FOREST OF DEAN DISTRICT COUNCIL

LEVEL I STRATEGIC FLOOD RISK ASSESSMENT

July 2023

Prepared by: Forest of Dean Local Plans team

Original 2008 report written by Halcrow Group Limited and updated in 2023 by Forest of Dean District Council. Proofread by Matthew Bennion Environment Agency June 2023. Edited by Forest of Dean District Council July 2023.

Executive Summary

To provide sustainable developments for communities, it is vital that the risk of flooding, both now and in the future, is considered at all stages of the planning process, from plan making through to site-specific assessments. The purpose of the SFRA is to assess and map all forms of flood risk from groundwater, surface water, impounded water bodies, sewer, river and tidal sources, taking into account future climate change predictions, to allow the Councils to use this as an evidence base to locate future development primarily in low flood risk areas. The outputs from the SFRA will also help the Councils to prepare sustainable policies for the long-term management of flood risk.

Flooding is a natural process which shapes the natural environment, but also threatens life and can cause substantial distress and damage to property. The effects of weather events can be increased in severity as a consequence of past decisions about the location, design and nature of development and as a consequence of climate change. While flooding cannot be wholly prevented, its impacts can be avoided and reduced through good planning and management. The SFRA aims to ensure that flood risk forms one of the material planning considerations to help deliver sustainable development.

The Forest of Dean District drains predominantly into the River Severn Estuary. The Severn is defended along the District's boundary, which has greatly reduced flood risk. As a result of climate change, the depth of flooding is likely to increase in well-defined floodplains, notably in the Lyd catchment, while the extent of flooding is likely to affect the Cinderford Streams as well as along the Severn Estuary, which will be subject to increased storm surges and wave height in the future.

The National Planning Policy Framework (NPPF) recommends a Sequential Approach to the future planning of development. In essence this seeks to guide any future development away from areas which are at high or medium risk of flooding and instead proposes to locate them within areas with the lowest flood risk. It is also necessary that when considering its design and location, future development should be made safe for its lifetime without increasing the flood risk elsewhere.

To this end, the Forest of Dean District Council has prepared a Level 1 Strategic Flood Risk Assessment (SFRA). The SFRA assesses the risk of flooding to the area from all sources, now and in the future, taking account of the impacts of climate change. This includes flooding risks from all watercourses, groundwater, reservoirs, sewers and artificial sources.

The SFRA has the purpose of:

- Informing the sustainability appraisal so that flood risk is taken into account when considering options in the preparation of strategic land use policies;
- Proposing appropriate policy recommendations for the management of flood risk within the Local Plan;
- Determining the acceptability of flood risk in relation to emergency planning capability;
- Identifying the level of detail required for future site-specific Flood Risk Assessments (FRAs) that support planning applications.

Project Overview

This Level 1 Strategic Flood Risk Assessment (SFRA) has been prepared by the Forest of Dean District Council (FoDDC) and the Study Area is therefore the whole of the Forest of Dean District. The SFRA provides an evidence base for site allocations and to inform the preparation of plan policies to ensure flood risk from all sources is managed in the Study Area.

In accordance with the National Planning Policy Framework (NPPF) and accompanying Planning Practice Guidance (PPG) this SFRA assesses the risk to the Study Area from flooding from all sources, both in the present and the future, including the impacts of climate change. The SFRA also assesses the impact that land use changes and development in the Study Area could have on future flood risk.

This SFRA supersedes the following previously published Level 1 SFRA for the FoDDC:

Forest of Dean District Council. Strategic Flood Risk Assessment for Local Development Framework. Level 1. September 2008. Written by Halcrow Group Limited.

Whilst this report does not directly supersede the current Level 2 SFRAs, where they have been produced, the information contained within them will need to be validated by Applicants to ensure that it has not been superseded by this Level 1 update or by other updated modelling and mapping of the area. However, it is intended that the existing Level 2 SFRAs (namely, Cinderford and Lydney) will be updated in the near future and additional Level 2 studies will be carried out in accordance with the emerging Local Plan (2021-2041).

This report should be read in conjunction with the available online map.

Contents

List of Tables/Figures

Chapter 1 - Introduction

1.1 SFRA Objectives

The aims of the planning policies within the NPPF and the associated PPG on development and flooding are primarily:

- to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding, and
- to direct development away from areas at highest risk.

Where new development is necessary in such areas, exceptionally, the national policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall. 'Safe' in the context of this study means that dry pedestrian access to and from the development is possible without passing through the 1% AEP (1 in 100 year) plus climate change floodplain; emergency vehicular access is possible during times of flood; and the development includes flood resistance and resilience measures to ensure it is safe.

The aim of this Level 1 SFRA is to provide an assessment of flood risk across the Forest of Dean District with a suitable level of detail to facilitate and to enable the application of the Sequential Test and, where applicable, the Exception Test, where required.

The Forest of Dean District Council is required to prepare an SFRA in accordance with the NPPF to support the Local Plan and to inform Development Management within the district. Specifically, as outlined in the PPG, the SFRA should:

- Determine the variations in risk from all sources of flooding, and also the risks to and from the surrounding areas in the same flood catchment;
- Inform the Sustainability Appraisal of the Local Plan;
- Enable the application of the Sequential Test and, where applicable, the Exception Test when determining land use allocations;
- Identify the requirements for site-specific Flood Risk Assessment (FRAs) in particular flood risk areas;
- Prepare appropriate policies for the management of flood risk;
- Determine the acceptability of flood risk in relation to emergency planning capabilities; and
- Consider opportunities to manage flood risk to existing communities and developments through better management of surface water, provision for conveyance and of storage for floodwater.

This SFRA has been completed in accordance with the NPPF and has included the following:

- Review of changes in key national, regional and local planning policy and strategies relevant to the management of local flood risk within the District;
- Consultation with the relevant authorities stakeholders to obtain up-to-date datasets, discussing current and future flood risk and understanding development management and flood management requirements;
- Review of available datasets to understand historic, current and future flood risks within the Study Area from all sources of flooding;
- Interpretation of available data in order to understand the local flood risks to people and property for the purpose of informing development management policies; and
- Recommendation of measures to ensure the sustainable management of flood risk within the Study Area in relation to development.

A key aim of a Level 1 SFRA is to provide the necessary information to inform the site selection process for future development sites and provide recommendations for policies to deal with non-allocated sites. The SFRA will feed into the Local Plan and enable informed decisions to be made relating to land use and development allocation.

1.2 Stakeholder Engagement

Key stakeholders have been engaged with throughout the development of this SFRA to source relevant data in relation to flood risk and development in the Study Area. The main stakeholders engaged in this process are:

- The Environment Agency (EA)
- Gloucestershire County Council (GCC) in their role as Lead Local Flood Authority (LLFA)
- Severn Trent Water
- Welsh Water
- Forest of Dean District Council Drainage Team

1.3 Sources of Flood Risk Data

A Level 1 SFRA is principally a desk-based study using existing information to allow application of the Sequential Test to identify whether the Exception Test is likely to be necessary.

The best available data within the study timescale has been collated for use in this study, and the nature of the data used has been agreed with the Environment Agency. It is, however, important to recognise that the SFRA is a 'living' document. As new information becomes available, (such as improved climate change modelling or river models) updates will be made to the Flood Zone maps and this should be reflected in the SFRA document, to ensure that the best information is used to guide the site selection process for future developments.

The data gathering process has resulted in a review of:

- Strategically important documents (NPPF, NPPG, Local Plans, etc.) including GCC Local Flood Risk Management Strategy (Summer 2014); Gloucestershire Parishes Flood Risk Prioritisation Assessment. Forest of Dean District Summary Report (February 2016); Gloucestershire County Council SFRA Level 1 (September 2008);
- Historical flooding information from Environment Agency historic fluvial flood outlines and various datasets from water companies and the Forest of Dean Council datasets;
- Environment Agency Flood Zone maps and detailed flood risk mapping outputs, including fluvial climate change outputs;
- Information on flood risk management infrastructure, including defences and culverts (supported by information from the LLFA, FoDDC Drainage Team and Environment Agency's National Flood and Coastal Defence (NFCDD database);
- Existing flood risk management reports and strategies;
- Environment Agency flood warning and flood watch information.

1.4 Flood Risk Sources

The sources of flooding assessed in this SFRA are as follows:

- Fluvial
- Tidal
- Surface Water

- Groundwater
- Sewers; and
- Artificial flood sources (reservoirs, canals, etc.)

The above has also included an assessment of the possible change to these flood risks in the future as a result of climate change.

1.5 Project Deliverables

The project outputs for a Level 1 SFRA have been adopted for this study. The deliverables of this assessment are:

- A technical report;
- Series of map layers which are available on the online map

The key project outputs are as follows:

1) Plans showing the administrative boundaries of the study area, watercourse centrelines, modelled watercourses, canals, defences, Areas Benefiting from Defences (ABDs) and culverted watercourse sections;

2) Strategic flood risk maps showing flooding from all sources, including fluvial Flood Zones, and areas at risk of flooding from other sources;

3) An assessment of the implications of climate change for flood risk in the study area over an appropriate time period;

4) The location of any flood risk management measures, including both infrastructure and the coverage of flood warning systems;

5) Guidance on the application of the Sequential Test (see Chapter 9);

6) Guidance on the preparation of FRAs for development sites (see Chapter 10);

7) Guidance on the likely applicability of different Sustainable Drainage System (SUDS) techniques for managing surface water run-off at key development sites (see Chapter 11).

1.6 Outcomes of the SFRA Process

The Level 1 SFRA provides sufficient data and information to enable the planning authority to apply the Sequential Test to land use allocations and to therefore identify where the Exception Test needs to be applied.

Under the Town and Country Planning (Local Development – England) Regulations 2004, a Sustainability Assessment (SA) is required for all LDFs. The purpose is to promote sustainable development through better integration of sustainability considerations in the preparation and adoption of plans. The Regulations stipulate that SAs for Local Plans should meet the requirements of the Strategic Environmental Assessment (SEA) Directive. An SFRA is used as a tool by a planning authority for the production of development briefs, setting constraints, identifying locations of emergency planning measures and requirements for FRAs. The SA should therefore be informed by the SFRA.

It is important to note that the formulation of Council policy and the allocation of land for future development must also meet the requirements of other planning policy. Clearly, a careful balance must be sought in these instances, and the SFRA aims to assist in this process through the provision of a clear and robust evidence base upon which informed decisions can be made. Importantly, policies should recognise the positive contribution that avoidance and management of flood risk can make to the development of sustainable communities.

1.7 The Sequential Test

The primary objective of the NPPF and related PPG is to steer development towards areas of lowest flood risk. The NPPF therefore advocates a sequential approach (NPPF para.158) to guide the planning decision making process (i.e. the allocation of sites). In simple terms, this requires planners to seek to allocate sites for future development within areas of lowest flood risk in the first instance. Preference should therefore be given to locating new development in Flood Zone 1, Low Probability (see section 2.4). If there is no reasonably available site in Flood Zone 1, the flood vulnerability of the proposed development can be taken into account in locating development in Flood Zone 2 (Medium Probability) and then Flood Zone 3 (High Probability). Within each Flood Zone new development should be directed away from 'other sources' of flood risk and towards the area of lowest probability of flooding, as indicated by the SFRA. The Sequential Test process and more governmental advice on flood risk assessments and the sequential test can be found in the PPG at https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants.

As an integral part of the sequential approach, the tables below showing the Flood Risk Vulnerability Classification (taken from Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825) stipulates permissible development types in which flood zones are most compatible. This considers both the degree of flood risk posed to the site, and the likely vulnerability of the proposed development to damage (and indeed the risk of the lives of the site tenants) should a flood occur. Provided the Sequential Test is carried out and it can be demonstrated that there are no sites available fully in Flood Zone 1, a site can be developed. It is important to note that where a 'tick' is shown in the Table, this does not imply that development may immediately proceed; the Sequential Test must still be applied and passed.

Table 1.1 Flood Risk Vulnerability Classification (Table 2 of PPG Para 079 Reference ID: 7-079-20220825).

EA Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception test required	✓	✓	✓
Zone 3a	Exception test required †	X	Exception test required	✓	✓
Zone 3b	Exception test required *	X	X	X	✓ *

✓Development is appropriate
X Development should not be permitted
† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to: remain operational and safe for users in times of flood; result in no net loss of floodplain storage; and not impede water flows and not increase flood risk elsewhere.

Table 1.2 Flood Risk Vulnerability Classification (Annexe 3 of the NPPF)

Essential infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly vulnerable	• Police 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	• Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, 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. • 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 Defense 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.

1.8 The Exception Test

If, following application of the Sequential Test, it is not possible, or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding, the Exception Test can be applied as indicated by para. 159 of the NPPF, Annexe 3 of the NPPF along

with Table 2 of 079 Reference ID: 7-079-20220825. This test provides a method of managing flood risk while still allowing necessary development to occur.

The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons (the need to avoid social or economic blight and the need for essential civil infrastructure to remain operational during floods). It may also be appropriate to use it where restrictive national designations such as landscape, heritage and nature conservation designations, e.g. Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and World Heritage Sites (WHS), prevent the availability of unconstrained sites in lower risk areas.

For the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community which outweigh flood risk, informed by an SFRA where one has been prepared. If the Local Plan has reached the 'submission' stage, the benefits of the development should contribute to the SA (Sustainability Appraisal) process;
b) The development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and,
c) A flood risk assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

It is possible that the Council will need to apply the Exception Test if sites fall within Flood Zone 2 and 3, although it is not possible to fully determine this until the Sequential Test process has been undertaken.

1.9 SFRA Context

The following flow diagram: Taking flood risk into account in the preparation of a Local Plan is taken from the PPG Paragraph: 007 Reference ID: 7-007-20220825 (https://www.gov.uk/guidance/flood-risk-and-coastal-change#para77) illustrates the responsibilities for the production of key documents required to effectively manage flood risk through each stage of the spatial planning process.

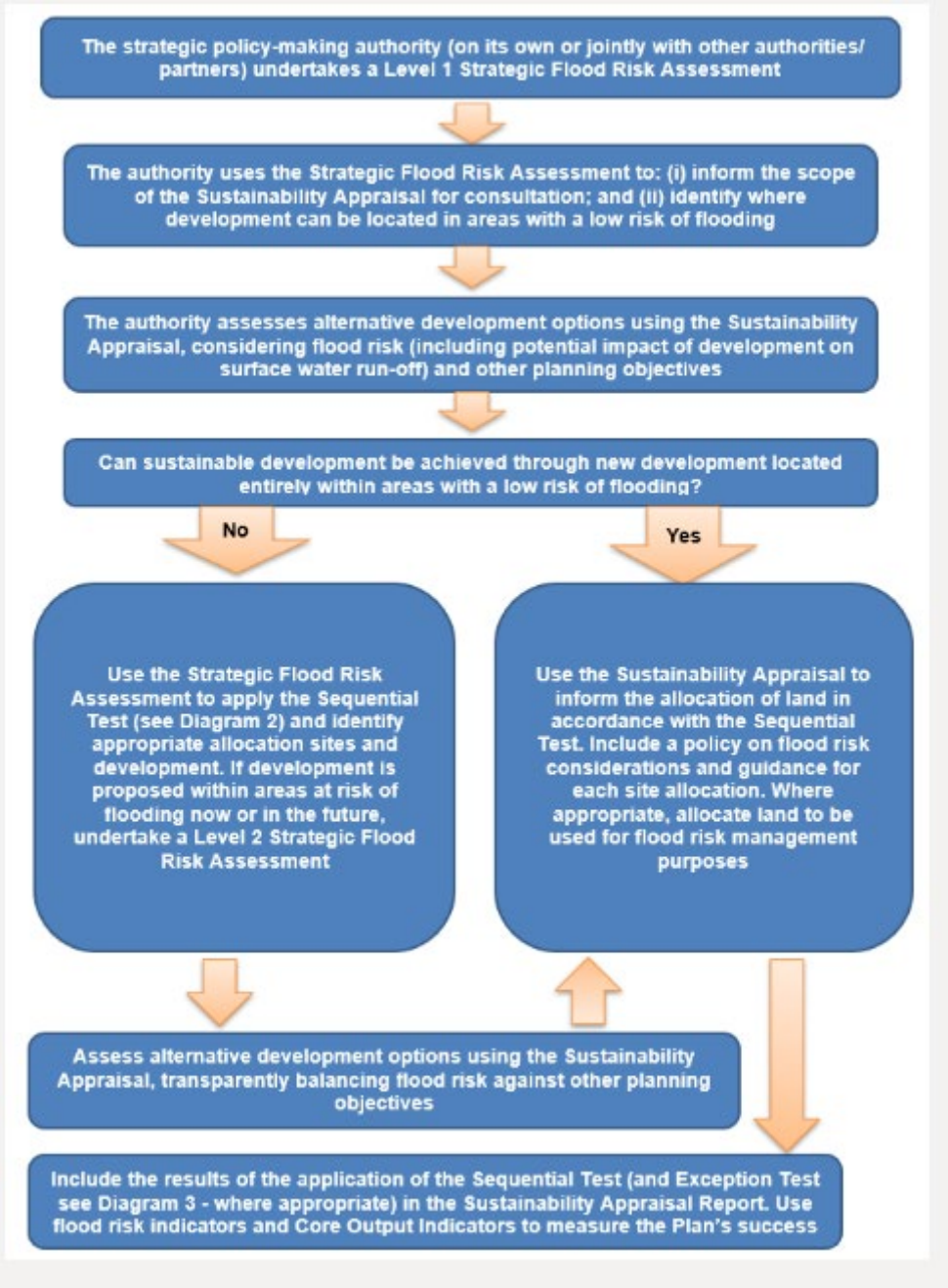


Fig 1.1 – Taking Flood Risk into Account

1.10 The Study Area

Forest of Dean is a local government District covering an area of some 526km^2. The District borders the Gloucestershire Districts of Tewkesbury and Stroud to the east, the District of Malvern Hills to the north east, Wales to the south west and Herefordshire to the north west. The District is predominantly rural in nature despite a long history of mineral extraction and processing in the south. The District is also characterised by the statutory Forest of Dean which lies between the rivers Wye and Severn in the southern extent of the District. The statutory Forest of Dean covers over 110km^2 of woodland and is described as one of the most distinctive areas of Britain, exhibiting stunning landscapes and spectacular scenery, attracting visitors who return year after year. In 1938 it was designated as a National Forest Park. There are also two sites of AONB including a substantial part of the Wye Valley AONB and a small area of the Malvern Hills AONB.

The main centres of population within the District include Coleford, Cinderford, Lydney and Newent, though there are a variety of settlement types within the District. The northern extent of the Forest of Dean District is characterised by high quality agricultural land and is landscaped with a typical rural settlement pattern of small villages. The total estimated population in the district is 86,500 (ONS, mid 2018 estimate).

1.11 Main Rivers, Hydrology, Geology and Topography

The Forest of Dean District occupies an area of varied topology and geology. Gently sloping lower lying areas near the Severn Estuary are contrasted with steep hills in the West of the District. Main River catchments within the District can be categorised as large catchments forming large watercourses (the Severn and Wye) and small catchments originating in the general vicinity of the District. All the rivers in the District eventually drain into the Severn Estuary.

The Rivers Severn and Wye both derive from large catchments: around 10,000km^2 and 3,300km^2 respectively. Both are consequently subject to great variability in flow rate and also have tidal influences. In the lower lying parts of the District the risk of the Severn coming out of bank and flooding some areas during periods of high flows has been substantially mitigated by the presence of defences along the estuary. The remaining small catchments also pose flood risk, depending on the characteristics of any localised storms. Inspection of the Environment Agency's Flood Zones in the District indicate that areas of flood risk from the smaller catchments are small and dispersed, including Parkend, Whitecroft, Drybrook, Cinderford and Newent. The catchment descriptors for the various river catchments in the District are shown in Table 1.3 as taken from the Flood Estimation Handbook (FEH) (Institute of Hydrology (1999), centre for Ecology & Hydrology).

It is noted that the smaller catchments all show a moderate BFIHOST (Base Flow Index derived using Hydrology of Soil Types classification) and SPRHOST (Standard Percentage Runoff derived using Hydrology of Soil Types classification), suggesting that they are underlain by rocks of moderate permeability. This indicates a moderate response to precipitation in general. However, the comparatively high values for DPSBAR (average Drainage Path Slope – an index of catchment steepness); indicate steep topography, which increases the speed with which the catchments respond to rainfall and can correspondingly increase the risk of flash flooding. The EA has advised that the watercourses are historically responsive to heavy rainfall in the south of the district over saturated catchments in the winter or intense summer storm events. Although the large forested areas temper this through greater interception.

