Stroud Level 2 Strategic Flood Risk Assessment

Final Draft Report

May 2021

www.jbaconsulting.com

Stroud District Council
Ebley Mill
Ebley Wharf
Stroud
GL5 4UB

Fiona Hartland
Pipe House
Lupton Road
Wallingford
Oxfordshire
OX10 9BS

Revision History

Revision Ref/Date	Amendments	Issued to
08/02/2019	Draft Report	Stroud District Council
11/11/2019	Draft Report – NPPF policy references updated	Stroud District Council
04/12/2020	Draft Report – updates to guidance (SFRA, climate change)	Stroud District Council
20/05/2021	Draft Final Report – Issue for consultation. **Dialogue continuing with Environment Agency on SFRA outputs**	Stroud District Council

Contract

This report describes work commissioned by Conrad Moore, on behalf of Stroud District Council by a letter dated 17th September 2018. Cheryl Briars, Emily Jones, Kirstie Murphy and Fiona Hartland of JBA Consulting carried out this work.

Prepared by ..... Emily Jones BSc
Assistant Analyst

..... Kirstie Murphy BSc MSc
Assistant Analyst

..... Cheryl Briars BSc MSc
Analyst

..... Fiona Hartland MSci
Analyst

Reviewed by ..... Anna Beasley BSc MSc CEnv MCIWEM C.WEM
Technical Director

Purpose

This document has been prepared as a Draft Report for Stroud District Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document

other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Stroud District Council.

Acknowledgements

JBA would like to thank Stroud District Council, Gloucestershire County Council, the Environment Agency, the Canal and River Trust, Wessex Water, Severn Trent Water and the Lower Severn Internal Drainage Board, for their input and supply of data.

Copyright

Carbon Footprint

A printed copy of the main text in this document will result in a carbon footprint of 412g if 100% post-consumer recycled paper is used and 525g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to reduce its per capita carbon emissions.

Executive summary

Introduction and Context

This Strategic Flood Risk Assessment (SFRA) document undertakes a Level 2 assessment of site options identified for potential allocation within the emerging Stroud Local Plan. It builds upon the Level 1 SFRA (2008) and Level 2 SFRA (2012 - 2014) for Stroud by providing updated information on surface water management and Sustainable Drainage Systems (SuDS), guidance for site-specific Flood Risk Assessments (FRAs) and opportunities to reduce flood risk to existing communities within the district of Stroud, in light of the revisions to national and local planning policy and guidance.

It involves the assessment of new proposed development sites required as part of the process of exploring the potential of sites to accommodate growth in the emerging District Local Plan.

SFRA Objectives

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

- Level 1: where flooding is not a major issue in relation to potential development sites 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 National Planning Policy Framework (NPPF) 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.

The objectives of this Level 2 SFRA update are to:

1. Provide individual flood risk analysis for site options using the latest available flood risk data, thereby assisting the Council in applying the Exception Tests to its proposed site options in preparation of its Local Plan.
2. Where available, re-run existing hydraulic modelling to account for the effects of climate change and any residual risk. Where flood risk information is unavailable or limited, conduct appropriate hydraulic modelling where possible to determine the flood risks to the proposed site options.
3. Using available data, provide information and a comprehensive set of maps presenting flood risk from all sources for each proposed site options.
4. Where the Exception Test is required, provide recommendations for making the site safe throughout its lifetime.
5. Take into account most recent policy and legislation in the 2018 National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG), Shoreline Management Plan (SMP2), and Stroud District emerging Local Plan. Using the documents provided, updating information on the requirements for site-specific FRAs, considerations for suitable surface water management methods and opportunities to reduce flood risk to the existing communities.

The SFRA also considers the impact of climate change on flood risk in the future and contains an assessment of the cumulative impact of development.

Level 2 SFRA outputs

The Level 2 assessment includes detailed assessments of the proposed site options. These include:

- An assessment of all sources of flooding including fluvial flooding, surface water flooding, groundwater flooding, mapping of the functional floodplain and the potential increase in fluvial flood risk due to climate change.
- Reporting on current conditions of flood defence infrastructure, where applicable.
- An assessment of existing flood warning procedures, including an assessment of safe access and egress during an extreme event.
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff.
- Advice on appropriate policies for sites which could satisfy the first part of the Exception Test and on the requirements necessary for a site-specific FRA, supporting a planning application to pass the second part of the Exception Test.

Summary of Level 2 SFRA

Stroud District Council provided 399 sites in total, which were screened against flood risk information (see Appendix O). Of these 399 sites, 19 were taken forward to a Level 2 SFRA and detailed site summary tables have been produced. These sites are sites within Flood Zone 2 or 3, which are shown to be at risk of fluvial flooding from watercourses running either through or adjacent to the site.

The site-level assessment is provided in Appendix P, with corresponding mapping provided in Appendix Q.

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

Detail is provided in Section 3 on how flood risk is assessed 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 available for use in this SFRA.

Guidance for planners and developers

Section 6 introduces guidance aimed at both planners and developers. Based on the latest flood risk and planning policy, it supersedes the guidance provided in previous SFRAs. 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.

Next steps

It is important to remember that information on flood risk is being updated continuously, as new information on flood risk, flood warnings or new planning guidance and legislation becomes available. The new information may be provided by Stroud District Council, Gloucestershire County Council, the Environment Agency, Highways England, or the water companies. As the Council moves forward with its Local Plan, they must use the most up to date information in the Sequential Test, and

developers should be aware of the latest information for use in Flood Risk Assessments.

The Flood and Water Management Act (2010), the Localism Act (2011) and the National Planning Policy Framework (2019) all offer opportunities for a more integrated approach to flood risk management and development. As they are in the relatively early stages of developing a Local Plan, the Council have a good opportunity to make sure development provides improvements to flood risk overall and enhancements to the river environment.

Planning policies should focus on supporting the lead local flood authority (LLFA) in ensuring that all developments build SuDS into their design and ensure that, from the concept stage, master planning integrates SuDS and makes space for water within the site design.

Contents

List of Figures

List of Tables

Definitions and Abbreviations

Term	Definition
AIMS	Asset Information Management System (Environment Agency GIS database of assets)
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
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
CSO	Combined sewer overflow
Defra	Department for Environment, Food and Rural Affairs

Term	Definition
EA	Environment Agency
EU	European Union
FFL	Finished floor level
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.
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
FWMA	Floods 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.
GCC	Gloucestershire County Council
GI	Green Infrastructure
Ha	Hectare
IDB	Internal Drainage Board
JBA	Jeremy Benn Associates Limited
LFRMS	Local Food Risk Management Strategy
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NFM	Natural Flood Management
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

Term	Definition
	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 Practice 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.
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.
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water map. Environment Agency national map showing risk of flooding from surface water.
SA	Sustainability Appraisal
SALA	Strategic Assessment of Land Availability
SDC	Stroud District Council
Sewer flooding	Flooding caused by a blockage or overflow in a sewer or urban drainage system.
SHLAA	Strategic Housing Land Availability Assessment - This is a technical piece of evidence to support local plans and their sites & policies . Its purpose is to demonstrate that there is a supply of housing land in the Borough/District which is suitable and deliverable.
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.
SMP	Shoreline Management Plan

Term	Definition
SPD	Supplementary Planning Document
STW	Sewage treatment works
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.
WCS	Water Cycle Study
WFD	Water Framework Directive
WWNP	Working With Natural Processes

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

This Strategic Flood Risk Assessment (SFRA) 2019 document undertakes a Level 2 assessment of sites identified for potential allocation within the emerging Local Plan. It provides an update to the policy and flood risk information provided in the existing Stroud Level 1 SFRA[1] (2008) and builds upon the Level 2 SFRA for Stroud originally published in March 2012[2], as well as the subsequent March 2014 Addendum[3].

1.2 Levels of SFRA

The Planning Practice Guidance (PPG)[4] advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

- Level One: where flooding is not a major issue in relation to potential development sites and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
- Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the National Planning Policy Framework (NPPF) 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 update fulfils the requirements of a Level 2 SFRA and provides up-to-date flood risk and planning guidance applicable to all development sites.

1.3 SFRA Objectives

The objectives of this Level 2 SFRA are to:

1. Provide individual flood risk analysis for site options using the latest available flood risk data, thereby assisting the Council in applying the Exception Tests to its proposed site options in preparation of its Local Plan.
2. Where available re-run existing hydraulic modelling to account for the effects of climate change and any residual risk. Where flood risk information is unavailable or limited, conduct appropriate hydraulic modelling where possible to determine the flood risks to the site options.
3. Using available data, provide information and a comprehensive set of maps presenting flood risk from all sources for each site option.
4. Where the Exception Test is required provide recommendations for making the site safe throughout its lifetime.
5. Take into account most recent policy and legislation in the NPPF, PPG, Stroud District Local Plan and Stroud District Emerging Strategy. Using these documents provided, updating information on the requirements for site-specific Flood Risk Assessments (FRAs), considerations for suitable surface water management methods and opportunities to reduce flood risk to the existing communities.

---

1 Gloucestershire County Council (2008) Strategic Flood Risk Assessment for Local Development Framework Level 1. Available at: https://www.gloucestershire.gov.uk/media/8040/stroud_district_council_level_1_sfra_final-28385.pdf
2 Stroud District Council (2012) Strategic Flood Risk Assessment for Local Development Framework Level 2. Available at: https://www.stroud.gov.uk/media/2324/level_2_sfra.pdf
3 Stroud District Council (2014) Strategic Flood Risk Assessment for Local Development Framework Level 2 – Addendum Report. Available at: https://www.stroud.gov.uk/media/2325/stroud_level_2_sfra.pdf
4 Ministry of Housing, Communities and Local Government (2014) Planning Practice Guidance: Strategic Flood Risk Assessment. Available at: https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment.

1.4 Context of the Level 2 assessment

A county-wide Level 1 SFRA was commissioned in 2007 by Gloucestershire County Council, in partnership with its Local Authorities including Stroud; the reports were published in 2008. Following this, a Level 2 SFRA was published in March 2012 for Stroud District alone to support the preparation of the Local Plan, adopted in November 2015, by assessing sites likely to be developed in flood risk areas. A subsequent Level 2 Addendum assessment was then carried out for Stroud District in 2014, to assess additional site options.

This Level 2 SFRA builds on the work undertaken in those previous studies, rather than completely replacing it, but is specific only to the district of Stroud. It involves the site-specific assessment for new site options required as part of the process of exploring the potential of non-strategic sites to accommodate growth in the emerging District Local Plan. All sites considered for allocation within the Emerging Local Plan have been screened for flood risk as part of this SFRA, of which several have been assessed in detail as part of the Level 2 SFRA. In addition, since the previous Level 2 SFRA and Addendums were published, there have been updates to national and local planning policy and guidance. This 2019 Level 2 SFRA provides updated information on the 2019 NPPF, the Shoreline Management Plan 2 (SMP2), surface water management and sustainable drainage systems (SuDS), guidance for site-specific FRAs and opportunities to manage flood risk to existing communities within the district of Stroud, due to the revisions to national and local planning policy and guidance.

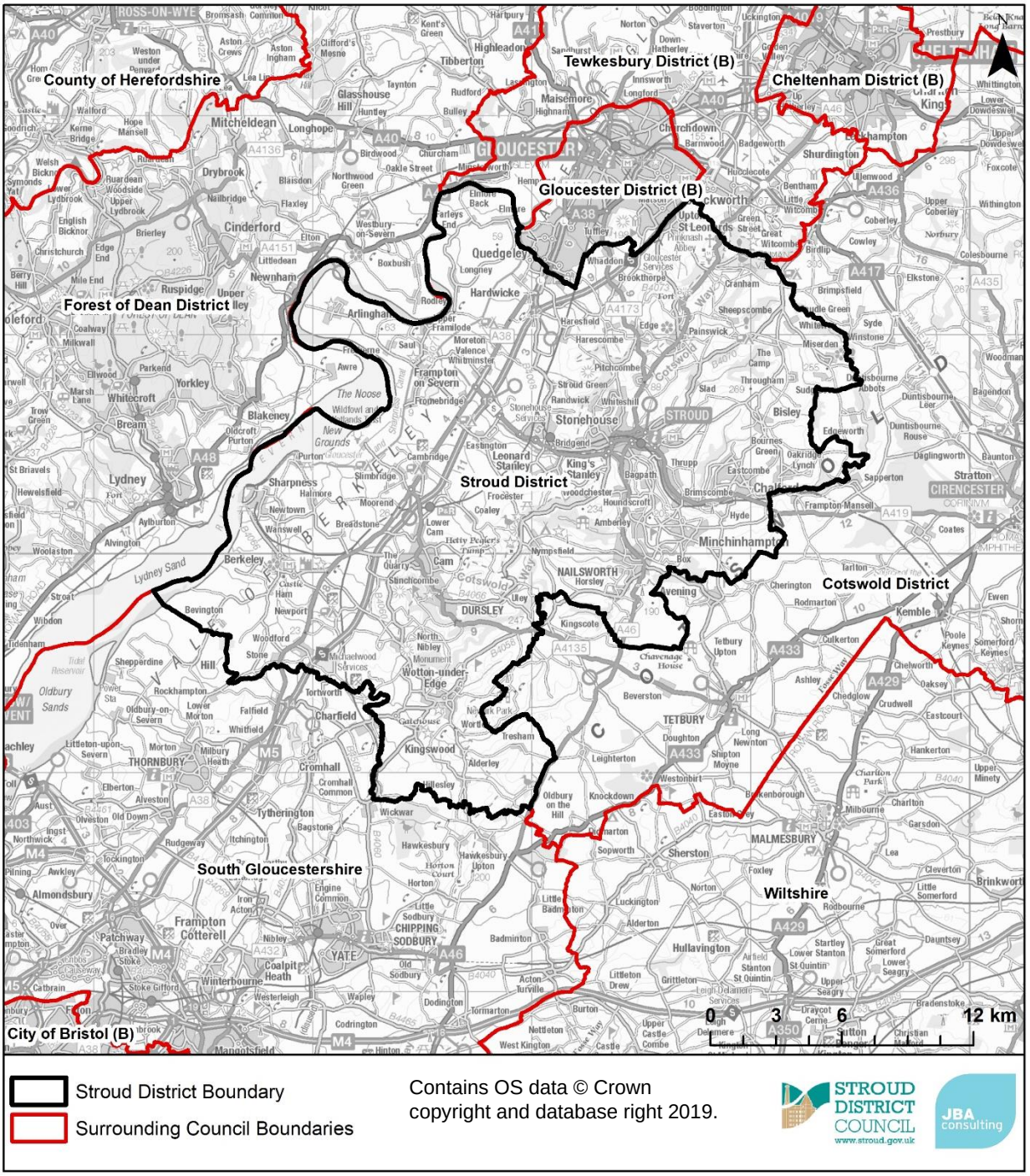
1.5 SFRA user guide

Table 1-1: SFRA 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.
3. The Sequential, risk-based approach	Describes the Sequential Approach and application of Sequential and Exception Tests.
4. Climate change	Outlines the latest EA guidance on climate change and how it has been adopted in this L2 SFRA.
5. FRA requirements and guidance for 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 LLFAs that should be followed.
6. Surface water management and SuDS	Advice on managing surface water run-off and flooding
7. Strategic Flood Risk Solutions	Information on potential flood risk solutions in the district, for example flood storage schemes, catchment restoration etc.
8. Sources of information used in preparing the L2 SFRA	Outlines what information has been used in the preparation of this Level 2 SFRA, e.g. technical datasets.
9. Screening of site options	Outlines the sites carried forward to a review of flood risk and an overview of the outputs from the flood risk screening process.
10. Level 2 Assessment Methodology	Outlines the sites taken forward to the L2, what is provided in the site summary tables and associated mapping, and the hydraulic modelling methodology.
11. Summary	Summary of SFRA findings
12. Recommendations	Summary of recommendations.

Section	Contents
Appendices A - N: Overview maps	District-scale maps of flood risk, flood history assessed in the L2 and mapping showing the flood risk to each individual site.
Appendix O: Screening of Potential Allocation Sites	A high level screening of flood risks to all sites received as part of the Local Plan process (regardless of their feasibility for allocation within the Local Plan), used to inform application of the Sequential Test.
Appendix P - Level 2 assessment - Site summary tables	Overview table of flood risk at each site assessed in the L2.
Appendix Q - Level 2 assessment – Site-specific mapping	Mapping showing the flood risk to each individual site.
Appendix R - Appendix Mapping Supporting Information	Further explanation of flood risk datasets used in Appendix maps.
Appendix S - SFRA guide to using technical data	Guide setting out how the data contained within the SFRA should be used to undertake the Sequential and Exception Tests.

Figure 1-1: Map of study area



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 that the potential risk of flooding is taken into account at every stage of the planning process. This section of the Level 2 SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities, given the changes since the previous SFRA publications. In preparing the subsequent sections of this SFRA, appropriate planning and policy have been acknowledged and taken into account.

SFRAs are linked to the preparation of Catchment Flood Management Plans (CFMP), Surface Water Management Plans (SWMP) and Water Cycle Studies (WCS) and contain information which should be referred to in formulating Local Plan policy and Local Flood Risk Management Strategies (LFRMS).

Figure 2-1 outlines the key strategic planning links for flood risk management and associated documents. It outlines how the Flood Risk Regulations and Flood and Water Management Act, in conjunction with the Localism Act 'duty to cooperate', introduce a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

A number of Risk Management Authorities operate in Stroud District. The key Risk Management Authorities, alongside their responsibilities, are summarised in Table 2-1.

2.1.1 Riparian ownership

A riparian owner is the person who owns the land on which, or adjacent to, a watercourse flows through. The law presumes, in the absence of any other evidence, that the land adjoining the watercourse includes the watercourse to its mid-point; therefore, there may be more than one riparian owner of a watercourse.

