabric of the sewerage system is another cause of sewer flooding. Infiltration is often related to shallow groundwater, and may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption[36] guidelines have meant that most new surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year, although until recently this did not apply to smaller private systems. This means that even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in any given year). Existing sewers can also become overloaded as new development adds to their catchment, where surface water is misconnected to foul sewerage systems, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the district.

Historical incidents of flooding are detailed by Thames Water in their DG5 registers. The databases record incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons, this data has been aggregated to the postcode sector level from the Sewer Flooding History Database (SFHD) of incidents of hydraulic overload. The information from the SFHD is shown in Table 5-5 below.

The SFHD hydraulic overload information indicates a total of 224 recorded flood incidents in the district. The more frequently flooded postcodes are OX39 4 (Chinnor), OX10 0 (Brightwell-Cum-Sotwell) and RG9 1 (Henley on Thames). The number of recorded events by post code sector are shown in map form in **Appendix J**. It is important to recognise that the information does not present whether flooding incidences were caused by general exceedance of the design sewer system, or by operational issues such as blockages. The information also represents a snap shot in time and may become outdated following future rainfall events. Also, risk in some areas may reduce in some locations by capital investment to increase of the capacity of the network. As such, the sewer flooding flood risk is not a comprehensive 'at risk register' and updated information should be sought to enhance understanding of flood risk from sewers at a given location.

36 Sewers for Adoption 8th Edition - A Design & Construction Guide for Developer. WRc plc. 2018.

Table 5-5: Summary of recorded sewer flooding incidents

Postcode Sector	Total recorded incidents	Postcode Sector	Total recorded incidents	Postcode Sector	Total recorded incidents
HP14 3	0	**OX3 0**	4	**RG30 6**	0
HP14 4	0	**OX3 8**	7	**RG31 6**	0
HP17 8	0	**OX3 9**	1	**RG4 5**	0
HP18 9	0	**OX33 1**	13	**RG4 6**	0
HP27 9	0	**OX39 4**	24	**RG4 7**	0
OX1 5	5	**OX4 2**	0	**RG4 8**	1
OX10 0	19	**OX4 4**	0	**RG4 9**	1
OX10 6	14	**OX4 6**	0	**RG6 1**	0
OX10 7	8	**OX4 7**	0	**RG8 0**	4
OX10 8	8	**OX44 7**	13	**RG8 7**	4
OX10 9	4	**OX44 9**	8	**RG8 8**	0
OX11 0	5	**OX49 5**	10	**RG8 9**	0
OX11 6	0	**OX9 2**	0	**RG9 1**	18
OX11 7	5	**OX9 3**	15	**RG9 2**	2
OX11 8	6	**OX9 7**	1	**RG9 3**	4
OX11 9	5	**RG1 3**	0	**RG9 4**	0
OX14 3	4	**RG1 8**	0	**RG9 5**	0
OX14 4	7	**RG10 8**	3	**RG9 6**	0
OX14 5	0	**RG10 9**	1		
OX2 8	0	**RG30 1**	0		

5.10 Flooding from reservoirs, canals and other artificial sources

5.10.1 Reservoirs

Reservoirs are artificial bodies of water, where water is collected and stored behind a man-made structure and released under control either to reduce the flow magnitudes in downstream channels or to meet a requirement when needed for purposes such as irrigation, municipal needs or hydroelectric power[37].

Flooding from reservoirs may occur following partial or complete failure of the control structure designed to retain water in the artificial storage area. It is estimated that the risk of such failure is low and the occurrence of complete reservoir failure is exceptionally rare since the introduction of safety legislation in 1930. However, 1.1 million properties in England are in areas to be considered at risk of flooding from reservoir failure.

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is very difficult to estimate, but it is much less likely than flooding from rivers or surface water. It may not be possible to seek refuge from floodwaters upstairs as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure. The Environment Agency maps (available online at the Environment Agency website)[38] represent a credible worst-case scenario. In these circumstances,

[37] National flood and coastal erosion risk management strategy for England, DEFRA (2011), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf on:
[38] 'What's in Your Backyard' website, Environment Agency (2017), Accessed online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/ on: 26/05/2017

it is the time to inundation, the depth of inundation and the velocity of flood flows that will be most influential.

The risk to development for reservoirs is residual but developers should consider reservoir flooding during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include:
  - Reservoir characteristics: type, dam height at outlet, area / volume, outflow location
  - Operation: discharge rates / maximum discharge
  - Discharge during emergency drawdown
  - Inspection / maintenance regime
- Developers should apply the sequential approach to locating development within the site. The following questions should be considered:
  - Can risk be avoided through substituting less vulnerable uses or by amending the site layout?
  - Can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted?
  - Can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?
- Developers should consult with relevant authorities regarding emergency plans in case of reservoir breach.

The Environment Agency does not identify any reservoirs within the SODC area that fall under the terms of the Reservoir Act, although numerous other small reservoirs exist. The risk of flooding from reservoirs in the SODC area is predominantly from outside the district's boundary, in particular from Wilstone Reservoirs close to Tring, which have a major impact on the River Thame until it meets the Thames near Shillingford. The number of properties at risk in the SODC area is low, however due to the nature of reservoir flooding, it is likely to happen with very little warning with water levels rising rapidly. A map showing the extent of reservoir flood risk can be found in **Appendix G**.

5.10.2 Canals

No canals have been identified within South Oxfordshire.

5.11 The impact of climate change

Flood Risk Assessments (FRAs) are required to demonstrate future implications of climate change have been considered, and risks managed where possible, for the lifetime of the proposed development. This may include for instance:

- Consideration of the vulnerability of the proposed development types or land use allocations to flooding and directing the more vulnerable away from areas at higher risk due to climate change.
- Use of 'built in' resilience measures. For example, raised floor levels.
- Capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

The last consideration acknowledges that there may be instances where some flood risk management measures are not necessarily needed now but may be in the future. This 'managed adaptive' approach may include for example setting a development away from a river so it is easier to improve flood defences in the future.

The latest guidance on climate change allowances for flood risk assessment released by the Environment Agency[39] provide predictions of anticipated change for:

- peak river flow;
- peak rainfall intensity;
- sea level rise; and
- offshore wind speed and extreme wave height.

5.11.1 Fluvial flooding

Climate change mapping for the SODC area has been provided in **Appendix D**. This presents Flood Zone 3a climate change mapping for +35% and +70% scenarios following the latest guidance and uses suitable hydraulic models where available, as summarised below in Table 5-6.

Table 5-6: Approaches to fluvial climate change modelling

Approach to climate change modelling	Models
1D-2D models rerun, climate change flood extents produced.	• Assendon Stream (Middle Assendon to Thames Confluence) • Chalgrove Brook (Chalgrove) • Chalgrove Brook (Watlington) • Thames (Mapledurham to Sonning)
1D only models, rerun, climate change flood extents not produced.	• Bradford's Brook (Wallingford) • Thames (Whitchurch to Henley)
Not rerun	• Thames (Sandford to Reading) produced in 2018 following latest climate change guidance • River Cherwell (Thrupps Bridge to Thames Confluence). This model only impacts upon a small area in the north-east of SODC, along the border with Cherwell District and Oxford City. • Moor Ditch (Didcot to Thames Confluence). The model files were incomplete and could not be rerun.