All main rivers within the Forest of Dean are listed in Table 1.3 along with brief watercourse descriptions and eight figure grid references for clarification on locations (using standard Ordnance

Survey (OS) notation). Main Rivers are watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Food and Rural Affairs (see online map). The Environment Agency has permissive powers to carry out works necessary for flood defence purposes on these rivers. The overall responsibility for maintenance, however, lies with the riparian owner. Named minor rivers (or ordinary watercourses) within the District are listed in Table 1.3. A number of minor rivers also exist within the District and are shown on the online map. Minor rivers cover every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. The local authority or Internal Drainage Board (IDB) where relevant, has powers for ordinary watercourses.

The Lower Severn Internal Drainage Board operates within the District. The IDB manages water levels at the margins of the Severn estuary using numerous rhynes, pills and control structures. Further to contact with the IDB in July 2020, it has been confirmed that the Lower Severn IDB still manage a network of Rhines within the Forest of Dean district. The only change since 2008 has been the installation of a replacement weir at Walmore Common in 2011.

Table 1.3 Main rivers in the Forest of Dean District and associated catchment descriptors as per FEH version 2

			Upstream Catchment Descriptors* (from FEH)					
River Name	Enters District	Exits District	Downstream point of catchment	Upstream Catchment Area (km^2)	BFIHOST	SPRHOST	DPSBAR (m/km)	Watercourse Description
River Severn	SO 7586 1646	ST 5398 8859	SO 8215 2160	9969.94 (very large)	0.512 (medium)	35.93 (medium)	73 (medium)	The River Severn is largest watercourse in the Forest of Dean District and forms the eastern boundary of the District, running the 40km boundary with Stroud District from SO 7586 1646 to ST 6298 9830 and the 15km boundary with South Gloucestershire from ST 6268 9830 to ST 5398 8859. All other main rivers in the District drain in an easterly or southerly direction toward the Severn. The River Severn through the Forest of Dean District is considered as a tidal estuary and, therefore, does not have any catchment descriptors attached to it. It is tidally dominant from the lower reaches of the Arlingham bend and this presents the critical flood definitions rather than fluvial return periods. This also affects the lower reaches of tributaries entering the Severn Estuary (including the River Wye) if directly or as a result of tidal locking where formal outfall are present. The catchment descriptors given here are therefore those of the fluvial river at the downstream point of the fluvial catchment. Tidal influence along the River Severn through the Forest of Dean is significant, especially the high spring tide (the famous 'Severn Bore') when a sudden increase in tidal water level downstream is funnelled quickly and sometimes dramatically up the watercourse.
River Wye/ Hunger Pill	SO 5982 1804	SO 5679 1579 SO 5529 1436	SO 5980 1800	3271.29 (large)	0.527 (medium)	36.63 (medium)	115 (high)	The River Wye, also known as the 'Hunger Pill' as it nears its confluence with the Severn, forms the western boundary between Forest of Dean District and Wales with occasional variations near SO 5679 1579 and SO

	SO 5588 1546 SO 5348 1014	ST 5398 8859						5529 1436, where the watercourse falls entirely outside the District (for a distance of 1.5km and 6.5km respectively). The river originates in the hills of central Wales and has a large and relatively steep catchment upstream of the Forest of Dean District, flowing through a steep, rural and wooded valley at the western edge of the District itself. A small number of minor rivers drain westwards in the Wye en route to the Severn and the sea. The lower reaches of the River Wye as far as Monmouth can be influenced by high Spring Tides, the lower reaches between Chepstow and Beachley like the Severn, are tidally dominant in respect to flood risk.
River Leadon	SO 7016 3521	SO 8002 2174	SO 8000 2175	325.46 (medium)	0.558 (medium)	35.94 (medium)	58.7 (medium)	The River Leadon rises 9km north of the District and enters the District at SO 7016 3521. Initially it forms the District boundary for around 2km as it continues to flow southwards, and then it continues for a further 20km in a south easterly direction toward its confluence with the Severn. In its passage through the rural and un-wooded north of the District the River Leadon collects flows from a number of minor rivers and four other main rivers. Its upstream portion is steeper, levelling out as it enters the broad Severn valley.
Glynch Brook	-	-						Glynch Brook begins as a minor river in the hills to the north of the District and flows southward toward the Severn. The Glynch is classed as a main river from SO 7835 2934 onward, from where it collects two minor rivers on the left bank as it winds its way toward the confluence with the River Leadon near Upleadon (SO 7700 2697).
Colliers Brook	-	-						Colliers Brook begins at SO 7986 2596 on the eastern boundary with Tewkesbury and flows for 4.5km south west toward its confluence with the River Leadon at SO 7764 2349, collecting flow from 4 minor rivers en route.
Red Brook	-	-						The Red Brook is another tributary of the River Leadon flowing into the Leadon at SO 7758 2223. Its catchment extends beyond the eastern District boundary where various minor rivers arise to form the Red Brook main

								river at SO 7557 2314. From here it flows another 2.5km south east toward its confluence with the River Leadon.
Ell Brook	-	-						Similar to the Red Brook, the Ell Brook upstream catchment begins in the Welsh hills from where various minor rivers arise and form the Ell Brook main river at Newent (SO 7208 2639). It continues south east to its confluence with the River Leadon at SO 7739 2453.
Tibberton Brook	-	-						Tibberton brook begins as a number of small streams centred around May Hill village, which flow east towards Tibberton. It is a tributary of the Red Brook and is within the Leadon catchment. It is only classified as a main river for 0.8km, from SO 7523 2250 to SO 7560 2314.
Cinderford Brook	-	-	SO 6970 0750	49.65 (small)	0.563 (medium)	26.43 (medium)	107.5 (high)	Cinderford Brook main river, together with the Lyd, collects water from a catchment occupying the central part of the Forest of Dean District, namely from the slopes the Forest of Dean itself. It is classed as a main river from Ruspidge onward (SO 6504 1260) from where it flows 12km south east through the village of Blakeney to its confluence with the tidal River Severn at SO 7003 0663. Note that this river changes its name to Soudley Brook, Forge Brook, Bideford Brook and Brims Pill en route to its confluence with the Severn.
River Lyd	-	-	SO 6440 0130	57.38 (small)	0.58 (medium)	25.31 (medium)	100.6 (high)	The River Lyd as a main river is very short, only beginning just upstream of the town of Lydney (SO 6316 0378). From here it winds its way a short 4km southward toward its confluence with the tidal Severn at SO 6517 0140.

Key Recommendations: Chapter One

- The primary objective of the NPPF and associated NPPG is to steer development towards areas of lowest flood risk (Flood Zone 1). Where development cannot be located in Flood Zone 1, the planning authority will need to apply the Sequential Test to land use allocation and, where necessary, the Exception Test (requiring a Level 2 SFRA).
- The Exception Test is only appropriate for use when there are large areas in Flood Zones 2 and 3, where some continuing development is necessary for wider sustainable development reasons or where restrictive national designations such as AONBs, SSIs and WHSs prevent the availability of unconstrained sites in lower risk areas.
- To achieve safe development, dry pedestrian access to and from the development must be possible without passing through the 1% AEP (1 in 100 year) plus climate change floodplain; emergency vehicular access must be possible during times of flood; and the development must include flood resistance and resilience measures to ensure it is safe.
- The SFRA is a living document. As new flood risk information becomes available (such as updated Flood Zone information and more extensive information on flooding from other sources) it should be incorporated into the SFRA.
- The Sustainability Appraisal should be informed by the SFRA, to promote sustainable development.
- The NPPF and PPG should not be applied in isolation, but as part of the planning process. A careful balance must be struck between the NPPF and PPG and the requirements of other planning policy.
  Policies should recognise the positive contribution that avoidance and management of flood risk can make to the development of sustainable communities.

Chapter 2 - Study Methodology

2.1 Level 1 SFRA Methodology

Government advice (https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment and https://www.gov.uk/guidance/flood-risk-and-coastal-change#Strategic-Flood-Risk-Assessment-section) recommends a staged approach to SFRAs, depending on the development pressures and significance of flooding issues in the study area. The PPG recommends that a Level 1 SFRA should principally be a desk-based study making use of existing information and collaborating with appropriate environmental and flooding bodies, to allow the application of the Sequential Test and to identify where the Exception Test is likely to be necessary.

The main tasks undertaken during this study were as follows:

a) Establishing relationships and understanding the planning context:
A meeting was held to build relationships between the Council and the relevant flooding bodies to understand each other's remit and come to an agreement on what is necessary to include within the Level 1 SFRA leading onto the Level 2 SFRA. This allowed the partnering approach to form and allowed the free exchange of available information. This discussion was held on 13th February 2020 and included members of the Forest of Dean District Council's Local Plans Team, Sustainability Team and Drainage Team, the Environment Agency and the Gloucestershire County Council Lead Local Flood Authority. The pressures on the planning team with regards to meeting housing targets and the status and potential direction of the new local plan were discussed. It was agreed between the parties that the majority of the current SFRA Level 1 is sound, however, there would need to be updates to include areas such as changes to planning policies, updated information on the climate change allowance (being updated at the time of the meeting), fluvial and rainfall information (being updated at the time of the meeting), flood warning and alerts management as well as current drainage projects (management plans) and surface water data updates. The EA provides online guidance and the local office should always be contacted to confirm the required approach on site specific application sites.

The two relevant drainage authorities (Severn Trent and Welsh Water) were also consulted by email at an early stage and were asked to provide information on local flooding issues, such as Hydraulic Overload (DG5 Register). Subsequent to Storm Dennis and Storm Ciara, which took place in February 2020, resulting in some 60 residences in the Forest of Dean being flooded, both ST and WW were re-consulted in March 2020 and asked for updated data.

The Local Internal Drainage Board (Lower Severn) was also consulted in early April 2020 and was asked for an update on any management and project work they are currently carrying out in the district.

The Herefordshire and Gloucestershire Canal Trust were contacted at an early stage to provide confirmation of any restoration works, breaches, overtopping and raised sections.
Gathering date and analysing it for suitability:

A quality review of flood risk information was carried out by the core team, who reviewed the collated data, assessed its significance and quality and advised on which data would be

needed to drive the SFRA. Some data updates were required and the core team members requested that information from the relevant bodies. The main approach adopted for this SFRA Level 1 was to build on and update the previous SFRA (2008) and update existing information supplied during the data collection phase.

b) Producing strategic flood risk maps, GIS deliverables and a technical report:

A series of GIS maps were produced using the data gathered in the early phases of the study. The main mapping output is the strategic flood risk maps of the entire study area, which shows Flood Zones 1, 2 and 3 and flooding from all other sources, and should be used to carry out the Sequential Test. Other maps include study areas maps showing canals, fluvial features, climate change maps showing the impacts of climate change on flood probability, geological maps, historic flood outline maps, and maps showing flood watch and warning areas. These online maps can be freely accessed, or GIS layers can be requested from the Planning Policy Team if required and available.

c) Providing suitable guidance:
Sections have been written in the report providing guidance on policy considerations, the application of the Sequential Test, guidance for the preparation of FRAs and guidance for the application of SUDS in the study.

2.2 Need for a Level 2 SFRA

Where the need to apply the Exception Test is identified, due to there being an insufficient number of suitably available sites for development, or existing allocations (which will be carried over to the new Local Plan) within zones of lower flood risk or due to possible increased is in flood risk arising from climate change, the scope of the SFRA will need to be widened to a Level 2 assessment.

This increased scope involves a more detailed review of flood hazard (flood probability, flood depth, flood velocity, rate of onset of flooding) taking into account the presence of flood risk management measures such as flood defences. This could include 2D modelling and breach/overtopping analysis for certain locations.

Level 2 SFRA outputs include:

- An appraisal of the condition of flood defence infrastructure and likely future policy;
- An appraisal of the probability and consequence of breach or overtopping of flood defence infrastructure;
- Maps showing distribution of flood risk across zones;
- Guidance on appropriate policies for making sites which satisfy parts a) and b) of the Exception Test safe; and the requirements for satisfying part c) of the Exception Test;
- Guidance on the preparation of FRAs for sites with varying flood risk across the Flood Zone.
- The impacts of relevant climate change guidance on all of the above.

In general, the Level 2 SFRA should aim to provide clear guidance on appropriate risk management measures for adoption on sites within Flood Zone 3, which are protected by existing defences. This should minimise the extent to which individual developers need to undertake separate studies on

the same problem. The scope of a Level 2 SFRA cannot be fully determined until the Sequential Test has been undertaken by the Council on all possible site allocations.

2.3 Technical Background

It is useful to gain a good understanding of Flood Zones and the approaches taken to satisfy the Level 1 SFRA requirements, using existing data.

2.4 Flood Zones

Flood Zones show the areas potentially at risk of flooding from rivers or the sea, ignoring the presence of defences (although areas benefitting from formal defences are identified).

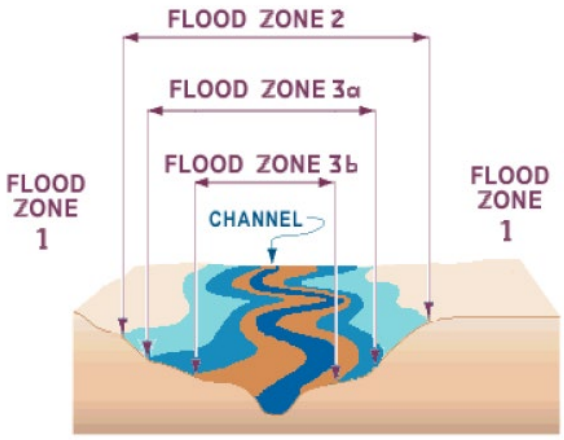


Fig 2.1 – Flood Zones

PPG defines the Flood Zones as follows:

Zone 1: Low Probability

This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<01.%).

Zone 2: Medium Probability

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

Zone 3a: High Probability

This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Zone 3b: The Functional Floodplain

This zone comprises land where water has to flow or be stored in times of flood (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, including water conveyance routes).

It should be noted that flooding from surface water, groundwater, sewers and impounded water bodies can occur in any zone, even Flood Zone 1.

Flood Zone maps in the SFRA have been produced from two sources: Environment Agency Flood maps, published and updated quarterly on their website (and GIS files provided to the Council) and detailed local hydraulic modelled outlines (a list of these models can be found in Table 5.1). Again, if the EA advises that this information has now been updated, it will be included in a future addendum.

2.5 Environment Agency Flood Zone Maps

A national flood map dataset has been produced by the Environment Agency. Most fluvial Flood Zones 2 and 3 are derived from the modelling package JFlow, which is a 'coarse' modelling approach. In many places the results of flood mapping studies have superseded the JFlow outlines. Generally these studies have included detailed hydrological research surveyed river cross sections, and more precise digital modelling such as ISIS, TuFlow and HecRas.

It should be noted that not all minor watercourses have had Flood Zone maps produced for them. Only watercourses with a catchment area greater than 3km^2 have been modelled using JFlow software and, therefore, smaller watercourses as identified on the 10K or 25K OS maps within Flood Zone 1 may not be covered by the Environment Agency Flood Zone maps. As such, for any development site located adjacent to an unmapped watercourse within Flood Zone 1, it is recommended that an 8m development easement from the top of bank is applied, and a site specific FRA is undertaken. It should be noted that the Environment Agency is not the statutory consultee for ordinary watercourses and developers should refer to the Lead Local Flood Authority (Gloucestershire County Council) or to the Council's Land Drainage department.

Key Recommendations: Chapter Two

- Not all minor watercourses have had Flood Zone maps produced for them, specifically, those with a catchment area of less than 3km^2. These watercourses may appear to be fully in Flood Zone 1, when in reality a degree of flood risk will be posed. For any development site located adjacent to an unmapped watercourse within Flood Zone 1, an 8m development easement from the top of bank must be applied and a site specific FRA undertaken.
- The Environment Agency is not the statutory consultee for ordinary watercourses and developers should refer to the Lead Local Flood Authority (GCC) or the Council's Land Drainage department.

Chapter 3 -Policy and Strategy Context

3.1 Introduction

This section provides an overview of the planning policy framework relevant to the Forest of Dean District Council.

This report has been prepared in accordance with the National Planning Policy Framework and Planning Practice Guidance. The Level 1 SFRA is a key point of reference to the council in developing their local flood risk policies and this section is designed to facilitate future policy development, as well as raising awareness of the policy that must be considered by developers wishing to build within the district.

3.2 Planning Policy Framework

The UK planning system has a comprehensive hierarchy of policies and plans, beginning with national guidance leading to development plans at the local level. Development plans are intended to provide the framework for the future development of an area. They are prepared following public and stakeholder involvement and are intended to reconcile conflicts between the need for development and the need to protect the wider built and natural environment.

The following paragraphs provide an overview of the relevant policy documents for the SFRA at the time of writing.

3.3 National Policy

3.3.1 National Planning Policy Framework and Planning Practice Guidance

The updated NPPF (updated 2021) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which local authorities can prepare plans for housing and other development.

The NPPF must be taken into account when preparing local development plans and is a material consideration in planning decisions.

The PPG provides guidance on the implementation of the planning policies set out in the NPPF, including a framework for the production of SFRAs.

Section 14 of the NPPF states that strategic policies should be informed by an SFRA, and manage flood risk from all sources. In the preparation of an SFRA, the EA and any other relevant risk management authorities should be consulted. Local plans should apply a sequential, risk-based approach to the location of new development in order to avoid, where possible, flood risk to people and property, and manage any residual risks, taking into account the impacts of climate change.

Paragraph 161 states that in general, these requirements will be met by:

"All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

a) applying the sequential test and then, if necessary, the exception test as set out below;

b) safeguarding land from development that is required, or likely to be required, for current or future flood management;

c) using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management); and

d) where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations."

3.3.2 The Sequential Test

In reference to the Sequential Test, Paragraph 162 of the NPPF states that:
"The aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding."

3.3.3 The Exception Test

In reference to the Exception Test Paragraphs 163-166 of the NPPF are relevant:
"163. If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3.

164. The application of the exception test should be informed by a strategic or sitespecific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. To pass the exception test it should be demonstrated that: a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and b) 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.

165. Both elements of the exception test should be satisfied for development to be allocated or permitted.

166. Where planning applications come forward on sites allocated in the development plan through the sequential test, applicants need not apply the sequential test again. However, the exception test may need to be reapplied if relevant aspects of the proposal had not been considered when the test was applied at the plan- 48 making stage, or if more recent information about existing or potential flood risk should be taken into account."

3.3.4 Flood risk vulnerability and Flood Zone compatibility

The assessment of flood risk considers the risk of flooding to a development site, from all sources and including an allowance for climate change, as well as the vulnerability of the proposed development to the impacts of flooding. The PPG summarises the proposed vulnerability classification for different types of development to flood risk. In addition to the use of the Sequential Test when determining the suitability of the site for development, a sequential approach should be

adopted within a proposed development site, which proposes to locate the most vulnerable areas of a development to those areas of lowest flood risk within the site.
The PPG provides recommendations on the vulnerability of different types of development and the compatibility of each vulnerability classification within each of the EA's mapped fluvial and tidal Flood Zones. Table 3.1 summarises the vulnerability classifications as set out within the PPG.

Table 3.1 Flood Risk Vulnerability Classifications (taken from Annexe 3 of NPPF)

Vulnerability classification	Examples of Development
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 infrastructure for electricity supply including generation, storage and distribution systems; and water treatment works that need to remain operational in times of flood. • Wind turbines. • Solar farms
Highly Vulnerable	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	Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, 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. • 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. • Car parks.
Water-Compatible Development	Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based

	recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 3.2 below summarises the compatibility of each vulnerability classification within each of the mapped fluvial and tidal Flood Zones and where the Exception Test will be required. It is important to note that even where development is considered acceptable, the Sequential Test and sequential approach (as discussed above) should still be applied.

Table 3.2 Flood Risk vulnerability and Flood Zone compatibility (taken from Table 2 of Para. 079 Reference ID: 7-079-20220825 of the PPG)

EA Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception test required	✓	✓	✓
Zone 3a	Exception test required †	X	Exception test required	✓	✓
Zone 3b	Exception test required *	X	X	X	✓ *

✓Exception test is not required
X Development should not be permitted
† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood

* In Flood Zone 3b (functional floodplain) essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

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

The PPG (https://www.gov.uk/guidance/flood-risk-and-coastal-change#table2) provides guidance on the implementation of the planning policies as set out in the NPPF. The application of the Sequential Test and Exception Test at the development level is discussed further in Chapter 9.

3.3.5 Flood Water Management Act

The Flood and Water Management Act (2010) UK Parliament (2010) Flood and Water Management Act 2010. Available online: http://www.legislation.gov.uk/ukpga/2010/29/contents provides the basis for implementing many of the recommendations from Sir Michael Pitt's Review of the major floods in

2007. The Review placed a series of responsibilities on local authorities with the primary aim of improving local flood risk management. The Flood and Water Management Act created the role of the LLFA (Lead Local Flood Authority). The LLFA for the whole Study Area is Gloucestershire County Council.