Anyone with a watercourse in or adjacent to their land has rights and responsibilities as a riparian owner. The Environment Agency, LLFA and other risk management authorities have permissive powers to work on watercourses under their jurisdiction, however, they are not required to do so.

Under land drainage law, watercourses cannot be obstructed, and the riparian owner must accept water flowing onto their land.

Riparian owners also have a role in risk management activities, for example by maintaining river beds and banks, controlling invasive species and allowing the flow of water to pass without obstruction. More information can be found in the Environment Agency publication 'Living on the Edge' (2012) and in Gloucestershire County Council's publication 'Waterside Living' (2014)[5].

5 Gloucestershire County Council (2014) Waterside Living. Available at: https://www.gloucestershire.gov.uk/media/16776/waterside-living-leaflet-web.pdf

Figure 2-1: Strategic planning links and key documents for flood risk

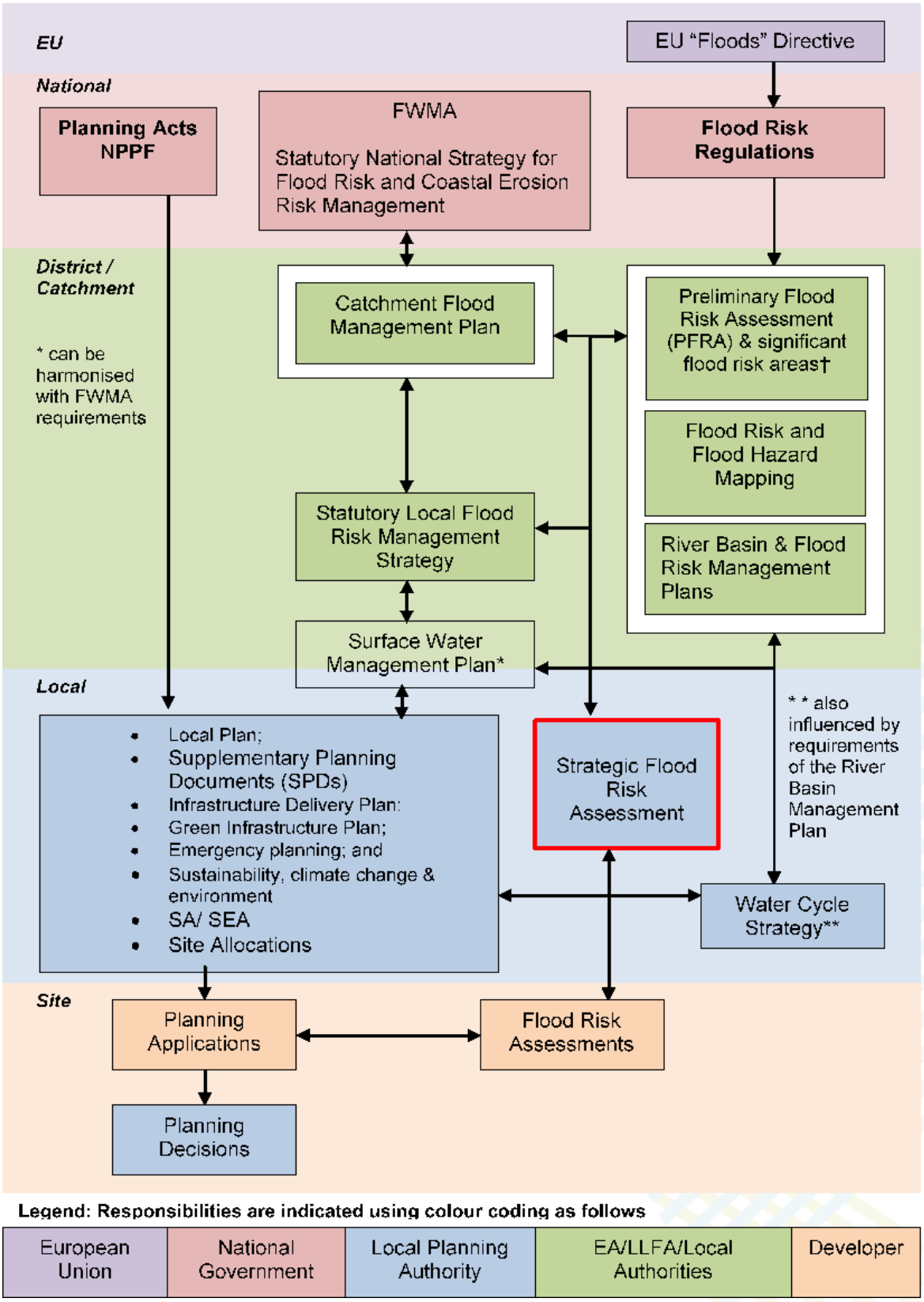


Table 2-1: Roles and responsibilities in Gloucestershire under FWMA 2010

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)*. • Managing flooding from Main Rivers and reservoirs and communication flood risk warnings to the public, media and partner organisations. • Identifying Significant Flood Risk Areas*. • Enforcement authority for Reservoirs Act 1975. • Managing Regional Flood and Coastal Committees (RFCCs) and supporting funding decisions, working with LLFAs and local communities. • Emergency planning and multi-agency flood plans, developed by local resilience forums. • Acting consistently with LFRMS in realising Flood Risk Management (FRM) activity and have due regard in the discharge of function of the strategy. • Designating authority of infrastructure with a significant impact on flood risk from surface water and groundwater.
Lead Local Flood Authority (Gloucestershire County Council)	Input to National Strategy Formulate and implement the Gloucestershire Local Flood Risk Management Strategy	• Power for enforcing and consenting works for ordinary watercourses. • Managing local sources of flooding from surface runoff and groundwater and carrying out practical works to manage flood risk from these sources where necessary. • Preparing and publishing a PFRA and identifying Flood Risk Areas. • Investigating certain incidents of flooding in the County in Section 19 Flood Investigations • Keeping asset registers of structures and features, which have a significant effect on local flood risk. • Acting consistently with LFRMS in realising FRM activity and have due regard in the discharge of other functions of the strategy. • Designating authority for Infrastructure with a significant impact on flood risk from surface runoff and groundwater.

Risk Management Authority (RMA)	Strategic Level	Operational Level
Lower Tier Authorities (Stroud District Council)	Input to National and Local Authority Plans and Strategy (e.g. Stroud District Local Plan – to develop a spatial strategy for growth within the district which accounts for flood risk)	• Powers to carry out works on ordinary watercourses to reduce flood risk. • Preparation of a Local Plan to guide development. • Acting consistently with LFRMS in realising FRM activity and have due regard in discharge of other functions. • 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.

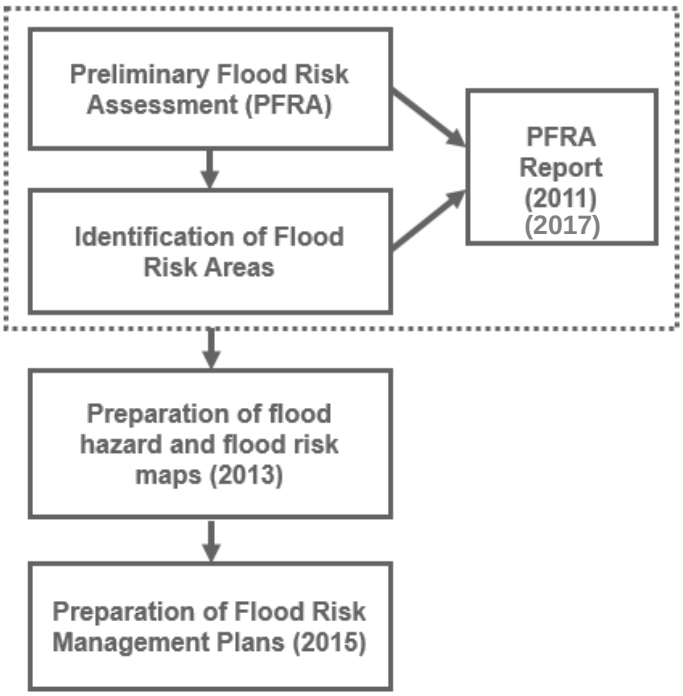
** Environment Agency exercised an exception permitted under the Regulations and devolved this power to the Lead Local Flood Authority.*

2.2 Flood Risk Regulations, 2009

The Flood Risk Regulations (2009) are intended to translate the current EU Floods Directive into UK law and place responsibility upon all LLFAs to manage localised flood risk. Under the Regulations, the responsibility for flooding from rivers, the sea and reservoirs lies with the Environment Agency; however, responsibility for local sources of flooding (from groundwater, surface water and ordinary watercourses) rests with LLFAs. The LLFA is Gloucestershire County Council.

Figure 2-2illustrates 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 Regulation Requirements



Under this action plan and in accordance with the Regulations, LLFAs have the task of assessing flood risk from local sources over a six-year cycle, beginning with the preparation of a Preliminary Flood Risk Assessment (PFRA) report. The next cycle of the Flood Risk Regulations has now begun (2015 – 2021).

2.2.1 Gloucestershire Preliminary Flood Risk Assessment, 2011

The PFRA covering Gloucestershire was published by the LLFA in 2011, and gives an overview of local flood risk in Gloucestershire based on a review of records of flooding and data derived from modelling of potential future flooding. It reports on significant past and future flooding from all sources except from Main Rivers and Reservoirs, which are covered by the Environment Agency, and sub-standard performance of the adopted sewer network (covered under the remit of Severn Trent Water and Wessex Water).

The PFRA is a high-level screening exercise and considers floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The Regulations require the LLFA to identify significant Flood Risk Areas, and therefore the PFRA identifies such areas and if they are considered to be nationally significant, as defined by Defra.

Based on this analysis, no areas were identified in Gloucestershire that meet the national criteria to be designated as Flood Risk Areas (clusters with a total of more than 30,000 people affected by local sources of flooding).

As part of the Flood Risk Regulations second planning cycle, an update to the Gloucestershire PFRA was provided in 2017 in the form of an addendum[6]. It identified no significant events which had changed the understanding of flood risk in the county since the 2011 PFRA. However, Cheltenham was identified as a potential Flood Risk Area due to surface water flood risks, which are being addressed with a planned flood alleviation scheme. No settlements in Stroud District were identified as Flood Risk Areas.

6 Gloucestershire County Council (2017) Preliminary flood risk assessment: Gloucestershire County Council – Addendum. Available at: https://www.gloucestershire.gov.uk/media/1519667/pfra-addendum-2017.pdf

2.2.2 River Basin Flood Risk Management Plans, 2016

Under the Flood Risk Regulations (2009), the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. As a result, it became a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP). The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans, in accordance with the Water Framework Directive.

Stroud District falls within the Severn River Basin District FRMP (March 2016). The FRMP explains the risk from flooding from all sources alongside how risk management authorities will work with communities to manage flood risk from 2015 to 2021. The FRMP draws on previous policies and actions identified in CFMPs and also incorporates information from Local Flood Risk Management Strategies (it should be noted that FRMPs do not supersede CFMPs). Each River Basin District is composed of a group of sub-areas or catchments. The FRMP summarises the flooding affecting each area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations.

Stroud lies within The Severn Vale sub-area of the FRMP, which extends from Dursley in the south to Great Malvern in the north. The following Environment Agency catchment measures for the Severn Vale apply specifically to Stroud District:

Preparing for risk:

- Work with communities along the Slad Brook to raise awareness of flood risk and produce flood plans;

Protecting from risk:

- Work with the communities to assess the feasibility of increasing the standard of protection of defences at Upper Framilode;
- Promote the use of rural SuDS in the Frome Catchment (Stroud Valleys);

Other measures:

- Reduce flood risk by working with the Stroud Water Canal restoration project.

2.3 Flood and Water Management Act, 2010

The Flood and Water Management Act (2010) (FWMA) aims to create a simpler and more effective means of managing both flood risk and coastal erosion and implements Sir Michael Pitt's recommendations following his review of the 2007 floods. The FWMA received Royal Assent in April 2010, and designated upper tier local authorities as LLFAs. Duties for Gloucestershire County Council as LLFA include:

- Develop, maintain and apply a Local Flood Risk Management Strategy for Gloucestershire under the Act, in consultation with local partners. This Strategy acts as the basis and discharge of duty for Flood Risk Management co-ordinated by Gloucestershire County Council, and outlines how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most
- When appropriate and necessary, investigate and report on flooding incidents, i.e. Section 19 reports (none reported in the district)
- 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
- When appropriate, 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
- When appropriate, perform consenting of works on ordinary watercourses

The FWMA also makes it clear that the LLFA has powers to manage flood risk from surface water and groundwater and has the lead responsibility for managing/ regulating flood risk from 'ordinary watercourses' (i.e. smaller ditches, brooks), unless there is an Internal Drainage Board (IDB) (e.g. Lower Severn IDB). The LLFA are the regulatory body for changes within ordinary watercourses, with responsibility for managing flood risk and actual

maintenance for ordinary watercourses (including development of bylaws) sitting with riparian owners, e.g. the district council, landowner, farmers etc. If a riparian owner wishes to alter a watercourse then consent from the LLFA is required, otherwise the LLFA has the power to take enforcement action. The Environment Agency are responsible for 'Main Rivers'.

The FWMA also updates the Reservoirs Act 1975 by reducing the capacity of reservoir regulation from 25,000m^3 to 10,000m^3. Phase 1 was implemented in 2013, requiring large, raised reservoirs to be registered to allow the Environment Agency to categorise whether they are 'high risk' or 'not high risk'.

2.3.1 Gloucestershire Local Flood Risk Management Strategy (LFRMS)

Gloucestershire County Council as a LLFA is responsible for developing, maintaining, applying and monitoring a Local Flood Risk Management Strategy for Gloucestershire[7]. The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management on a day to day basis. The Strategy also sets measures to manage local flood risk. The six key strategic objectives of the Strategy for managing flood risk include:

- Improving the understanding of local flood risk;
- put in place plans to manage identified flood risks;
- avoid inappropriate development and ensure new development does not increase flooding elsewhere;
- increase public awareness of flooding and encourage local communities to take action;
- ensure close partnership working and co-ordination with other risk management authorities in Gloucestershire, and;
- support the response to, and recovery from, flooding incidents.

As part of the LFRMS, Gloucestershire County Council maintains an Annual Implementation Plan, which quantifies the relative flood risks within each parish in the county, to aid the process of prioritising areas which flood alleviation schemes. The plan provides details of completed, ongoing and potential future flood alleviation works in the Stroud District parishes[8].

2.4 National Planning Policy Framework

The National Planning Policy Framework (NPPF)[9] was issued on 27 March 2012 and updated on 24 July 2018, with the latest revision published on 19 June 2019. The NPPF was updated as part of reforms 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 LPAs to assist in preparation of Local Plans, as well as for applicants preparing planning submissions.

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*".

7 Gloucestershire County Council (2014) Local Flood Risk Management Strategy. Available at: https://www.gloucestershire.gov.uk/your-community/emergencies-and-your-safety/flooding-and-drainage/gloucestershire-county-councils-local-flood-risk-management-strategy-lfrms/

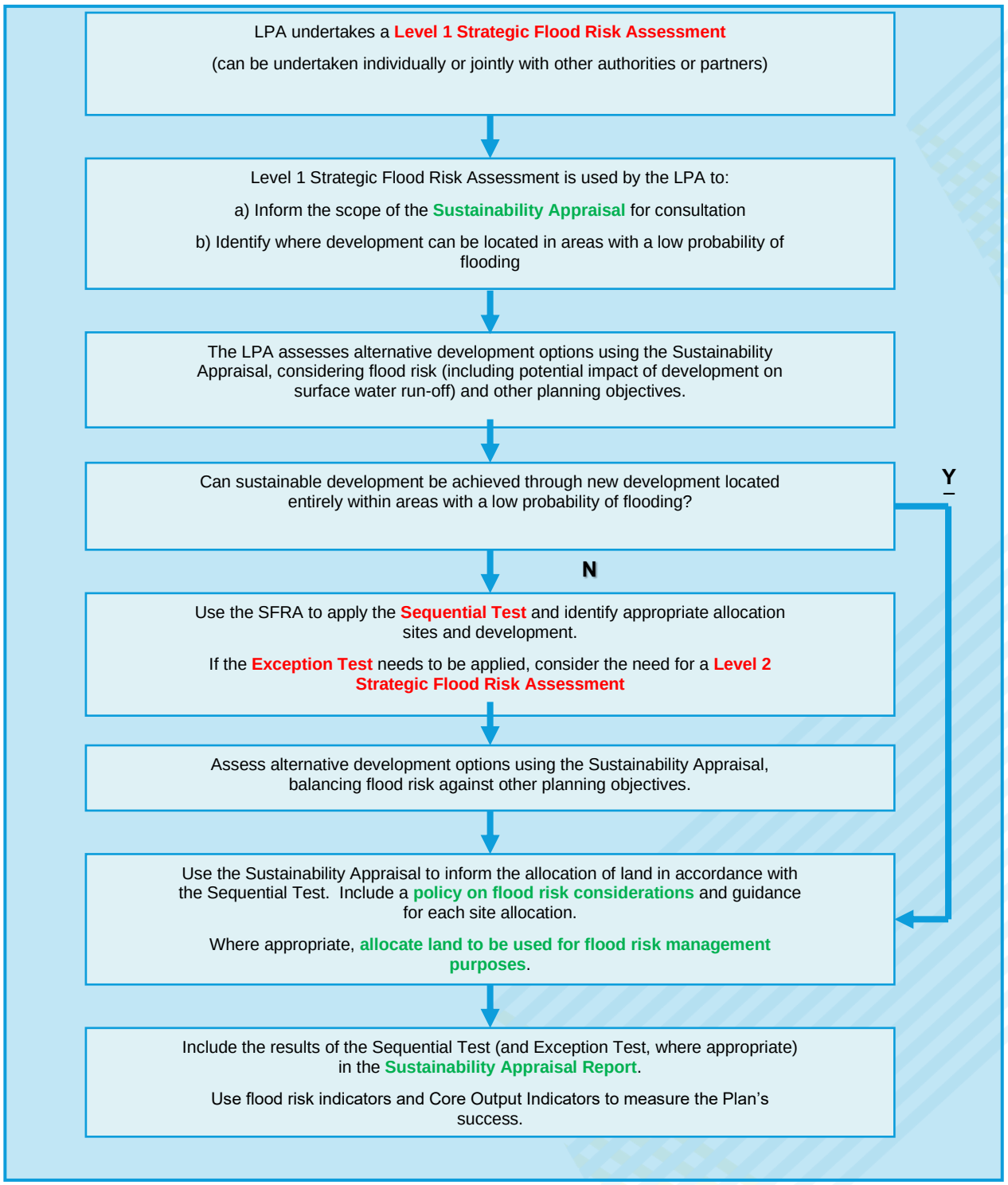
8 Gloucestershire County Council (2018) Local Flood Risk Management Strategy Annual Progress and Implementation Plan 2017/18. Available at: https://www.gloucestershire.gov.uk/your-community/emergencies-and-your-safety/flooding-and-drainage/gloucestershire-county-councils-local-flood-risk-management-strategy-lfrms/

9 Ministry for Housing, Communities and Local Government (2019) National Planning Policy Framework. Accessed online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

The web-based Planning Practice Guidance on Flood Risk and Coastal Change[10] (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 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 2-3 below.