It is noted that the existing EA models of Bradford's Brook in Wallingford, is 1D only and these have been used to give an indication of the change in water level as a result of climate change, but have not been used to map the extent of flooding due to their age and changes to modelling techniques since their development. The 1D model results will be held by the Environment Agency, so may be obtained by practitioners undertaking Flood Risk Assessments in areas which may be impacted by these watercourses.

Where model data was not available, Flood Zone 2 was used as a proxy as a conservative estimate of Flood Zone 3a + 70%.

It is important to note that climate change does not just affect the extent of flooding. Even where flood extents do not significantly change; flooding is likely to become more frequent under a climate change scenario. The impact of an event with a given probability is also likely to become more severe. For example, as water depths, velocities and flood hazard increase, so will the risk to people and property. Although

39 Flood Risk Assessments: Climate Change Allowances, Environment Agency (2017), Accessed online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances on 26/05/2017

qualitative statements can be made as to whether extreme events are likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of localised impact of these changes. Further details regarding the uncertainties in predicting the impacts of climate change can be found in:

- Environment Agency (2016) Flood Risk Assessments: Climate Change Allowances
- UK Climate Projections (UKCP09)

5.11.2 Surface water flooding

Climate change is predicted to increase rainfall intensity in the future by up to 40% (for the Upper End estimate to the 2080s period (2070 to 2115) under the new range of allowances published by the Environment Agency. This will increase the likelihood and frequency of surface water flooding, particularly in impermeable urban areas, and areas that are already susceptible. The Risk of Flooding from Surface Water mapping in **Appendix E** does not account for the potential impacts of climate change. Changes to predicted rainfall should be incorporated into flood risk assessments and drainage and surface water attenuation schemes associated with developments.

5.11.3 Groundwater flooding

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is more uncertain. The updated climate change guidance released in February 2016 does not provide information on expected changes to groundwater flooding under future climate change. However, milder, wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer, drier summers could counteract this effect by drawing down groundwater levels to a greater extent during the summer months. Where groundwater flooding is expected to influence a development site, it will be expected that consideration of groundwater flooding under a changing climate is assessed and measures taken to mitigate any change in risk.

6 Assessment of flood risk in potential development areas

The Level 1 SFRA assessed the flood risk to nine strategic sites provided by SODC. The purpose of this assessment was to provide flood risk information for all sources to inform the Sequential Test. The outputs of this assessment are included in **Appendix K.** A Level 2 SFRA site assessment was undertaken for seven of the strategic sites, which were considered for allocation. The purpose of this assessment was to better understand the spatial distribution of flood risk and the possible implications for planning policy. he outputs of this assessment are included in **Appendix L.**

An assessment of flood risk was also undertaken for all designated Neighbourhood Plan Areas within South Oxfordshire, to aid communities in considering flood risk during the allocation of sites when preparing Neighbourhood Plans. Mapping to assist in the preparation of Neighbourhood Plans is provided in **Appendix M**.

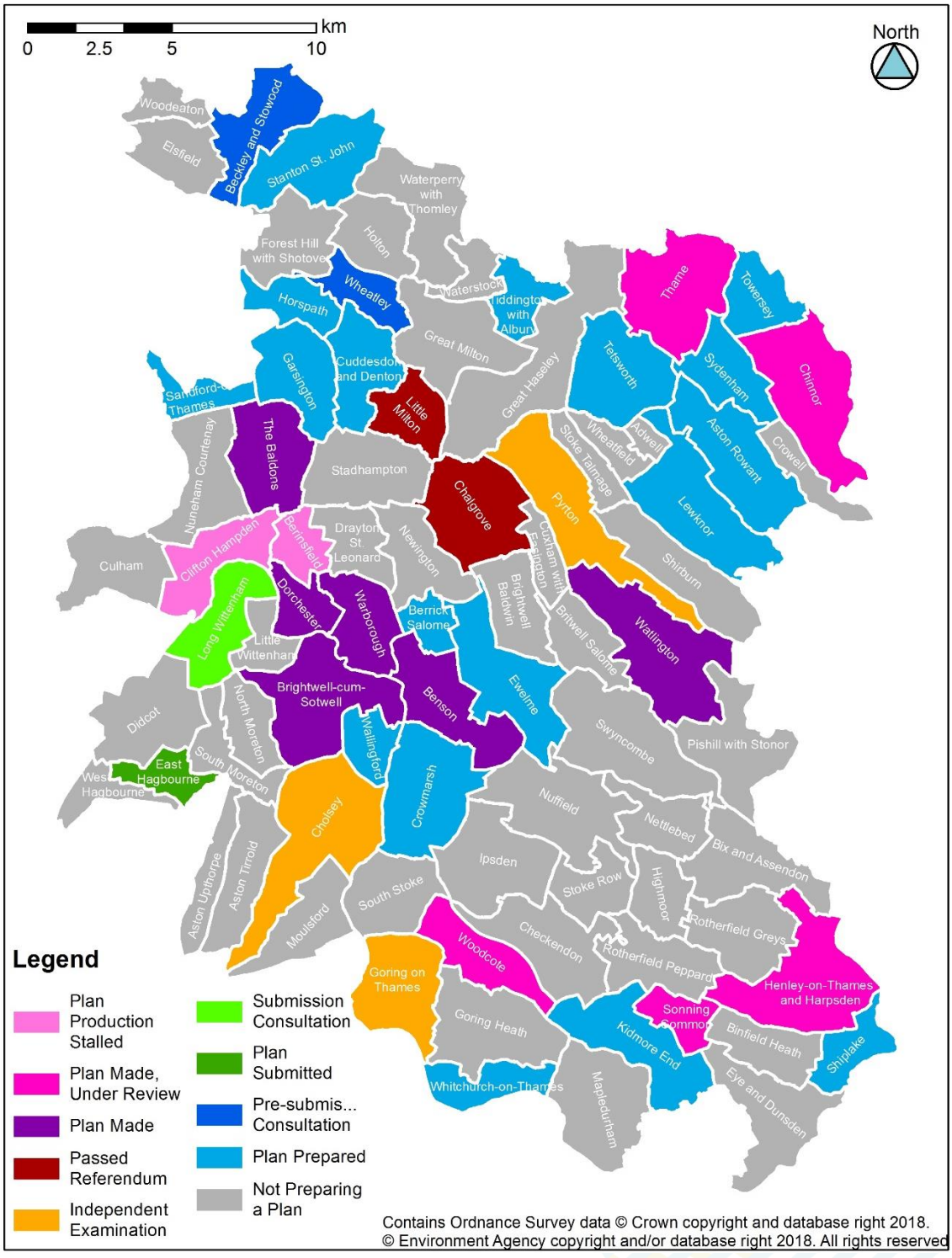


Figure 6-1: Status of Neighbourhood Plan preparation in SODC (as of November 2018)

6.1 Level 1 assessment

A flood risk screening process was completed for all of SODC's strategic sites considered for allocation. The screening assessment calculated the proportion of each site that was at risk of flooding from rivers, surface water and groundwater. It also considered the proportion of the site which has experienced flooding, according to the Historic Flood Map. The outputs from the assessment are summarised in Table 6-1 and **Appendix K**.