3.3.6 Environmental Permitting (England and Wales) Regulations

Under the Environmental Permitting Regulations (England and Wales) 2016 (UK Parliament (2016) Environmental Permitting Regulations 2016 (http://www.legislation.gov.uk/uksi/2016/1154/contents/made) , it is an offence to cause or knowingly permit the discharge of polluting materials to surface waters or groundwater, unless complying with an exemption or a Discharge Activities Permit that can be obtained from the EA as detailed in their guidance (Department for Environment, Food and Rural Affairs and Environment Agency (2016) Check if you need an environmental permit (https://www.gov.uk/guidance/check-if-you-need-an-environmental-permit). Under the Environmental Permitting Regulations, it is also a requirement to obtain a Flood Risk Activities Permit (Department for Environment, Food & Rural Affairs and Environment Agency (2018) Flood risk activities: environmental permits) (previously known as Flood Defence Consent) for any works on or near a main river, on or near a flood defence structure, in a floodplain, or on or near a sea defence.

3.3.7 Localism Act

The Localism Act (2011) (UK Parliament (2011) (http://www.legislation.gov.uk/ukpga/2011/20/contents/enacted) aims to transfer certain decision-making powers from central government to local government, communities and individuals. In relation to the planning of development, the Localism Act provides new rights to allow local communities to come together and shape new developments by preparing Neighbourhood Development Plans, Neighbourhood Development Orders and Community Right to Build Orders.

The Localism Act also supported and reformed the Community Infrastructure Levy (CIL), that provides councils with an alternative source of potential funding for infrastructure schemes. It is a tool that LPA's can use to deliver infrastructure that supports development anywhere in their administrative area. The charges vary across LPA's and are levied on the size and type of the new development. The money raised from the CIL could be used to fund flood defence works and flood alleviation schemes within the Study Area, however, CIL is not currently in place in the Forest of Dean District.

3.3.8 Land Drainage Act

The Land Drainage Act (1991) (https://www.legislation.gov.uk/ukpga/1991/59/contents) sets out the maintenance responsibilities of riparian owners to reduce local flood risks. Riparian owners, who are land owners with a watercourse either running through their land or adjacent to, have the responsibility to ensure that the free flow of water is not impeded by any obstruction or build-up of material within the watercourse. A riparian owner has the duty to accept the natural flow of water from upstream and has the right to convey the flows unimpeded downstream.

Under the Land Drainage Act, on designated Main Rivers, the EA has permissive powers to require landowners to undertake maintenance activities. Named minor rivers (or ordinary watercourses) within the District are listed in Table 1.3. A number of minor rivers also exist within the District and are shown in the online map. Minor rivers cover every river, stream, ditch, drain, cut, dyke, sluice,

sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. The local authority or Internal Drainage Board (IDB) where relevant, has powers for ordinary watercourses.

The Lower Severn Internal Drainage Board operates within the District. The IDB manages water levels at the margins of the Severn estuary using numerous rhynes, pills and control structures.

3.3.9 The Water Act

The Water Act (2003) (https://www.legislation.gov.uk/ukpga/2003/37/contents) amended the Reservoirs Act (1975) (https://www.legislation.gov.uk/ukpga/1975/23) and requires the preparation of dedicated Flood Plans for large raised reservoirs, to be prepared by the asset owner. A large raised reservoir is defined in the Act as a structure 'designed to hold, or capable of holding, more than 25,000m3 of water above that level (the natural level of any part of the land adjoining it).'

As of 2009 dedicated Flood Plans must be prepared by the reservoir owner for all large raised reservoirs that may pose flood risk. A Flood Plan is a set of documents that describe the arrangements to be put into operation in response to a sudden large release of water from a reservoir that could pose a threat to property and life downstream. They include an assessment of the impacts of dam failure, a review of the measures that can be taken by the reservoir operator to prevent the catastrophic failure and an assessment of the emergency response mechanism required to minimise risk to life and property should a failure occur.

3.3.10 Water Framework Directive

The primary aim of the Water Framework Directive (WFD) is to improve/maintain the Ecological Status/Potential of all water bodies and to prevent deterioration in status of the water bodies and their associated WFD quality elements. Ecological Status/Potential is determined by a suite of biological, physio-chemical and hydromorphological quality elements.

The overarching objective of the WFD is for surface water bodies to attain overall 'Good Ecological Status (GES) or 'Good Ecological Potential' (GEP). GES refers to situations where the ecological characteristics show only a slight deviation from natural/near natural conditions. In such a situation, the biological, chemical, physio-chemical and hydromorphological conditions are associated with limited or no human pressure. Artificial and heavily modified water bodies have a target to achieve GEP, which recognises their important uses, whilst ensuring the quality elements are protected as far as possible.
The introduction of a new modification, change in activity or change to a structure on a water body needs to be considered in relation to whether it could cause deterioration in the Ecological Status or Potential of any water body. Regulatory bodies responsible for implementing the WFD are the Environment Agency (Main Rivers) and Local Authorities/LLFAs (Ordinary watercourses).

3.4 Regional Policy and Strategy

3.4.1 Flood Risk Management Plans and Strategies – Severn River & River Wye

There is also a wide range of Flood Risk Management Strategies and Plans for the relevant areas within Gloucestershire (mainly covering the Severn Estuary and the River Wye) which are equally as important when creating planning policies. More detailed information on these can be found in Chapters 4, 6 and 7 of this report.

3.4.2 Gloucestershire Local Flood Risk Management Strategy

Gloucestershire County Council (GCC) is the Lead Local Flood Authority (LLFA) as defined by the Flood and Water Management Act 2010. As part of that role, the LLRA is obliged to publish a Local Flood Risk Management Strategy (https://www.gloucestershire.gov.uk/your-community/emergencies-and-your-safety/flooding-and-drainage/gloucestershire-county-councils-local-flood-risk-management-strategy-lfrms/). This document was published in the Summer of 2014 and sets the direction for local flood risk management in Gloucestershire. It identifies the range of measures the LLFA will take in partnership with others to manage flood risk. It is a 'living document' and will be updated as and when necessary to support future local flood risk management.

3.5 Local Policy

3.5.1 Local Development Framework

The LDF is not a single document, but rather a 'folder' into which a series of documents are placed. This flexible approach enables some aspects of the Framework to be revised quickly in response to changing circumstances, whilst leaving others to endure for the longer term. The composite documents (the LDDs) have different purposes, some used to guide and others to inform. The main documents involved are:

- The Statement of Community Involvement
- The Authorities Monitoring Report
- The Local Development Scheme
- Supplementary Planning Documents
- The Core Strategy
- Site Specific Allocations
- Adopted Proposals Map
- Generic Development Management Policies (DPD)

Supplementary Planning Documents (SPDs) may be prepared to add further detail or guidance to DPDs.

In preparing the LDF, the Council is required to prepare a Local Development Scheme (LDS). This is a three-year project plan setting out, in detail, how and when the Council intends to prepare the various components of its LDF. The Forest of Dean Council is currently in the preliminary stages of developing a new Local Plan. This planning process is referred to as "Plan 41" which will provide a new Local Plan for the district, replacing the current Local Development Framework.

The Local Development Scheme (LDS) is our timetable for preparing the new Local Plan and other Local Plan documents.

This planning process has already begun and is expected to run until 2024, when a new Local Plan is scheduled to be adopted, which will guide and control development in the district up to the year 2041.

The Statement of Community Involvement (SCI) sets out how the Council will involve the community in preparing and revising all local planning documents and in making decisions on planning applications and other related applications.

3.5.2 Core Strategy

The Core Strategy was adopted in February 2012, superseding the Forest of Dean District Local Plan Review (2005). It forms the principal document in the Local Plan for the Forest of Dean.

The main policies regarding flooding within the CS are as follows:

Policy CSP.1 seeks to achieve *'Design, environmental protection and enhancement'* by considering the following (amongst others):

Whether the development is at risk from flooding, whether it can be permitted taking into account any risks, and the sequential approach and any mitigation that may be necessary to ensure the development is safe and flood risk is not increased elsewhere;

The provision of water supply and the development's impact on groundwater, watercourses and any protected abstractions.

Policy CSP.2 is concerned with *'Climate Change Adaptation'* and includes the following:

Water Management

1. Improving water efficiency-proposals should demonstrate high levels of water efficiency. Rain water harvesting and grey water recycling systems should be incorporated unless it can be demonstrated that it is not appropriate in a specific location.
2. Managing surface water run off- Sustainable Drainage Systems (SUDS) and measures to reduce or avoid water contamination and safeguard water supply should be incorporated into all development unless it can be demonstrate that this is not appropriate in a specific location.
3. Flood risk- ensuring that risks (including risks due to climate change) are taken account of in new development, including improving resistance, resilience and safety of the areas concerned.

3.5.3 Allocations Plan

The Allocations Plan forms part of the current Local Plan, alongside the Core Strategy, with which it shares common aims and objectives. The AP was adopted in 2018 and looks forward to 2026. Many of the policies within the AP are site specific and whilst sustainability and the aim to provide a quality environment are common themes through the AP, there are no specific policies for flood risk, drainage or water quality.

3.5.4 Local Plan (2021-2041)

The new Local Plan is currently being prepared and it is intended that it will come into and provide the basis for planning decisions within the area up until 2041.

3.5.5 Forest of Dean – Technical Guidance (Amended 2015)

The Building Control department of the FoDDC has published a document named 'Planning Stage Guidance on Drainage Requirements for Domestic Extensions and Single Dwellings'. It provides technical guidance on how to adequately design and implement sustainable drainage methods which will meet building control regulations.

3.5.6 Neighbourhood Development Plans (NDPs)

The following Neighbourhood Development Plans have been made:

- Berry Hill, Christchurch and Edge End
- Coleford
- Longhope
- Lydney
- Mitcheldean
- Alvington

Other NDPs are currently being developed, however, they are not yet made. These include:

- Newent
- Dymock
- Pillowell

  Huntley (has been examined)

3.6 Other Important Policies/Guidance

3.6.1 Non-Statutory Technical Standards for Sustainable Drainage

The Non-Statutory Technical Standards for Sustainable Drainage Systems (LASOO – Non-statutory Technical Standards for Sustainable Drainage – Practice Guidance.) set out the core technical standards for Sustainable Drainage Systems (SuDS) proposed within England. These standards should be used in accordance with the NPPF and the PPG.

Whilst the standards should be considered for new and existing development of any size, they are judged to be of particular importance to major development as defined in the Town and Country Planning (Development Management Procedure) (England) Order 2010 (UK Parliament (2010) The Town and Country Planning (Development Management Procedure) (England) Order 2010. Available online: http://www.legislation.gov.uk/uksi/2010/2184/contents/made).

The standards include guidance on controlling flood risk within a development boundary and elsewhere, peak flow and runoff volume control, and the structural integrity of SuDS.

3.6.2 The SuDS Manual (C753)

The SuDS Manual published by CIRIA (updated 2015) (https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx) provides comprehensive guidance on the planning, design and implementation of SuDS. The manual provides guidance on runoff estimation, design of attenuation and infiltration systems, designing for exceedance and pollution control. In addition, it provides guidance on planning for the future operation and maintenance of SuDS which is important to ensure suitable arrangement can be put in place to manage the infrastructure for the lifetime of the development. It also supports the cost-effective delivery of multiple benefits via the use of SuDS.

3.6.3 Lower Severn Internal Drainage Board Advice

The Lower Severn internal Drainage board operates within the District. The IDB manages water levels at the margins of the Severn estuary using numerous rhines, pills and control structures. The Lower Severn IDB does not currently have any published planning guidance for developers.

3.7 Roles and Responsibilities

The following table provides a brief overview on the roles and responsibilities of different parties in relation to flood risk:

Authority	Roles and Responsibilities
Environment Agency	The EA has a strategic role in all flood risk matters but is directly responsible for the prevention, mitigation and remediation of flood risk for main rivers, large reservoirs and coastal areas. The EA's main roles and responsibilities include: • Strategic overview of the management of all sources of flooding; • Operational responsibility for managing the risk of flooding from main rivers and reservoirs; • Consultee for strategic plans including this SFRA; • Responsible for flood forecasting and flood warning; • Issuing levies to local authorities to support the implementation of flood defence schemes and managing the allocation of funding for flood defence and flood resilience schemes; • Power for enforcing, consenting and carrying out works for main rivers;

	• Produce flood risk mapping and manage historical flood records/data; • Enforcement authority for Reservoirs Act 1975; • Issuing of environmental permits for flood risk activities; and • Consultee for the majority of development located in Flood Zones 2 and 3 and all development within 20m of a main river.
Gloucestershire County Council (LLFA)	GCC is the LLFA as defined by the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009. This means GCC has the leadership and coordinating role for flood risk across the county from surface water runoff, ordinary watercourses and groundwater. In addition GCC has a responsibility for managing flood risk from the highway network and planning for emergencies. GCC also has the statutory duty to develop and maintain a Local Flood Risk Management Strategy. This Strategy (2014) sets out how GCC will aim to manage flood risk in partnership across Gloucestershire over the next 10 years: - Develops a strategy to tackle local flood risk from local sources; surface water, ordinary watercourses, groundwater, canals, lakes and small reservoirs - Builds partnerships and ensures effective working between flood risk management authorities - Investigates all significant flooding incidents in accordance with Section 19 of the Flood and Water Management Act - Acts as statutory consultee for surface water for all major planning application developments.
Forest of Dean District Council	The Local Authority has powers to undertake flood risk management work to ordinary watercourses and have a responsibility for coastal erosion. - Power to designate structures and features that affect flooding or coastal erosion - Power to do works on ordinary watercourses; and - Power to implement and maintain flood defences on ordinary watercourses The Local Planning Authority must also develop planning policies within its Local Plan and guidance documents to address flood risk. The LPA is required to undertake technical studies to support this function, such as compiling this SFRA.
Lower Severn Internal Drainage Board	The Lower Severn IDB is a drainage body under Section 72 of the Land Drainage Act 1991. Its responsibilities include: - Contributing to the management of flood risk and protecting and enhancing biodiversity in urban and rural areas - Managing ordinary watercourses and ordinary watercourses and the surrounding land that will derive benefit or avoid danger as a result of drainage operations. Works are funded via charges on development, drainage rates paid by landowners and a special levy upon the eight local authorities within which the Board operates.
Severn Trent Water and Welsh Water	Within their operational areas, the sewerage undertaker's responsibilities are: - Maintain and manage sewerage systems to manage the impact and reduce the risk of flooding and pollution to the environment - Statutory consultee for any proposed discharge to the public sewerage system - Provide advice to LLFAs on how water and sewerage company assets impact on local flood risk - Work with developers, landowners and LLFAs to manage risks.
Riparian owners	Under the Land Drainage Act, riparian owners are land owners with a watercourse either running through their land or adjacent to it. They have responsibility to ensure that the free flow of water is not impeded by any obstruction or build-up of material within the watercourse. A riparian owner has the duty to accept the natural flow of water from upstream and has the right to convey the flows unimpeded downstream.

The following diagram has been provided by the LLFA (Local Flood Risk Management Strategy) and shows the roles and responsibilities for different water sources within Gloucestershire:

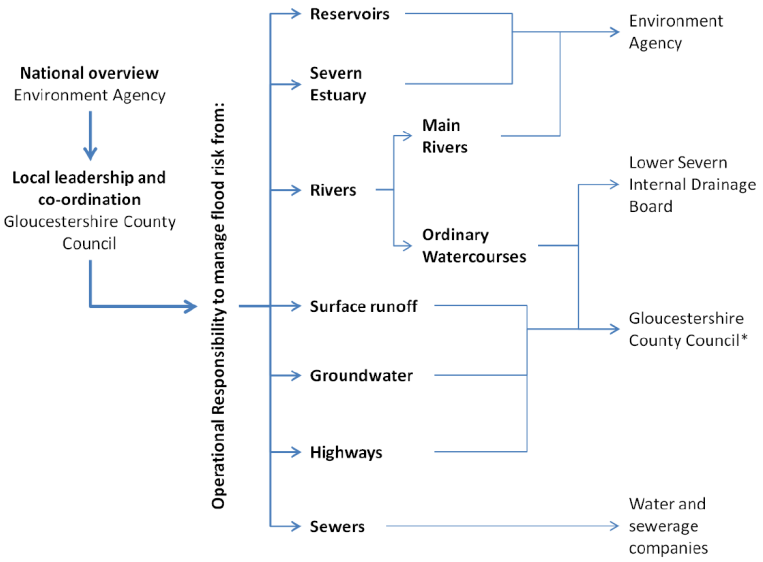


Fig 3.1 Roles and Responsibilities

Chapter 4 – Data Collection and Review

4.1 Overview of Flooding Sources

Flooding can come from a variety of sources, including rivers, rainfall on the ground surface (surface water), rising groundwater, overwhelmed sewer and drainage systems and breached or overtopped reservoirs and canals. This chapter gives a strategic assessment of the risk posed to the study area from these sources.

4.2 Approach to Data Gathering

Throughout the data collection and review process it has been critical to make best use of the significant amount of information which already exists with respect to flood risk (held by the Councils, Environment Agency, the Highways Agency, Severn Trent Water, Welsh Water and the Lower Severn Internal Drainage Board. The data gathering process has resulted in a review of:

- Strategically important documents
- Historical flooding information from Environment Agency historic flood outlines and various datasets from water companies, as well as the Council's own datasets detailing flooding experienced from 'other sources'
- Environment Agency Flood Zone maps and detailed flood risk mapping outputs, including fluvial climate change outputs
- Information on flood risk management infrastructure, including defences, culverts and structures (supported by information from the Council and the Environment Agency's National Flood and Coastal Defence Database)
- Existing Flood Risk Management Plans, Flood Risk Management Strategies, Shoreline Management Plans, etc.
- Environment Agency flood warning and flood watch information

The team has been able to review the collected data, assess its significance and quality, and advise on which part of the collected data should be used for the SFRA. The main approach to the SFRA has been to build on previous studies and gathered information.

Consultation has formed a key part of the data gathering stage of the SFRA. The stakeholders were consulted during the SFRA and as part of the consultation process, an Inception Meeting was held on 13th February 2020, including members of the Forest of Dean District Council's Local Plans Team, Sustainability Team and Drainage Team, the Environment Agency and the Gloucestershire County Council Lead Local Flood Authority. This allowed the key stakeholders to share their experience and knowledge of flooding issues across the study area. The EA has kindly acted as a critical friend and proofread a draft version of this document, offering relevant comments.

4.3 The Pitt Review

The Pitt Review was undertaken by Sir Michael Pitt on behalf of the Government in 2007. It was an independent review with the purpose of reviewing the flood-related emergencies which had occurred during the 2007 summer floods. The final report made recommendations which are still relevant today, including the lead role and responsibility of the Local Authority with regards to flood risk management with support of the relevant organisations.

4.4 Regional Flood Risk Appraisal (RFRA)

The last South West Regional Flood Risk Appraisal was completed in February 2007. Its purpose was to inform the SA of the Regional Spatial Strategy (RSS were revoked in 2010). It provided a broad overview of the source and significance of all types of flood risk across the region, and has been used to assess and influence housing and employment as well as to identify where flood risk management measures may be functional at a regional level. The main aim of the RFRA was to direct development away from areas at highest risk of flooding. Whilst this report is now outdated, it still provides a good level of historical information.

4.5 LLFA – Local Flood Risk Management Strategy (LFRMS)

Under 2010 legislation, Gloucestershire County Council has new responsibilities as a Lead Local Flood Authority (LLFA). This means GCC has a leadership and coordinating role for flood risk across the county from surface water runoff, ordinary watercourses and groundwater. In addition GCC has a responsibility for managing flood risk from the highway network and planning for emergencies. The 2010 legislation also gave GCC the statutory duty to develop and maintain a Local Flood Risk Management Strategy. The Strategy sets out how GCC will aim to manage flood risk in partnership across Gloucestershire over the next 10 years. As part of the Strategy, GCC has identified the most vulnerable locations for flood risk and these remain our highest priority for seeking viable and cost effective solutions. On an annual basis, GCC prepares and publishes an Annual Progress and Implementation Plan.

The LFRMS was adopted in 2014 and discusses the principles of the LFRMS, an understanding of flood risk in Gloucestershire, measures to manage local flood risk, funding strategies, action plans and monitoring and review procedures.

4.6 Flood Risk Management Plans

The study area is covered by the Severn River Basin Flood Risk Management Plan 2021-2027 (FRMP), which is a collaboration between the Environment Agency and relevant local and risk management authorities. It is a second cycle Flood Risk Management Plan which aims to manage significant flood risks in the Flood Risk Areas (FRAs) identified in the Severn River Basin District (RBD). The FRMP covers flood risk from fluvial, tidal, surface water and sewer sources.

4.7 Catchment Flood Management Plans

A Catchment Flood Management Plan (CFMP) was a high-level strategic plan through which the Environment Agency sought to work in partnership with other key decision-makers within a river catchment to explore and define long term sustainable policies for flood risk management. CFMPs have now been superseded by the Flood Risk Management Plans (see above).