10 Department for Communities and Local Government (2015) Planning Practice Guidance: Flood Risk and Coastal Change, Accessed online at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/.

Figure 2-3: Flood risk and the preparation of Local Plans



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

2.4.1 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[11]. Following public consultation on the draft revised NPPF between March and May 2018, the framework was published on 24 July 2018 and updated on 19 June 2019. 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:

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.

Requirements for sustainable drainage systems (Paragraph 165)

Major developments should incorporate SuDS, unless there is clear evidence that it would be inappropriate. Reinforces the need for maintenance arrangements and provision of multiple benefits.

2.5 Stroud District Local Plan

The planning policies applicable within Stroud District are contained within the Stroud Local Plan, comprised of the Strategy and Development Plan[12]. The plan was adopted in November 2015, and sets out the Council's framework for future development of the District up to 2031, in accordance with the National Planning Policy Framework.

As part of the Local Plan Review, the plan policies are currently being reviewed and revised where required, as a part of the five-year plan review cycle.

Once finalised and adopted, the revised Stroud District Local Plan will replace the 2015 Local Plan in outlining the policies and principles that will guide future development.

---

11 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.

12 Stroud District Council (2015) Stroud District Local Plan. Available at: https://www.stroud.gov.uk/environment/planning-and-building-control/planning-strategy/stroud-district-local-plan

2.6 Surface water flood risk and drainage

Since the production of the 2008 Level 1 SFRA, and 2012 – 2014 Level 2 SFRAs, there have been numerous documents published relating to surface water management and SuDS including:

- Gloucestershire SuDS Design and Maintenance Guide (2015)
- The SuDS Manual (C753), published in 2007, updated in 2015
- DEFRA Non-statutory technical standards for sustainable drainage systems, 201513
- LASOO Non-Statutory Technical Standards for Sustainable Drainage: Practice Guidance, 201614
- BS8582 Code of practice for surface water management for development sites15
- Institute of Civil Engineers (ICE) SuDS Route Maps: Guide to Effective Surface Water Management, 201816
- The House of Commons: Written Statement HCWS161 on Sustainable Drainage Systems, 2014
- The Building Regulations, 2010 (Part H: drainage and waste disposal)

The 2008 Level 1 SFRA provides recommendations on how SuDS can be used to manage surface water flood risk. However, this area of flood risk management has significantly progressed since 2008; there is now a national standard for sustainable drainage systems with supporting non-statutory technical standards, a code of practice for surface water management and local supplementary planning guidance published by Gloucestershire County Council on surface water drainage systems. Further information of SuDS is provided in Chapter 6.4.

2.6.1 The House of Commons: Written Statement on Sustainable Drainage Systems, 2014

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 for major development from 6 April 2015.

Major developments are defined as:

- residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and
- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of 1 hectare or more.
- When considering major planning applications, LPAs should consult the LLFA on the management of surface water in order to satisfy that:
- the proposed minimum standards of operation are appropriate
- there are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

---

13 Department for Environment, Food and Rural Affairs (2015) Non-statutory technical standards for sustainable drainage systems Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

14 Local Authority SuDS Officer Organisation (2016) Non-Statutory Technical Standards for Sustainable Drainage: Practice Guidance. Available at: https://www.susdrain.org/files/resources/other-guidance/lasoo_non_statutory_suds_technical_standards_guidance_2016_.pdf

15 British Standards Institution (2013) BS 8582: Code of practice for surface water management for development sites. Available at: https://shop.bsigroup.com/ProductDetail?pid=000000000030253266

16 ICE & ACO (2018) SuDS Route Maps: Guide to Effective Surface Water Management. Available at: https://www.ice.org.uk/getattachment/knowledge-and-resources/best-practice/sustainable-drainage-systems/ICE-ACO-SuDS-Route-Map-Booklet-Feb2018.pdf.aspx

In March 2015, the LLFA was made a statutory consultee which came into effect on 15 April 2015. As a result, Gloucestershire County Council is required to provide technical advice on surface water drainage strategies and designs put forward for new major developments[17].

2.6.2 Defra Non-Statutory Technical Standards for SuDS

On March 23 2015, the Department for Environment, Food and Rural Affairs (Defra) published the Non-Statutory Technical Standards for SuDS. The standards should be used in conjunction with the NPPF and NPPG. These standards cover the following aspects:

- Flood risk outside the development
- Peak flow control
- Volume control
- Flood risk within the development
- Structural integrity
- Designing for maintenance considerations
- Construction

2.6.3 C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015) replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high-level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development.

2.6.4 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. 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 in a particular area 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 covering Stroud.

[17] http://www.gloucestershire.gov.uk/planning-and-environment/flood-risk-management/surface-water-drainage-and-major-planning-applications/

2.7 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

There are six pre-defined national policies provided in the CFMP guidance and these are applied to specific locations through the identification of 'Sub-areas'. These policies are intended to cover the full range of long-term flood risk management options that can be applied to different locations in the catchment.

The study area is covered by the Severn Tidal Tributaries CFMP. Stroud falls within the sub-areas 2: Severn Vale, 3: Gloucester Streams, 4: Cotswolds, 5: Frome, and 6: Little Avon and Cam.

The preferred policies of the Environment Agency by Sub-area are as follows:

- Sub area 2: Severn Vale - Policy Option 3 – Areas of low to moderate flood risk where existing flood risk is generally being managed effectively.
- Sub area 3: Gloucester Streams – Policy Option 5 – Areas of moderate to high flood risk where further action can generally be taken to reduce flood risk.
- Sub area 4: Cotswolds – Policy Option 6 – Areas of low to moderate flood risk where action will be taken with others to store or manage runoff in locations which provide overall flood risk reduction or environmental benefits.
- Sub area 5: Frome – Policy Option 4 – Areas of low, moderate or high flood risk where flood risk is already being managed effectively, but where further actions may need to be taken, to keep pace with climate change.
- Sub area 6: Little Avon and Cam – Policy Option 3 – Areas of low to moderate flood risk where existing flood risk is generally being managed effectively.

2.8 Shoreline Management Plans

A Shoreline Management Plan is a non-statutory document which provides policy options for managing coastal erosion over the next 20, 50 and 100 years. SMPs are policy documents and do not detail specific coastal management schemes.

Stroud District is covered by the Severn Estuary Shoreline Management Plan (SMP), which was prepared by the Severn Estuary Coastal Group in 2010, and updated in 2017 within the Shoreline Management Plan Review (SMP2).

The Severn Estuary coastline is divided into 16 'Theme Areas', within which 66 sub-sections, or 'Policy Units', are defined. Each Policy Unit is assigned one of four policy options is recommended:

- No active intervention (NAI) - No investment in the construction of new defences, maintenance or upgrade of existing defences
- Hold the line (HTL) - Keeping the line of defence in approximately the same location as it is now. Existing defences are maintained, replaced or upgraded along their current alignment. This may or may not include upgrades to counter climate change and sea level rise
- Managed realignment (MR) - Landward retreat of defences, giving up some land to the sea to form a more sustainable defence in the long-term
- Advance the line (ATL) - Reclaim land from the sea by building new defences further seaward

Stroud District is located within two SMP2 Theme Areas: Sharpness to Gloucester and Severn Crossing to Sharpness. The policy options for each section of coast in Stroud District is summarised in Table 2-2.

Table 2-2: Severn Estuary SMP2 Policies covering Stroud District

Policy Unit	Location	Epoch		
		0 – 20 years (2025)	20 – 50 years (2050)	50 – 100 years (2115)
SHAR1	Elmore	HTL	MR	MR
SHAR2	Longney	HTL	MR	HTL
SHAR3	Upper Framilode	HTL	HTL	HTL
SHAR4	Arlingham	HTL	MR	MR
SHAR5	Not specified	NAI	NAI	NAI
SHAR6	Fretherne, Frampton-on-Severn	HTL	HTL	HTL
SHAR7	Slimbridge	MR	HTL	HTL
SHAR8	Purton, Sharpness	NAI	NAI	NAI
SEV1	Newton to Berkeley	HTL	HTL	HTL
SEV2	Not specified	HTL	HTL	HTL
SEV3	Clapton	HTL	HTL	HTL

2.9 Localism Act

The Localism Act outlines plans to shift and re-distribute the balance of decision making from central government back to councils, communities and individuals. The Localism Act was given Royal Assent on 15 November 2011.

In relation to the planning of sustainable development, provision 110 of the Act places a duty to cooperate on Local Authorities. This duty 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".

The Localism Act also provides new rights to allow local communities to come together and shape new developments by preparing Neighbourhood Plans. This means that local people can decide not only where new homes and businesses should go and but also what they should look like. As neighbourhoods draw up their proposals, Local Planning Authorities will be required to provide technical advice and support.

2.10 Neighbourhood Plans in Stroud District

In Stroud District, Neighbourhood Plans are guided by visions for eight parish cluster areas, developed as part of the Stroud District Local Plan, in consultation with communities. They are also guided by a set of Basic Conditions, set by Stroud District Council, which include ensuring preservation of listed buildings and maintaining or enhancing the character of conservation areas.

Once the neighbourhood plans have successfully undergone consultation and examination, they become part of the Stroud District Development Plan.

The following parishes and neighbourhoods in Stroud District are currently covered by 'made' (adopted) Neighbourhood Plans:

- Dursley (February 2019)
- Eastington (October 2016)
- Hardwicke (October 2017)
- Kingswood (May 2017)

- Minchinhampton (July 2019)
- Stonehouse (February 2018)
- Stroud Town Centre (October 2016)
- Whitehill and Ruscombe (October 2016)

2.11 Water Framework Directive

The EU Water Framework Directive (WFD) seeks to integrate and enhance the way in which water bodies are managed throughout Europe by the preservation, restoration and improvement of the water environment. In England, the Environment Agency is responsible for the delivery of the WFD objectives.

The WFD aims to achieve at least 'good' status for all water bodies; the default deadline for achieving this objective is by 2021 although, in some cases, where it is deemed more appropriate, less stringent objectives have been set with extended deadline of 2027 or beyond. The WFD requires the production of Management Plans for each River Basin District. These plans assess the pressures facing the water environment in each district. Each district is composed of a group of catchments termed river basins to which all water bodies are assigned.

Any adverse impacts can cause a waterbody's ecology to deteriorate and prevent environmental improvements from being undertaken. Nevertheless, in-channel works can also be beneficial if they can be designed to help achieve environmental improvements included in the RBMP, thus enhancing the water environment for plants and animals. Any activity which has the potential to have an impact on the ecology of a waterbody will need consideration in terms of whether it could cause deterioration in its Ecological Status or Potential.

2.11.1 Severn River Basin Management Plan (RBMP), 2015

The Severn River Basin Management Plan (2015) is prepared under the WFD and assesses the pressures facing the water environment in the Severn River Basin District. The 2009 version was updated in December 2015.

There are several challenges which can impact progress towards cleaning and protecting natural assets including:

- Physical modifications
- Pollution from waste water
- Pollution from towns, cities, transport and rural areas
- Changes to the natural flow and level of water; and,
- Negative effectives of invasive non-native species.

To achieve the environmental objectives set out by the WFD. The RBMP summarises the ongoing measures which seek to prevent the deterioration in status and improve the quality of the water environment.

Stroud District is located in the Severn Vale catchment of the Severn RBMP. The key aims for the catchment are reducing: diffuse rural pollution, diffuse urban pollution and physical modification (morphology and barriers to species migration).

The Frome and Cam catchments in Stroud District have been identified as priority areas for the Severn Vale catchment, with ongoing schemes including Stroud Rural SuDS and Bonds Mill, Stonehouse palaeo-channel restoration, already working to deliver the RBMP aims.

2.11.2 Green Infrastructure

Although not in itself a policy, Green Infrastructure (GI) is a recurring theme in planning policy. GI can be defined as a strategically planned and managed network of greenspaces and environmental components, which connect and surround the urban built environment and rural settings and consist of:

- open spaces – lakes, nature reserves, woodland, parks, wetlands, and formal gardens;

- connections/ linkages – greenways, canals and river corridors, pathways and cycle routes; and/or
- "urban green" networks – green roofs, private gardens, street trees and verges.

The identification and planning of GI is critical to sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. It is central to climate change action and is referred to frequently in the planning policy. Identifying and planning for GI is intrinsic to sustainable growth and therefore, merits investment and consideration as much as other socio-economic priorities.

A GI strategic framework for Gloucestershire, including Stroud District, was prepared in 2015[18]by Gloucestershire Local Nature Partnership. It defined a number of strategic principles for the County, including integration of GI within developments and wider projects such as flood alleviation schemes, embedding the principles within planning policy documents, and establishing a GI evidence base.

The 2015 GI Strategic Framework and the 2015 Gloucestershire SuDS Design and Maintenance Guide both emphasise the opportunities and wider benefits of integrating green infrastructure within SuDS design.

To support the Local Plan Review, and the provision of a wide range of green spaces for local people, Stroud District Council have prepared an Open Space and Green Infrastructure Study[19] as well as a Green Infrastructure, Sport and Recreation Study[20].

18 Gloucestershire Local Nature Partnership (2015) A strategic framework for green infrastructure in Gloucestershire 2015. Available at: https://www.stroud.gov.uk/media/558659/gi_framework_final_2015.pdf

19 Stroud District Council (2019) Stroud Open Space and Green Infrastructure Study. Available at: https://www.stroud.gov.uk/environment/planning-and-building-control/planning-strategy/evidence-base/environmental-evidence/green-infrastructure-sport-and-recreation-study/stroud-open-space-and-green-infrastructure-study-cluster-analysis

20 Stroud District Council (2019) Green Infrastructure, Sport and Recreation Study. Available at: https://www.stroud.gov.uk/environment/planning-and-building-control/planning-strategy/evidence-base/environmental-evidence/green-infrastructure-sport-and-recreation-study

3 The sequential, risk-based approach

3.1 Flood Zones

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 3, Defences, Areas Benefiting from Defences, and Flood Storage Areas. There is no distinction in the Flood Map for Planning between Flood Zone 3b, known as the Functional Floodplain and represented by a 1 in 20-year flood extent, and Flood Zone 3a, the 1 in 100-year flood extent. Further details of how Flood Zone 3b is defined are provided in Section 3.1.2.

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

Figure 3-1: Definition of Flood Zones

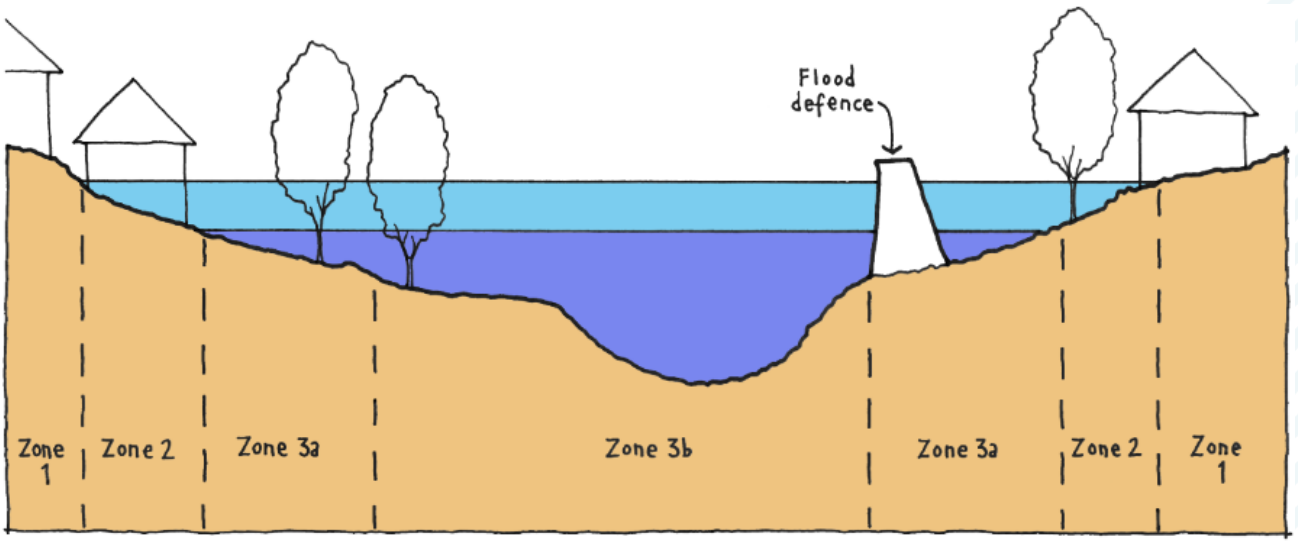


Table 3-1: National Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1,000 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 1Ha or above, flood risk assessments must consider the vulnerability[21] (see Table 5-3) to flooding from other sources (surface water, groundwater, ordinary watercourses and sewers), the potential to increase flood risk elsewhere, and the effect of new development on surface water runoff.
		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 1,000 annual probability of river flooding (0.1% - 1%) or, in coastal areas, between 1 in 200 and 1 in 1,000 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) are permitted in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test (see Section 3.3.2).
		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 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 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 (see Section 3.3.2).
		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.
		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.