Table 6-1: Flood risk screening of strategic sites

Strategic Site Allocation	Flood Zones				RoFSW			GW	HFM
	FZ3b	FZ3a	FZ2	FZ1	High	Mid	Low	High	
Oxford Brookes University Campus, Wheatley	0	0	0	100	0	1	3	96	0
Chalgrove Airfield	0	0	0	100	1	2	6	82	0
Land at Berinsfield	4	4	5	95	0	1	3	80	0
Grenoble Road	0.2	0.2	0.5	99.5	4	7	17	22	0
Land north of Bayswater Brook	7	7	10	90	5	7	20	47	2
Northfield	14	14	17	83	7	11	22	87	0
Land West of the Railway at Culham Science Centre	9	11	15	85	0	1	3	70	15

The screening assessment found that Northfield had the highest proportion of the site at risk of flooding from rivers. The sites at lowest risk were at Wheatley, Chalgrove Airfield and Grenoble Road. High groundwater could be an issue for a large portion of five of the nine sites screened. Therefore, ground investigation should be completed at these sites as part of the planning process.

6.2 Level 2 assessment

The flood risk summary sheets and maps in **Appendix L** provide flood risk information for each Level 2 strategic site. These are intended to support the application of the Sequential Test and inform SODC whether the Exception Test would be required and development will be viable. These summary sheets and maps form a key output of the SFRA.

The following information has been assessed for each strategic site within the summary sheets:

- Basic site information (area, type of site)
- Type of development – The Level 1 SFRA provides further detail of the type of development considered appropriate for each Flood Zone
- Existing watercourses.
- History of flooding (where information is available).
- Description of the availability and limitations of modelled data.
- Fluvial flooding description – % of site in each Flood Zone. For Flood Zone 3b (the functional floodplain), 3a, 2 and 1 these are cumulative (i.e. sum should be 100%). Where there is no detailed modelling, it was assumed that the area of Flood Zone 3b was equal to Flood Zone 3a. Flood Zone 3a plus climate change has been calculated separately as a simple % of the site covered by this zone.

- Fluvial flooding description – characteristics, extents, hazard, velocity, depths, rate of onset and duration of flooding (where information is available)
- Surface water flooding description - % of site in each Risk of Flooding from Surface Water category, description of surface water flow paths.
- Areas Susceptible to Groundwater Flooding Map class.
- Description of reservoir and canal flood risk.
- Assessment of flood defences – description, standard of protection, assessment of residual risk.
- Assessment of the presence of culverts or other structures which may be prone to blockages, and a qualitative assessment of the potential impacts of blockages.
- Flood warning coverage.
- An assessment of how safe access and egress could be managed.
- Assessment of the impact of climate change on flood risk at the site.
- Geology (www.bgs.ac.uk) and soil types (www.landis.org.uk/soilscapes).
- Recommendations on drainage control and impact mitigation, including SuDS and flood betterment opportunities.
- Recommendations for policies within the Local Plan based on the evidence, including requirements for the Exception Test, flood risk assessments and site design.

6.3 Cumulative impact of development

In accordance with NPPF 2018, when allocating land for development, consideration should be given to the potential cumulative impact on flood risk within a catchment. Development increases the impermeable area within a catchment, which if not properly managed, can cause loss of floodplain storage, increased volumes and velocities of surface water runoff, and result in heightened downstream flood risk. Whilst individual developments should only have a minimal impact on the hydrology and flood risk of an area, the cumulative effect of multiple developments may be more severe.

A cumulative impact assessment has been undertaken as part of the SFRA. The full document has been included as **Appendix N**. The study concluded that the strategic allocations are often hydrologically separate (i.e. they fall in separate river catchments). As a result, the district is not highly susceptible to cumulative development impacting flood risk. The biggest risk was identified on the River Thames catchment (between Evenlode and Thame) because of the strategic allocation at Culham and development in the neighbouring authorities of Oxford City and the Cherwell District.

Planning policy considerations have been identified for the catchments where cumulative development is likely to have the greatest impact on flood risk to communities.

To avoid a cumulative impact of development, development in sensitive catchments should strive to limit discharge rates and volumes to greenfield. As per national planning policy, development within Flood Zone 3a (with consideration of climate change) should provide suitable flood compensation storage to avoid a net loss in floodplain.

Where more than one strategic site is identified in a sensitive catchment, flood risk evidence prepared as part of planning application for a site should consider not just that site, but also the development at the other sites.

6.4 Conclusions

In several of the strategic sites, a small percentage of the site is within Flood Zone 2 or 3. There must be an expectation that all built development is located within Flood Zone 1 and areas within Flood Zone 2 and 3 are preserved for biodiversity enhancements and green space. In these cases, detailed site-specific FRAs should ensure that the Flood Zones are well defined using hydraulic modelling, the effect of climate change is considered and that development is compliant with the NPPF. However, the Council may need to consider that such sites will not be able to use their full area to accommodate housing, meaning that the capacity of the site may be reduced.

7 Opportunities for managing flood risk through the planning system

Many of the potential development sites within South Oxfordshire offer opportunities to manage flood risk and provide betterment as part of sustainable development. Opportunities within the SODC Strategic Sites have been highlighted on the relevant site summary sheets **(Appendix L)**. Such opportunities should be discussed with the LLFA and Environment Agency as appropriate at an early planning stage. The South Oxfordshire Local Plan 2034 (Final Publication Version 2nd) document states an objective to *"seek to ensure that the planning and design of development not only protects water supply and quality, but also protects and, where appropriate restores, natural river form and function, whilst maximising resistance and resilience to flood risk."* [40]

7.1 Fluvial

7.1.1 Existing watercourses and assets

Permanent or temporary works within or adjacent to a watercourse require a Flood Risk Activity Permit from the Environment Agency (in the case of Main Rivers) or Ordinary Watercourse Consent from Oxfordshire County Council (in the case of Ordinary Watercourses) under the Land Drainage Act 1991.

Development proposals which are adjacent to Environment Agency assets, including Main River channels, must demonstrate a minimum clearance of 10m from these assets to permit maintenance and renewal. The South Oxfordshire Local Plan 2034 (Final Publication Version 2nd) document also includes a requirement in Policy ENV4 to include an appropriate buffer zone either side of a watercourse to create a corridor of land and water favourable to biodiversity. Buffer zones also help to reduce incidences of flooding by allowing water storage and natural drainage of rainwater.

The Environment Agency have a presumption against allowing further culverting and building over culverts on Main Rivers, which is also backed up in the South Oxfordshire Local Plan 2034 (Final Publication Version 2) which states that *"all opportunities to de-culvert a watercourse should be taken and new culverting should be avoided and only used as a last resort"*. All new developments with culverts running through the site should seek to de-culvert rivers for flood risk management and conservation benefit. Existing watercourses and drainage channels should be retained, offering risk management authorities benefits in terms of maintenance, future upgrading, biodiversity and pollution prevention. The CIRIA (2010) Culvert Design and Operation Guide provides guidance in this area[41].