4.8 Shoreline Management Plans (SMPs)

Shoreline Management Plans (SMPs) deal with the flood risk management of a shoreline rather than a river catchment. The Severn Estuary Shoreline Management Plan (SMP2) was updated in 2017. It is developed by the Severn Estuary Coastal group in partnership with the Environment Agency and other local authorities, regulators and other stakeholders, and is a high level non-statutory policy document. It provides a large-scale assessment of the risks (to people, property, the natural and historic environment) associated with coastal erosion and flooding at the coast in the long-term. It proposes policies to manage these risks sustainably over the next hundred years.

The Severn Estuary Shoreline Management Plan 2 (SMP2) is relevant to the Forest of Dean District. More detailed information on this can be found in Chapter 6.

4.9 Flood Risk Management Strategies

The Environment Agency also produces flood risk management strategies, which aim to deliver strategic options for flood risk management. The most relevant to this District are primarily the Severn Estuary Flood Risk Management Strategy as well as the 2017-2027 Severn Estuary Strategy. More detailed information on these can be found in Chapter 6.

4.10 Gloucestershire Parishes Flood Risk Prioritisation Assessment – Forest of Dean District Summary Report 2016

In its role as Lead Local Flood Authority, Gloucestershire County Council (GCC) is proactively seeking to promote flood risk improvements throughout the County. Atkins Limited was commissioned to undertake a Flood Alleviation Pre-Feasibility assessment at 19 selected parishes and wards within the County. The objective of the investigation is to identify locations where low-engineered improvements could be targeted to achieve best value in reducing the overall level of flood risk, and suggest feasible, cost-beneficial solutions. (Gloucestershire Parishes Flood Risk Prioritisation Assessment 2016). Within the Forest of Dean District, 7 civil parishes (CP) have been identified for potential flood risk improvements. These are:

- Awre CP;
- Coleford CP;
- Mitcheldean CP;
- Newland CP;
- Tidenham CP;
- West Dean CP; and
- Westbury-on-Severn CP.

The predicted areas of flooding and proposed improvements can be summarised as follows (details of the monetary value placed on flooding damage and the proposed improvements can be found in the main report):

Places most likely to be flooded in each Civil Parish	Type of flooding considered in report	Predicted flooding of properties in the whole of the Civil Parish	Number	Predicted area flooded (m^2)	Proposed Improvement scheme
Awre Civil Parish					
• High Street, Blakeney • Moorfield Ave, Blakeney • Nibley, Blakeney	Pluvial & Fluvial	Residential Retail Warehouses Public Building Industry Leisure Electricity substation	86 6 100 2 1 2 1	7,470 515 9,500 586 67 121 16``	1) Flood protection to electricity substation off The Smithy 2) Flood protection to the doctor's surgery off Millend Road 3) Construct flow control structure and flood embankment upstream of Old Mill 4) Remove the weir in Blackpool Brook located off Bridge Street 5) Construct flood defence embankment at Nibley.
Coleford Civil Parish					
• Coleford Town Centre • Crucible Close and Stepbridge Road • Suntory factory	Pluvial & Fluvial	Residential Retail Offices Warehouses Public Building Industry Leisure Electricity substation	495 97 49 171 9 2 4 6	33,175 50,464 3,716 42,616 2,582 309 995 564	1) Construct dwarf wall and concrete slab at electricity substation off New Road 2) Construct dwarf wall and concrete slab at electricity substation off Newland Street 3) Construct dwarf wall and concrete slab at electricity substation off Market Place 4) Install channel drains and a new drainage network in the town centre of Coleford 5) Improve drainage infrastructure at the industrial estate at Crucible Close and Stepbridge Road.
Mitcheldean Civil Parish					
• Mitcheldean town centre	Pluvial & Fluvial	Residential Retail Offices Warehouses Public buildings Industry Leisure Electricity substation	150 45 11 75 6 4 2 2	13,439 62,105 5,808 12,577 3,470 407 437 38	1) Intercept surface water runoff and convey to unnamed watercourse at A4136 highway 2) Intercept surface runoff at Baynham Road and installation of SuDS storage 3) Construct surface water pumping station at low point in industrial estate.
Newland Civil Parish					
• Brewery Cottages, Redbrook • Playing fields, Clearwell • Clearwell Castle	Pluvial & Fluvial	Residential Retail Warehouses Public buildings Leisure	87 2 95 1 2	6,649 437 9,751 188 414	1) Protection of the electricity substation at Tinman's Green, Redbrook 2) Reconstruct canalised Valley Brook channel in Clearwell 3) Install individual flood protection measures in Newland 4) Excavate new channel and replace existing culvert in Newland

• Laundry Road, Newland • Northern boundary of parish • Clearwell Road, Newland • Rose Cottage, main road in Newland • Yew Tree Cottage, Newland		Electricity substation	1	16	5) Install individual flood protection measures to properties on Newland Road.
Tidenham Civil Parish					
• Day House Farm, Tidenham • Wyedean School, Sedbury	Pluvial & Fluvial	Residential Retail Warehouses Public buildings Leisure Electricity substation	204 1 81 2 3 1	18,126 77 19,320 2,846 2,754 13	1) Interception and diversion of surface water flows from Wyedean School 2) Construct flood defence bund around Day House Farm
West Dean Civil Parish					
• Berry Hill • Bream • Parkend • Phipps Bottom and Whitecroft • Sling • Yorkley Slade	Pluvial & Fluvial	Residential Retail Offices Warehouses Public buildings Industry Leisure Electricity substation	386 25 1 201 5 6 3 7	27,698 17,439 106 25,254 2,064 6,210 412 288	1) Construct flood bund, new culvert and outfall at the Gamekeeper's Inn, Berry hill 2) Install flood protection measures, Bream 3) Use the recreation ground for storage, Parkend 4) Install flood protection measures, Phipps Bottom and Whitecroft 5) Construct flood wall adjacent to industrial units at Whitecroft 6) Install drainage improvement measures, Sling 7) Construct bund across upper catchment and install drainage improvements, Yorkley Slade.
Westbury-on-Severn					
• Broadoak • Elton Road • Upper Ley • Westbury-on-Severn	Pluvial & Fluvial	Residential Retail Warehouses Industry Leisure	96 3 235 1 3	8,977 331 48,912 100 1,900	1) Restrict flow through culverts through railway embankment, Westbury-on-Severn 2) Construct flow control structure and embankment upstream of A48 highway, Westbury-on-Severn 3) Construct a new culvert under the A48 highway, Westbury-on-Severn 4) Improve existing culvert and channel, install additional pipe culverts, Elton 5) Install property level protection to flood risk properties, Broadoak 6) Install package pumping station and flood storage area, Broakoak

					7) Install property level protection to flood risk properties, Upper Ley 8) Construct a flood defence embankment around village, Upper Ley.

Table 4.1 Proposed Improvement Scheme

4.11 LLFA Annual Progress and Implementation Plan

The LLFA's Annual Progress and implementation Plan 2019/20-2020/21 gives information on future capital scheme are programmed according to Prioritised Flood Alleviation Schemes list (PFAS). Within the current (2020/2021) list of schemes with confirmed funding are:

Table 4.2 Progress and Implementation

Forest of Dean	Coleford CP	Coleford Town Centre	Install channel drains and a new drainage network in the centre of Coleford	179	£471,000
Forest of Dean	Lydney CP	Cookson Terrace	Property Flood resilience measures to rear gateways and boundary walls	TBC	£30,000

Although there is currently no timescale for when these works will be carried out.

4.12 Historical flooding

Recent years have seen a number of large scale flood events throughout the UK including Easter and October 1998, Autumn 2000, February 2002, New Year 2003, February 2004, Summer 2007, etc. More recently, there has been Storm Dennis in February 2020 and a subsequent storm in December 2020. These events have caused flooding (both internal and external) for properties within the District. Data provided by the LLFA demonstrates the number of properties which reported internal/external flooding for these storm events:

Table 4.3 Historic Flooding, Storm Dennis (February 2020)

Parish	Internal	External	Total
Awre	2		2
Aylburton	5		5
Blaisdon	1		1
Drybrook	1		1
Lydbrook	1		1
Lydney	34		34
Mitcheldean		1	1
Ruspidge & Soudley		2	2
Total number of flooding incidents logged:	**44**	**3**	**47**

Table 4.4 Historic Flooding, December 2020 Storm

Parish	Internal	External	Total
Alvington	1	2	3
Awre	1		1
Aylburton	2		2
Blaisdon	4		4
Cinderford	10	1	11
Corse	2		2
Drybrook	5		5
Hartpury	1		1
Hewelsfield and Brockweir	1		1
Littledean	3		3
Longhope	12	2	14
Lydbrook		1	1
Lydney	33		33
Mitcheldean	2		2
Newent	15	1	16
Newland	2	1	3
Oxenhall	2		2
Ruardean	1		1
Rudford & Highleadon	1		1
Ruspidge & Soudley	13		13
St Briavels	2		2
Tidenham	3	1	4
West Dean	2		2
Westbury on Severn	1		1
Total number of flooding incidents logged:	**119**	**9**	**128**

The Environment Agency has produced a number of historic flood outlines within the Forest of Dean District and this information can be found on the online map.

Historically, flooding along the River Severn Estuary has occurred since Roman times. Records indicate that flood defences were constructed in Roman times to protect newly reclaimed land from high tides. In 1981, severe flooding occurred along the Severn Estuary as a result of high tides coinciding with heavy rainfall and a high surge. Following the 1981 flooding, the Avonmouth to Worcester Improvement scheme was commissioned by Severn Trent Water and a series of embankments and flood walls were constructed along the estuary. Following the construction of the defences, the frequency and severity of flooding along the Severn has significantly reduced. Christmas 1999 saw floods which affected properties on the east bank with further flooding experienced along the estuary in November and December 2000 primarily as a result of significant rainfall in the Severn catchment. More recently, it is noticeable that flooding incidents reported by properties is wide-spread throughout the district, however, the most prone areas are Lydney, Cinderford, Ruspidge and Soudley (Feb 2020 and Dec 2020).

The River Wye also has a history of flooding, including 1981 at Tintern Parva and Brockweir, and more recently in 2012 and 2014 in both Tintern and Chepstow (which are located in Monmouthshire).

4.13 Historic Tidal Flooding

Tidal flooding from the River Severn is one of the main sources of flood risk in the Lower Severn Valley and large floods have occurred in the Severn Estuary Coastal Group area (particularly in 1981, 1990, 1995, 1999, 2000 – data taken from historical flooding outline map from EA). Flooding due to tidal process can affect areas as far up the estuary as Gloucester and occasionally beyond – although at Gloucester fluvial processes tend to be the dominant factor. Further downstream, for example at Lydney, flooding due to tidal processes can reach in the region of 10mAOD (with a 1% (1 in 100 year) chance of occurring in any year). Similarly, analysis of gauge records at Gloucester has shown that water levels can reach more than 11mAOD (based on a combined fluvial and tidal event with a 1% (1 in 100 year) chance of occurring in any year).

Water levels in the River Severn estuary have a significant effect on water levels in the tributaries which flow into it. The tributaries of the River Severn are protected from tidal flooding from the estuary by large embankments along the River Severn and tidal flaps or gates at the mouth of each tributary which allow water to discharge freely at low tide but prevent sea water from entering the tributary at high tide. In some cases, this can lead to increased flooding on the tributaries if high river flows on the tributaries coincide with high tides resulting in water from the tributary being unable to discharge into the estuary. This is referred to as 'tide-locking'.

4.14 Fluvial Flood Risk in Forest of Dean District

Flood Zones show the areas potentially at risk of flooding from rivers, ignoring the presence of defences. This information has been used, in conjunction with other data, to give an account of flood risk in the study area. This has focussed primarily on the Main Rivers including the River Severn, River Lyd, River Leadon, River Wye, Cinderford Streams and Westbury Brook. In general, the Non Main Rivers have narrow Flood Zones constrained by the local steep gradients. In some places, small ditches and streams exist without Flood Zones. It is clear that many of these watercourses, though small, do pose local flood risk issues. Site-specific FRAs will be required for all new developments, to appropriately take these drainage systems into account. The assessment of flood risk has also been enhanced using the Severn Tidal Tributaries CFMP, the Severn Estuary Flood Risk Management Strategy along with valuable local information obtained from the Council.

Within the Lower Severn Valley, flooding can occur from a combination of both tidal and fluvial processes. Many of the Main Rivers within the District discharge into the River Severn estuary and as such can be affected to some extent by the tide. Sea water from the Severn Estuary is prevented from entering the tributaries by tidal flaps and a series of embankments along the River Severn. These control structures allow water to discharge into the estuary freely at low tide but prevent sea water from entering the tributary at high tide. This can lead to an increase in flooding on the tributaries when high river flows in the watercourses coincide with high tides in the estuary, preventing flood water from discharging into River Severn, thus backing up along the watercourse and overtopping river channels and embankments. This is referred to as 'tide locking'.

An initial assessment of the Flood Zone maps within the District indicated that of the 57,345 properties (all types of properties, not just dwellings) located within the District, 2,248 are located within Flood zone 2 and 1,041 are located within Flood Zone 3 (Table 4.5 below).

Table 4.5 Properties located within Flood Zone maps within Forest of Dean District.

	No. Properties	**Percentage of Properties Located within Flood Zone (%)**
Whole District	57,345	-
Flood Zone 3	1,041	1.8
Flood Zone 2	2,248	3.9

The watercourses within the District mainly rise within the Forest of Dean plateau towards the western extent. In general, Flood Zone maps in the upper reaches are narrow, confined by steep sided valleys. As the watercourses flow towards the coastal floodplains of the River Severn, the Flood zone maps widen significantly, and extend onto vast areas of flat, coastal floodplain.

The main urban area at risk from tide locking within the Forest of Dean District is Lydney. The River Lyd flows in a southerly direction through the District before meeting the River Severn at Lydney Harbour. In its upper reaches the Flood Zone maps are narrow, confined by the steep, surrounding topography, with very little flood risk to property. However, as the watercourse flows through Lydney, the Flood Zone maps widen significantly and a number of commercial and residential properties are located within Flood Zones 2 and 3. Flood risk to the town can be exacerbated further by rapid flows through the town, which can be frequently impeded by channel blockages. A flood alleviation scheme designed to protect the town to a 1% AEP (1 in 100 year) flood event was constructed in 1994, with ongoing improvement works to the dock area helping to alleviate flood risk further.

Tide locking is also extensive on the Cinderford Streams. Flood Zone maps for the lower reaches of the Cinderford Brook indicate that a number of farms, vast areas of agricultural land and some minor roads are located within the floodplain. It is uncertain as to how much of Blakeney itself floods as much of the village is located on higher ground. However, there are numerous structures between the Cinderford Brook and Blakeney which could potentially block and act as temporary dams. Upstream of Blakeney, the Flood Zone maps are generally narrow, and the Cinderford Brook drains freely into the lowland valleys of the Forest of Dean. The greatest flood risk here is thought to be due to culvert blockages which can lead to flooding in Soudley, Ruspidge and Wenchford.

The River Wye forms the western boundary of the District from SO 5917, flowing in a southerly direction towards it confluence with the River Severn. Flood Zone maps for the Wye extend across the District boundary into rural floodplain with a number of properties at Lower Lydbrook and a large works area by Stowfield Farm located within Flood Zones 2 and 3. Flooding has also been reported on the B4228 at Lydbrook. At Coldwell Rocks the watercourse exits the District, flowing around Symonds Yat before once again forming the District boundary between Highmeadow Woods and the confluence with the Whippington Brook then exiting the District. At these locations, the Flood Zone maps extend only a small distance into the District, being confined by the river cliffs formed by the underlying limestone and sandstone geology. At Lower Redbrook the River Wye again forms the District boundary, with a number of properties located within Flood Zones 2 and 3

for the River Wye and adjoining Valley Brook tributary. The A466 has been subject to road closures as a result of flooding from the tributary joining the River Wye.

As the River Wye continues through the District the Flood Zone maps extend across the District boundary and continue to be confined by the surrounding topography, incorporating a number of farms and isolated buildings. At Brockweir (SO 5399 0114) a number of properties are located within Flood Zones 2 and 3. Similarly, properties are located within Flood Zones 2 and 3 at Tintern Parva (Monmouthshire). Although many of these properties are not within the Forest of Dean District itself, any development at this location may impact on the fluvial flood risk and therefore it is recommended that the Council liaises with the adjoining Council of Monmouthshire. Further properties are located within Flood Zones 2 and 3 at Tutshill, Chepstow (ST 5410 9360), Severn Bridge Park (ST 5459 9213) and Beachley (ST 5478 9110). Here, the Flood Zone maps widen significantly as the watercourse meanders towards its confluence with the River Severn.

Towards the north of the District on the River Leadon, a tributary of the River Severn, flows in a south easterly direction through the District. The Leadon is a rural, lowland catchment, and as such, there is very little flood risk posed from the watercourse as it flows through the district. In general, Flood Zone maps extend predominantly onto rural floodplain with only a few isolated properties and farms shown to be at risk. Through Pauntley the Flood Zone maps narrow slightly, reflecting the steeper topography of the catchment as the watercourse flows between Poolhill and Cobhill. Downstream of Pauntley, the floodplain widens once again, and is reflected in the Flood Zone maps which widen. At Upleadon Flood Zone 2 widens on the right bank by up to 450m, encompassing buildings at Upleadon Court. At the downstream extent of the watercourse the Flood Zone maps are relatively wide reflecting the lowland, rural topography. A dismantled railway downstream of Barber's Bridge acts as an informal defence, constraining flood risk as the watercourse flows through Rudford, and eventually out of the District in the north-eastern extent at the boundary with Tewkesbury Borough Council by Lassington.

Flood Zone maps exist for a number of tributaries of the River Leadon including the Preston Brook (and tributary Ludstock Brook), Kempley Brook, an unnamed drain to the south east of Dymock (incorporating a few properties), Ell Brook (and tributaries including Peacock's Brook), Colliers Brook, Red Brook (and tributary Tibberton Brook), and a series of unnamed watercourses and drains. Misalignments are evident in a number of these watercourses, further details of which are provided in Table 1.3. The catchments of these watercourses are predominantly rural and low lying and in general flood risk is relatively low, with only a few isolated properties located within Flood Zones 2 and 3. The exception to this is at Newent, where a number of properties are located within Flood Zones 2 and 3. It should be noted that there are a number of misalignments evident within the Flood outlines along Peacocks Brooks, and therefore caution should be taken when interpreting the Flood Zone information at this location. Further refinement of the Flood Zone maps may be required as part of the Level 2 SFRA should development be proposed at this location.

Flood Zone maps for the Red Brook are relatively wide reflecting the low lying nature of the surrounding floodplain. At SO 7524 2314 a sewage works is located within Flood Zones 2 and 3. Downstream of the confluence with the Tibberton Brook, the floodplain widens significantly as the floodplain itself widens through Tibberton Meadows. Some misalignments are evident in the upper reaches of both the Red Brook and Tibberton Brook within the District. Downstream of Tibberton Meadows, the Flood Zone maps narrow as the Red Brook continues on towards its confluence with the River Leadon.

Towards the northern extent of the District, the Glynch Brook, a tributary of the River Leadon, flows in a south-easterly direction through Bromsberrow. The Flood Zone maps for the watercourse are misaligned in a number of places as the watercourse enters the District. Initially, the watercourse flows through rural floodplain, with a few isolated properties and farms located within Flood Zone 3. At Russelsend Coppice the watercourse is confined by the M50 to the north. Downstream of Russelsend Coppice, Flood Zone 2 widens significantly on the left bank extending approximately 600m up to the M50, due to the constraining nature of the road bridge at Blackford Mill Farm. A number of small drains are also encompassed within Flood Zone 2 at this location, indicating that this area acts as a natural flood plain during times of high flow. As the watercourse continues to flow through the District the Flood Zone maps narrow again with only a small number of residential and commercial properties located within the Flood Zone 2.

At the centre of the District, Flood Zone maps exist for the Longhope Brook and Westbury Brook. The Flood Zone maps are relatively narrow, reflecting the slightly steeper topography of the catchments. As the watercourse flows in a southerly direction through the District a number of properties are located within Flood Zones 2 and 3 through Longhope. At the confluence of the Longhope Brook/unnamed right bank tributary, the Flood Zone maps widen. However, no properties are located within the Flood Zones at this location. Properties are located within Flood Zones 2 and 3 by Blaisdon and within Flood Zones 2 and 3 of the Westbury Brook as the watercourse approaches the Severn Estuary. The town of Westbury and the A48 have experienced flooding in the past. However, following realignment of the road and construction of a flood relief channel, flooding has been relieved somewhat. In 2000/01, the water gardens owned by the National Trust were flooded causing widespread environmental damage (due to the agricultural pollutants in the water). This area continues to be at risk from both fluvial and tidal flooding. A number of misalignments are evident within the Flood Zone maps of both the Longhope Brook and Westbrook Brook.