21 Ministry of Housing, Communities & Local Government (2014) Table 2: Flood risk vulnerability classification. Planning Practice Guidance Paragraph 66, Reference ID: 7-066-20140306. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification

Zone	Probability	Description
		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.

The Flood Zones describe land that would flood from rivers or the sea if there were no defences present.

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, it is not provided for specific sites or for land where the catchment area of the watercourse falls below 3km². 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, where flood risk is an issue at a site and the Flood Map for Planning is based on generalised modelling, developers may be required to undertake their own detailed modelling.

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[22].

For planning purposes under the NPPF, a more detailed breakdown of risk within Flood Zone 3 is required as the flood map for planning does not define Flood Zone 3b. The SFRA is required to define Flood Zone 3b (also known as a Functional Floodplain), and also assess the impact of climate change on the 1 in 100-year flood event, using more detailed data from hydraulic models where available. This information is included in the detailed mapping which accompanies this report and has been used to assess all of the potential allocation sites provided by Stroud District Council.

3.1.1 Updating the Flood Zone Mapping

The Environment Agency's Flood Zones 2 and 3 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.

The Flood Zone 3b and the 1 in 100-year flood extent plus climate change provided by the SFRA will not be automatically updated. However, users should be aware that if Flood Zones 3 and 2 have changed, this is an indication that newly modelled information is also available which could be used to refine Flood Zone 3b and 3a plus climate change.

3.1.2 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 3 (1 in 100-year flood extent) represents the functional floodplain.

22 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

3.1.3 Climate Change (Flood Zone 3a (1 in 100-year) 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.

Updated government guidance on assessing the impact of climate change on flooding in line with the UKCP09 Climate Change Projections[23] was released in February 2016, and subsequently updated in July 2020[24]. 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. Further information on assessing the impact of climate change on flood risk is provided in Section 5.

For the purposes of strategic planning, the key epoch considered is 2070-2115 as this reflects the lifetime of residential 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 Severn river basin respectively, and 40% or 85% in the South West river basin).

In order to assess the impact of these climate change scenarios on the 1 in 100-year flood risk (Flood Zone 3a) at development sites, in accordance with the NPPF, the following hierarchy of modelling information has been used:

- Re-run of existing detailed models with the Higher Central and Upper End climate change flows scenarios.
- Flood Zone 2 as a proxy.

The source of climate change information and the impact on flood risk to the individual sites, is also noted on the summary sheets under 'Climate Change – Implications for the Site'.

It should be noted that Environment Agency guidance on climate change allowances is currently being revised in line with the UK Climate Change Projections 2018 (UKCP18), which provide the latest source of information on how the UK climate is predicted to change over the rest of this century.

The updated guidance is due to be released in 2021, and once available, should be incorporated within the SFRA. While awaiting issue of the latest guidance, the current Environment Agency 2016 guidance has been used within the SFRA.

3.2 The sequential, risk-based approach

The sequential, risk-based approach is designed to ensure areas with little or no risk of flooding (from any source) are developed 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 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 (which show the extent of inundation assuming that there are no defences) are too simplistic and a greater understanding of the scale and nature of the flood risks is required.

3.3 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 SFRAs to apply the Sequential and Exception Tests where necessary.

3.3.1 Sequential Test

23 UK Climate Projections (UKCP09), Met Office (2015), Accessed online at: http://ukclimateprojections.metoffice.gov.uk/21678
24 Climate change allowances, Environment Agency (2020) Accessed online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

The Sequential Test should be applied to the whole LPA area to increase the opportunities to allocate development in areas not at risk of flooding. The Planning Practice Guidance 'Applying the Sequential Test in the preparation of a Local Plan' describes the process.

Stroud District Council will carry out the Sequential Test for all sites that have come forward through the local plan process, taking into account all sources of flooding, and an appropriate allowance for climate change. The climate change allowances have been considered in the modelling of this study. The findings will be considered in balance with other criteria, outlined either within a Sequential Test document or as part of the Sustainability Appraisal process.

Figure 3-2: Applying the Sequential Test in the preparation of a Local Plan

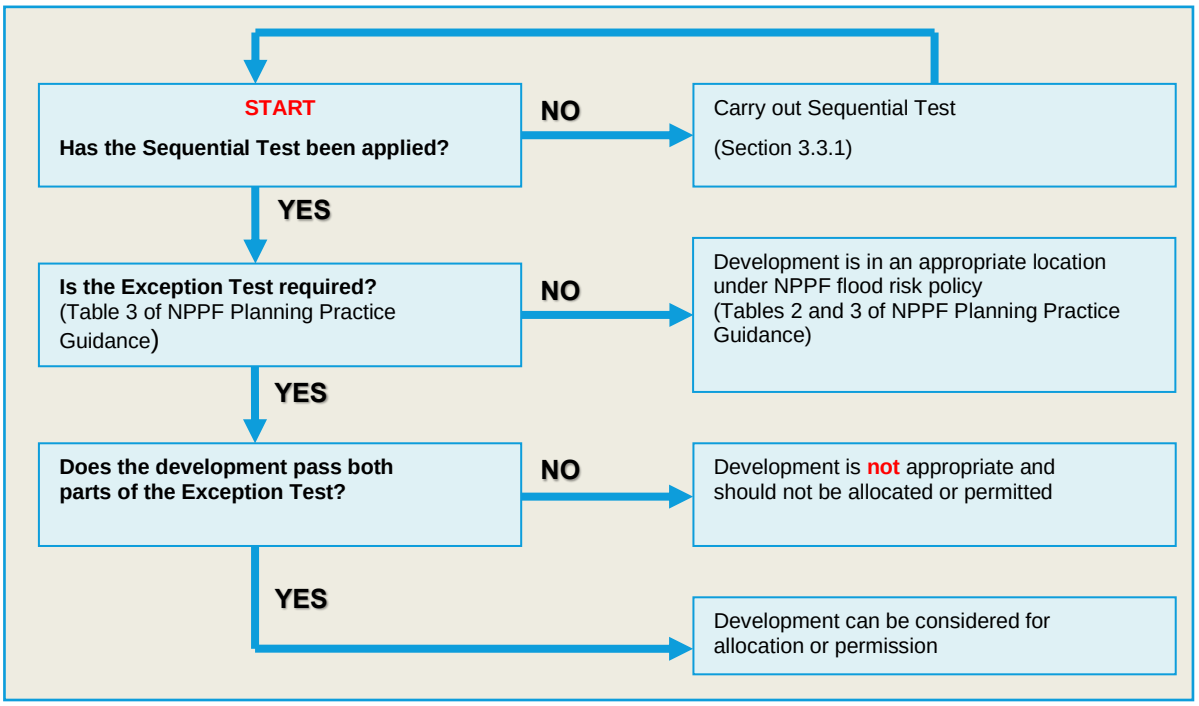
The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPF Planning Practice Guidance: Flood Risk and Coastal Change. The NPPF PPG describes how the Exception Test should be applied in the preparation of a Local Plan (Figure 3-2).

3.3.2 Exception Text

If, following an 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 required.

The guidance also explains how the Exception Test should be applied in the preparation of a Local Plan (Figure 3-3), as shown in Diagram 3 of the Planning Practice Guidance.

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



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

3.4.1 Sequential Test

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. A pragmatic approach should be taken when applying the Sequential Test.

Stroud District Council, with advice from the Environment Agency, are 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 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 (however the Exception Test may need to be reapplied[25]).
- 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 Zone 1 satisfy the requirements of the Sequential Test; however, consideration should be given to risks from all sources and areas with critical drainage problems.

3.4.2 Exception Text

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

25 Ministry of Housing, Communities & Local Government (2018) Planning and Flood Risk: Paragraph 162. National Planning Policy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf

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. LPAs 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 LPA 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.

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 FRA 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[3]:

- 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 PPG provide detailed information on how the Test can be applied.

3.5 Actual flood risk

If it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) in any year; and
- residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% (1 in 200-year chance of flooding) in any year*. **Note: there are tidal influences within the district, i.e. the River Severn*.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed.

- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change will erode the present-day standard of protection afforded by defences and so commitment is needed to invest in the maintenance and upgrade of defences if the present- day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where consideration is given to the mitigation of the consequences of flooding or where it is proposed to place lower vulnerability development in areas that are at risk from inundation.

3.6 Residual flood risk

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 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.
- 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.

Developers should include an assessment of the residual risk where developments are in areas benefitting from defences. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping. Any improvements to defences should ensure they are in keeping with wider catchment policy.

The breach modelling undertaken by the Environment Agency should be used as a starting point for breach modelling as part of detailed site-specific flood risk assessments. The assessments should identify rapid inundation zones, the speed of onset of flooding, the depth, hazard and extent of flood water.

Level 2 SFRAs are intended to help local authorities apply the Exception Test. A key element of the Exception Test is to consider whether the site will be safe for its lifetime. As part of the Level 2 summary tables, the actual and residual risk to the site, has been considered, alongside guidance for developers on site-specific Flood Risk Assessments.

The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future requires consideration as part of the risk based sequential approach and this should inform conclusions as to whether possible site options for development are appropriate and sustainable. In addition, detailed 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.

4 Understanding Flood Risk in Stroud

4.1 Flood History

Over recent years, Stroud has experienced several notable flood events. These are mapped on the Environment Agency's historic flood outlines map and includes the January 1939, March 1947, July 1968, December 1981, January 1990, December 2000 and summer 2007 events.

The key flood events in the district are summarised in Table 4-2.

Table 4-1: Summary of flood history in Stroud District

Flood Event	Watercourse	Description of Affected Watercourses and Areas
January 1939	River Severn	Flooding occurred on rural floodplain near the district boundary with Tewkesbury. No flooded properties.
March 1947	River Severn	Flooding occurred in predominantly rural locations throughout the northern extent of the district. Elmore Back Farm, Severn Bank Farm and Weir Green Farm recorded flooding.
July 1968	Various	Several isolated areas throughout the district were affected by several watercourses including the River Severn, Stroud Water Canal, River Frome, River Cam and Wickster's Brook, River Ewelme, and the Little Avon. These affected many towns and villages including Stroud, Dursely, Cam, Berkeley and Saul.
December 1981	River Severn	Extensive flooding of rural floodplains in the west of the district.
January 1990	Dimore Brook	A small area of flooding occurred around the Dimore Brook confluence with the River Severn.
December 2000	River Severn	Rural floodplain at Elmore was flooded, in the northern part of the district.
July 2007	River Frome	Flooding of rural floodplain occurred where the Frome passes below the Gloucester and Sharpness Canal. Further upstream, flooding of towns occurred including Stonehouse and Stroud. This included the flooding of many roads such as the A419, A38 and several other roads within the affected towns.
November 2012	Little Avon	Flooding of rural floodplain, due to channel exceedance, along the Little Avon stretching from the confluence with the River Severn through Oakhunger, Berkley and Woodford. Also caused flooding on several roads including A38 and other minor roads. Two further localised flood incidents occurred near Alderley (also due to channel exceedance).

The River Severn has an extensive history of severe flooding which dates back to Roman times. Following the flooding of December 1981, Severn Trent Water commissioned the development of a series of embankments and flood walls along the estuary. This has resulted in a significant reduction in the frequency and severity of flooding. Some of the embankments have deteriorated (as shown in Table 4-3) and so the original standard of protection may have declined, resulting in a reduction in defended area.

4.1.1 July 2007

The summer 2007 floods are the most recent severe floods that have affected Stroud District. This flood event occurred as a result of exceptionally high rainfall resulting in high flows along many river systems. The intense and prolonged storm events rapidly overwhelmed the drainage systems. Extensive flooding occurred along the River Frome affecting large areas of rural floodplain and large towns including Stonehouse and Stroud. Numerous properties and businesses were damaged as a result of the flood waters. Flooding also affected many roads (including the major roads A419 and A38) leading to large disruption across the district.

4.1.2 November 2012

In 2012, heavy rain led to much of Gloucestershire being affected by flooding. Stroud District was also affected by the flood event however the flooded areas were relatively localised. The largest area of flooding occurred along the Little Avon which affected mainly rural floodplain as well as some towns.

4.2 Fluvial Flood Risk

The fluvial risk within the Stroud District is high, due to the presence of numerous watercourses, many with steep catchments which respond rapidly to rainfall. A map showing the watercourses can be found in Appendix B.

The flood risk associated with each of these watercourses is summarised briefly in the below sections. A comprehensive overview of each catchment can be found in the 2008 Level 1 SFRA[26].

4.2.1 River Severn

The River Severn forms the western boundary of Stroud, separating the district from the Forest of Dean. The Severn is tidally influenced, and flood events can result from a combination of fluvial and tidal sources. Notable events associated directly with the River Severn include July 1968 and December 1981. As detailed below, the River Severn is the discharge point for multiple rivers which flow through Stroud. Consequently, the Severn can result in flooding of these watercourses when high flows reduce discharge capacity. Similarly, tide-locking occurs during period of high tide which can also result in the backing-up of water along the tributaries.

Within Stroud, the majority of the River Severn is lined with flood defences in the form of embankments. The defences present provide varying levels of protection, however, provide large areas with flood protection (shown in Appendix H).

4.2.2 River Frome

The River Frome enters Stroud District in the east (near Chalford), flowing in a north-westerly direction. The steep and narrow Frome catchment can cause severe flooding during storm events. As the channel is realigned and higher than the valley floor in sections, flood waters can travel a significant distance from the channel, to follow the natural topography of the valley floor.

The Frome has a long history of fluvial and tidal flood risk with notable flood events occurring in November 1875, October 1882, December 1965, December 1992, October 2000, January 2003 and summer 2007. These flood events have affected settlements along the course of the river from Chalford in the east, to Saul in the north west. Flooding is exacerbated by frequent debris blockages on the River Frome, at Stroud, Chalford and Nailsworth, which often occur at historical structures, such as weirs and culverts, as well as on bypass channels, during periods of high flow.

In the downstream reaches of the River Frome, tide-locking is a common mechanism of flooding. This occurs when a fluvial flood event coincides with high tide on the River Severn. As the watercourse is unable to discharge into the Severn, water backs up along the River Frome, causing flooding. To alleviate the impact of tide-locking at Upper Framilode, the tidal flapped outfall of the River Frome is closed for 1.5 hrs during high tides, causing the backing

26 Gloucestershire County Council (2008) Stroud District Council Strategic Flood Risk Assessment for Local Development Framework. Available at: https://www.gloucestershire.gov.uk/media/8040/stroud_district_council_level_1_sfra_final-28385.pdf

up of flood waters towards Saul, which is diverted into the flood storage area in Upper Framilode.

4.2.3 Nailsworth Stream

Nailsworth Stream flows northwards from the town of Nailsworth and joins the River Frome downstream of Stroud, near Dudbridge. Culverted in many sections as it passes through towns, the areas at greatest risk of flooding from the Nailsworth Stream are Theescombe, Woodchester and Dudbridge.

4.2.4 Little Avon

Several flood events have affected the Little Avon, which enters the district near Totworth and discharges into the River Severn via the Berkeley Pill. These occurred in 1968, 1999 (January, May and June), 2000 and 2012, with Wotton-under-Edge commonly affected, as well as the towns of Stone and Berkeley.

4.2.5 The Berkeley Pill

This watercourse provides the outfall for the Little Avon into the River Severn. During high tides on the Severn, tide-locking occurs along the channel, resulting in flooding in Berkeley which can extend into Charfield and Woodford. Flooding along the Berkeley Pill also occurs as a direct result of flood waters from the Little Avon, Dovete Brook and Lynch Brook, often when these watercourses are tide-locked.

4.2.6 River Cam and Wickster's Brook

The steeply embanked River Cam and its smaller tributary, Wickster's Brook, discharge into the Gloucester and Sharpness Canal under normal flow conditions. However, during a flood event, a siphon drains flood waters below the canal. The watercourse is largely separate to the Internal Drainage Board (IDB) drainage network, with only two noted interactions; at the sluices on Wickster's Brook, and at a ditch near Newhouse Farm. Flood events have been recorded on the River Cam and Wickster's Brook in June 1966 and August 1972. A flood storage area was constructed between the River Cam and Wickster's Brook in the 1970s, to protect the Gloucester and Sharpness Canal from flooding.

4.2.7 Dimore Brook

Dimore Brook closely follows the boundary with the Tewkesbury Borough, before forming a confluence with the River Severn. Here tidal-locking can cause flooding issues, with flows backing up to RAF Quedgeley. There is further flood risk associated with the siphon and trash screens on the brook, where the watercourse passes below the canal, as blockage can result in the accumulation of flows and out-of-bank flood waters. There are no recorded flood events within Stroud District associated with Dimore Brook, however it should be noted that there are a number of flood risks associated with the watercourse.

4.2.8 Daniel's Brook

Daniel's Brook is located in the north of Stroud District and flows in a north-westerly direction, before joining the Gloucester and Sharpness Canal in Gloucester. Running parallel with the river, from Thoresbury Avenue to Tuffley Lane, is a flood relief channel. Flooding events associated with Daniel's Brook occurred in July 2007 and December 2008. The areas affected in both events are located on the right bank of the watercourse. The cause of the 2008 event is unknown; however the 2007 event is believed to have occurred due to overtopping of the brook, exacerbated by non-fluvial sources of flooding, including surface water drainage.