Where developers are riparian owners, they should also assess existing assets (e.g. bridges, culverts, river walls, embankments) and renew them to last the lifetime of the development. Enhancement opportunities should be sought when renewing assets, e.g. bioengineered river walls, raising bridge soffits to account for climate change. Any works should be designed to be maintenance free, but there is an obligation to the riparian owner to undertake maintenance when required.

7.1.2 Flood storage

There are currently no areas formally allocated by the Environment Agency for flood storage within South Oxfordshire, although extensive areas of undeveloped floodplains play an important role in slowing and storing water during floods. The SODC Strategic Sites are large areas of land located close to tributaries of the major rivers within the District, such as Littlemore Brook at the River Thames, Bayswater Brook on the River

40 Local Plan - Second Preferred Options, South Oxfordshire District Council, (2017), Accessed online at: http://www.southoxon.gov.uk/sites/default/files/SODC%20LP2033%202nd%20preferred%20options%20CHAPTERS_2.pdf on: 22/06/2017

41 Culvert Design and Operation Guide - CIRIA report C689, CIRIA (2010)

Cherwell, and Chalgrove Brook upstream of the River Thame. These sites provide opportunities to attenuate flood waters by enhancing existing floodplain storage or implementing formal flood storage areas.

Some sites contain structures, such as culverted watercourses beneath roads, which currently hold back water and could be further developed as areas of storage. Potential schemes would need to be tested to ensure that changing the timing of peak flows does not exacerbate flooding downstream.

7.1.3 Strategic transport infrastructure

Several sites are located in the vicinity of proposed routes of new transport infrastructure such as the Thames crossing between Culham and Didcot and the Oxford to Cambridge Expressway. In addition to these schemes there are a number of major infrastructure projects planned outside the district that may still impact on the district such as Crossrail to Reading and East West Rail through Oxford.

There may be opportunities for flood management measures to be included at the design stage of the strategic transport infrastructure. For example, consideration should be given to the possibility to provide further flood mitigation by constructing strategic transport routes on embankments, where appropriate, to allow storage of water upstream. In addition, the planned transport infrastructure developments may allow improvements to be made to the efficiency of existing structures within sites, such as culverts.

7.2 Surface water

7.2.1 What is meant by Surface Water Flooding

For the purposes of this SFRA, the definition of surface water flooding is that set out in the Defra SWMP guidance[42]. Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall in urban areas.

Surface water flooding includes

- pluvial flooding: flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity;
- sewer flooding: flooding that occurs when the capacity of underground water conveyance systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters which may cause water to back up and flood on the urban surface. Sewer flooding can also arise from operational issues such as blockages or collapses of parts of the sewer network; and
- overland flows entering the built-up area from the rural/urban fringe: includes overland flows originating from groundwater springs.

7.2.2 Role of the LLFA and Local Planning Authority in surface water management

From April 2015, local planning policies and decisions on planning applications relating to major developments or major commercial developments should make provision for sustainable drainage systems to manage run-off, where major development is defined by the Development Management Procedure Order 2010.

42 Surface Water Management Plan Technical Guidance, DEFRA (2010), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf on: 26/05/2017

The Local Planning Authority must satisfy themselves that clear arrangements are in place for future maintenance of the management arrangements and the LLFA (Oxfordshire County Council), as statutory consultee is required to review the drainage and Sustainable Drainage (SuDS) proposals to confirm they are appropriate.

When considering planning applications, local planning authorities should seek advice from the relevant flood risk management bodies, principally the LLFA on the management of surface water (including what sort of SuDS they would consider to be reasonably practicable), satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the development's lifetime. Judgement on what SuDS system would be reasonably practicable should be through reference to Defra's technical standards and should take into account design and construction costs.

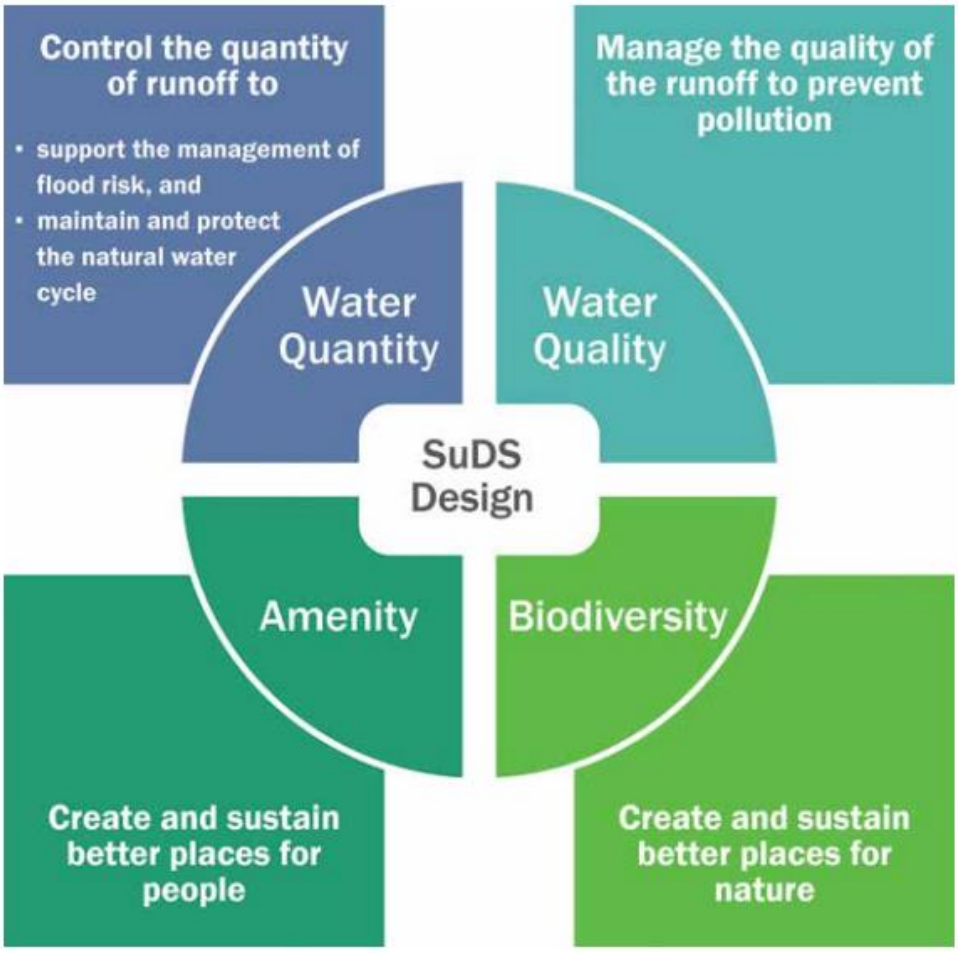
It is essential that the consideration of sustainable drainage takes place at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These principles are:

- Quantity: should be able to cope with the quantity of water generated by the development at the agreed rate with due consideration for climate change via a micro-catchment based approach
- Quality: should utilise SuDS features in a "treatment train" that will have the effect of treating the water before infiltration or passing it on to a subsequent water body
- Amenity/Biodiversity: should be incorporated within "open space" or "green corridors" within the site and designed with a view to performing a multifunctional purpose

This is also aligned with Policy ENV5 from the South Oxfordshire Local Plan 2034 (Publication Version 2nd), to incorporate green infrastructure into developments.