To the east of Westbury, Flood Zone maps for the River Severn extend onto Walmore Common and other areas along the west bank of the Severn. This area floods frequently, inundating agricultural land, some isolated properties and minor roads.

Within the Forest of Dean itself, Flood Zone maps exist for a number of minor watercourses including: Dry Brook, Old Engine Brook, Soudley Brook, Forge Brook, Bideford Brook, Blackpool Brook, Cannop Brook, Park Brook, Ferneyley Brook, Cone Brook and Black Brook. In general the Flood Zone maps for these watercourses are relatively narrow and confined by the steeper surrounding topography, with some properties located within Flood Zones 2 and 3. As the watercourses approach the Severn Vale however, the Flood Zone maps widen slightly. Misalignments are apparent in the Flood Zone maps for all the watercourses detailed above.

4.15 Tidal Flood Risk in the Forest of Dean District

Tidal Flood Zone maps for the River Severn extend for large distances into the District incorporating a number of properties at locations including: Walmore Common (SO 7403 1513), Rodley (SO 7413 1145), Westbury on Severn (SO 7172 1394), Newnham (SO 6925 1190) and Lydney (SO 6340 0176). At Lydney, floods due to tidal processes can reach approximately 10mAD (with a 1% AEP (1 in 100 year) chance of occurring in any year).

Flooding along the Severn Estuary can be caused by a combination of factors including high tides, tidal surges and eaves overtopping defences. The funnel-shape of the Severn Estuary encourages tidal waters to propagate up the estuary, resulting in flooding to undefended areas at inland locations. Tidal flooding can affect areas as far as Tewkesbury. In general, however, the weirs at Gloucester (Lanthony Weir on the East Channel, SO 8219 1820; and Maisemore Weir on the West Channel, SO 8183 2165) are considered to represent the boundary between the tidal and fluvial flows, and higher up the channel towards Gloucester the influence of fluvial flows becomes increasingly dominant in flooding. The channel also becomes narrower providing a constriction to high tides moving upstream and river flows moving downstream.

Within the Severn Estuary tide levels can increase by up to 2 metres during tidal surges. Tidal surges can occur when atmospheric pressure changes. When atmospheric pressure is low, a positive surge can occur, resulting in increased water levels. Low pressure weather systems are characterised by wet and windy weather, which can result in further increases in water levels. Particularly severe flooding can occur if a surge coincides with the peak of a high tide. Wave action can also have a significant effect on the overtopping of defences and flooding. Sea defence walls are designed to accommodate a degree of wave overtopping.

Flooding also occurs on a number of tributaries which feed into the River Severn and Estuary. A number of these watercourses and drainage systems along the estuary have flapped outfall structures to prevent tidal inundation. Flooding can occur in these watercourses when outfalls are tide-locked (i.e. water levels in the estuary are high, preventing river flood flows progressing any further down the channel) leading to fluvial flows backing up and overtopping the banks.

Flooding in the upstream sections of the Severn Estuary may be worsened by development on the floodplain. This can reduce the amount of floodplain storage and obstruct flow across the floodplain, which may result in additional flooding problems elsewhere. EA maps identify a number of strategically important flood storage areas FLOOD STORAGE CELLS (see near Oakle St in Tile A3 and Stantway/Rodley A5) within the floodplain of the River Severn (see online map).

Further demands for new development on the floodplain will inevitably occur, however, these should be discouraged particularly as water levels are expected to rise due to the effects of climate change.

4.16 Issues with Existing Flood Maps

It should be noted that much of the Flood Zone information in the study area has been derived from the modelling package JFLOW, which is national broadscale model and as such has known limitations. The accuracy of the Flood Zones in some areas is poor, likely to be due to the upload fluvial setting and complex nature of drainage. The Flood Zones can be misaligned from the channel or follow a path which does not have a watercourse. The JFLOW flood extents also do not show the impact of flood defence structures or culverts.

When viewing the Flood Zone data these inaccuracies are clear, and whilst the best available information has been used in the SFRA, appropriate judgement should be exercised when applying the Sequential Test. In the future, updates to the Flood Zone maps may be undertaken as part of the Environment Agency's ongoing Flood Map improvements. Updates to the Flood Zone maps should therefore be incorporated into the SFRA when they become available. It may be prudent for a suitably qualified flood risk management specialist to review and assess preliminary site allocations, to advise on local Flood map issues and areas where further investigation may be required.

4.17 Flooding from Other Sources

Information has been gathered on flooding experienced from sources other than rivers, and is described in this section.

4.18 Flooding from Artificial Drainage Systems (Sewers)

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled.

Higher flows are likely to occur during periods of prolonged rainfall, common to the autumn and winter months. This is also when the capacity of the sewer systems is most likely to be reached. During periods of low flow, for example summer months, sewers become susceptible to blockage as the low flows are unable to transport solids. This leads to deposition and gradual build up of solid debris.

Two water companies cover the Forest of Dean District study area: Severn Trent Water (STW) and Welsh Water (WW). Both water companies have been consulted for information on flooding from surface water and artificial drainage sources and this has been provided where data is available.

All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the Hydraulic Flood Risk Register. This includes records of flooding incidents from foul sewers, combined sewers and surface water sewers which are deemed to be public and therefore maintained by the Water Company. Flooding from land drainage, highway drainage, rivers/watercourses and private sewers is not recorded within the register.

The Hydraulic Flood Risk Register tends to show, to a greater or lesser extent: the location of the incident, the date of the incident, a description of the incident, whether the incident occurred internally or externally and the register the incident has been recorded on. When an incident is reported, a decision chart is used to assess whether the properties/areas are 'at risk' and then the record is added to the appropriate register.

The recording of flood events by the authorities has often led to improvements intended to prevent reoccurrence, so historical flooding is not necessarily evidence of propensity for future flooding.

The Hydraulic Flood Risk Register data received from STW has been grouped at a 6-digit postcode level, as Severn Trent has requested that no street level information is published in this document owing to the sensitive nature of the data. In summary, it is evident that 48 postcode areas within the District are identified as having properties at risk of flooding from artificial drainage systems and surface water runoff (data updated since April 2020). As this information is provided only at postcode level, caution should be taken when interpreting this information. In general, the level of flood risk from artificial drainage systems within the District is medium to low with the greatest level of risk (as the network generally has medium to very high resilience to flooding). The data for the District is illustrated in the table below.

Table 4.6 Flooding from sewers as recorded in the Severn Trent Water DG5 Register.

Postcode Area (6-digit)	No. of Properties Affected	Network Resilience Risk (taken from the ST Network Resilience Risk maps (e.g. Very high resilience means there is a low risk of future flooding and vice versa).
GL14 1D	4	Low
GL14 1L	2	Very high
GL14 1N	1	Unknown *
GL14 1Q	3	Unknown *
GL14 2D	1	Very high
GL14 2H	2	Very high
GL14 2L	1	Very high
GL14 2N	1	Very high
GL14 2T	5	Very high
GL14 2U	5	Very high
GL14 3D	2	High
GL14 3E	2	Very high
GL14 3H	1	Unknown*
GL15	1	Very high
GL15 4A	2	High
GL15 4D	7	Very high
GL15 4J	1	Very high
GL15 4L	1	Unknown*
GL15 4P	6	Very high
GL15 4Q	1	Low
GL15 5E	7	Very high
GL15 5L	2	Low
GL15 5P	4	Unknown*
GL15 5S	2	Low
GL15 6A	6	Very high
GL15 6B	3	Very high
GL15 6H	2	Very high
GL15 6N	2	Low
GL15 6Q	1	Unknown*
GL16 7N	8	Unknown*
GL17 0B	1	Low
GL17 0H	1	Very high
GL17 0L	1	High
GL17 0Q	3	Very high
GL18 1B	1	Unknown*
GL18 1E	2	Unknown*
GL18 1H	1	Unknown*
GL18 1L	1	Very high
GL18 2A	3	Medium
GL18 2B	1	Unknown*
GL18 2E	2	Unknown*
GL19	1	Unknown*
GL19 3A	4	High
GL19 3B	6	Low
GL19 3H	2	Medium
GL19 3Q	1	Unknown*
GL19 3R	2	Very high
GL2 8E	7	Medium

*Level of risk not shown on the Network Resilience maps for this area.

Severn Trent Water stresses that Local Planning Authorities should adopt a planning policy requiring the use of SUDS as proposed by the National Planning Practice Guidance. The NPPF and NPPG also states that the Sequential Test should be used to allocate land for development within low risk Flood

Zones, so that the risk of fluvial flooding is minimised. This reduces the risk of fluvial flood waters entering public foul and surface water sewers and resultant widespread flooding and pollution. Individual developments should be designed so that natural flood pathways are left free of buildings. Guidance on the application of SUDS can be found in Chapter 11.

Welsh Water covers a small area to the south and western edge of the District of the Forest of Dean District, which includes the town of Coleford. Consultation with Welsh Water has highlighted that there have been 10 recorded instances of sewer flooding (hydraulic overload) in their area since 2005, the majority of which have been around Coalway and Berry Hill (around Coleford). Owing to the nature of the majority of sewers being combined (foul and surface water) in the area of Coleford, short sharp flash floods have historically been problematic. However, it is now recognised from the data provided that WW records no flooding attributed to hydraulic overload (this does not include short-term blockage, collapse or equipment failure) in the Forest of Dean for the year 2020. Welsh Water also advises that it delivered a capital scheme to resolve internal and external flooding caused by Hydraulic Overloading in Coleford in 2011-2012.

14.19 Flooding from Surface Water

Surface water flooding occurs when excess water runs off across the surface of the land and is usually the product of short duration but intense storms. This type of flooding usually occurs because the ground is unable to absorb the high volume of water that falls on it in a short period of time, or because the amount of water arriving on a particular area is greater than the capacity of the drainage facilities that take it away. Surface water flooding can also occur from wet antecedent condition. Where discharge is directly to a watercourse, locally high water levels can cause back-up and prevent drainage taking place. In each instance the water remains on the surface and flows along the easiest flow path towards a low spot in the landscape. The impermeability of concrete and tarmac is often responsible for reduced infiltration and resultant high runoff. Roads often make for easy flow paths, leading to situations where roads become impassable.

Surface water flooding is often short lived and localised. Several instances may result from a single storm throughout a catchment. Often there is limited notice as to the possibility of this type of flooding. This, combined with the high velocities achievable when water is flowing along a contained smooth surface such as a road, can cause surface water flooding to be devastating in nature. Suspended material can be carried into drains by overland flows or floodwaters and this can also lead to them becoming blocked, exacerbating the problem.

The Council has current datasets (available on the Geographical Spatial Information System) which shows areas which are susceptible to surface water flooding from heavy rainfall, which could be used to inform future updates of the SFRA and are of use to the local emergency responders and for planning purposes. Data on the surface water flooding hotspots are included in this SFRA (see online map).

The geology and topography of the District contribute to the rainfall response within the District and therefore the likelihood and nature of surface water flooding. The upper reaches of river catchments within the District, although underlain by permeable limestone and sandstone, are often steep, promoting rapid surface runoff which can lead to localised flooding. In addition, the clays and mudstones found within the Severn Valley lie close to the groundwater table for much of the year and are frequently saturated. Rainfall can therefore be slow to drain away, increasing the risk of

localised surface water flooding. Areas with an abundance of impervious surfaces are also at risk of surface water flooding, especially when local intense rainstorms occur. Surface water flooding associated with poor urban drainage and backing up within urban drainage systems under high river flows also affects Coleford, Lydney and Newent. Any site-specific FRA would need to adequately access the risk from surface water flooding.

A change in the way surface water is managed is required to alleviate the risk of flooding from this source. Management of surface water through the overland system is generally considered more effective than relying solely on the capacity of the underground systems. Slowing down the water and storing it before it reaches the piped system can greatly reduce the potential impact of surface water flooding. In less extreme circumstances, this approach should be able to prevent flooding. This approach was set out in the Government's Water Strategy, Future Water (published in 2008), by stating that by 2030 surface water will be managed more sustainably by allowing for the increased capture and reuse of water, slow absorption through the ground, and more above-ground storage and routing of surface water separate from the foul sewer, where appropriate. There will be less reliance on the upgrading of the sewer system to higher design standards and rather that water will be increasingly managed on the surface.

Since the devastating flooding in 2007 Gloucestershire County Council (Highways) has been working with its local flood risk management partners to better understand and alleviate flooding in Gloucestershire. These include Gloucestershire Roads, the six District Councils, the Environment Agency, Severn Trent Water, Thames Water and the Lower Severn Internal Drainage Board. A key part of this approach is to look at areas most vulnerable to surface water flooding. This has led to the creation of several Gloucestershire Surface Water Management Plans, however, there is not currently one in place for the Forest of Dean District. It is recommended that the GCC considers the production of a SWMP for the District.

However, the Gloucestershire Local Lead Flood Authority (GCC) has published a Local Flood Risk Management Strategy (https://www.gloucestershire.gov.uk/your-community/emergencies-and-your-safety/flooding-and-drainage/gloucestershire-county-councils-local-flood-risk-management-strategy-lfrms/). This document was published in the Summer of 2014 and sets the direction for local flood risk management in Gloucestershire.

4.20 Flooding from Impounded Water bodies

As part of the SFRA it is necessary to consider the risk of overtopping or breach of reservoirs and canals. British Waterways (BW) were consulted to gain information on past overtopping incidents of canals, while the Environment Agency datasets on reservoir flooding were accessed through their website. It should be noted that there is a residual risk of breach from all impounded water bodies and development should be avoided adjacent to these locations.

4.20.1 Canals

It is important that canals are included in an SFRA as canals can form a vital land drainage function. Occasionally, canals can overtop due to high inflows from natural catchments and if overtopping occurs from adjacent water courses. This additional water can be routed/conveyed by the canal which may cause issues elsewhere, not only within the catchment of interest but also in neighbouring catchments where the canal might cross a catchment boundary. In addition, where canals impound water above the natural ground level, there may be a risk of failure of the embankment resulting in rapid inundation of the surrounding area.

Only limited lengths of the Herefordshire and Gloucestershire Canal near Newent are located within the District. This canal is currently disused and Herefordshire and Gloucestershire Canal Trust have confirmed the following:

- There are no areas of the canal within the FODDC area being restored.
- There are no records of breaches or overtopping.
- There are no raised sections.

At present canals do not have a level of service for flood recurrence (i.e. there is no requirement for canals to be used in flood mitigation). It is important, therefore, that any development adjacent to a canal be investigated on an individual basis regarding flooding issues and should be considered as part of any FRA.

4.20.2 Reservoirs

Many reservoirs in the UK lie immediately of, or adjacent to heavily populated areas. The rapid, uncontrolled discharge of water from such reservoirs could have catastrophic consequences on life and property (though the risk of this occurrence is very low). Reservoirs with an impounded volume in excess of 25,000 cubic metres (measured above natural ground level) are governed by the Reservoirs Act 1975 and are listed on a register held by the Environment Agency (for capacity over 25,000 cubic metres).

Table 4.7 Reservoir Register for Forest of Dean District Council

Reservoir	Physical Status	Situation	NGR	Category	Year Built	Dam Type	Max. Height (m)	Capacity (m^3)	Surface Area (m^2)
Mitcheldean	In Operation	Near Mitcheldean	SO6550018700	Non-impounding	1975	Concrete service	7	36900	6000
Lower Cannop Pond	In Operation	Near Coleford/Ross-on-Wye	SO6080011000	Impounding	Unknown	Gravity & Earthfill	7	7200	22500

Due to high standards of inspection and maintenance required by legislation, normally flood risk from registered reservoirs is moderately low. Whilst the reservoir register, and indeed the SFRA, has identified impounded water bodies with a storage volume greater the 25,000m^3, it should be stressed that a number of smaller impounded water bodies are located within the District, all of which pose a flood risk and will need to be assessed further as part of a Level 2 SFRA. Development immediately downstream of any reservoir or impounded water body (not just those contained within the reservoirs database) should be discouraged and will be subject to a Level 2 SFRA if the development is deemed necessary.

There are no records of breaching/overtopping within the Forest of Dean District. Reporting of dam incidents to the Environment Agency is a voluntary process and the system has only been in place since 2007. Prior to that reports of incidents were collected on an ad hoc basis by the Building Research Establishment, from published papers and questionnaires. Due to the voluntary nature of incident reporting the records held by the Environment Agency are not complete and the incidents provided only represent those overtopping incidents or breaches that the Environment Agency have been informed of. It should be noted that when referring to 'overtopping' the records held by the Environment Agency are referring to the overtopping of an embankment and are not referring to water flowing down a reservoir spillway. A spillway operating in the way that it was designed is not a reportable reservoir incident under the post-incident reporting system.

4.21 Flooding from Groundwater

Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive regional aquifers (e.g. Chalk or Sandstone) or localised sands or river gravels in valley bottoms underlain by less permeable rocks. Groundwater flooding occurs as a result of water rising from the underlying rocks or from water flowing from abnormal springs. This tends to occur after long periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas the water table is usually at shallower depths anyway, so during the very wet periods, all the additional groundwater flowing towards these areas can cause the water table to rise to the surface causing groundwater flooding.

Different geological aquifers can react in different ways to high rainfall intensity events. For example, limestone aquifers can readily transmit groundwater as they are fractured in nature and thus may exacerbate flooding issues in watercourses when combined with other hydrological factors. In comparison, the effects and impacts of groundwater flooding in sandstone aquifers can take long periods of time to dissipate due to the high storage potential of the aquifer. Groundwater flooding differs from fluvial flooding and surface water flooding in that it may take weeks or months to dissipate, because groundwater flow is very slow and water levels take much longer to fall, therefore groundwater flooding effects can still be evident a long time river levels have subsided.

In recent times the decline in industry has led to an increase in groundwater levels due to a reduction of abstraction, though there is no record of this problem in the study area.

In comparison to fluvial and tidal flooding, the understanding of the risks posed by groundwater flooding is limited and mapping of areas susceptible to groundwater flooding is in its infancy. There is currently no one organisation with responsibility to respond to groundwater flooding, therefore the risks of mechanism of groundwater flooding are poorly reported. Owing to the complexities of representing the flow and emergence of groundwater, there is limited understanding and documenting of groundwater flooding. The main approach to collecting data and preparing for such occurrences is through the 'susceptibility' of areas to groundwater flooding. As such, the EA has produced a groundwater susceptibility map known as 'Areas Susceptible to Groundwater Flooding Map' which is set on a 1km square grid identifying vulnerability to the groundwater emergence, but it does not show the likelihood of groundwater flooding occurring. The mapping covers a large area of land and does not indicate where groundwater is likely to flow or pond, and where flooding will occur. Of the areas included on the mapping only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding. Data can also be found through the British Geological Survey, which gathers information on Understanding Groundwater Flooding Mechanisms; Modelling Groundwater Flooding and Areas Susceptible to Groundwater Flooding.

Groundwater level monitoring records are available for areas on Major Aquifers, however, at lower lying valley areas, which can be susceptible to groundwater flooding such as mudstones, clays and superficial alluvial deposits, very few records are available. As such, a need for the co-ordination of groundwater flood risk management was identified and Gloucestershire County Council (Lead Local Flood Authority) commissioned Atkins Ltd to complete a Gloucestershire Groundwater Management Plan, Groundwater Strategic Assessment, and this was published in 2013. The purpose of this document is to enable the future development of a Groundwater Management Plan and forms the output from the strategic stages of the study. It details a list of areas determined to be of high

priority and require further assessment and groundwater risk maps have been produced. Of note for the Forest of Dean, the results from the vulnerability matrix indicate that Lydney and Birdwood may be at a potentially higher risk of groundwater flooding and this is where further study should be focused or where groundwater flooding should be considered in future planning or flood management. This is because areas identified as high risk are concentrated around Lydney which is low lying, has a high coverage of sands and gravels and a varying bedrock geology including both limestone and mudstone. The area around Birdwood is identified as high risk and is low lying, with a large percentage of superficial deposit coverage and underlying bedrock geology of mudstone.

4.22 Historical Groundwater Flooding

One of the most widespread incidents of groundwater flooding throughout the UK occurred during the winter of 2000/2001 (with some further locations affected during 2002/2003) and followed a period of exceptionally heavy rainfall. During an eight month period from September 2000, rainfall in England and Wales was 166% of the long term average with the highest rainfall coinciding with areas of Chalk outcrop. Summer groundwater flooding is relatively rare as dry soil conditions normally preclude widespread aquifer recharge during the summer months (exceptions include 1879, 1912 and 2007). Again, in the summer of 2007 there were several very wet periods and the heavy storms in June and July resulted in significant recharge occurring in many areas.

Records of groundwater flooding have been limited, although now information on ground water susceptibility is becoming available and the Gloucestershire County Council (LLFA) Groundwater Strategic Assessment is pertinent (as discussed above).