4.3 Groundwater Flood Risk

Groundwater flood risk in Stroud District is concentrated in two areas. The permeable Great Oolite formation limestone in the east of the district has the potential to store and transmit large volumes of groundwater, providing a regional-scale water supply. Towards the west and south of the district, the bedrock geology transitions to Lias Group mudstone, which is a secondary aquifer with limited potential for the below ground storage of water.

There are also large areas of superficial deposits throughout the district including alluvium, river terrace deposits and landslip deposits. Although the mudstone geology is relative impermeable, where it is overlain by more permeable sand and gravel deposits, there is the potential for water to be absorbed and transmitted close to the ground surface, which can form a perched water table. This is reflected by the presence of surface aquifers in these deposits.

The areas of highest groundwater flood risk within the district broadly correspond with the locations of permeable superficial geology deposits, and surface aquifers.

Groundwater flooding has been recorded across the Stroud District by Gloucestershire County Council in Kingswood (January 2004, two other events on unknown dates), Little Haresfield (December 2017), Standish (March 2018), Whitminster (date unknown) and Stroud (date unknown). Comparing these locations with the underlying geology, there is a correlation between the recorded events and areas identified at higher flood risk in the Environment Agency Areas Susceptible to Groundwater Flooding dataset (shown in Appendix K).

4.4 Tidal Flood Risk

Tidal flooding is associated with the occurrence of high tides, tidal surges and the overtopping of defences by waves. The River Severn is subject to tidal surges, where the estuary's funnel shape acts to propagate flood waters upstream. However, the most significant tidal flood risk issue in Stroud District occurs at high tide as a result of the 'locking' of watercourses from discharging into the River Severn, and the associated backing-up of flood waters along watercourses. The flood mechanisms and risks have been discussed, with relation to specific watercourses, above in Section 4.1.

A large section of the estuary coastline in Stroud District is defended against tidal flooding from the River Severn, with details provided in Section 4.8.

4.5 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 and usually occurs in lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems can be linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding. This can be made worse by local insufficient drainage capacity. Where discharge is directly to a watercourse, locally high-water levels can cause backing-up and flooding to take place.

The highest surface water flood risk in Stroud District is associated with the steep river catchments of The Cam and River Frome. The steep topography results in a naturally flashy response to rainfall, whereby water runs rapidly off the ground as surface water runoff. In the lower reaches, where the topography becomes very flat and low-lying, and the geology is a more impermeable clay, water can easily pool, forming large areas of surface water ponding. The water table also lies close to the ground surface in areas alongside the River Severn, and any further rainfall on the saturated ground can lead to the formation standing water. In urban areas, rainfall is restricted from infiltrating naturally into the ground surface, so forms overland flow paths, or areas of ponding on flatter topography.

Analysis of the Risk of Flooding from Surface Water mapping (Appendix J) shows that surface water flow paths throughout Stroud District typically follow the natural topography of river valley sides, reflecting the steep and flashy nature of the river catchments. In the south-west of the district, where the topography becomes flatter, large areas of surface water ponding form during all return periods. Surface water accumulation and ponding is substantial around the towns of Arlington, Berkeley, Sharpness and Slimbridge during the 1 in 30-year rainfall event and greater return periods.

The recorded surface water flooding history correlates with the modelled surface water flood risk. Of the surface water flooding incidents reported by Gloucestershire County Council, the majority occurred in July 2007, a further seven occurred in November 2012 and one occurred in 2018. Many of the incidents occurred in the south-western area of Stroud District, which is

susceptible to large areas of surface water ponding, and the internal flooding of properties. The other incidents were recorded in King's Stanley, Chalford and Cranham.

4.6 Canals

Canals do not generally pose a direct flood risk as they are a regulated waterbody. However, there is a residual risk from canals associated with lower probability events such as overtopping and embankment failure (breach and sudden escape of the water retained in the canal channel).

The level of water in canals is controlled by the level and size of weirs. When surface water enters a canal, the level of water rises. The water level may then reach a point in which it discharges from the canal through control structures such as weirs. If the capacity of these control structures is exceeded, or should they become blocked, overtopping may occur.

Flooding from a breach of a canal embankment is largely dictated by canal and ground levels, canal embankment construction, breach characteristics and the volume of water within the canal that can discharge into the lower lying areas behind the embankment. Although there is no specific flood risk mapping for canals, an assumption can be made that where canals have raised embankments, there is a potential hazard of flooding to downslope areas.

Within the district, there are three canals; the Gloucester and Sharpness Canal, the Thames and Severn Canal and the Stroudwater Canal.

4.6.1 Gloucester and Sharpness Canal

The Gloucester and Sharpness Canal is found in the north-western area of the district. The raised canal embankments act as an informal line of defence. Many watercourses discharge into, and interact with, the canal and consequently, flooding of the canal has the potential to cause waters to back up, causing flooding further upstream.

For the River Cam and Wickster's Brook, a series of flood defences have been constructed whereby the watercourse discharges into the canal (detailed in Section 4.2.6). Along the canal, several overtopping and breach events have occurred, in particular during 2007 and 2008. The flood events are clustered along four locations along the canal: near Parkend, between Upper Framilode and Whitminster (where the River Frome passes below the canal), near Slimbridge, and in the north along the district border near Quedgeley. All of these flood events have occurred as a result of high-water levels in the canal and heavy rainfall.

4.6.2 Stroudwater Canal

The Stroudwater Canal flows from east to west through the centre of the district. Upstream of Thrupp, the canal is known as the Thames and Severn Canal. From Chalford in the east, the canal flows through the towns of Thrupp, Stroud and Stonehouse before discharging into the River Severn at Upper Framilode. The canal has complex interactions with the River Frome along much of its extent, which requires consideration when analysing the flood risk to individual site developments. Four flood incidents were recorded along the canal at Stonehouse in July 2007. Three of the incidents occurred as a result of a storm event, however one incident is reported to have occurred as a result of weed growth blocking flows.

4.6.3 Cotswold Canal

The Cotswold Canal is currently undergoing restoration, with the restored canal linking the River Thames and the River Severn. The canal is also the focus of restoration plans and policies within the Stroud Local Plan[27]. Within the Stroud District, the canal will follow a route between the Sapperton Tunnel in the east, and the Saul Junction in the west, where it will discharge into the River Severn. The canal is proposed to pass through several towns and villages (including Sapperton, Stroud and Brimscombe), which will pose a residual flood risk to existing property along the canal route. The potential flood risk should be considered as the restoration

27 Stroud District Local Plan. Stroud District Council. (2015). Accessed online at: https://www.stroud.gov.uk/media/1455/stroud-district-local-plan_november-2015_low-res_for-web.pdf. Accessed on: 31/01/2019.

progresses, and developments should also consider and assess the future presence of the canal.

4.7 Reservoirs

Flooding from reservoirs occurs following partial or complete failure of the control structure designed to retain water in the artificial storage area. 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.

There are six major reservoirs in or affecting Stroud District, which measure 25,000m^3 or greater in volume, and are therefore included within the Environment Agency Reservoir Flood Map. These are:

- Witcombe (No 1, 2 and 3)
- Middle Pond, Woodchester
- Parkmill Pond, Woodchester
- Churchdown No 5
- Saintbridge Balancing Pond
- Purton (No 1 and 2)
- Oldbury Power Station
- Kennet Pond, Woodchester
- Cam and Wickster's Brook FSA
- Tortworth Lake
- Horsbere Brook FAS

The one incident of internal property flooding related to impounded water bodies in the district is recorded in Frampton-on-Severn in June 2014. The mechanism of flooding was suspected to be due to overtopping of large lakes to the east of the town. This highlights the need to consider the flood risk from other waterbodies, not defined as 'reservoirs'.

Any development immediately downstream of a reservoir or impounded waterbody should be avoided where possible, and a Level 2 SFRA is required if the development is deemed as necessary.

4.8 Flood Defences in Stroud

There are numerous formal flood defences across Stroud District, which provide varying levels of protection. Table 4-3 shows a number of these and focuses upon those which are associated with 'area benefitting from defences'. This area is focused along the left bank of the Severn estuary and is associated with the fluvial/tidal defences present. For other flood defences across the district, refer to the previously completed 2008 Level 1 SFRA for Stroud District[28].

Along the River Severn estuary, lines of embankments defend large coastal stretches. These provide varying levels of protection (discussed in Section 4.2.1), however overall mitigate the risk of tidal flooding occurring. The areas defined by the Environment Agency as benefitting from defences are classified on the assumption of the defences providing protection during a 0.5% AEP event. Consequently, there are areas along the estuary which appear undefended despite the presence of embankments. Areas which are defenced include Upper Framilode, Saul, Frampton on Severn, New Grounds, and parts of Oakhunger and Bevington. However, the areas which are shown to be undefended include Elmore Back, Epney, Arlingham, Berkeley and several other villages. These areas may have defences along the associated stretch of coastline, however the standard of protection (SoP) is not sufficient to protect against a 200-year (0.5% AEP) event.

28 Strategic Flood Risk Assessment for Local Development Framework Level 1. Stroud District Council. (2008). Accessed online at: file:///N:/2018/Projects/2018s1377%20-%20Stroud%20District%20Council%20-%20Stroud%20L2%20SFRA/Data%20Management/Incoming%20Data/Client/Documents/stroud_district_council_level_1_sfra_final-28385.pdf/.

Elsewhere, naturally higher ground, such as raised channel banks and railway embankments, provide more informal flood defences. These have been removed from the overview of defences, as they are not designated flood defence assets. Appendix H shows the location of formal flood defences in Stroud District and the areas defined as benefitting from defence.

4.9 Defence condition

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 for condition assessment is provided in Table 4-2. This detail, in addition to descriptions and standard of protection for each, were provided by the Environment Agency for the purpose of preparing this SFRA.

Table 4-2: 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 flood defences and whether they will continue to be maintained and/or improved in the future requires consideration as part of the risk based sequential approach and this should inform conclusions as to whether possible site options for development are appropriate and sustainable. In addition, detailed 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.

The major defences in Stroud District are generally 'Good' or 'Fair' in condition, with some defects which could affect asset performance. Therefore, there are opportunities for future development which would benefit from flood defences to contribute funds to the improvement of these assets.

A review of key defences across the study area, their condition and standard of protection is included in the following sections.

Table 4-3: Flood Defences in Stroud

Defence	Location	NGR		Standard of Protection	Defence Type	Areas benefitting from defence	Current condition
		Upstream	Downstream				
Earth embankment on left bank	Nupdown	ST 6410 9826	ST 6410 9826	1 in 200-years	Coastal/estuary – River Severn	Bevington Rockhampton Upper Hill	2 – Good
Earth embankment on left bank	Nr. Bull Rock	ST 66324 99998	ST 65884 99702	1 in 200-years	Coastal/estuary – River Severn	Hamfield Oakhunger	2 – Good
Earth embankment on left bank	North of Hamfield Farm	ST 66670 99892	ST 66329 99998	1 in 100-years	Coastal/estuary – River Severn	Oakhunger	3 – Fair
Earth embankment on left bank	Oakhunger to Sharpess	SO 66723 01946	ST 66670 99892	1 in 100-years	Coastal/estuary – River Severn	Oakhunger Sharpness	2 – Good
Earth embankment on left bank	The Gloucester and Sharpness Canal (New Grounds)	SO 74366 07955	SO 71961 05478	1 in 100-years	Tidal/Fluvial	New Grounds The Moors	2 – Good
Flood Storage Area between River Cam and Wickster's Brook	Cambridge	SO 74774 04611 (Centroid)	SO 74774 04611 (Centroid)	Assumed 1 in 20-years	FSA	New Grounds The Moors	Not Applicable
Earth embankment on left bank	Arlingham	SO 72460 11373	SO 72235 09375	1 in 100-years	Tidal/Fluvial	Saul Frampton on Severn	2 – Good
Concrete Flood Wall	Epney	SO 76101 11007	SO 75863 10755	1 in 100-years	Tidal/Fluvial	Not specified	3 – Fair
Concrete Flood Wall	Upper Framilode	SO 75058 10490	SO 74969 10438	1 in 100-years	Tidal/Fluvial	Upper Framilode Saul	3 – Fair
Concrete Flood Wall	Upper Framilode	SO 74640 10405	SO 74525 10445	1 in 100-years	Tidal/Fluvial	Springfield Saul	2 – Good

5 Climate change

5.1 Climate Change Guidance

The Environment Agency published climate change guidance[29] on 19 February 2016, which was subsequently updated on 22 July 2020 and must be considered in all new developments and planning applications.

Environment Agency guidance on climate change allowances is currently being updated, in order to account for the latest climate projections for the UK (UKCP18). While awaiting its issue, the current 2016 guidance has been applied within the SFRA, as it is the best available guidance at the time of writing.

The Environment Agency can give a free preliminary opinion on fluvial and tidal flood risk to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice. The LLFA should be contacted for advice on flood risk from local watercourses, surface, or groundwater.

5.2 Peak River Flows

The peak river flow allowances show the anticipated changes to peak flow by river basin District which the subject watercourse resides. Once this is determined, guidance on uplift in peak flows are assigned for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th percentiles, respectively. The allowance category to be used is based on the vulnerability classification of the development and the flood zones within which it resides.

These allowances (increases) are provided for three climate change 'epochs':

- Total potential change anticipated for '2020s' (2015 to 2039)
- Total potential change anticipated for '2050s' (2040 to 2069)
- Total potential change anticipated for '2080s' (2070 to 2115)

One or two of the percentiles are provided for each combination of vulnerability and flood zone, which in the latter case provides a 'range' of allowances. The allowances for the Severn River Basin District are provided in Table 4-1, with the allowances for the South West River Basin provided in Table 5-2.

Table 5-1: Peak river flow allowances for the Severn River Basin District

Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
High ++	25%	45%	90%
Upper end	25%	40%	70%
Higher central	15%	25%	35%
Central	10%	20%	25%

29 Environment Agency (2020) Flood risk assessments: climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Table 5-2: Peak river flow allowances for the South West River Basin District

Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper end	25%	40%	85%
Higher central	20%	30%	40%
Central	10%	20%	30%

5.2.1 High++ allowances

A high impact climate change scenario (known as High++ or H++) can be applied in assessments for developments that are very sensitive to flood risk and that have lifetimes beyond the end of the century. This scenario is recommended to be considered for development of nationally significant infrastructure projects, new settlements or significant urban extensions. It provides a 'sensitivity test' for large-scale climate change expected to occur over the lifetime of the development. Further information is provided in the Environment Agency climate change guidance and the publication, Flood Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities[30].

5.2.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification (Table 5-3) should be considered when deciding which allowances apply to the development or the plan. The guidance states the following:

Flood Zone 2

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	✓
Highly vulnerable		✓	✓
More vulnerable	✓	✓	
Less vulnerable	✓		
Water compatible	None		

[30] Environment Agency (2016) Adapting to climate change: guidance for risk management authorities. Available at: https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities

Flood Zone 3a

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable		✓	✓
Less vulnerable	✓	✓	
Water compatible	✓		

Flood Zone 3b

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

Table 5-3: Flood risk vulnerability classifications of development and land uses

Flood risk vulnerability classification	Examples of development and land uses
Essential infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk; • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly vulnerable development	• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').
More vulnerable development	• Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less vulnerable development	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.

Flood risk vulnerability classification	Examples of development and land uses
	• Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
Water-compatible development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Source: Table 2: Flood risk vulnerability classification, Paragraph 66, PPG.

5.3 Peak rainfall intensity allowance

Increased rainfall affects river levels and land and urban drainage systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments.

For FRAs, both the central and upper end allowances should be assessed to understand the range of impact.

Table 5-4: Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Gloucestershire County Council set out how they, as LLFA, expect climate change allowances to be used in FRAs and drainage strategies in their Surface Water Guidance document. However, it should be noted that the allowances provided in the guidance pre-date the Environment Agency 2020 climate change allowances, and the most up-to-date guidance should always be used.

5.4 Sea level allowances

As the majority of watercourses in Stroud District flow into the tidal River Severn, a significant proportion of the north and west of the district is affected by tidal influences. As such, increases in sea level may have an impact on parts of the district and where necessary, this will need to be taken into account. The government's updated climate change guidance provides details on the sea level allowance for certain epochs.

5.5 Using climate change allowances

To help decide which allowances to use to inform the flood levels that the flood risk management strategy will be based on for a development or development plan allocation, the following should be considered:

- likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s)
- vulnerability of the proposed development types or land use allocations to flooding
- 'built in' resilience measures used, for example, raised floor levels
- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach

5.6 Representing climate change in the L2 SFRA

Climate change modelling for the watercourses in Stroud District was undertaken based on the latest climate change guidance. Existing Environment Agency hydraulic models were run for the 2080s period for the Higher Central and Upper End allowance categories. Mapping of the climate change modelling outputs are provided in Appendix G.1.

6 FRA requirements and guidance for developers

6.1 Over-arching principles

This Level 2 SFRA focuses on delivering a strategic assessment of flood risk at site options within Stroud District. Due to the strategic scope of the study, prior to any construction or development, site-specific assessments will need to be undertaken for individual development proposals (where required) so all forms of flood risk at a site are fully addressed. It is the responsibility of the developer to provide a Flood Risk Assessment (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 for any development. Where the FRA shows that a site is not appropriate for a particular usage, a lower vulnerability classification may be appropriate.

6.2 Requirements for site-specific Flood Risk Assessments

6.2.1 What are site-specific FRAs?

Site-specific FRAs are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with planning applications and should demonstrate how flood risk will be managed over the development's lifetime, taking into account climate change and vulnerability of users.

Paragraph 068 of the NPPG Flood Risk and Coastal Change Planning Practice Guidance sets out a checklist for developers to assist with site specific flood risk assessments.

Site-specific FRAs are required in the following circumstances:

- Proposals of 1 hectare or greater in Flood Zone 1.
- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the LLFA or the Environment Agency).

Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding. A FRA may also be required for some specific situations:

- If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1)
- Where the site is intended to discharge to the catchment or assets of a water management authority which requires a site-specific FRA
- Where the site drainage system may have an impact on an IDB system
- Where evidence of historical or recent flood events have been passed to the LPA
- In an area of significant flood risk from other sources.