7.2.3 Sustainable drainage systems (SuDS)

The NPPF paragraph 165 states that major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. Sustainable Drainage Systems (SuDS) are water management practices which aim to enable surface water to be drained in a way that mimics (as closely as possible) the run-off and drainage prior to site development. The primary benefits of SuDS can be categorised under four distinct themes. These are highlighted in Figure 7-1 below.



Source: The SuDS Manual C753 (2015)

Figure 7-1: Four pillars of SuDS design

There are a number of ways in which SuDS can be designed to meet surface water quantity, water quality, biodiversity and amenity goals. Given this flexibility, SuDS are generally capable of overcoming or working alongside various constraints affecting a site, such as restrictions on infiltration, without detriment to achieving these goals.

The inclusion of SuDS within developments should also be seen as an opportunity to enhance ecological and amenity value as well as promote Green Infrastructure by incorporating above ground facilities into the landscape development strategy. SuDS must be considered at the outset and during preparation of the initial conceptual site layout to ensure that enough land is given to design spaces that will be an asset to the development as opposed to an ineffective afterthought. For SuDS trains to work effectively the appropriate techniques should be selected based on the objectives for drainage and the site-specific constraints. It is recommended that on all developments source control is implemented as the first stage of a management train allowing for improvements in water quality and reducing or eliminating runoff from smaller, more frequent, rainfall events.

Where practicable, all new major development proposals should ensure that sustainable drainage systems for management of run-off are put in place. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

7.2.4 Types of SuDS

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (see Table 7-1). The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA) e.g. the CIRIA SuDS Manual C753 (2015).

Table 7-1: Examples of SuDS techniques and potential benefits

SuDS Technique	Water Quantity	Water Quality	Biodiversity	Amenity
Green roofs	✓	✓	✓	✓
Basins and ponds	✓	✓	✓	✓
Constructed wetlands	✓	✓	✓	✓
Filter strips and swales	✓	✓	✓	✓
Infiltration devices	✓	✓	✓	
Soakaways	✓	✓	✓	
Infiltration trenches and basins	✓	✓	✓	
Permeable surfaces and filter drains	✓	✓		
Gravelled areas	✓	✓		
Solid paving blocks	✓	✓		
Porous pavements	✓	✓		
Tanked systems	✓			
Over-sized pipes/tanks	✓			
Storm cells	✓			

SuDS should not be used individually but as an interconnected system, designed to capture water at the source and convey it to a discharge location. By using a number of SuDS features in series it is possible to reduce the flow and volume of runoff as it passes through the system, minimise the pollutants which may be generated by a development, and tailor surface water management to the local context.

A key part of the four pillars of SuDS is to provide the maximum improvement to water quality. To maximise the treatment within SuDS, CIRIA recommends the following good practice guide is implemented in the treatment process:

1 Manage surface water runoff close to source: This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area.

2 Treat surface water runoff on the surface: This allows treatment to be delivered by vegetation and the sources of pollution to be more easily identified. It also helps with future maintenance work and identifying damaged or failed components of the treatment train.

3 Treat a range of contaminants: SuDS should be chosen and designed to deal with the likely contaminants that may pose a risk to the receiving environment and be able to reduce them to acceptably low levels.

4 Minimise the risk of sediment remobilisation: SuDS should be designed to prevent sediments being washed into receiving water bodies or systems during events greater than those for which the component may have been specifically designed.

5 Minimise the impact of a spill: Designing SuDS to be able to trap spills close to the course, facilitate contamination management and removal. The selected SuDS should also provide robust treatment along several components in series.

The number of treatment stages required depends primarily on the source of the runoff. The C753 SuDS Manual advises a simple index approach to determining the number of treatment stages. This involves determining a pollutant hazard score for each pollutant type. An index is then used to determine the treatment potential of different SuDS features for different pollutant types. This is known as the mitigation index. The total SuDS mitigation index should be equal or greater than the pollution hazard score to deliver adequate treatment.

7.2.5 Discharge location

Paragraph 79 of the NPPG states that SuDS should be designed so that discharge of surface run off is as high up the following hierarchy of drainage options as reasonably practicable:

1 into the ground (infiltration);

2 to a surface water body;

3 to a surface water sewer, highway drain, or another drainage system;

4 to a combined sewer.

7.3 Groundwater

Groundwater flooding has a very different flood mechanism to flooding from other sources and for this reason many conventional flood defence and mitigation methods are not suitable. The only practicable way to fully reduce flood risk is through building design (development form), so that floor levels are raised above flood water levels e.g. the water levels caused by a 1 in 100 annual probability plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland so flood risk is not increased downstream or on adjacent land.

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk on or off the site. Developers should provide evidence and ensure that this will not be a significant risk. Consideration should also be given to the location of infiltration SuDS in relation to Groundwater Source Protection Zones to ensure water quality is preserved.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an appropriate solution.

7.4 Sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage, and determine whether there is a requirement to improve the drainage infrastructure to reduce flood risk on site and regionally. It is important that a drainage impact assessment shows that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

When redeveloping existing buildings, the installation of some permanent or temporary flood-proofing and resilience measures could protect against both surface water and

sewer flooding. Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 1 in 100 annual probability plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques.

7.5 River restoration and enhancement

All new development close to watercourses should consider the opportunity presented to improve and enhance the river environment. For instance, as a minimum, developers should aim to set back development at least 10m from the river, providing a buffer strip to 'make space for water' allowing additional capacity to accommodate climate change as well as accounting for natural processes such as erosion[43]. The 10m buffer should not contain any built environment including roads, lighting and fencing. Furthermore, it is stated within the South Oxfordshire Local Plan 2034 that any development within 20m of the river must have a construction management plan, agreed with the council, which shows the watercourse is protected from damage, disturbance and pollution (to a satisfactory level).

Developments should look at opportunities for river restoration, de-culverting (daylighting), and river enhancement as part of the development. Restoration can take place on various scales, from small enhancement measures to full river restoration. Options include backwater creation, in-channel and bank habitat enhancement, removal of redundant structures e.g. weirs, removal of toe-boarding, restoration of banks and reinstatement of meanders.

When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river. Advice on river restoration, de-culverting and providing other environmental enhancements on development sites is available from the Environment Agency. Early consultation is recommended.

Any modifications made as part of the proposed de-culverting, and / or restoration of river channels and corridors should be designed by suitable professionals and a full flood risk assessment of the impact of modification will be required to be carried out.

The River Restoration Centre is the national advice centre for best practice river restoration, habitat enhancement and catchment management, with an advisory board consisting of members from the Environment Agency and Natural England, (and regional equivalents from Scotland, Wales and Northern Ireland). The Manual of River Restoration Techniques[44] contains examples of best practice and case studies as well as links to further information.