In conclusion, data on areas largely at risk (more susceptible) to groundwater flooding is gradually becoming more available and must be considered as part of any further FRA.

Key Recommendations: Chapter Four

- Gloucestershire Lead Local Flood Authority takes a lead role in the management of flood risk (including ground water flooding) and the Groundwater Strategic Assessment (2013) is a pertinent document, including important data for the Forest of Dean.
- All historical events are important in obtaining an understanding of the flood risk posed to the District, and should be considered in the location of new development and as part of any assessment of flood risk.
- Where accuracy of the flood zones in some areas of the District is poor (they can be misaligned from the channel or follow a path which does not have a watercourse), appropriate judgement should be exercised when applying the Sequential Test. It may be prudent for a suitably qualified flood risk management specialist to review and assess preliminary site allocations, to advise on local Flood map issues and areas where further investigation may be required (such as a Level 2 SFRA).
- The Environment Agency will require further surface water investigation and mapping to be carried out as part of a Level 2 SFRA.
- There should be less reliance on the upgrading of the sewer system to higher design standards to accommodate new developments; rather, water should be managed on the surface through the appropriate application of SUDS.
- New development adjacent to raised sections of canals will require breach analysis to be carried out as part of a Level 2 SFRA.
- Development immediately downstream of any reservoir or impounded water body should be discouraged and will be subject to a Level 2 SFRA if the development is deemed necessary.
- The assessment undertaken as part of this SFRA is not exhaustive and the susceptibility to flooding from groundwater must be considered as part of any further FRA.

Chapter 5 - Strategic Flood Risk Mapping

5.1 Strategic Flood Risk Maps

This chapter provides a clear description of the data that has been used for the purpose of strategic flood risk mapping. The online map shows flood risk from sources including fluvial, surface water, foul and combined sewers, groundwater and impounded water bodies including reservoirs and canals. The Sequential Test process primarily uses the Flood Zone maps to locate developments in low fluvial flood risk areas. The point of mapping flooding from other sources is to ensure new developments are also located away from areas which have experienced flooding from 'other sources'.

The strategic flood risk information is also presented as GIS layers and can be interrogated to gain the associated descriptive information. These are available through the FoDDC online map and by request.

In accordance with the NPPF and associated PPG, the Level 1 SFRA has used Flood Zone outlines which have been produced using detailed modelling techniques in preference to the Environment Agency's Flood Zone maps, wherever possible. Flood Zone outlines are undefended and should be used to carry out the Sequential Test. When representing the Flood Zones, Level 1 SFRAs should also show the functional floodplain, Flood Zone 3b, where such outlines exist. If Flood Zone 3b has not been produced as part of a detailed modelling project, similar outlines, such as the 1 in 25 year outline can be used, upon agreement with the Environment Agency. In the absence of such detailed information, the PPG recommends that all areas within Flood Zone 3a should be considered as Flood Zone 3b unless, or until, an appropriate FRA shows to the satisfaction of the Environment Agency that it can be considered as falling within Flood Zone 3a. Therefore, as part of this SFRA, modelled outlines have been used to represent Flood Zone 3b where they exist. Where no modelled outlines exist, Flood Zone 3a has been used to represent Flood Zone 3b.

5.2 Hydraulic (River) Models

River models have been collected and used for the production of the SFRA flood maps. Within the study area, Environment Agency hydraulic models exist for the River Severn Fluvial (with the exception of model data on the Leadon and its tributaries that lie within the FOD district). The table overleaf gives details of the modelled Flood Zone outlines (this data can be found on the online map).

For the remainder of watercourses in the study area, the Environment Agency's Flood Zone information has been used and is also available to view on the online map. It should be noted that some smaller watercourses do not have Flood Zones produced for them.

Table 5.1 Environment Agency Hydraulic Models and Modelled Flood Zones within Forest of Dean District

Model	Watercourse Modelled	Derived From	Modelled Extents through District		Modelled Flood Zones			Notes
			Upstream	Downstream	3b	3a	2	
River Severn Fluvial	River Leadon	Environment Agency Strategy & SFRM models	SO 7743 2447	SO 8001 2178	√	√		Model forms part of the boundary with Tewkesbury Borough Council 4% AEP (1 in 25 year) outline used for Flood Zone 3a. Analysis of modelled Flood Zone 2 outlines with Flood Zone 2 maps indicated differences. Following consultation with the Environment Agency, it was recommended that the existing Flood Zones were used for Flood Zone 2 as the current planning system is based on the Flood Zone outline.
	Red Brook	Environment Agency Strategy & SFRM models	SO 7559 2314	SO 7758 2224	√	√		4% AEP (1 in 25 year) outline used for Flood Zone 3b. 1% AEP (1 in 100 year) outline used for Flood Zone 3a. Analysis of modelled flood outlines with Flood Zone 2 maps indicated differences. Following consultation with the Environment Agency it was recommended that the existing Flood Zones were used for Flood Zone 2 as the current planning system is based on the Flood Zone outline.
River Severn Tidal	River Severn	Environment Agency Strategy & SFRM models	SO 7586 1646	ST 5400 8860		√	√	The model extends along the District boundary with Tewkesbury Borough and Stroud District for much of its extent. Analysis of the existing Flood Zone maps and modelled flood outlines indicated differences. Following consultation with the Environment Agency it was recommended that the existing Flood Zones were used for Flood Zones 3a and 2 as the current planning system is based on the Flood Zone outline.

River Lyd	The Lyd	Environment Agency Strategy & SFRM models	SO 6301 0390	SO 6517 2014		√		Various modelled outlines produced as part of SFRM modelling study. Analysis of the modelled flood outline for Flood Zone 3a and the existing Flood Zone 3a indicated that there were some differences in the outlines. Following consultation with Environment Agency it was recommended that the existing Flood Zones were used for Flood Zone 3a as the current planning system is based on the Flood Zone outline.

5.3 Sewer Flooding

See Chapter 4.18 for more detail. However, future updates to the DG5 flood register should be fed into future updates of the SFRA. At present, the relatively course resolution of data limits its use for the purpose of spatial planning. Owing to data protection, water companies are unlikely to provide full location information to be publically available and therefore the onus is on developers to assess sewer flood risk as fully as possible as part of the site-specific FRAs.

5.4 Flooding from Surface Water, Impounded Water Bodies and Groundwater

See Chapter 4.19 (flooding from surface water, canals, reservoirs and groundwater has been mapped using the historical data collected). GIS 'points' have been used to indicate where flooding from these sources has occurred. This is not considered to be exhaustive since the data are based on historical events rather than predictive modelling (and therefore may not represent very rare events) so the full extent of these flooding mechanisms may not have been captured. It is therefore recommended that during future updates to the SFRA, reviews and consultations are undertaken to ensure that any new surface water, canal, reservoir and groundwater flooding locations and issues are fully taken into account.

5.5 Climate Change

Government webpages Climate Change Explained and Climate Change Allowances provide information on how climate change is happening due to human activities. Along with warming, many other changes are occurring such as melting polar ice, rising sea levels and more frequent floods, droughts and heatwaves. The above webpages provide advice on the causes and impacts of climate change and how to tackle it. Specific information is provided on when and how local planning authorities, developers and agents should use climate change allowances in flood risk assessments.

It is worth noting here that the western extent of the district falls within the River Wye uplift area (the Wye Management Catchment maps shows how the river catchment crosses the Welsh-English border).

Furthermore, any assessment of climate change should be based on development size rather than simply related to flood plain. This therefore ensures that developers/agents undertake appropriately detailed FRA's, particularly for major development. Minor development could use nominal allowances.

Peak Rainfall Intensity:

Increased rainfall affects surface water flood risk and how you need to design drainage systems. Further information and Climate Change Allowances for Peak Rainfall can be found on the DEFRA webpages for **Climate Change Allowances** and **Peak Rainfall Maps**.

Peak river flow allowances:

Peak river flow allowances show the anticipated changes to peak flow by river basin district. Further information and current data on this subject can be found on the DEFRA webpages for Climate Change Allowances and Peak River Flow Maps.

5.6 Sea Level Height

Sea levels are rising and up to date information on sea level allowances, coastal erosion, storm surge and adaptive approaches can be found on the government webpage for Sea Level Allowances**.**

5.7 Offshore Wind Speed and Extreme Wave Height

Wave heights may change because of increased water depths and changes to the frequency, duration and severity of storms. Further data and advice on this matter can be found on the government's Climate Change Allowances webpage.

5.8 Likely Climate Change Impacts

Climate change impacts on fluvial flood risk mean upland areas will be subject to deeper, faster flowing water, while in lowland areas the extent of flooding is likely to become greater. Levels of the Severn Estuary are likely to rise by 5mm per year. This is a combined result of the southern England land mass sinking and rising sea levels due to global warming (continental ice sheets melting and thermal expansion of the oceans).

The floodplains in the western upland areas of the District are generally narrow and well defined, though they widen and flatten towards the Severn Estuary. Well-defined flood plains generally mean that the extent of flooding is negligible under climate change scenario. In areas where no detailed climate change modelling exists, this finding is supported by the relatively small difference in the extents of Flood Zone 2 and Flood Zone 3a. However, it is important to note that as a result of climate change, the depth of flooding is likely to increase in well-defined floodplains. This is particularly likely in the Lyd catchment, mainly at Whitecroft and Lydney. In particularly steep areas the velocity might also increase. This will have a significant impact on the flood hazard. A Level 2 SFRA, which assesses flood hazard, will therefore be required for site allocations which need to satisfy the Exception Test. Level 2 SFRA will also need to take full account of climate change if potential allocation sites are located partially in or adjacent to Flood Zone 3 areas.

By contrast, the effect of climate change on flood risk in flat areas can be dramatic. Flood extents are expected to increase in the Cinderford streams, though the main changes affect the agricultural land in the downstream area of the catchment. Where climate change is expected to increase flood risk considerably, for example, where current Flood Zones are large (usually in wider, flatter floodplains), the LPA should consider using the climate change maps to carry out the Sequential Test, in order to give a particularly long-term risk-based approach to planning. Locations where it might be prudent to do so are at the south eastern side of the District, namely along the Severn Estuary and its downstream tributaries.

Chapter 6 –Flood Warning Systems and Flood Risk Management Measures

6.1 Flood Risk Management

Flood risk management can reduce the probability of flooding occurrence through the management of land, river systems and flood defences, and reduce the impact through influencing development in flood risk areas, flood warning and emergency response.

6.2 Flood Risk Management Plans

The study area is covered by the Severn River Basin Flood Risk Management Plan 2021-2027 (FRMP), which is a collaboration between the Environment Agency and relevant local and risk management authorities. It is a second cycle Flood Risk Management Plan which aims to manage significant flood risks in the Flood Risk Areas (FRAs) identified in the Severn River Basin District (RBD). The FRMP covers flood risk from fluvial, tidal, surface water and sewer sources.

6.2.1 Severn River Basin District (RBD)

The Severn River Basin District (RBD) is one of 10 RBDs that are wholly or partly in England. The Severn RBD spans the England and Wales border and lies mainly within England. This Flood Risk Management Plan (FRMP) covers the English portion of the Severn RBD only. You can find out more about the flood risk management planning process in Wales by visiting Natural Resources Wales.

The Severn RBD extends from the uplands of Wales, down through valleys and rolling hills to the lowlands and the Severn Estuary. The RBD covers an area of over 21,000 kilometres squared. The water bodies of the Severn RBD are made up of:

- 7,512km of river
- 76 lakes
- 36 canals
- 40 ground water bodies
- 545km2 of estuary

The Severn is the longest river in Britain, stretching 350km from its source in Wales to the mouth of the Bristol Channel. Its main tributaries in England include the following rivers:

• Vyrnwy • Teme • Warwickshire Avon • Wye • Bristol Avon

The RBD in England is divided into 8 management catchments with 5 catchments within England:

- Shropshire Middle Severn
- Worcestershire Middle Severn
- Warwickshire Avon
- Severn Vale

• Bristol Avon & North Somerset Streams

Three management catchments straddle the border between England and Wales:

• Severn Uplands

• Teme

• Wye

These catchments range from energetic upland streams to slower rivers in the lowlands. They include sandstone and limestone aquifers used for public water supply in the Midlands.

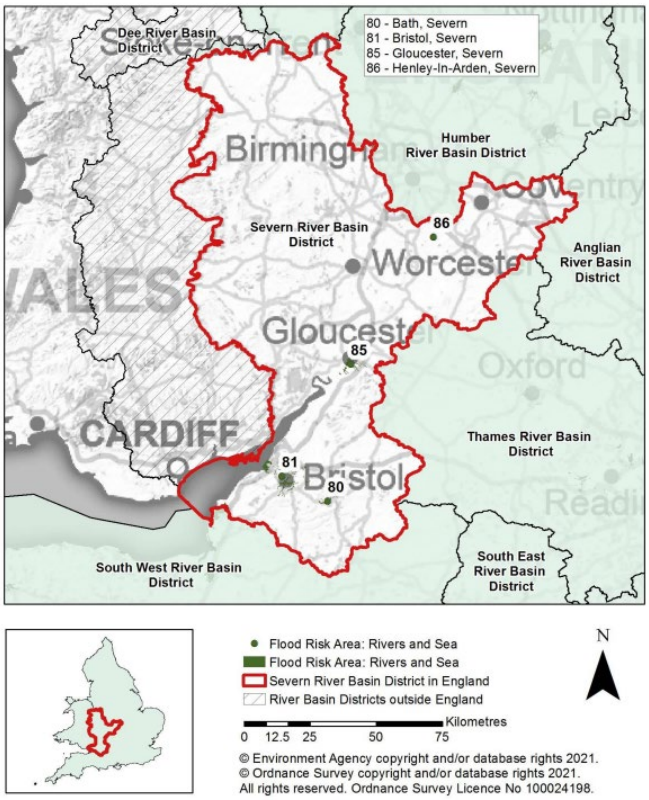


Fig. 6.1 FRAs for significant risk of flooding from main rivers and sea in the Severn RBD

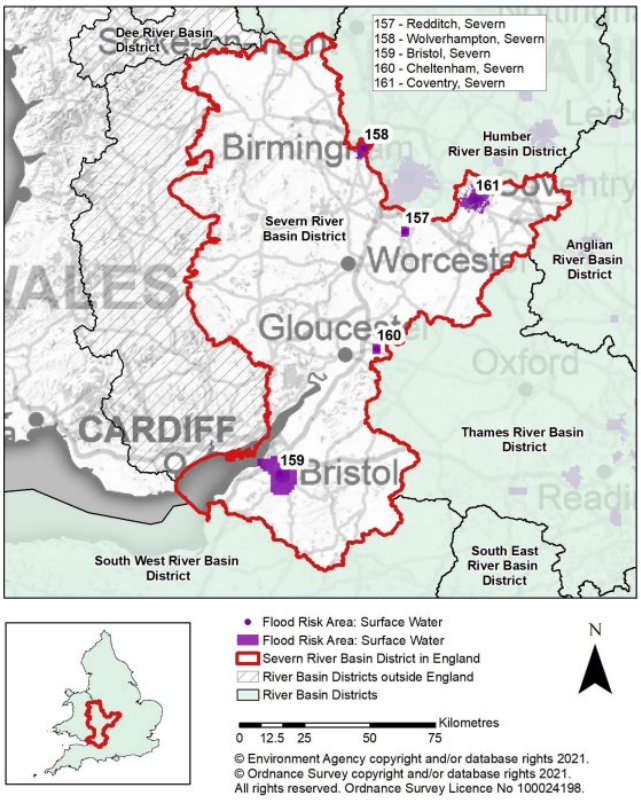


Fig. 6.2 FRAs for significant risk of flooding from surface water in the Severn RBD

6.3 Wye Catchment Partnership Plan

The Wye Catchment Partnership (WCP) was formed in 2014 and is hosted by the Wye & Usk Foundation and Natural Resources Wales. The Partnership covers the whole catchment making it the largest partnership in the UK, now comprising of over 50 organisations and numerous individual working collaboratively. The purpose of the partnership is to deliver improvements to water quality, water quantity and biodiversity. The WCP Plan was published in 2019-2020.

The Wye catchment covers 4,285km^2 spanning two countries and five counties. It relates to the Forest of Dean District as it weaves its way along the southwestern border. It is rich in wildlife and precious habitat which is recognised by its designated areas including SSSIs as well as the Wye Valley Area of Outstanding Natural Beauty, which also falls partly within the Forest of Dean District. The River Wye is a well-established and nationally significant salmon, brown trout and coarse fish fishery. Elver fishing also takes place within the tidal reaches of the Wye.

It is the Lower Wye Catchment which falls within the Forest of Dean District and the actions which have been identified for this area include:

- Restore condition of and connectivity to flood plain meadows to provide flood storage and improved biodiversity
- Install additional phosphate stripping (areas within Herefordshire)
- Continue programme to eradicate non-native invasive plant species like Giant Hogweed and Japanese Knotweed.

6.4 Shoreline Management Plan

Shoreline Management Plans (SMPs) deal with the flood risk management of a shoreline rather than a river catchment. The Severn Estuary Shoreline Management Plan (SMP2) was updated in 2017. It is developed by the Severn Estuary Coastal group in partnership with the Environment Agency and other local authorities, regulators and other stakeholders, and is a high level non-statutory policy document. It provides a large-scale assessment of the risks (to people, property, the natural and historic environment) associated with coastal erosion and flooding at the coast in the long-term. It proposed policies to manage these risks sustainably over the next hundred years.

The Severn Estuary Shoreline Management Plan 2 (SMP2) follows the shoreline from Lavernock Point, near Penarth in Wales to Anchor head, just north of Weston Bay in England. The upstream boundary of the SMP2 is at Haw Bridge, near Gloucester. SMP2 includes estuaries up to their tidal limit. As such, the SMP2 is relevant to the Forest of Dean District, in that it includes the River Wye (tidal limit to Bigsweir Bridge) and the River Severn West Channel (tidal limit to Maisemore Bridge). From the shoreline, the area of the SMP2 extends inland one kilometre or to the extent of a 1 in 1,000 year flooding event (whichever is greatest) and upstream into rivers that flow into the estuary.

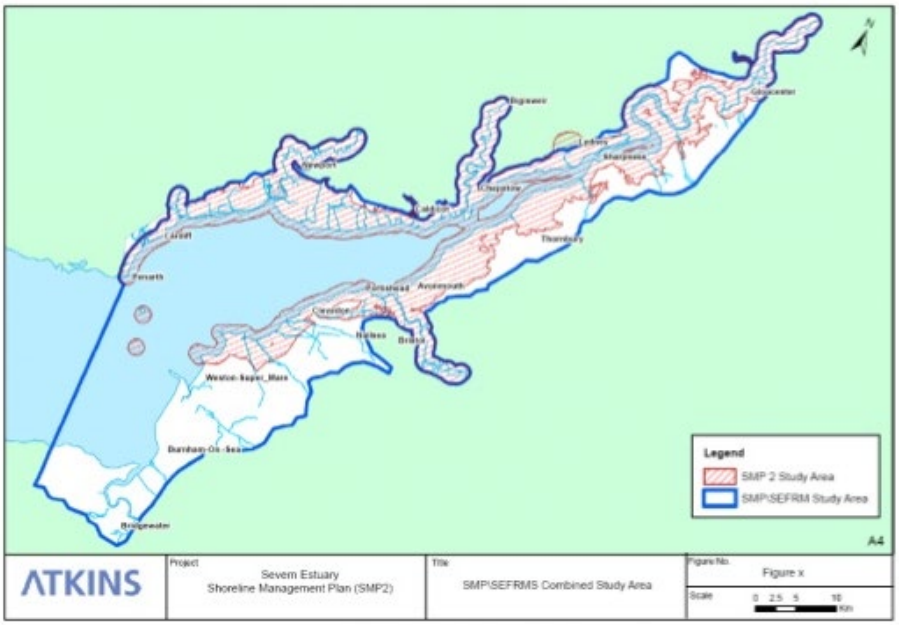
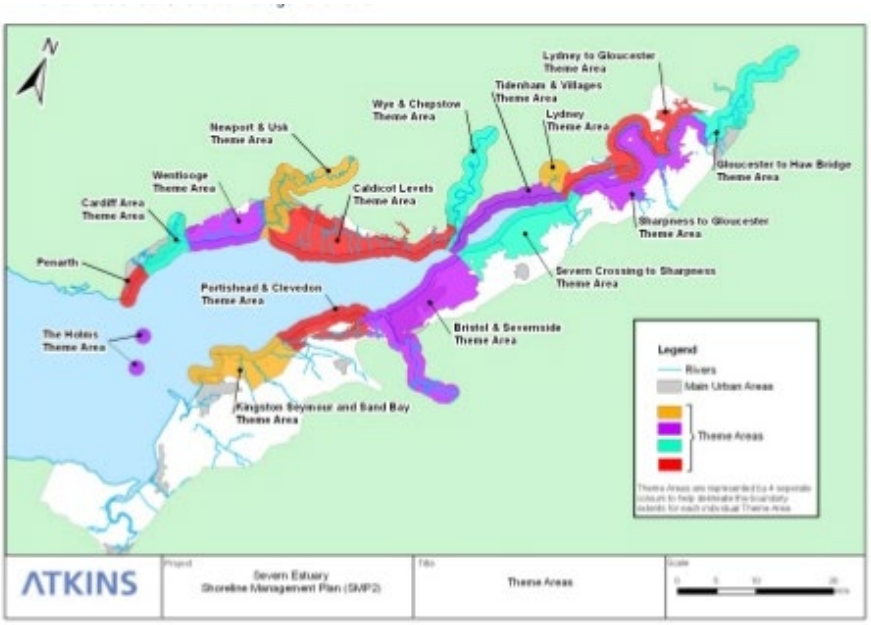


Fig 6.3 SMP2 Study Area (Severn Estuary SMP2)

The study is split into Theme Areas where the potential areas at risk are assessed and the high level objectives are discussed.