6.2.2 Objectives of site-specific FRAs

Site-specific FRAs should be proportionate to the degree of flood risk, as well as appropriate to the scale, nature and location of the development. Site-specific FRAs should establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether a proposed development will increase flood risk elsewhere;
- whether the measures proposed to deal with the effects and risks are appropriate;

- the evidence, if necessary, for the LPA to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Stroud District Council. Guidance and advice for developers on the preparation of site-specific FRAs include:

- Standing Advice on Flood Risk (Environment Agency)[31];
- Flood Risk Assessment for Planning Applications (Environment Agency)[32];
- Site-specific Flood Risk Assessment: Checklist (NPPF PPG)[33];

Guidance for local planning authorities for reviewing flood risk assessments submitted as part of planning applications was published by Defra in 2015 – Flood Risk Assessment: Local Planning Authorities.

Stroud District Council has a pre-planning application advice and enquiry service to discuss any potential issues that may arise from the development proposals. As part of the early discussions relating to development proposals, developers can use this service to discuss requirements relating to site-specific Flood Risk Assessments and drainage strategies. As part of this pre-planning application advice service, the Council may seek technical advice and views from other Flood Risk Management Authorities. However, the Council's pre-planning application advice service is separate to similar pre-application consultation services provided by other Risk Management Authorities (e.g. the Environment Agency) and the Council would expect developers to obtain pre-application advice from the relevant Risk Management Authority on a separate basis.

6.3 Flood risk management guidance – mitigation measures

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

6.3.1 Site layout and design

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 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.

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 water levels rise.

31 Environment Agency (2019) Preparing a flood risk assessment: standing advice. Available at: https://www.gov.uk/guidance/flood-risk-assessment-standing-advice
32 Environment Agency (2017) Flood risk assessment for planning applications. Available at: https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications
33 Ministry for Housing, Communities & Local Government (2016) Site-specific flood risk assessment: Checklist. Planning Policy Guidance Para 68. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section

6.3.2 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 floor levels should be raised to a minimum of 600mm above the maximum water level caused by a 1 in 100-year fluvial flood event including an appropriate allowance for climate change or 1 in 200-year tidal/coastal flood event plus an appropriate allowance for climate change The additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

If raised floor levels are proposed, these should be agreed with Stroud District Council and the Environment Agency. The minimum finished floor level may change depended on the vulnerability and flood risk of the 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 sleeping accommodation in Flood Zone 2 and 3a should be located above the recommended flood level. No sleeping accommodation should be located in Flood Zone 3b.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zones will be required to pass the Exception Test.

6.3.3 Access and egress

Safe access and egress will need to be demonstrated at all development sites. Vehicular access to the site should be achievable, taking into account extreme events.

If safe access and egress cannot be achieved, the Defra/EA Technical Report: FD2320: Flood Risk Assessment Guidance for New Development should be referred to, to determine the hazard to people posed along the access route. This can also be used to inform a Flood Warning and Evacuation Plan for the site.

Emergency vehicular access should be possible during times of flood.

6.3.4 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 act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities, property or protected habitat.

There should be no interruption to flood flows or loss of flood storage as a result of any proposed development. Flood storage compensation may be appropriate for sites on the edge of the existing floodplain or within a flood cell.

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 be in the vicinity of the site and within the red line of the planning application boundary.

Any proposal for modification of ground levels will need to be assessed as part of a detailed flood risk assessment and must demonstrate that there is no adverse impact on the hydrological and hydrogeological setting, following consultation with the Environment Agency.

6.3.5 Groundwater Mitigation

Groundwater flooding has a complex, and very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not

suitable. An available option to manage groundwater flood risk would be through building design (development form), ensuring Finished Floor Levels are raised 300mm above the water levels caused by a 1 in 100-year plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream. Obstruction of sub-surface flows by buried services and basements should be avoided.

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 acceptable solution and basements should be avoided in high groundwater zones.

The management of groundwater also requires consideration during the construction process, as there is a risk that groundworks can lead to releases of groundwater, and/or provide a pathway for the contamination of groundwater. Consultation with the Environment Agency is recommended.

6.3.6 Sewer Flooding Mitigation

Where development is proposed within, or further up the network from, areas where sewer flooding has been recorded, it is recommended that the relevant water and sewerage company is consulted as early as possible in the planning process, as there may be network capacity issues which need to be dealt with.

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 agreed with the relevant water and sewerage company and must be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut.

6.3.7 Developer contributions

In some cases, and following the application of the Sequential Test, it may be necessary for the developer to contribute 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).

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.

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 Stroud District Council, the LLFA and the Environment Agency.

6.4 Existing watercourses and assets

Permanent or temporary works within or adjacent to a watercourse require a consent from the relevant authority, under either the Environmental Permitting Regulations or the Land Drainage Act 1991. A Flood Risk Activity Environmental Permit[34] must be obtained from the Environment Agency for any works carried out within the channel, banks or within 8m from the edge of a main river. For works within 8m of an ordinary watercourse, a Land Drainage Consent must be requested from Gloucestershire County Council and also the Lower Severn IDB, where works are proposed within the administrative area of the IDB. For discharges into any river (including main) or watercourse, the flow rate must also be agreed with Gloucestershire County Council.

Proposed developments which are adjacent to watercourses or assets which are overseen by the Environment Agency, the Lower Severn IDB or Gloucestershire County Council, must demonstrate a minimum clearance of 8m from these assets.

Under the Environmental Permitting (England and Wales) Regulations 2016[35], the Environment Agency specifies that no development is permitted within 8m either side of a Main River. The Lower Severn IDB Land Drainage Byelaws[36] prevent the construction of any permanent or temporary obstructions within 8m of the bank top of watercourses within the IDB. Gloucestershire County Council and Stroud District Council also ensure an 8m buffer width is retained alongside ordinary watercourses.

This allows sufficient space for access to the watercourse, and maintenance of any the banks, defences or in-channel structures. It also maintains a corridor for wildlife migration, limits disturbance and destabilisation of the riverbanks, and provides additional capacity in the watercourse to accommodate higher flows expected under future climate change scenarios. Appendix N shows the buffer areas for the watercourses within Stroud District.

The Environment Agency and Gloucestershire Council have a presumption against allowing further culverting and building over culverts on watercourses. 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.

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. Practical guidance on the responsibilities of riparian owners is provided by the Environment Agency.[37]

The responsible parties for ownership and maintenance of all watercourses within a proposed development site must be specified. Both short and long-term maintenance requirements should be taken into account.

34 Flood risk activities: environmental permits, Environment Agency (2018). Accessed online at: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits on: 01/10/2018

35 The Environmental Permitting (England and Wales) Regulations 2016. Available at: https://www.legislation.gov.uk/uksi/2016/1154/contents/made

36 Lower Severn Internal Drainage Board (2001) Land Drainage Byelaws. Available at: https://lowersevernidb.org.uk/development/land-drainage-byelaws/

37 Owning a watercourse, Environment Agency (2018). Accessed online at: https://www.gov.uk/guidance/owning-a-watercourse

7 Surface water management and SuDS

7.1.1 Introduction

Sustainable Drainage Systems (SuDS) are management practices which enable surface water to be drained in a more sustainable manner and to mimic the local natural drainage. The inclusion of SuDS within developments is an opportunity to enhance ecological and amenity value, and promote Green Infrastructure, incorporating above ground facilities into the development landscape strategy.

The Level 2 SFRA provides surface water drainage considerations to inform Local Plan policy, and the review of planning applications as part of the Development Management process. Technical guidance on SuDS design is provided by Gloucestershire County Council, as Lead Local Flood Authority, as well as the Defra Non-statutory Technical Standards[38] and CIRIA SuDS Manual[39].

7.1.2 Sources of SuDS Guidance

C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015) provides the latest industry guidance and best practice on the planning, design, construction and maintenance of SuDS.

It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development.

Defra Non-Statutory Technical Guidance (March 2015)

The guidance was developed to site alongside the PPG and provide non-statutory standards as to the expected design and performance for SuDS. The Local Planning Authority will refer to these as a minimum standard for determining whether proposed SuDS are appropriate.

Gloucestershire SuDS Design and Maintenance Guide (November 2015)

The Gloucestershire SuDS Design and Maintenance Guide sets out the planning, design and maintenance requirements for SuDS schemes specific to Gloucestershire, with the aim of producing benefits to the environment and communities. The document is intended to be complementary to the National Standard for SuDS (2015) and The SuDS Manual (CIRIA C753).

Since April 2015[40], management of the rate and volume of surface water has been a requirement for all major development sites, through the use of Sustainable Drainage Systems (SuDS). This has been strengthened by the inclusion of SuDS requirements for major developments within the 2018 NPPF update.

7.1.3 SuDS Opportunities in Stroud District

SuDS can be integrated into the design of all new development within Stroud District. The effectiveness of SuDS within a site is defined by site characteristics including (but not limited to) topography, geology, soil permeability, water table, existing water flows across the site, land ownership and extent of site coverage necessary to effectively manage surface water runoff and drainage.

Site characteristics can vary greatly over small areas and therefore each site should be individually investigated to ensure suitability of the proposed infiltration technique.

Oolite Limestone present in the eastern areas of the Horsley, Wotton, Cotswold and Cam-Dursley Clusters (see Figure 7-1) provides opportunities for infiltration techniques,

38 Defra (March 2015) Non-statutory technical standards for sustainable drainage systems https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

39 CIRIA (2015) The SuDS Manual (C753). Available at: http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

40 House of Commons: Written Statement (HCWS161) Written Statement made by: The Secretary of State for Communities and Local Government (Mr Eric Pickles) on 18 Dec 2014. Department for Communities and Local Government (2014). Accessed online at: https://www.parliament.uk/documents/commons-vote-office/December%202014/18%20December/6.%20DCLG-sustainable-drainage-systems.pdf

such as soakaways and infiltration trenches, subject to infiltration testing and low groundwater flood risk. The lower permeability Lias Mudstone and undifferentiated rocks which underlie the Berkeley, Stonehouse, Gloucester Fringe and Severn Clusters, have good potential for creating surface detention features, such as ponds and basins. Where more permeable surface deposits, such as sands and gravels, overlie these geologies, there may also be options for shallow infiltration SuDS, such as filter drains. Areas at risk of fluvial flooding can still provide attenuation and biodiversity benefits through the use of conveyance features, such as swales, and wetland areas.

Opportunities for SuDS in the steep and more densely populated areas of Stroud District, such as Stroud, Stonehouse and Dursley may appear more limited. However, there are a range of suitable, space-efficient options for managing surface water, such as green roofs, rills and permeable paving, which can provide benefits in terms of efficient use of water resources, amenity, biodiversity and overall water quality.

Details of broadscale mapping of SuDS Suitability in Stroud District undertaken as part of this SFRA can be found in Section 7.1.8.

7.1.4 SuDS Design

The CIRIA SuDS Manual details the industry standards for the design of SuDS and should be consulted in all surface water drainage designs.

A comprehensive understanding of the hydrological processes within a catchment (i.e. the nature and capacity of the existing drainage system) is essential in the design of SuDS. The site drainage must be designed around the natural flow routes at the masterplanning stage, keeping water on the surface to provide maximum benefits.

Details of the operation and maintenance requirements for the surface water drainage system should be provided and guaranteed for the lifetime of the development.

Where SuDS are located within Public Open Space, shared private space or roads, it may be possible for future maintenance or adoption to be discussed with the Local Authority or Water Company. Where SuDS are located within property boundaries, responsibility for maintenance generally falls to the property owner.

Planning and managing the construction of SuDS is a key consideration, and a construction management plan should accompany SuDS proposals. Further guidance and considerations are detailed in the CIRIA Guidance on the Construction of SuDS[41].

7.1.5 Runoff rates and storage volumes

The Defra Non-Statutory Technical Standards for Sustainable Drainage and Gloucestershire County Council SuDS Guide provide the following requirements for developments on greenfield and previously developed sites:

- Discharge flow rates from the 1 in 1-year to the 1 in 100-year rainfall events should be limited to the greenfield runoff rates for the same events.
- Flooding must not occur on any part of the site for a 1 in 30-year rainfall event.
- Flooding must not occur during a 1 in 100-year plus climate change rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
- Rainfall in excess of a 1 in 100-year plus climate change rainfall event must be managed via exceedance routes that minimise the risks to people and property.

41 Guidance on the Construction of SuDS (C768), CIRIA (2018) Accessed online at: https://www.ciria.org/Resources/Free_publications/Guidance_on_the_construction_of_SuDS_-_C768.aspx

- On previously developed sites, runoff rates should be restricted to the greenfield rate. Where this can be demonstrated to be unfeasible, the site is required to meet a "betterment" rate, which is considerably lower than the previously developed state. In Gloucestershire, peak discharge rates should be reduced as far as reasonably practical to greenfield rates for the same events, with a minimum 40% reduction.
- Interception storage should be provided to store the first 5mm of rainfall. Where Long Term Storage is provided, for runoff volumes in excess of the 1 in 100-year 6-hour rainfall event, it must be provided in a separate feature to the attenuation storage.
- On previously developed sites, the runoff volume should be limited as close as practicable to the greenfield runoff volume. It should not exceed the existing runoff volume for the site.

Gloucestershire County Council guidance specifies that discharge rates should be set with a view to prevent frequent blockage of structures, with a common minimum practicable discharge rate for outfall devices of 5l/s.

For residential development, which has an assumed design life of 100 years, the 'upper end' (2080s) climate change allowance of 40% must be applied to storage volumes for the 1 in 30-year and the 1 in 100-year rainfall events. The upper end '2050s' allowance of 20% may be appropriate for developments with a short to medium-term design life, such as employment sites.

An allowance in calculations must also be made for 'urban creep', the impact of permeable surfaces in a development (e.g. front gardens), gradually becoming paved over to form impermeable extensions (such as patios or driveways).

7.1.6 Discharge Location

The destination of surface water that is not collected for use on site should be prioritised according to the discharge hierarchy with infiltration preferred, followed by discharge to surface waters, such as a watercourse or lake, then discharge to a surface water sewer, and finally discharge to a combined sewer as a last resort.

Discharge to watercourse will require agreement from the Environment Agency, for Main Rivers, Gloucestershire County Council for Ordinary Watercourses, and the Lower Severn IDB for watercourses within the IDB administrative area. There may also be an opportunity to discharge flows into the canal system, subject to agreement from the Canal and River Trust.

New connections to existing surface water or combined sewers are the least preferred options and should only be considered where other discharge routes are proven to be unfeasible. Discharge to a foul sewer is not a viable option, as it is a major contributor to sewer flooding.

The sewerage undertaker (Severn Trent Water or Wessex Water) should be consulted at an early stage to agree allowable discharge rates and to ensure that sufficient capacity is available in the existing sewer system. In some circumstances discharge to a highway drainage system may be allowed, following agreement from Gloucestershire County Council.

Gloucestershire County Council require site discharge agreements in principle to be in place from the relevant authorities, prior to submission of the planning application.

7.1.7 Water Quality, Biodiversity and Amenity

Sustainable Drainage Systems (SuDS) allow the management of diffuse pollution generated by urban areas, through the sequential treatment of surface water (or SuDS Management Train) reducing the pollutants entering lakes and rivers. This results in lower levels of water supply and wastewater treatment being required. This treatment of diffuse pollution at source can contribute to meeting WFD water quality targets, as well as national objectives for sustainable development.

SuDS components should be designed in series, to provide sequential treatment of pollution close to its source, and deliver gradual improvement in water quality. This also provides an environmental buffer for accidental spills or unexpected high pollutant loadings from the site.

Gloucestershire County Council requires all sites to provide treatment for the first 5mm to 10mm of rainfall, which usually mobilises the 'first flush' of pollutants, to ensure contaminants are not released from the site. At least one treatment stage should be provided, to deliver source control of runoff and pollutants, with above ground, 'green' SuDS preferred.

The water within a SuDS component is essential for the growth and development of plants and animals. The greatest biodiversity value can be achieved where SuDS are planned as part of a wider green landscape, providing important habitat, and wildlife connectivity. With careful design, SuDS can provide shelter, food, foraging and breeding opportunities for a variety of species including plants, amphibians, invertebrates, birds, bats and other animals.

Designs using surface water management systems to help structure the urban landscape can enrich its aesthetic and recreational value, promoting health and well-being and supporting green infrastructure.

Gloucestershire County Council guidance requires SuDS to protect and enhance the existing environment, while creating a variety of habitats, in line with local Habitat Action Plans and the eight priority habitat groups in Gloucestershire:

- Lowland farmland,
- Wetlands,
- Woodlands,
- Coastal,
- Lakes and Ponds,
- Urban and Brownfield,
- Uplands.

In addition, SuDS should be aesthetically landscaped and integrated into areas of open space within a development, to provide amenity for occupiers of the site.

7.1.8 Mapping the Suitability of SuDS techniques in Stroud District

As part of this SFRA, a broadscale assessment of suitable SuDS techniques in Stroud District has been undertaken. Mapped on a 1km grid square, it is designed to inform the early-stage site planning process and is not intended to replace site-specific detailed drainage assessments.

The assessment is based on geological and hydrological catchment characteristics involved the analysis of the following spatial datasets from the British Geological Survey (BGS) and Environment Agency:

- BGS Bedrock and Surface Geology;
- EA Groundwater Source Protection Zones (GSPZ);
- BGS Soluble Rock Risk;
- EA Historic Landfill Sites; and
- EA Flood Zones.

The resulting groupings are summarised in Table 7-1 and Figure 7-1.

Other SuDS methods may also be appropriate, depending on where they are placed and the magnitude of storm they are designed to.