[43] South Oxfordshire Local Plan 2011-2033, South Oxfordshire District Council, (2017). Accessed online at: http://www.southoxon.gov.uk/ccm/support/dynamic_serve.jsp?ID=776170511&CODE=D2E6F03567847CD279E120E088D3DB19

44 The Manual of River Restoration Techniques, River Restoration Centre (2013), Accessed online at: http://www.therrc.co.uk/manual-river-restoration-techniques on: 02/06/2017

8 Flood risk guidance for planners and developers

This SFRA focuses on delivering a strategic assessment of flood risk within the boundary of SODC. To support planning applications and prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk at a site are fully addressed. In addition, at some sites the FRA must include evidence that demonstrates the proposals satisfy the Sequential and Exception Tests in accordance with the NPPF requirements (the Sequential Test must be performed for sites not allocated in the plan). In these circumstances, further assessment should be performed and described in a detailed Flood Risk Assessment (FRA). Any site that does not pass the Exception Test should not be allocated for development.

It is the responsibility of the developer to provide an FRA with an application.

It should be acknowledged that a detailed FRA may show that a site is not appropriate for development of a particular vulnerability or even at all. Where the FRA shows that a site is not appropriate for a particular use, a lower vulnerability classification may be appropriate.

8.1 When is a flood risk assessment required?

The Flood Risk Assessment: Local Planning Authorities[45] guidance, available online, outlines when a flood risk assessment is needed as part of a planning application, how it should be undertaken and the review process. As stated in the online guidance, a FRA is required in the following circumstances:

- All developments located within Flood Zone 2 or 3. This includes standing advice for minor developments such as non-residential extensions, alterations which do not increase the size of the building or householder developments. It also includes changes of use of an existing development.
- All developments greater than 1ha located in Flood Zone 1.
- All developments less than 1ha in Flood Zone 1 where a change of use in development type leads to a more vulnerable classification or where development could be affected by sources of flooding other than rivers and the sea. This would include surface water, drains and reservoirs.
- All developments located in an area which has been highlighted as having critical drainage problems by the Environment Agency.
- Developments located within a dry island where the safe access and egress route(s) pass through Flood Zone 3, taking into account the potential change in Flood Zone 3 as a result of climate change.

Advice should be sought from the Local Planning Authority (SODC), the Lead Local Flood Authority (OCC) and/or the Environment Agency at the pre-planning application stage to determine the need for a site-specific FRA.

8.2 Requirements for flood risk assessments

Principal aims of an FRA are to demonstrate that the development is protected to the 1 in 100-year fluvial flood scenario and is safe during the design flood event, including an allowance for climate change. This includes assessment of mitigation measures required to safely manage flood risk. Development proposals requiring FRAs should:

- be performed in accordance with the requirements of the Sequential Test and, when necessary, Exception Tests;

45 DEFRA and Environment Agency, (April, 2015), Flood risk assessment: local planning authorities

- not increase flood risk, either upstream or downstream, of the site, taking into account the impacts of climate change;
- seek to not increase surface water volumes or peak flow rates to those above the level permitted by Oxfordshire County Council and Thames Water, which would result in increased flood risk to the receiving catchments (the permissible rates should be agreed with the relevant authorities);
- use opportunities provided by new development to, where practicable, reduce flood risk within the site and elsewhere;
- ensure that where development is necessary in areas of flood risk (after application of Sequential and Exception Tests), provisions are made so it is safe from flooding for the lifetime of the development, taking into account the impact of climate change; and
- consider all sources of flood risk.

FRAs for sites located in the study area should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Oxfordshire County Council. In circumstances where FRA's are prepared for windfall sites, they should include evidence that demonstrates the proposals are in accordance with the policies set out in the Local Plan and satisfy the Sequential Test.

There may be instances where flood risk management measures are not necessary now but may be in the future. If it is not appropriate to include full provision for climate change effects within the proposals at the time of implementation of new development, consideration can be given to a 'managed adaptive approach', e.g. setting the development away from a river so it is easier to improve flood defences in the future. If a managed adaptive approach is proposed the evidence submitted must describe how the necessary future commitment is secured for the investment required. The Environment Agency will consider whether an FRA has incorporated a management adaptive approach for planning applications[46].

8.3 Mitigation measures

Mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to avoiding and reducing risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

Often the factor determining whether a particular development is appropriate, is the practical feasibility, financial viability and long-term maintenance implications of flood risk mitigation, rather than technical limitations. Detailed technical assessments are required in the FRA to assess the practical feasibility, together with a commercial review by the developer of the cost of the mitigation works and how contributions will be made for their long-term maintenance. At the SFRA stage, broad assumptions must be made regarding the feasibility of flood risk mitigation to highlight sites with greater development potential. The formulation of measures that not only provides an appropriate standard of protection to new development, but also reduces the risk to existing communities, will be an important consideration.

Attention must also be paid to the provision of safe access and egress during flood events, including climate change, and how this is linked to flood warning and emergency evacuation where necessary. The Emergency Services and local authority should be consulted on the evacuation and rescue capabilities and any advice or requirements included.

46 Flood Risk Assessments: Climate Change Allowances, Environment Agency (2017), Accessed online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances on 26/05/2017

There should not normally be any obstruction of flood flows or loss of flood storage as a result of proposed development. Flood storage compensation may be appropriate for sites on the edge of the existing floodplain or within a flood cell. If proposed development does present an obstruction, then the effects on adjacent land should be evaluated and if necessary appropriate mitigation measures included.

Whilst it might be possible to identify appropriate flood mitigation measures for some sites, it is worth noting that in some instances the findings of individual FRAs may determine that the risk of flooding to a proposed development is too great and mitigation measures are not feasible or appropriate. In these instances, the development is likely to be subject to an objection by the Environment Agency, the Local Authority or the Lead Local Flood Authority.

The minimum acceptable standard of protection against flooding for new residential property within flood risk areas is the 1 in 100 annual probability event for fluvial flooding and 1 in 100 annual probability event for surface water flooding. Developments susceptible to flood risk resulting from blockage or exceedance of structures should be protected beyond the 1 in 100 annual probability event plus an allowance for climate change. An allowance for climate change over the lifetime of the development must be made when assessing each of these scenarios. The measures chosen will depend on the nature of the flood risk and the vulnerability of the development.

The latest guidance for climate change requires allowance to be made for peak flow for different river basin districts. Developers should refer to the latest climate change guidance when designing a site. Where the relevant fluvial models have not been run using the latest climate change uplifts for river flow, it may be necessary for developers to undertake this modelling in order to ensure that the impacts of climate change are properly assessed. In the first instance, advice should be sought from the EA.

8.4 Site layout and design

8.4.1 Principles

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from Flood Zones, to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can possibly be located in higher risk areas. However, vehicular parking in floodplains should be based on the nature of parking, flood depths and hazard including evacuation procedures and flood warning and should not compromise floodplain storage or obstruct floodplain flows.

Waterside areas, or areas along known flow routes, can act as Green Infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as flood water levels rise.

8.4.2 Raised floor levels

The raising of floor levels within a development avoids damage occurring to the interior furnishings and electrics in times of flood. If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable, the development should be raised to a minimum of 600 mm above the maximum water level caused by a 1 in 100 annual probability fluvial flood event including an appropriate

allowance for climate change[47]. However, if raised floor levels are proposed these should be agreed with the local planning authority. The minimum Finished Floor Level (FFL) may change depended on the vulnerability and flood risk of the development. Reference to the latest climate change guidance will be made when considering the FFL.