Fig 6.4 Theme Areas under SMP2



The Theme Areas relating to the FoD district are:

- Wye & Chepstow
- Tidenham & Villages
- Lydney
- Lydney to Gloucester

Note: The SMP2 only considers risks from ***tidal sources*** (coastal erosion and coastal flooding).

Fig 6.5 Maps demonstrating the Management Approaches and Flood Extents for the areas in the Forest of Dean:

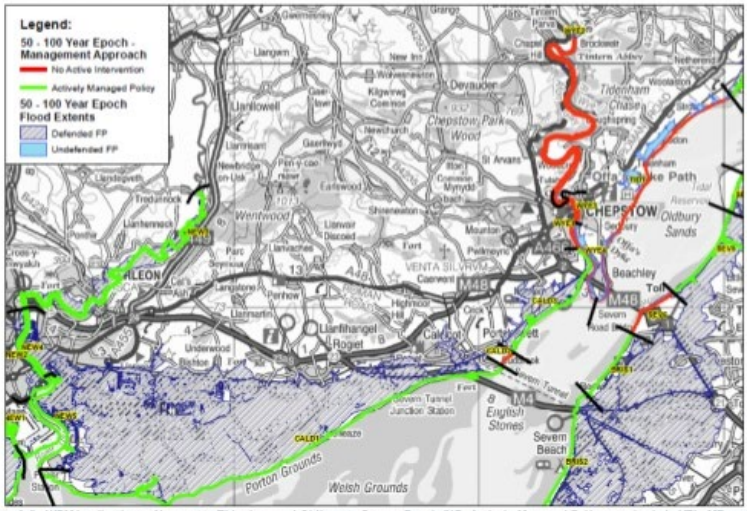


Figure 3.5 - WPM implications –Newport to Tidenham and Oldbury to Severn Beach (NB: Actively Managed Policy may include HTL, MR or ATL)

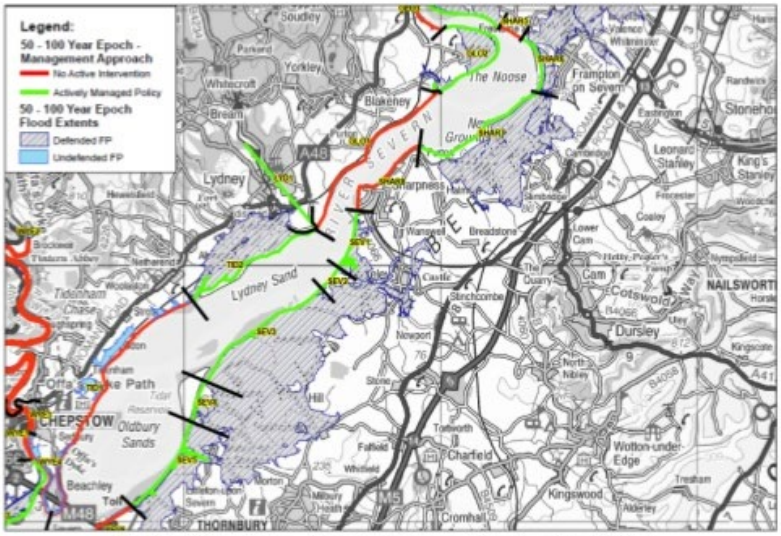


Figure 3.6 - WPM implications – Tidenham to the Noose, and Frampton on Severn to Oldbury
(NB: Actively Managed Policy may include HTL, MR or ATL).

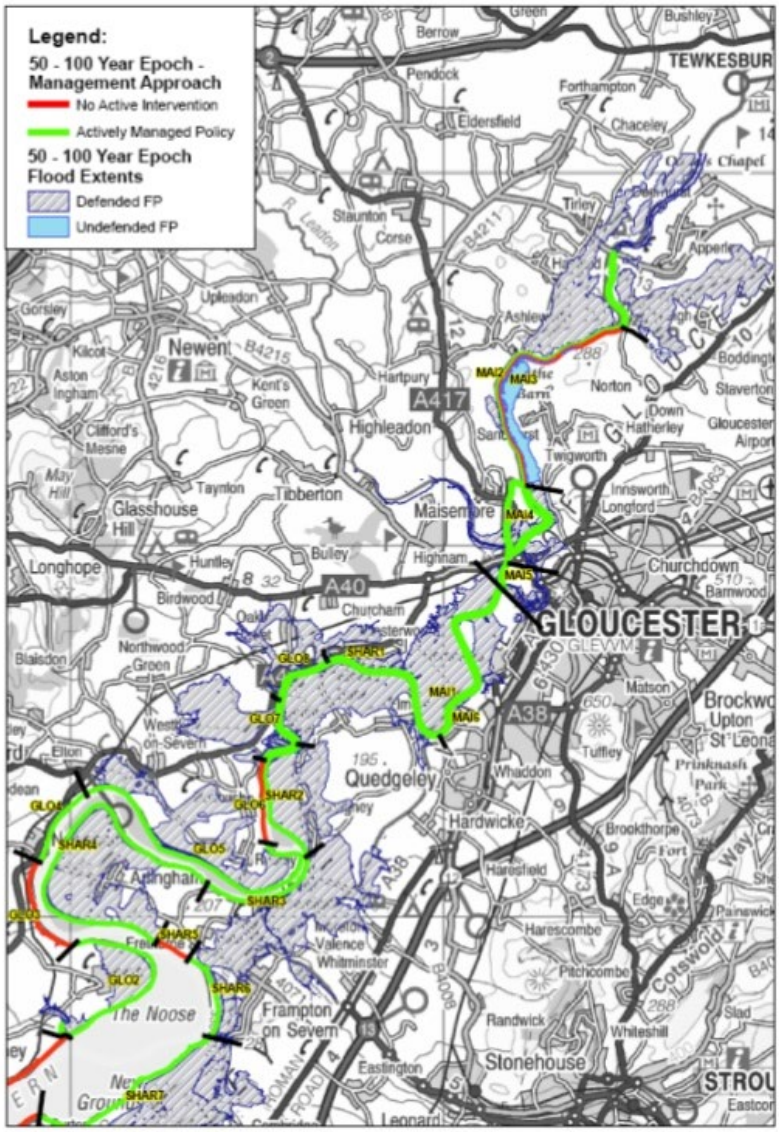


Figure 3.7 - WPM implications –Wentlooge Levels and Clevedon to Severn Beach (NB: Actively Managed Policy may include HTL, MR or ATL)

Relevant policy units and Policy options overtime (in SMP2) for the Forest of Dean District:

Policy Unit	Local Area	Policy Option 0-20 yrs (2025)	Policy Option 20-50 yrs (2050)	Policy Option 50-100 yrs (2105)
WYE 2	Woodcroft Tutshill	NAI	NAI	NAI
WYE 3	Sedbury	NAI	NAI	NAI
WYE 4	Beachley	NAI	NAI	NAI
TID1	Beachley Sedbury Tidenham	NAI	NAI	NAI
TID2	Alvington Aylburton	HTL	HTL	MR
LYD1	Lydney	HTL	HTL	HTL
GLOS1	Blakeney	NAI	NAI	NAI
GLOS2	Awre	MR	HTL	HTL
GLOS3	Bullo	NAI	NAI	NAI
GLOS4	Newnham Broadoak	HTL	HTL	HTL
GLOS5	W.O.S Rodley	HTL	HTL	HTL
GLOS6	Bollow	NAI	NAI	NAI
GLOS7		HTL	HTL	HTL
GLOS8		HTL	HTL	HTL

Key for the maps and the table:

NAI – No active intervention (assumes that no maintenance, repair or replacement of existing defence structures take place. A 'do nothing' scenario).

AM – Actively managed (this can include HTL, MR and ATL).

HTL – Hold the line (to provide some level of coastal defence, keeping the position of the defence approx. where it is now. This does not automatically mean that defences will be improved to counteract climate change)

MR – Managed Realignment (landward movement of defences, giving up some land to the sea to form a more sustainable defence line in the future)

ATL – Advance the line (reclaiming land from the sea)

In the short term, the Environment Agency's policy is to 'hold the line', that is, settlements and other features or assets will continue to be protected to an appropriate level by maintenance of the existing defences, e.g. Lydney, Alvington, Aylburton, W.O.S. Newnham. However, there is no benefit in advancing the line and some areas of the defence line are to be re-appraised. In the long term, however, the policy is 'No active intervention', that means to do nothing and effectively retreat the line, particularly in areas where there is little or isolated development.

This will involve moving defences away from their current position to a location further away from the riverbank. No substantial areas for retreat are specifically identified, although some proposals are made, particularly in agricultural areas away from settlements or major infrastructure. The policy of

retreat will, however, be constrained by how much settlements, infrastructure or other interests can be defended locally.

It is noted that the EA will no longer invest in the long term in the culverts in the railway embankment and TID1 area has a policy of No Active Intervention, thus putting the railway track into danger of flooding (unless Network Rail invest in flooding defences). It is estimated that the cost of a new railway track to be £3.6m per km. In the Action Plans in the SMP2 it is expected that the EA will encourage Network Rail and water and utility providers to undertake an assessment of the current and future risks and resilience to flooding of the railway line and to develop a flood resilience and adaptation plan as appropriate.

To the north of Bollow (GLO7), it is expected that the EA and the CFMP will undertake a study into opportunities to remove the flood embankments to increase the connection of the floodplain with the rivers.

In the short term (2025) Awre is expected to see managed realignment (landward movement of defences, giving up some land to the sea to form a more sustainable defence line in the future) of the sea defences and then it is expected to hold the line. This does not mean that the defences will be up kept and given that the Severn Estuary Flood Risk Management Strategy states that the EA will not spend any more public funds on this area, it is likely that the sea will eventually take control (unless the community wish to pay for defence maintenance).

6.5 Flood Risk Management Strategies

The Environment Agency also produces flood risk management strategies, which aim to deliver strategic options for flood risk management. The most relevant to this District is the Severn Estuary Flood Risk Management Strategy:

6.6 Severn Estuary Flood Risk Management Strategy (SEFRMS)

The Environment Agency has produced a Flood Risk Management Strategy (2013) for the tidal section of the river Severn, that is, from the weirs at Gloucester. The Strategy does not have any formal approval from Defra or Welsh Government. It is also likely that it will be reviewed and updated within the lifetime of the FoDDC emerging local plan (2021-2041) and hence the EA's strategy for parts of the estuary may change accordingly.

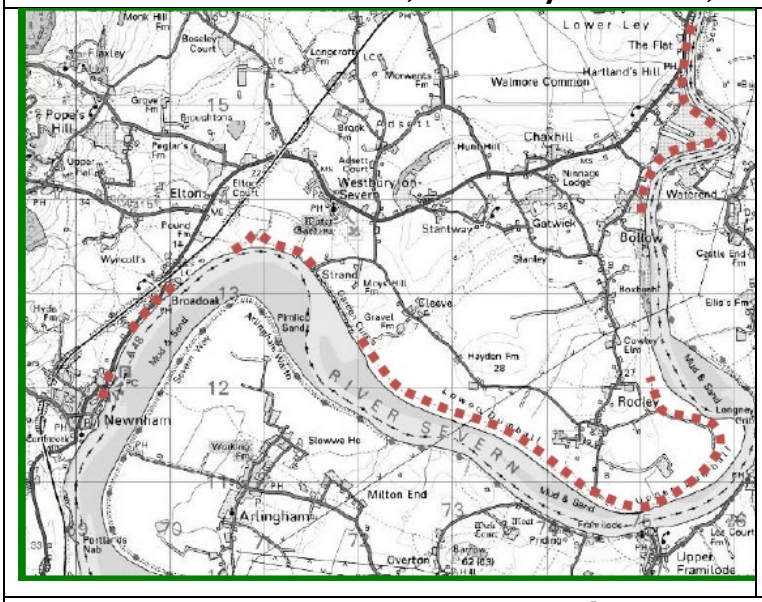
However, this Strategy is the starting point for ongoing collaboration between the Environment Agency, National Resources Wales, landowners, communities and organisations, to consider and plan for change for the next 100 years.

The three main objectives of the strategy are:

- to define a 100 year plan of investment for flood defences by the Environment Agency, National Resources Wales and local authorities
- to prioritise other flood risk management measures such as providing advice to utility companies to protect critical infrastructure, development management advice and flood warning investment
- to decide where we should create new inter-tidal wildlife habitats to compensate for losses of habitat caused by rising sea levels

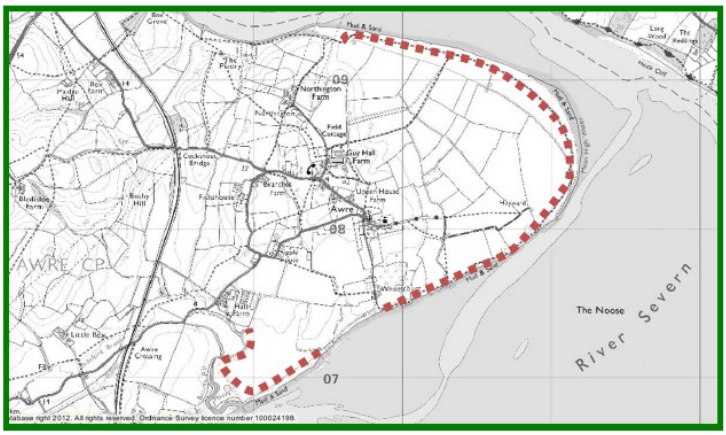
Fig 6.6 Summary of proposals for each section along the estuary (nb. This is 2013 data from SEFRMS):

Newnham, Westbury on Severn, Rodley and Bollow



- At Newnham and Westbury the EA intends to continue to maintain and repair the defences (as funds allow) and to then sustain the current standard of protection by raising the defence in response to climate change (as funds allow).
- The National Trust is currently considering flood risk management options for Westbury Court Gardens. The EA will work with the National Trust to secure flood risk and environmental benefits for the area.
- The EA intends to continue to maintain the embankments between Cleeve and Rodley and at the Noards (as funds allow), and to then sustain the current standard of protection if sea level rises over 0.3m (as funds allow). Raising the height of the defences on their existing line or realigning them inland are both options that could be considered with landowners at that time. Earlier managed realignment of defences may be an option should landowners wish to consider this.

Awre

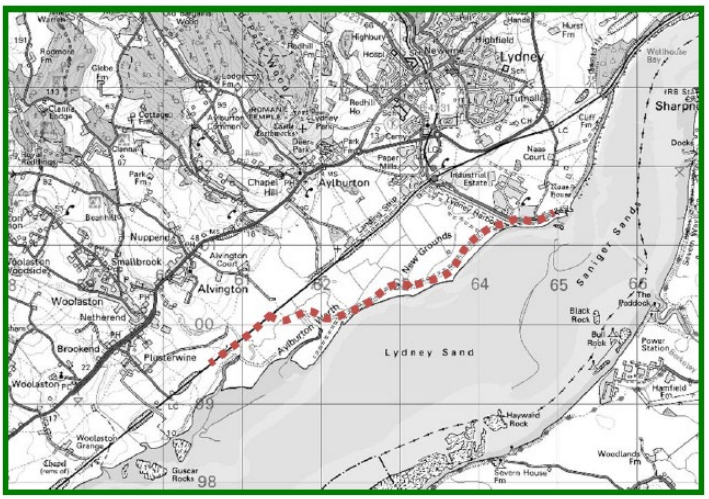


There is no economic justification for the Environment Agency to continue to use public funding to undertake maintenance work on the defences. We have had to make the decision to stop carrying out works in this area.
There are a number of options that can be considered for ongoing management of tidal flood risk at Awre.
Those options may include:

- Working in partnership between public authorities, landowners and community to maintain the defences.
- Landowners taking on responsibility for the maintenance of the defences (subject to the appropriate consents or permissions being obtained). Raising the defences above the existing height may impact on the protected environment of the estuary adjacent to Awre and formal consents would be needed.
- Doing nothing and allowing the standard of protection to reduce as condition of existing defences deteriorates.
- Landowners, community and the EA exploring a voluntary managed realignment scheme to provide an improved standard of protection for property access, if required, and allow some land to be used for habitat creation.
- Adapting farming activities to become more resilient to flooding.

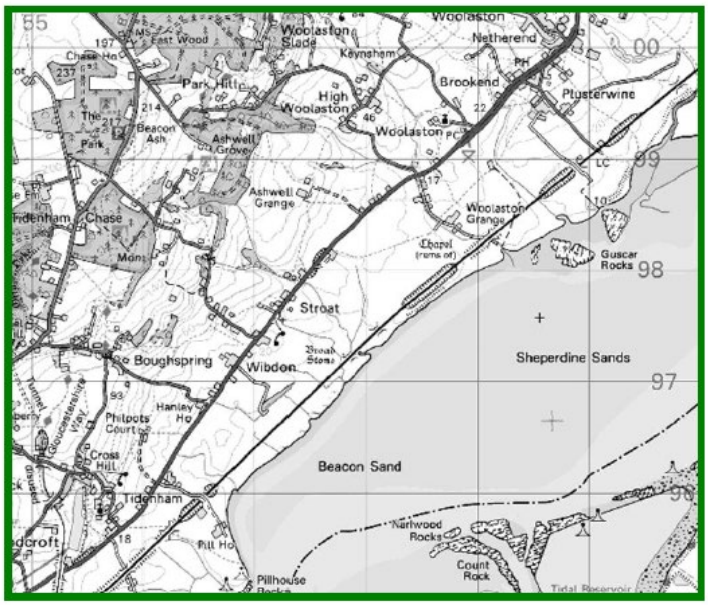
The 2011 version of the Severn Estuary Flood Risk Management Strategy proposed managed realignment for this location. This is no longer the proposal, although it is an option which landowners may wish to consider going forward.

Alvington, Aylburton and Lydney



The EA intends to maintain the defences (as funds allow), and then sustain the current standard of protection by raising the defences at Lydney and Aylburton New Grounds in response to climate change.
This is subject to the availability of funding. Please see the Supporting Information for further explanation of EA maintenance and funding.
The Lydney and Aylburton New Grounds defences are not expected to need to be raised until towards the end of the century. This depends on the ongoing condition of the defences and how much actual sea level rise is experienced. At that time strengthening the existing defences or realigning them inland could be considered.
Earlier managed realignment of defences may be an option, should landowners wish to consider this.

Tidenham, Stroat and Woolaston



The railway line is an important transport link, wholly in the control of Network Rail. As sea level rises Network Rail may need to increase maintenance on the rail embankment.
The EA cannot justify expenditure of public funds to replace the tide flaps on the culverts under the railway as the cost would be more than the economic benefits of reducing flood risk to small areas of agricultural grazing land.

Key

Existing defences referred to in text

Overall, the Environment Agency will continue to maintain and repair existing estuary defences (as funds allow) and raise the defence in response to climate change (as funds allow).

However, at Awre, there is no economic justification for the Environment Agency to continue to use public funding to undertake maintenance work on the defences, as such the decision has been made to stop carrying out works in this area. The options in this area are:

- Do nothing
- Landowners/community (possibly in partnership with the EA or alone) carry out repairs and maintenance to defences
- Adapt farming activities to become more resilient to flooding.

Finally, the railway line is an important transport link, wholly in the control of Network Rail. As sea level rises Network Rail may need to increase maintenance on the rail embankment. The EA cannot justify expenditure of public funds to replace the tide flaps on the culverts under the railway as the cost would be more than the economic benefits of reducing flood risk to small areas of agricultural grazing land.

6.7 2017-2027 Severn Estuary Strategy

In 1995 the Severn Estuary Partnership was formed to provide support to those who have responsibilities or interests in the estuary and to encourage working together to achieve a more integrated approach to the management of the estuary. The Severn Estuary Partnership is an independent, non-statutory organisation which relies on the support and active participation of its members, as well as a range of individuals and other organisations. It has recently updated its Severn Estuary Strategy 2017-2027 (http://www.severnestuarypartnership.org.uk/sep/strategy/15-16/) which provides a new Vision and a series of Principles, Objectives, Outcomes and Actions. The aims of this Strategy are to:

- Achieve a sustainable marine ecology
- Ensure a strong, healthy and just society
- Live within environmental limits
- Promote good governance
- Use sound science responsibly.