Storage for surface water runoff from developments during large storm events should be located out of the fluvial floodplain. However, SuDS in areas of flood risk can provide

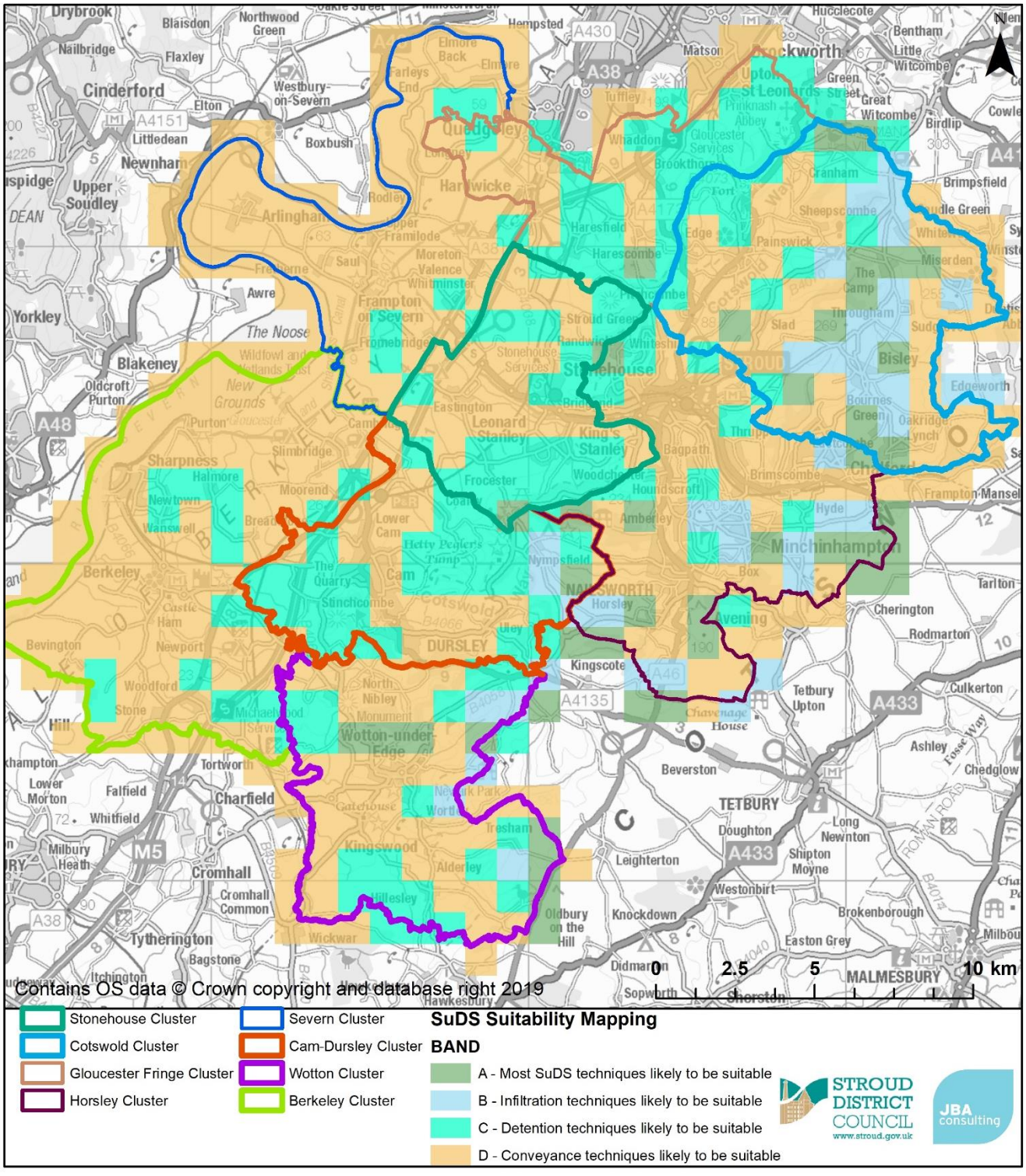
conveyance and treatment of surface water under smaller, more frequent storms, provided floodplain capacity is not reduced.

Table 7-1: Categories of SuDS Suitability Mapping for Stroud District

Category	Description	Underlying data
A	**Most SuDS techniques likely to be suitable**	Geology: Transition from Limestone to Mudstone Historic Landfill: None. Flood Risk: Not in FZ3. Soluble Rock Risk: Medium to low. GSPZ: 2c to 3.
B	**Infiltration techniques likely to be suitable**	Geology: Limestone with permeable surface deposits. Historic Landfill: None. Flood Risk: Not in FZ3. Soluble Rock Risk: Low / not present. GSPZ: 1 to 2.
C	**Detention techniques likely to be suitable**	Geology: Mudstone or Undifferentiated Impermeable Rocks. Moderate to low permeability surface deposits. Historic Landfill: May be present. Flood Risk: Not in FZ3. Soluble Rock Risk: Medium to low. GSPZ: 1 to 3.
D	**Conveyance techniques likely to be suitable**	Geology: Limestone, Mudstone or Undifferentiated Impermeable Rocks. High to low permeability surface deposits. Historic Landfill: May be present. Flood Risk: In FZ3. Soluble Rock Risk: Low to extremely high. GSPZ: 1 to 3.

The suitability of SuDS techniques has also been assessed for each of the Level 2 SFRA sites identified. The assessment of suitability is broadscale and indicative only; more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. The LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors.

Figure 7-1: Broadscale SuDS Suitability Mapping for Stroud District



8 Strategic flood risk solutions

8.1 Introduction

Strategic flood risk solutions offer potential opportunities to reduce flood risk in Stroud District.

8.2 Natural Flood Management

Natural Flood Management (NFM) is the use of natural functions of catchments, floodplains, rivers and the coast to reduce flooding and coastal erosion. In river catchments, a key aim is to reduce the water height of a flood or delay the arrival of a flood peak downstream, by 'slowing the flow' and increasing the time available to prepare for a flood[42].

Due to the presence of steep, rapidly responding catchments, with rural land uses in the upper reaches, Stroud District has high potential for the implementation of NFM.

There are a number of approaches and techniques within NFM, which are summarised in the following sections.

8.2.1 Catchment and Floodplain Restoration

Floodplain restoration allows watercourses to return to a more naturalised state, and flooding to occur on the floodplain.

Floodplain connectivity has historically been lost through development on the natural floodplain and modifying watercourses with culverts and weirs, which has the potential to increase flooding to downstream settlements.

Where sites close to watercourses are considered within the Local Plan or put forward by developers, the sequential approach should be used to locate development away from these watercourses. This will ensure that watercourses retain their connectivity to the floodplain. It is acknowledged that sites located on the urban fringes within the district may have limited opportunities to restore floodplains in previously developed areas.

8.2.2 Upstream Natural Catchment Management

Opportunities that reduce flood and erosion risk, whilst working with natural processes, should be prioritised, as they provide additional environmental benefits while reducing the overall cost of flood management schemes.

Several catchments within Stroud District have potential for upper catchment retention of water, as the Working with Natural Processes Mapping highlights (see Section 8.2.5).

Stroud Rural SuDS were introduced into the Slad Brook, Painswick Stream, Nailsworth Stream, Ruscombe Brook areas of the River Frome catchment, following the 2007 floods. The project is funded in partnership through the Regional Flood and Coastal Committee, the Environment Agency, Gloucestershire County Council and Stroud District Council, with funding secured until 2026. The project began in 2014, has introduced 684 interventions in the Stroud Frome catchment to date.

The Slad Brook, a designated Rapid Response Catchment, which caused destructive flash flooding in 2007, received 122 interventions to slow and reduce peak flows, in partnership with local community groups, land owners, farmers and partner organisations. These included:[43]

- In-stream structures (leaky dams, timber filled gullies) to slow down peak flood flows, divert and attenuate water

42 Natural Flood Management, Stroud District Council, 2019. Accessed on 11/01/2019. Online at: https://www.stroud.gov.uk/environment/flooding-and-drainage/stroud-rural-sustainable-drainage-rsuds-project/natural-flood-management

43 Stroud Rural SuDS, Stroud, SuSDrain, 2019, accessed on 11/01/2019 online at: file:///N:/2018/Projects/2018s1377%20-%20Stroud%20District%20Council%20-%20Stroud%20L2%20SFRA/Data%20Management/Incoming%20Data/Client/Documents/NFM/035_18_04_30_susdrain_suds_awards_stroud_rural_suds_stroud.pdf

- Attenuation and deflection structures within high-flow channels (shallow in field dams, leaky dams, timber filled gullies)
- Culvert crossings with soakaways and flow restrictions downstream
- Erosion prevention (timber filled gullies, tree planting, cattle drinking troughs)

Figure 8-1: Leaky dam on Stroud Slad Farm, Slad Valley (low and peak flow in photographs) Source: Stroud Rural SuDS, Susdrain

8.2.3 Structure Removal and Modification (e.g. weirs)

Structures within and adjacent to watercourses, can alter the geomorphology and hydraulics of the channel. Many artificial in-channel structures (such as weirs and culverts) are redundant and, where feasible, should be removed or lowered, to allow the passage of fish.

However, it must be recognised that some artificial structures within Stroud District have important functions or historical/cultural associations, particularly those linked to historic mills, which need to be considered carefully when planning and designing restoration work.

Further information is provided in the 'Trash and Security Screen Guide 2009', published by the Environment Agency/Defra, which should be used as evidence for any culvert assessment, improvement or structure retention.

8.2.4 Bank Removal and Realignment

The removal or realignment of flood embankments and walls can reinstate connectivity between the river channel and the floodplain. Within confined urban areas, this can be achieved by providing pockets of green space along rivers, which improve floodplain storage during times of flooding.

Detailed assessment is required to understand the responses to channel modification, including flood risk impacts. Formal defences have a role in reducing flood risk, and need

to be maintained, however there may be opportunities for bank removal where informal artificial structures (embankments, walls) within the district are now redundant.

8.2.5 Working with Natural Processes Mapping (WWNP)

The WWNP mapping produced by JBA Consulting and the Environment Agency recognises significant potential for furthering the extent of flood and coastal erosion risk reduction measures across the Stroud District. These are summarised in Table 8-1 below, with opportunity areas illustrated in Appendix M.

Table 8-1: WWNP opportunities in Stroud District.

Area of Stroud District	WWNP Potential
Bevington	Opportunity for riparian woodland and floodplain reconnection.
Stone and Woodford	Opportunity for floodplain reconnection, riparian woodland and floodplain woodland. There are pockets of opportunity for 1 in 30-year runoff attenuation features.
North Nibley and Wotton-under-Edge	Opportunity for floodplain reconnection, riparian woodland and floodplain woodland. There are pockets of opportunity for 1 in 30-year runoff attenuation features.
Dursley and Cam	There is opportunity for implementation of riparian woodland in this part of the catchment, along with pockets of floodplain reconnection, floodplain woodland and a small amount of 1 in 30-year runoff attenuation features.
Stonehouse and Leonard Stanley	Opportunity for a large amount of floodplain woodland, riparian woodland, floodplain reconnection and pockets of 1-30yr runoff attenuation features.
Hardwicke, Harescombe and Pitchcomb	Opportunity for riparian woodland, large stretches of floodplain woodland and areas of floodplain reconnection and waterbodies. There are small areas dotted around this area of Stroud where runoff attenuation features can reduce flood risk under the 1 in 30-year flood extent.
Quedgeley	Opportunity for riparian woodland and floodplain woodland in this part of the catchment. There are also small pockets of floodplain woodland and floodplain reconnection areas of potential.
Edge, Cranham and Sheepscombe	Opportunity in this area of a significant amount of riparian woodland particularly alongside the area of where waterbodies lie. There are also areas of opportunity for floodplain reconnection and floodplain woodland.
Slad and Througham	There is opportunity for riparian woodland and pockets of floodplain woodland and floodplain reconnection.
Chalford, Bisley and Brimpsfield	Opportunity predominantly for riparian woodland intervention.
Minchinhampton and Avening	Opportunity for small areas of riparian woodland and floodplain woodland. Small pockets of opportunity for 1 in 30-year runoff attenuation features.

8.3 Flood Storage Schemes

Flood storage schemes aim to detain river flows, or the additional surface water runoff created by development, and release it downstream at a slower rate, to mitigate any increase in flood depths or frequency downstream. Methods to provide these schemes include[6]:

- enlarging the river channel;
- raising the riverbanks; and
- constructing a storage area set back from the river.

The construction of upstream storage schemes as part of a catchment-based approach within Stroud District could provide a strategic solution to flood risk. Watercourses, such as the River Frome and River Cam, which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the rural open land can provide sufficient space for attenuation.

The feasibility of implementing flood storage options upstream of potential development areas in the River Frome valley, was investigated as part of the Stroud Valleys Initiative project. The approach looked at large strategic storage features, rather than relying on the piecemeal approach of each development providing site-scale attenuation.

Eleven potential storage locations were assessed, with Wemberley Mills to St. Mary's Mill providing a notable flood risk benefit. Although not all storage options were cost-beneficial at the time of the assessment, the analysis can be used to inform future strategic flood storage area planning in the Frome Valley.

8.3.1 Promotion of SuDS

Surface water flood risk is a key consideration in Stroud District. By considering SuDS at early development stages, the risk from surface water can be limited to the site and reduce the risk that the site poses to third party land. Regionally, SuDS should be promoted on all new developments to ensure the quantity and quality of surface water is dealt with sustainably to reduce flood risk. The detailed policies and guidance produced by Gloucestershire County Council (referenced in Section 7), should actively promote developers to use this information to produce technically proficient and sustainable drainage solutions.

9 Assessment of flood risk in potential development areas

9.1 Introduction

A number of potential allocation sites for the Local Plan were provided by Stroud District Council and were screened to provide a summary of flood risk to each site. Sites were received from the following sources:

- Strategic Assessment of Land Availability (SALA) 2018[44]
- Sites submitted following Emerging Strategy Public Consultation

Note that sites which may have already been rejected for other planning reasons were included, as it is important that the Sequential Test identifies the reason that low flood risk sites were rejected.

9.2 Site flood risk summary

Flood risk from all sources was assessed for each of the sites received. This information is provided in a 'summary sheet' format in Appendix A and gives more detailed information regarding the risks posed to each development site.

The following information is provided for each potential development area:

- % of site within each Flood Zone (3b, 3a, 3a plus climate change and 2)
- % of site within Risk of Flooding from Surface Water (total % at surface water risk up to 30-year, 100-year and 1,000-year)
- Historic flooding (based on the Environment Agency's Historic Flood Map).
- % within Risk of Flooding from Reservoirs maximum extent.
- % of site within Environment Agency Areas Susceptible to Groundwater Flooding Map (AStGWF).
- Presence of watercourse mapped in Detailed River Network layer (watercourses under 3km² may not have Flood Zones).
- The sites were also considered against the Environment Agency's Areas Benefiting from Defences dataset to determine if the site benefits from formal flood defences.
- Whether the site is within 50m of a canal embankment.
- Whether the site contains/is adjacent to an Ordinary Watercourse - Flood Zone mapping is often not available in catchments where the watercourse falls below 3km^2. Additional modelling of ordinary watercourses in these instances may be required to fully understand the level of risk to the site.

9.3 Conclusions of site screening

The sites were screened against a range of flood risk datasets. Those sites shown to be at fluvial flood risk are carried forward to the Level 2 assessment. Some sites are shown not to be located in the Flood Zones (because their catchments may be <3km^2 and hence not represented in the Flood Map for Planning). However, there may be small drains or ordinary watercourses located near to or within these sites; OS mapping was therefore checked, along with LIDAR, to confirm whether there could still be a flood risk posed.

Due to the relatively precautionary Flood Zone extents in Stroud District, a large number of sites fall within Flood Zones 2 and 3. Therefore, the level of detail for the site-specific Level 2 SFRA assessment was tailored to the extent of flood risk within each site.

Table 10-1 lists the sites which have a summary tables and associated mapping, as part of the Level 2 assessment.

[44] Stroud District Council (2018) Strategic Assessment of Land Availability. Available at: https://www.stroud.gov.uk/environment/planning-and-building-control/planning-strategy/evidence-base/housing-evidence/strategic-assessment-of-land-availability-sala

9.4 Cumulative impacts of development on flood risk

Cumulative impacts are defined as the effects of past, current and future activities on the environment. Under the 2019 NPPF, strategic policies and their supporting Strategic Flood Risk Assessments (SFRAs), are required to '*consider cumulative impacts in, or affecting, local areas susceptible to flooding*' (para. 156).

When allocating land for development, consideration must be given to the potential cumulative impact of development on flood risk. The increase in impermeable surfaces and resulting increase in runoff increases the chances of surface water flooding if suitable mitigation measures, such as SuDS, are not put in place. Additionally, the increase in runoff may result in more flow entering watercourses, increasing the risk of fluvial flooding downstream.

Consideration must also be given to the potential cumulative impact of the loss of floodplain as a result of development. The effect of the loss of floodplain storage should be assessed, at both the development and elsewhere within the catchment and, if required, the scale and scope of appropriate mitigation should be identified.

Whilst the increase in runoff, or loss in floodplain storage, from individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe without appropriate mitigation measures.

The cumulative impact of development should be considered at the planning application and development design stages and the appropriate mitigation measures undertaken, within an FRA. This is to ensure flood risk is not exacerbated, and in many cases, development can have a positive cumulative impact to improve the flood risk.

9.4.1 Methodology

A range of metrics was used to assess the potential cumulative impacts, which provide a balance between predicted and observed flooding data recorded by the LLFA and Water Companies. In addition, it was considered important to identify those catchments where an increase in flows (as a result of development) would have the greatest impact upon downstream flood risk.

For the purpose of this assessment, the WFD river catchments defined in the River Basin Management Plans were used to divide Stroud District into manageable areas on which to base a cumulative impact assessment. The National Receptor Dataset (NRD), a GIS layer containing a number of risk receptors including building and transport, was used to provide a quantitative estimate of affected receptors.