The additional height that the floor level is raised above the predicted flood water level is referred to as the "freeboard". Additional freeboard may be required to account for risks such as blockages to the channel, culvert or bridge, uncertainty in the predictions and should be considered as part of an FRA.

Many areas currently situated within Flood Zone 2 may become part of Flood Zone 3a in the future due to the effects of climate change. Therefore, it is essential that the potential risk of flooding in the future is considered when planning development.

Allocating the ground floor of a building for less vulnerable, non-residential use is an effective way of raising living space above flood levels. Such uses include:

- shops;
- restaurants, cafes and hot food takeaways;
- parking associated with the proposed development

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days. All residential accommodation in Flood Zone 2 and 3a should be located above the recommended flood level. No residential accommodation should be located in Flood Zone 3b.

Similarly, the use of basements should be avoided in Zone 2 and Zone 3 or in areas where flood risk from other sources could result in rapid inundation. Under the NPPF, habitable uses of basements within Flood Zone 3 should not normally be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test.

8.4.3 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution. Consideration should also be given to the residual risk if the defences fail or are overtopped during an event that exceeds the design capacity. Breach and overtopping assessments should not only consider the residual risks to the occupants of new development but should also address the ability of proposed structures to withstand the dynamic and hydrostatic loadings associated with a breach event.

Temporary or demountable defences are not normally acceptable forms of flood protection for a new development but might be appropriate to address circumstances where the consequences of residual risk are severe. In addition to the technical measures the proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate.

8.4.4 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not

47 Flood risk assessment: standing advice, Environment Agency (2012): Accessed online at: https://www.gov.uk/guidance/flood-risk-assessment-standing-advice on: 26/05/2017

act as conveyance for flood waters. However, care must be taken at locations where the effect on flood flows and volumes as a consequence of raising ground levels could adversely affect existing communities and property.

In most areas of fluvial flood risk, raising land above the floodplain would reduce conveyance or flood storage and could worsen flood risk downstream or on neighbouring land. Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should normally be in the vicinity of the site and within the red line of the planning application boundary (unless the site is a strategic allocation).

Raising ground levels can also deflect flood flows, so analysis should be performed to demonstrate that there are no adverse effects on third party land or property. Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels will need to be assessed as part of a detailed FRA.

8.4.5 Developer contributions

In some cases, and following the application of the sequential test, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both proposed new development and the existing local community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS).

Operating authorities can make requests for contributions to activities including flood risk management schemes through DEFRA's Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[48]. However, the availability of such funding is limited by the priorities for public spending and thus linked to the anticipated requirements set out in the Local Flood Risk Management Strategy (LFRMS). The available funding is based on the projected benefits and it is often the case that the cost of providing flood risk management measures is greater than the benefits that can be obtained by reducing the flood frequency. Often schemes are only partly funded by FCRMGiA and the shortfall in funds has to be found from elsewhere. For example, local levy funding, local businesses or other parties benefitting from the scheme or contributions from developers or other parties that benefit from the provisions.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer and should include the cost of maintenance.

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not mean the development is appropriate as other policy aims must also be met. Funding from developers should be explored prior to the granting of planning permission and in partnership with the local planning authority and the Environment Agency.

The Environment Agency is committed to working in partnership with developers to reduce flood risk. Where assets are in need of improvement or a scheme can be implemented to reduce flood risk, the Environment Agency request that developers contact them to discuss potential solutions.

[48] Principles for implementing flood and coastal resilience funding partnerships (Environment Agency, 2012)

8.4.6 Resilience measures

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined in this chapter. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk from larger flood events. In these cases (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not normally be relied on for new development as an appropriate mitigation method. Most of the measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small scale pumping equipment to control the flood water that does seep through these systems. The following measures are often deployed:

Flood alerts and flood warnings

The Environment Agency offer a flood warning and alert service. These are free services that are frequently updated and accessible for 24 hours of the day. A map of the flood alert and flood warning areas is included in **Appendix H**.

Permanent barriers

Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers.

Temporary barriers

Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale, temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.

Wet-proofing

Interior design measures to reduce damage caused by flooding. For example:

- Electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level
- Water-resistant materials for floors, walls and fixtures
- Non-return valves to prevent waste water from being forced up bathrooms, kitchens or lavatories
- If redeveloping existing basements for non-residential purposes, new electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level to minimise damage if the development floods

Resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by the FRA.

Community resilience measures

These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

Emergency planning

Safe access and egress from the site should be provided to reduce the residual risks to a development. The developer should seek to incorporate an emergency plan and a safe refuge point if the development site has been identified to be at risk of flooding.

The Local Planning Authority and Emergency Services should be consulted when designing an emergency plan. For further details on emergency planning.

8.5 Making space for water

The NPPF sets out a clear policy aim in Flood Zone 3 to create space for flooding by restoring functional floodplain.

All new development close to rivers should consider the opportunity presented to improve and enhance the river environment. Developments should, where possible, encompass opportunities for river restoration and enhancement as part of the development. Options include backwater creation, de-silting, in-channel habitat enhancement and removal of structures. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

Consideration for making space for water should also be applied to surface water generated by impermeable surfaces. All new developments should aim to incorporate SuDS to minimise the amount of surface water that is generated. Through a sequential design, known areas of flood risk from surface water can be set aside as open space to ensure flow routes are not blocked, preventing water from building up to potentially dangerous depths. The provision of SuDS also allows water related features to become part of the landscape, offering improved aesthetics to a development and removing the need for underground storage or culverting.

9 Surface water runoff and drainage guidance for planners and developers

9.1 What is meant by Surface Water Flooding

For the purposes of this SFRA, the definition of surface water flooding is that set out in the Defra SWMP guidance[49]. Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall in urban areas.

Surface water flooding includes

- pluvial flooding: flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity;
- sewer flooding: flooding that occurs when the capacity of underground water conveyance systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters which may cause water to back up and flood on the urban surface. Sewer flooding can also arise from operational issues such as blockages or collapses of parts of the sewer network; and
- overland flows entering the built-up area from the rural/urban fringe: includes overland flows originating from groundwater springs.

9.2 Role of the LLFA and Local Planning Authority in surface water management

From April 2015, local planning policies and decisions on planning applications relating to major developments or major commercial developments should make provision for sustainable drainage systems to manage run-off, where major development is defined by the Development Management Procedure Order 2010.

Advice on surface water management for applications for minor development is provided by SODC's internal drainage team.

The Local Planning Authority must satisfy themselves that clear arrangements are in place for future maintenance of the management arrangements and the LLFA (Oxfordshire County Council), as statutory consultee is required to review the drainage and Sustainable Drainage (SuDS) proposals to confirm they are appropriate.

When considering planning applications, local planning authorities should seek advice from the relevant flood risk management bodies, principally the LLFA on the management of surface water (including what sort of SuDS they would consider to be reasonably practicable), satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the development's lifetime. Judgement on what SuDS system would be reasonably practicable should be through reference to Defra's technical standards and should take into account design and construction costs.

It is essential that the consideration of sustainable drainage takes place at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These principles are listed in Section 7.2.3.