Predicted Flood Risk:

The risk metrics calculated for predicted (modelled) flood risk were:

- Percentage of properties within the combined 1 in 100-year fluvial, pluvial and groundwater flood risk extent. The Risk of Flooding from Surface Water 1 in 100-year extent was merged with Flood Zone 3a to create a combined layer showing predicted flood risk.
- Proposed level of growth was assessed using the committed developments in Stroud District (as of April 2018) compared with existing numbers of residential dwellings in the National Receptor Database (NRD), as well as the potential future development extent.

Historic Flood Risk:

The risk metrics calculated for historic flood risk were:

- Number of recorded flood incidents, recorded by Gloucestershire County Council
- Whether sewer flooding has been recorded by Wessex Water or Severn Trent Water within the catchment (yes or no, as the incidents are recorded at the postcode boundary scale)

Scoring

A relative risk score of 1 to 3 (low to high) was applied to each flood risk metric and summed to give an overall relative flood risk score for each WFD catchment (Table 9-1).

Table 9-1: Individual components of relative cumulative impacts score (per WFD Catchment)

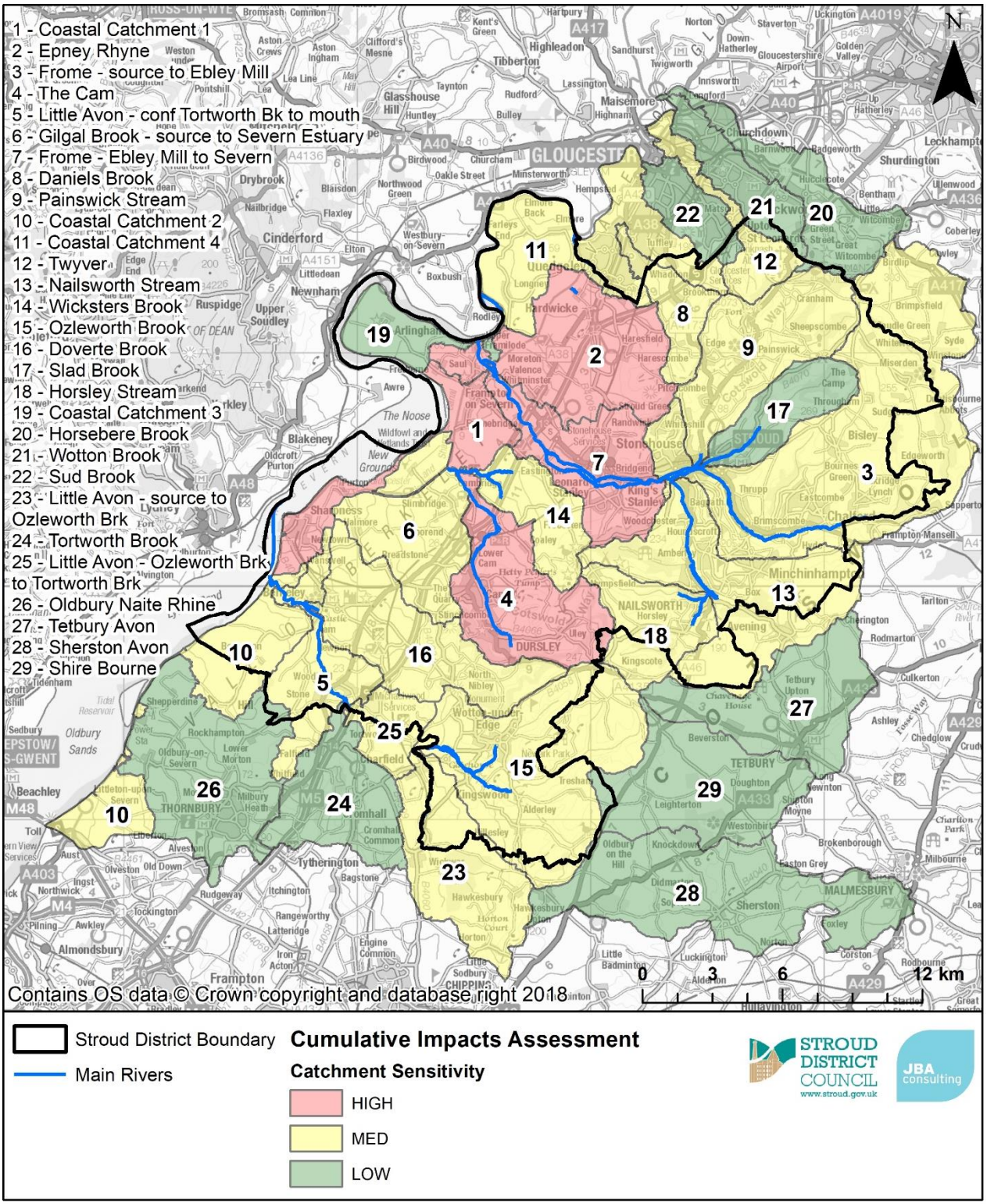
Score	% properties within combined 1 in 100-year fluvial and pluvial flood risk extent	Recorded flood incidents (GCC)	Sewer Flooding (Yes/No)	% increase in dwellings (based on commitments per Parish as of April 2018 compared with NRD)	% Proposed level of growth
1 – Low risk	< 5%	< 5	No	0 – 5%	0 – 1%
2 – Medium risk	5 to 10%	6 – 12	Yes	6 – 26%	2 – 4%
3 – High risk	>10%	12 – 30	N/A	>26%	5 – 15%

Table 9-2: Translating total score to cumulative impact score

Total Score	Cumulative Impact Score
4 - 7	LOW
8 to 10	MEDIUM
≥ 11	HIGH

The relative flood risks within each catchment are provided in Appendix Maps A to L, with a summary of the Cumulative Impacts Assessment results shown in Figure 9-1 below.

Figure 9-1: Relative sensitivity to cumulative impacts by catchment



9.5 Planning Policy Considerations for Catchments

The following Planning Policy recommendations have been made for the catchments where cumulative development is likely to have the greatest impact on flood risk.

The below recommendations can be applied to the parish clusters within the Stroud District Local Plan, containing the higher sensitivity catchments, in this case: Gloucester Fringe, Cam-Dursley, Stonehouse, Severn and Berkeley.

In addition to assessment at the SFRA level, it is recommended that site-specific FRAs are required to include consideration of the cumulative effects of the proposed development. It should be demonstrated that flood risk downstream will not be made worse by the combination of effects from more than one development allocation.

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

1 Site-specific analysis should consider how the cumulative effects of potential peak rates and volumes of water from development sites would impact on peak flows, duration of flooding and timing of flood peaks on receiving watercourses. Such studies could be used to justify greater restrictions/ enforce through Local Planning Policy development site runoff rates and volumes specific to each catchment that are over and above those required by National and Local SuDS Standards. They could also identify where there are opportunities with allocated sites to provide off-site betterment e.g. online/ offline flood storage and where land should be safeguarded within proposed site allocations to fulfil this purpose.

2 Where appropriate, that the opportunity to implement further Natural Flood Management in rural areas, SuDS retrofit in urban areas and river restoration should be maximised in these catchments, with developments contributing to delivery of these schemes. Culverting should be opposed, and day-lighting existing culverts promoted through new developments.

3 Developers should explore through site specific FRAs opportunities to provide wider community flood risk benefit through new developments.

4 Developers should contribute to community flood defences outside of their red line boundary in these catchments to provide wider benefit and help offset the cumulative impact of development.

5 The LLFA and other RMAs should use this information, alongside the high priority settlement information in the Local FRM Strategy to inform a long-term pipeline of flood alleviation studies and schemes to help inform points recommendations 2 to 4 above.

6 The Environment Agency, in consultation with Stroud District Council and Gloucestershire County Council, should consider whether to formally designate these catchments as Critical Drainage Areas. This would mean that a detailed Flood Risk Assessment would be required for all developments that are proposed, regardless of their size.

9.6 Cross-Boundary Considerations

In addition to catchment-scale flood risk considerations, Stroud is bordered by five authorities, and consequently cross-boundary flood risk is a key consideration.

The Stroud District boundary borders the following Local Authorities:

- Forest of Dean District
- Gloucester District
- Cotswold District
- South Gloucestershire
- Tewkesbury District

The topography of Stroud District, and the surrounding districts, typically slopes northwards and eastwards towards the River Severn estuary, which forms the western boundary of Stroud.

Consequently, surface water runoff generated in the districts upslope of Stroud, including Tewkesbury, Cotswold and Forest of Dean, has the potential to impact on flood risk

within Stroud District. Conversely, runoff generated in Stroud may have an impact on Gloucester City.

As many of the watercourses in Stroud District originate in upstream districts, or pass into other districts, there is the potential for any changes in rates, volumes or timings of peak flows to increase the risk of flooding in downstream.

The upper reaches of the River Frome, River Cam and Nailsworth Stream originate in Cotswold District, and therefore any changes in rates or volumes of flows in the District has the potential to increase flood risk in Stroud District. From Stroud District, the upper reaches of several watercourses, including the Sud Brook, Daniel's Brook, Whaddon Brook and River Twyver, flow into Gloucester.

Stroud and South Gloucestershire Districts share a boundary with the Little Avon and its tributary Dyers Brook, therefore any change in flood risk associated with the watercourse will impact both districts.

A high-level overview of the potential cross-boundary impacts for Stroud District and the neighbouring authorities is provided in Table 9-3. In most cases, if appropriate flood risk considerations and management of surface water drainage are provided, development in neighbouring authorities is unlikely to affect flood risk within Stroud.

However, where sites are located near an authority boundary, or have the potential to contribute to, or be affected by, flood risk in an adjacent authority, site developers are advised to also consult the SFRAs of the relevant adjacent authorities.

It is recommended that Stroud District Council consult with neighbouring authorities, particularly during the consultation phases of their respective Local Plans, to identify and review potential cross-boundary issues.

Table 9-3: Summary of the potential cross-boundary impacts of development on flood risk in Stroud and neighbouring authorities

Cross-boundary Authorities	
Potential to Affect Stroud District	**Potential to be Affected by Stroud District**
South Gloucestershire	Forest of Dean District
Forest of Dean District	Cotswold District
City of Gloucester	Gloucester District
	Tewksbury District

10 Level 2 Assessment Methodology

10.1 Introduction

Following the screening of 399 site options provided by the Council for assessment, 19 sites were brought forward to undergo the Level 2 assessment. The selection of sites was based on fluvial flood risk posed to the sites.

These sites are:

Table 10-1: Sites carried forward to a Level 2 assessment

Site code	Site name
G1	Land south of Hardwicke
G2	Land at Whaddon
PS01	Brimscombe Mill
PS02	Brimscombe Port
PS09	Rooksmoor Mill
PS11	Merrywalks Arches, Merrywalks, Stroud
PS13	Central river, canal corridor
PS14	Stanley Mills
PS19a	Stonehouse Northwest
PS20	M5 Junction 13
PS25	East of River Cam
PS30	Hunts Grove Extension
PS33	Northwest of Berkeley
PS34	Sharpness Docks
PS36	New settlement at Sharpness
PS37	New settlement at Wisloe
PS43	Javelin Park
PS47	Land west of Renishaw New Mills
WHI007 / WHI011	Land north of Grove End Farm, Whitminster

This Level 2 SFRA assessment helps to determine variations in flood risk across the site options, identifying site-specific FRA requirements and helping guide local policies to provide sustainable developments, as well as reducing flood risk to existing communities.

10.2 Site summary tables and maps

As part of the Level 2 SFRA, detailed site summary tables have been produced for the sites listed above in Table 10-1. The summary tables can be found in Appendix P.

Where available, the results from existing detailed Environment Agency hydraulic models were used in the assessment to provide depth, velocity and hazard information.

Using the model information combined with the Flood Zones, climate change and Risk of Flooding from Surface Water (RoFfSW) extents, detailed site summary tables have been produced for the site options (see Appendix XVIIP).

To accompany each site summary table, there is a map, displaying all the mapped flood risk outputs for each site (see Appendix Q).

10.2.1 Important note on datasets used for the summary table maps

It is important to recognise that for the SFRA, several different sets of data have been used to inform the extent, depth, hazard and velocity for each site.

Flood Zones

The extent of flooding, which determines the proportions of the site falling into the different Flood Zones, were determined from several sources:

- Flood Zone 2: based on the Environment Agency's Flood Map for Planning Flood Zone 2.
- Flood Zone 3a: based on the Environment Agency's Flood Map for Planning Flood Zone 3a.
- Flood Zone 3b: based on the defended 20-year flood extent from the Environment Agency's detailed hydraulic models (or 25-year in the absence 20-year), where present. Flood Zone 3a can be used as an indication of Flood Zone 3b where detailed modelling is not available.

Depth, velocity and hazard

Depth, velocity and hazard mapping for the 1 in 100-year event (Flood Zone 3a) have been taken from the Environment Agency's detailed defended hydraulic models, where models are present.

For 1D-only models, velocity and hazard data were unable to be presented as these are not available outputs from 1D-only models. Depth outputs are available; however, due to updates to LIDAR since the previous studies, the flood mapping would yield a slightly different extent to the original flood extents provided, and therefore to prevent confusion, these have not been presented. Developers should consider improving or upgrading these models to 1D-2D where deemed appropriate, to derive the level of detail required at a site-specific FRA level.

The Environment Agency's 1 in 100-year surface water depth and hazard mapping has been shown in the accompanying mapping to provide further detail and also to serve as an indication of risk in the absence of modelled fluvial depth, velocity and hazard data.

Climate change

Climate change extents are derived by upscaling the 100-year defended event from existing detailed hydraulic models for the relevant climate change allowance for the 2080s epoch. Where 1D-only or generalised models were present, Flood Zone 2 has been shown as a conservative indication in this area.

10.3 Note on SuDS suitability

The hydraulic and geological characteristics of each site option were assessed to determine the constraining factors for surface water management. This assessment is designed to inform the early-stage site planning process and is not intended to replace site-specific detailed drainage assessments.

11 Summary and Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA. Following this, several recommendations have been made for the Council to consider as part of their planning policy and flood risk management. These have been summarised below.

11.1 Site allocations

- It is recommended that the outputs from this study are used for Sequential Test decision-making, to allocate development in the areas of lowest flood risk. If land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development, the Exception Test will need to be applied.
- This is where the Level 2 SFRA supports, as it considers the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.
- Where a site allocation is shown to be in either Flood Zone 2 or 3 the site is to be taken forward to the Level 2 assessment.
- The Level 2 assessment seeks to identify the probable extent, depth and velocity of flooding as well as the hazard posed to people, safe access and egress to help inform the Exception Test, and provide more detailed guidance for site-specific FRAs.

11.1.1 Assessing Flood Risk and Developments

- Criteria where a site-specific FRA is required is provided in Section 6.2. in The FRA should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development.
- At site-specific level, for any developments shown to be at residual flood risk, for example from a breach or overtopping (e.g. reservoir, canal, perched watercourse), it is recommended that a detailed hydraulic modelling study is carried out using Environment Agency guidance to assess the residual risk.
- The LPA, the Environment Agency and LLFA should be consulted to confirm the level of assessment required and to provide any information on any known local issues.
- When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test, as well as provide evidence to show that they have adequately considered other reasonably available sites.
- To demonstrate the Exception Test has been passed, flood resilience design and emergency planning must be accounted for including:
    - The development will remain safe and operational under flood conditions;
    - A strategy for safe evacuation and / or safely remaining in the building under flood conditions;
    - Key services will continue to be provided under flood conditions; and
    - Buildings are designed for a quick recovery following a flood.
- Development must seek opportunities to reduce the overall level of flood risk at the site, for example by:
    - Reducing the volume and rate of surface water runoff based on local planning policy and LLFA Guidance;
    - Locating development to areas with lower flood risk;
    - Creating space for flooding; and

- Integrating green infrastructure into mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

11.1.2 Promotion of SuDS

- Planners should be aware of the conditions set by Gloucestershire County Council and the Lower Severn IDB for surface water management and ensure development proposals and applications are compliant with the Council's policy. It is recommended that these policies should also be incorporated into the emerging Local Plan.

11.1.3 Infrastructure and Access

- Any developments located within an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard should be identified and the use of developer contributions considered to fund improvements.
- Safe access and egress for residents and emergency and service vehicles will need to be demonstrated at all development sites.

11.1.4 Strategic flood risk solutions

- The information provided in the SFRA should be used as a base for investigating potential strategic flood risk solutions within the district. Opportunities could consist of the following:
  - Floodplain restoration, for example bank stabilisation and structure removal/ modification.
  - Construction of new upstream storage schemes could be considered on a number of watercourses within the district. Any watercourses which are rural in their upper reaches, but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream.
  - If flood defences are to be constructed to protect a development site, it should be demonstrated that defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.

11.2 Use of SFRA data and future updates

- 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 a 'living document', and as a result should be 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 Stroud District Council, Gloucestershire County Council, the Highways Authority, Canal and River Trust, Severn Trent Water, Wessex Water and the Environment Agency. Such information may be in the form of:
  - New hydraulic modelling results
  - Flood event information following a future flood event
  - Policy/ legislation updates
  - Environment Agency flood map updates

- New flood defence schemes etc.

- The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment.
- Where flood extents 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 generally accurate on a large scale, they are not provided for specific sites or for land where the catchment of the watercourse falls below 3km^2.

Appendices

A Site Locations

B Watercourses

C Bedrock Geology

D Superficial Geology

E Source Protection Zones

F Flood History

G Flood Zones

G.1 Flood Zone 3 plus climate change

H Flood Defences

I Flood Warnings and Alerts

J Risk of Flooding from Surface Water

K Areas at Risk of Groundwater Flooding

L Sewer Flooding

M Working with Natural Processes Mapping

N Watercourse Buffer Strips

O Site Screening of Potential Allocation Sites

P Level 2 Site Summary Tables

Q Level 2 Site Maps

R Appendix Mapping: Supporting Information

S Guide to using technical data in SFRA

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

Jeremy Benn Associates Limited

Registered in England 3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007