49 Surface Water Management Plan Technical Guidance, DEFRA (2010), Accessed online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf on: 26/05/2017

9.3 Role of the developer in surface water management

It is the responsibility of a developer to make proper provision for surface water drainage to ground, water courses or surface water sewers (following the hierarchy defined in Section 7.2). It must not be allowed to drain to the foul sewer, as this is a major contributor to sewer flooding.

9.4 Site-scale surface water management

The effectiveness of a flow management scheme within a single site is defined by site constraints including (but not limited to) topography, geology, soil permeability and available area. However, even on heavily constrained sites such as space-limited urban redevelopments, or sites with poor permeability, there are still SuDS techniques that can provide benefits.

A clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential. Additionally, for infiltration SuDS it is imperative that the water table is low enough and a site-specific infiltration test is undertaken. Where sites lie within or close to source protection zones further restrictions may be applicable, and guidance should be sought from the Environment Agency.

The design, construction and ongoing maintenance regime of such a scheme must be carefully defined, and consideration of SuDS design and surface water flow routes from the concept design onwards will ensure that the scheme is effective. FRAs should consider the long-term maintenance and ownership of SuDS.

The destination of surface water that is not collected for use on site should be prioritised, with infiltration preferred, then discharge to surface waters, followed by discharge to a surface water sewer. Discharge to a combined sewer is the least preferred option. Discharge to a foul sewer should not be considered as a possible option. The sewerage undertaker should be consulted at an early stage to ensure that sufficient capacity is available in the existing drainage system.

9.5 Large-scale integrated surface water management

When considering the development of new settlements, SODC has opportunities for developing an integrated water management strategy across development site boundaries, and a catchment-led approach should be adopted. Integrated drainage systems may be considered suitable for catchments where other developments are being planned or constructed, and where on-site measures are set in isolation of the systems and processes downstream.

An integrated approach to controlling surface water drainage can lead to a more efficient and reliable surface water management system, as it enables a wider variety of potential flood mitigation options to be used, and delivers numerous other benefits, including improved water quality and a reduction of water demand through rain-water recycling and reuse.

Considering SuDS at an early master planning stage for new settlements, alongside other planning requirements, for instance green infrastructure and public space/amenity, habitat and landscape needs and water recycling needs (for example to meet Building Research Establishment Environmental Assessment Methodology (BREEAM) targets), enables them to be fully integrated and to contribute to and complement these other requirements. These other benefits can also make SuDS more economically viable.

9.6 Wastewater

Major developments and those upstream of areas where sewer flooding is known to be a problem must carry out wastewater capacity checks and should liaise with the sewerage undertaker at an early stage. This is to prevent an increase in sewer flooding

and/or spills from combined sewer overflows (CSOs) further down the wastewater system, as a result of the development.

The impact of an increased volume of foul water discharge on watercourses should also be considered for large sites, or where several sites are likely to be developed in the same Waste Water Treatment Works (WwTW) catchment, particularly where the receiving WwTW discharges into the same watercourse as the surface water runoff from the site.

The SODC Water Cycle Study[50], contains information on wastewater capacity which highlighted that there were some potential constraints to developments. This information has been used for the preparation of the Local Plan.

9.7 Water quality and biodiversity

The impact of a new development site's drainage scheme on the receiving watercourse needs to be assessed, as a change to either water quality or water quantity could have a detrimental effect on water framework classification of waterbody that may need to be mitigated. For example, SuDS schemes can alter the discharge runoff rate into watercourses and consideration needs to be given to the impact of this change on the physical structure of the watercourse and its ecology.

An impact assessment should also be carried out if the floodplain habitat currently depends on periodic inundation, for example water meadows.

[50] South Oxfordshire District Council Water Cycle Study, JBA (2017), Accessed online at: http://www.southoxon.gov.uk/sites/default/files/Water%20Cycle%20Study%20Phase%201%20-%20S%20Oxfordshire%20District%20Council.pdf on: 15/06/2017

10 Summary and conclusions

10.1 Summary

The 2019 South Oxfordshire SFRA has been produced to reflect recent changes in national policy, guidance and legislation, to bring the planning context and flood risk information up to date and to aid the preparation of the Local Plan.

The SFRA provides general advice for planners and developers on:

- Sources of flood risk mapping and other evidence to inform the Sequential Test
- Flood risk from each source of flooding in the District
- Requirements for a Flood Risk Assessment
- Other issues that need to be considered when carrying out development close to watercourses.

10.2 Use of SFRA data

It is important to remember that information on flood risk is being updated continuously. This is particularly true now that the LLFA have taken responsibility for carrying out and recording flood investigations under the Flood and Water Management Act 2010. The Environment Agency has a rolling programme of flood modelling and mapping studies, and updates to the Flood Map are made quarterly. Where new mapping studies are carried out this will also affect the definition of the functional floodplain (Flood Zone 3b) and Flood Zone 3a + climate change. It is important that the Environment Agency is consulted to determine whether updated information is available prior to commencing a detailed Flood Risk Assessment.

The SFRA should be periodically updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Oxfordshire County Council as the Lead Local Flood Authority and Highways Authority, Thames Water, and the Environment Agency. It is recommended that the SFRA is reviewed internally on an annual basis, allowing a cycle of review, by checking with the above bodies for any new information to allow a periodic update.

10.3 Next steps

As the Council moves forward with their Local Plan in partnership with the Neighbourhood Planning Groups, they must use the most up to date information in applying the Sequential Test, and developers should be aware of the latest information for use in FRAs. Both should be aware of any future changes to advice in the consideration of climate change for planning FRAs.

Level 2 SFRA assessments should be undertaken at any sites which have been identified as 'at risk' and which may be carried forward in the Local Plan. The aim of the Level 2 assessments is to provide more information for the Sequential Test, and evidence to help determine whether or not the Exception Test could be passed, i.e. development could be achieved safely, for sites that have been found to be at risk by the Level 1 assessment.

The NPPF Planning Practice Guidance states:

"A Level 2 Strategic Flood Risk Assessment should consider the detailed nature of the flood characteristics within a Flood Zone including:

- *flood probability;*
- *flood depth;*
- *flood velocity;*

- *rate of onset of flooding; and*
- *duration of flood"*

The Level 2 assessment must also provide more detail on the impacts of climate change on flood risk.

The Flood and Water Management Act (2010), the Localism Act (2011) and the NPPF all offer opportunities for a more integrated approach to flood risk management and development. As it is in the relatively early stages of developing its Local Plan, the Council has a real chance to approach planning for flood risk, sustainable drainage, green infrastructure, water quality, amenity, bio-diversity and habitat, and Water Framework Directive considerations in an integrated way. The Council's planning policies should focus on supporting the LLFA in ensuring that all developments, even minor ones, build SuDS into their design. New settlements on greenfield sites (and other major developments) offer excellent opportunities to ensure that master planning integrates SuDS and making space for water into site design right from the concept stage.

10.4 Further information

The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

11 Appendices

K Appendix: SFRA Level 1 site flood risk screening

L Appendix: SFRA Level 2 site summary sheets

M Appendix: Flood risk mapping for designated Neighbourhood Plan areas

N Appendix: Cumulative impact assessment to inform site selection process

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