The Strategy is more of an overarching desire to improve the general environmental, social and economic wellbeing of the estuary and surrounding area. It does not, however, provide specific policies for certain locations.

6.8 Summary of Environment Agency Policies and Options

There are distinct areas in the Forest of Dean District covered by different policies and options for flood risk management in the future.

In the western half of the District there are steep-sided valleys which contribute to catchments' rapid response to storms and high surface water runoff. Here, the Environment Agency's overall policy is to realise opportunities to reduce flood risk by providing increased flood storage and improvement management of surface water (i.e. promoting the use of SUDs and natural flood management techniques). Improvements in river management including the restoration of river channels and functioning floodplains and the creation of buffer zones adjacent to rivers will all help manage flood risk in the area. This policy will have implications for future development in the District; indeed, Council can help deliver this policy by: seeking to ensure that Flood Zones 2 and 3 remain undeveloped, reinstating areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones) and promoting the use of SUDS. The main aims of the Lower Wye Catchment which falls within the Forest of Dean District includes the improvement of the condition and connectivity to flood plain meadows to provide flood storage and improved biodiversity, and eradicate non-native invasive plants.

In the eastern half of the District (including Lydney) the area has extremely flat coastal floodplain, with some areas protected by existing defences. In the short term, the Environment Agency's policy is to continue to protect features or assets by maintenance of the existing defences (Hold the Line), however, this does not necessarily mean that all the defences will be improved/maintained over time, as this will depend on how funds allow. Generally, many areas along the Severn Estuary are determined for No Active Intervention by the EA, and therefore, in the long term, the policy is to retreat the line. This will be reappraised and planned for in the near future. This will involve moving defences away from their current position to a location further away from the riverbank, particularly in agricultural areas away from settlement or major infrastructure (e.g. Awre peninsula). The policy

of retreat will, however, be constrained by how much settlements, infrastructure of other interests can be defended locally. Again, this policy will have implications for future development in the District. Indeed, Council can help deliver this policy, by: ensuring new development does not take place in areas along the estuary which are shown to be at risk and/or are currently defended. Such areas are likely to be exposed to greater flood risk in the future (due to climate change) and may well be earmarked for long term retreat in the future. When buildings within defended areas reach the end of their natural life, the Council should consider the option of not re-developing the site. It is also highlighted that the EA will no longer invest in the long term in the culverts in the railway embankment and TID1 area has a policy of No Active Intervention, thus putting the railway track into danger of flooding (unless Network Rail invest in flooding defences). In the Action Plans in the SMP2 it is expected that the EA will encourage Network Rail and water and utility providers to undertake an assessment of the current and future risks and resilience to flooding of the railway line and to develop a flood resilience and adaptation plan as appropriate.

Chapter 7 - Flood Defences

Flood defences are structures which affect flow in times of flooding and therefore prevent water from entering property. They generally fall into one of two categories: 'formal' or 'informal'. A 'formal' defence is a structure which has been specifically built to control floodwater. It is maintained by its owner (but this is not necessarily the Environment Agency) so that it remains in the necessary condition to function. An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function. A study of informal defences is also included in this section. Should any changes be planned in the vicinity of road or railway crossings over rivers in the study, it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal defences should be identified as part of site-specific detailed FRAs and the residual risk of their failure assessed.

The reduction in flood risk that a defence provides depends on the Standard of Protection (SoP) (the return period against which a defence offers protection) and the performance and reliability of the defence. Flooding may still occur in defended areas if the defence is overtopped or breached, or if flooding occurs as a result of non-fluvial sources such as groundwater flooding, surface water flooding or poor drainage. Development behind defences should, therefore, be planned with due regard to the flood risk in the defended area. This would need to be facilitated by a Level 2 SFRA.

7.1 Informal Defences

Road and railway embankments and other linear infrastructure may act as informal defence and divert flood water elsewhere, hold back water or create enclosure to form flood storage areas. Raised embankments may also offer a degree of flood protection. The EA has been asked for updated information on informal and formal defences and when any further data is received, it will be included in an addendum (and the map updated).

Informal defences should only be relied upon to protect new development following an FRA. This should investigate:

- The suitability of the embankment materials to prevent seepage of water, and whether it is physically strong enough to withstand the pressure of water on one side.
- An assessment as to whether there are any culverts through the embankment or other gaps within the structure that may let water through.
- The performance of the structure during recent historical flood events.
- The long-term Asset Management Plan (AMP) provided by the owner of the embankment.
- Whether by holding water back, the structure may fall under the regulation requirements of the Reservoirs Act (1975).

An assessment of all informal defences should be made as part of an FRA.

7.2 Culverts

Sections of culverted watercourse as identified within the UK Centre for Ecology and Hydrology – Detailed Rivers Network mapping database, which can be found in the interactive online map. This map provides details on location, type of culvert as well as the length. Although this is a very detailed map, it is still possible, however, that culverts exist which are not identified on this database. Therefore, when locating development, OS tiles should be analysed to identify any culverts in the vicinity of development sites. In some cases site visits may be required. Further details of the implications of culverts (residual risks) on new development can be found in Section 7.5.

On any new development site and indeed on existing sites, further culverting and building over of culverts should be avoided. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit.

7.3 Parish flood defences

Part of the District Council's remit is to invest in local flood defence schemes. The following summarises the Parish Flood Defence schemes which the FoDDC has been part of in the last few years:

- **Cinderford**
  In 2017, the Council contributed 50% towards the cost of Flood Doors installed at two properties along St Whites Road to protect the properties from flooding from The Cinderford Brook.

- **Coleford**
  In 2019, the Council made drainage improvement works to alleviate flooding along the ordinary watercourse on the Milkwall Cycle Track, Coleford. A replacement trash screen was constructed to reduce the degree of blockage and improve the conveyance of water, and new steps were installed to improve access for maintenance.

- **Hartpury**
  In order to reduce the frequency of flooding to a property at high flows, the Council installed a Stop Log Flow Control to improve the conveyance of water away from the property and enable the watercourse to be used to its full capacity.

- **Longhope**
  It is planned that the Council will undertake drainage improvement works in 2020, to alleviate flooding of residential properties from an ordinary watercourse off Church Road, Longhope. A replacement trash screen will be constructed to reduce the degree of blockage and improve the conveyance of water. Access will also be improved for ease of maintenance.

- **Lydney - Lakeside Ave (upstream attenuation)**
  In 2015, a penstock was installed by the Council upstream of the A48, to maximise the capacity of the channel and attenuate runoff, slowing the flow of water towards the downstream residential area (Lakeside Ave).
  At the request of FODDC, further in-channel attenuation was installed by the land owner in Spring 2017. This consisted of two earth bunds to maximise the capacity of the channel and further slow the flow of water towards the downstream residential area (Lakeside Ave).

- **Lydney - Lakeside Ave (replacement headwall and trash screen)**
  In Summer 2017, the Council improved the evacuation of water at the culvert entrance upstream of Lakeside Ave. The original trash screen had the potential to block and during high rainfall events in Summer 2007 and Winter 2013 and 2014, resulted in significant flooding along Lakeside Avenue.
  The scheme involved extending both culverts, 12m upstream onto Forest of Dean District Council land and installing a new brick and block headwall with main culvert and overflow "on face". An improved trash screen design was installed, with vertical flat bars to reduce the potential for blockage.

- **Newent**
  A flood alleviation scheme was undertaken in 2018 to reduce the frequency of flooding to properties in Newent Town Centre and a number of residential properties adjacent to the Peacocks Brook. The main aspect of this flood alleviation work was the construction of a 50m long, 1.5m high earth bund, to create a significant storage area upstream of the residential area.

7.4 Storage Areas

Storage in a catchment is often considered as an important flood management option. Storage can have the effect of delaying the time at which the peak of a hydrograph occurs. Delaying the peak of one hydrograph can alter the phasing of the other hydrographs in a system. Altering the phasing of peaks may mean that it is possible to stop the peak flow from one tributary combining with that of another. This can have the effect of reducing peak flow, and therefore flooding, in the main channel.

There are a number of areas of extended floodplain acting as natural storage within the District. For example, at Russelsend Coppice (SO 7500 3324) the Glynch Brook is confined by the M50 to the north. Downstream of Russeland Coppice, Flood Zone 2 widens significantly on the left bank, extending approximately 600m up to the M50, due to the constraining nature of the road bridge at Blackford Mill Farm. This area acts as a natural flood plain during times of high flow.

It is imperative that any storage areas used as a means of attenuation of flood waters should be maintained to ensure their efficient operation during a flood event. If the storage areas are not maintained this may lead to an increased risk of flooding at locations downstream.

A number of flood storage areas are situated along the River Severn. There are areas of natural, low lying topography bounded by high ground, with earth embankments along the edge of the river. These earth embankments have a SoP of typically 1 in 20 years (or less). During a flood event, water from the River Severn spills into the storage areas and is contained by a series of high embankments. They function by removing large volumes of flood water, retaining it, and then allowing it to drain back to the main channel via flapped outfalls and sluice gates after the peak of the flood event. Key storage cells located within the Forest of Dean District include: Oakle Street (SO 7626 1775), Walmore Common (SO 7382 1557), Rodley (SO 7382 1183) and Northington (SO 7148 0853). These flood storage areas can be viewed on the online map.

A number of artificial lakes, formed from past aggregate extractions, can be found in several areas on the Severn floodplain, many of which are important sites for wildlife and recreation. Often these sites maintain high water levels and provide little capacity for flood water storage. Any increase in runoff to these areas may result in a further loss of storage capacity, and subsequent increase to flood risk at downstream locations.

It is imperative that any storage areas used as a means of attenuation of flood waters area safeguarded from development and maintained to ensure their efficient operation during a flood event. If the storage areas are not maintained this may lead to an increased risk of flooding at locations downstream.

7.5 Residual Risk

In producing Flood Zone maps the Environment Agency takes the presence of defences into account by showing the area that benefits from the defence (ABD). This area can also be deemed an area which is at risk of defence overtopping or failure. It can therefore also be described as a residual risk zone. Residual flood risks from defences can arise due to:

- The failure of flood management infrastructure such as a breach of a raised flood defence
- A severe flood event that exceeds a flood management design standard and results in, for example, overtopping

No ABDs have been mapped by the Environment Agency within the District, though this does not mean that no residual risk areas exist. Any defence will have a residual risk of breach or overtopping. An assessment of residual risk should therefore be made at the site-specific level as there will be residual risk associated with all defences. Actual levels of residual risk will vary spatially depending on flow routes, velocities, flood depths and proximity to the breach or overtopping location. In the event that development is located in or near a residual risk area (e.g. behind a defence) the scope of the SFRA should be extended to a Level 2 assessment to refine information on the flood hazard in these locations. Known defence locations available on the online map assist with this.

Residual risks can also arise from the following sources:

- Blockage or collapse of a culvert
- Blockage of a surface water conveyance system
- Overtopping of an upstream storage area
- Failure of a pumped drainage system
- Surcharging of surface water conveyance systems and SUDS systems, drainage networks

There is currently no dataset which identifies precise residual risk areas from these sources, therefore again any development in the vicinity of culverts, surface water conveyance systems, storage areas and pumped drainage systems should assess residual risk through a Level 2 SFRA. Known culvert locations can be views on the online map. These should be referenced by those proposing development to identify the possibility of localised residual risks as well as opportunities for de-culverting and restoring the natural channel. OS tiles should be analysed to identify any culverts in the vicinity of development sites which are not recognised in the interactive map. In some cases site visits may be required.

Poorly maintained trash screens and rubbish inappropriately dumped in watercourses can reduce culvert and structure capacity, therefore presenting residual risk. This can be mitigated by regular inspection and clearance of culverts and trash screens.

Information received from the Environment Agency indicated that there is an issue with culverts falling into a state of disrepair, particularly in buried valleys or under tips. These pose a particularly

high risk of collapse, therefore they pose residual risk. It is recommended that any development in the vicinity of culverts should assess the potential of de-culverting. If this is not possible, an assessment of the state of the culvert should be made, and any remedial works carried out prior to the development of the site.

7.6 Existing Flood Warning System

One aspect of the Environment Agency's work is reducing risks to people and to the developed and natural environment from flooding through flood forecasting, flood warning and response. The Environment Agency is the lead organisation on flood warning and they work closely with Local Authorities and Emergency Services to plan for flooding emergencies and reduce the risk of flooding to people and properties. The Forest of Dean District falls within the Midlands and Wales Regions of the Environment Agency.

When conditions suggest that floods are likely, it is the responsibility of the Environment Agency to issue flood warnings to the Police, Fire and Rescue Service, to the relevant local authorities, and to the public.

Communities and individuals are able to find out about flood warnings in several ways. The www.gov.uk website provides a Flood Information Service.

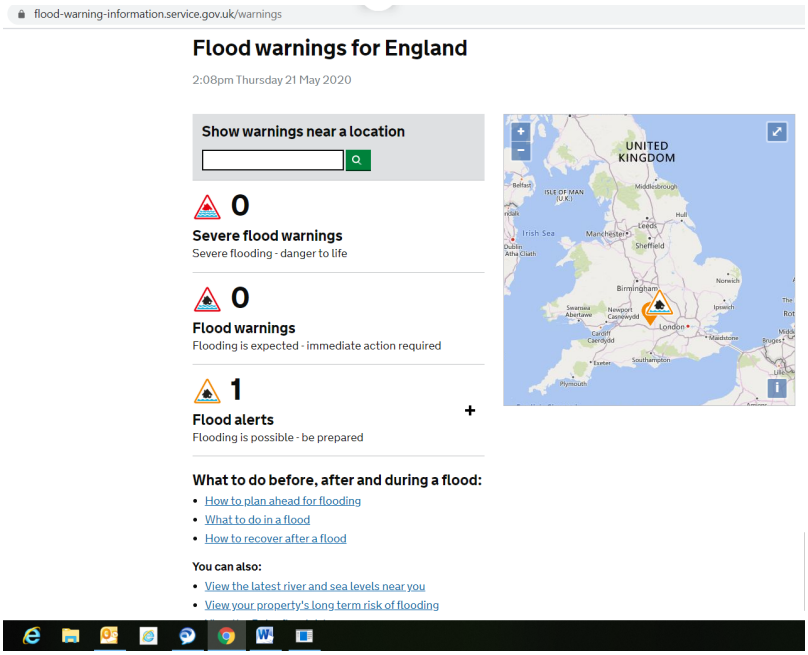


Fig 7.1 Flood Warning Information Service https://flood-warning-information.service.gov.uk/warnings

Here you can find flood alert warnings for the UK by using the location search and also seeing warning signs on the map. This system provides different levels of flooding:

	**Flooding Alert**	Flooding is possible – be prepared
	**Flood Warnings**	Flooding is expected – immediate action required
	**Severe Flood Warnings**	Severe flooding- danger to life.

Fig 7.2 Flood Warning Signs

The Flood Warning Information Service states clearly that the best way to protect yourself and your property from flooding is to know in advance. This is why it issues 3 levels of warning (as above). Each stage provides you with guidance on what to do:

	**Flooding Alert**	**PREPARE** • Prepare a bag that includes medicines and insurance documents • Check flood warnings
	**Flood Warnings**	**ACT** • Turn off gas, water and electricity • Move things upstairs or to safety • Move family, pets and car to safety
	**Severe Flood Warnings**	**SURVIVE** • Call 999 if in immediate danger • Follow advice from emergency services • Keep yourself and your family safe

Fig 7.3 What to do for Each Alert Level

It is suggested that each family, business and community have a personal flood plan for such situations and templates to aid with this are provided on the Flood Warning Information Service website.

Anyone can sign up to get flood warnings in England (and throughout the UK). The warnings will be issues either by phone, email or text message to homes and businesses at risk and the service is free. Signing up for this service can be done:

Online at https://www.fws.environment-agency.gov.uk/app/olr/register

You can also register, update your details or cancel your account by calling the Floodline:

Floodline
Telephone: 0345 988 1188
24-hour service (charges apply)

The Targeted Flood Warning Service also provides warnings for multiples businesses locations (this carries a cost unless it is a not-for-profit organisation)

Targeted Flood Warning Service
Telephone: 03708 506 506
Monday to Friday, 8am to 6pm

The www.gov.uk website also provides the latest river and sea levels, as well as the capability to view your property's long-term risk of flooding as well as the 5-day flood risk.

The Flood Information Service also provides helpful information on the following:

What to do in a flood:

It is important that you prepare for a flood prior to it happening. This can be done through the Flood Warning Information Service alert system, which anyone can sign up for. A simple flood plan is provided by the Flood Warning Information Service describing the phases of alert and how to prepare.

If you get a **flood alert**, you should do the following:

- Check your flood risk
- Keep up to date with the latest situation (Floodline 0345 988 1188, follow @EnvAgency and #floodaware on Twitter for the latest updates)
- Have a bag ready with vital items like insurance documents and medications in case you need to leave your home
- Check you know how to turn off your gas, electricity and mains water supplies
- Plan how you'll move your family and pets to safety.

If you get a **flood warning**, you should do the following:

- Move vehicles to higher ground if it's safe to do so
- Move family and pets to safety
- Move important items upstairs or to a safe place in your property, starting with cherished items and valuables, then furniture and furnishings
- Turn off gas, electricity and water supplies if it's safe to do so; never touch an electrical switch if you're standing in water
- If you have property protection products such as flood barriers, or air brick covers, use them now
- Keep track of the latest situation.

If you get a **severe flood warning**, you should do the following:

A severe flood warning means there is danger to life: you must act now.

- Call 999 if you're in immediate danger
- Follow advice from the emergency services and evacuate if you're told to do so
- Make sure you have an emergency kit including a torch, spare batteries, mobile phone and charger, warm clothes, important numbers like your home insurance, water, food, first aid kit and any medicines and babycare items you may need
- Alert neighbours and offer help if it's safe to do so
- Avoid driving or walking through flood water: just 30cm (1 foot) of fast flowing water could move your car and even shallow moving water can knock you off your feet
- Keep your family and pets away from floodwater – it may contain heavy debris, sharp objects, open manhole covers, sewage and chemicals
- Wash your hands if you've been in contact with flood water which may contain toxic substances

How to recover from a flood:

After a flood, you should do the following:

- Contact your insurance company. If you don't have insurance, the National Flood Forum can offer you advice.

National Flood Forum

Is a charity to help, support and represent people at risk of flooding.

Website: https://nationalfloodforum.org.uk/

Phone number: 01299 403 055

- Find your local flood action group or flood warden.
- Check with the emergency services if you can return home
- Clean and repair your home. Before you start cleaning, take photographs to document damage and record the flood water height. Ask your insurer before discarding items that cannot be cleaned, like mattresses and carpets. Always wear gloves, a face mask and sturdy footwear when cleaning your home. Flood water may contain harmful substances like sewage, chemicals and animal waste which could make you unwell. If you come into contact with flood water, wash your hands thoroughly. Take advice from specialists before starting repairs to your property. Most of the repair work after flooding will need to be undertaken by professionals appointed by your insurers. If you use heaters or dehumidifiers to dry out your property, make sure there is good ventilation. Never use petrol or diesel-powered generators indoors – their exhaust gases are potentially lethal.
- Protect your property from future floods, such as laying tiles instead of carpets, moving electrical sockets higher up the walls and fitting non-return valves.
- Stay healthy. If you notice a change in the colour, taste or smell of your tap water, stop using it and phone your water company. Do not eat food that's touched flood water. If your electricity is off, do not eat fresh food from a fridge after 4 hours or from a freezer after 24 hours.
- Get help, emotional support or financial aid. The Environment Agency has specially trained Flood Support Officers across the country who provide information and advice during and after floods. Call Floodline (24-hour service) on 0345 988 1188 or type-talk (for the hard of hearing) on 0345 602 6340 to find out if they are active in your area. Having a flooded home is very stressful. If you need emotional support, contact family and friends, your doctor or an organisation like the Red Cross or the Samaritans. You may be able to get financial aid for flood recovery. Apply to your local council (Forest of Dean District Council).

Table 7.1 Flood Warning Areas within the Forest of Dean District

Flood Warning Areas	EA Region
River Lyd at Lydney	West Midlands
River Severn at Minsterworth and Stonebeach	West Midlands
River Wye at Lydbrook	West Midlands
Tidal Severn from Elmore to Rodley	West Midlands
Westbury, Broadoak and Newnham on Severn Estuary	West Midlands
Sharpness and Lydney Harbour on the Severn Estuary	West Midlands
Wye Estuary at Elmdale, Chepstow	West Midlands
Wye Estuary at Brockweir	West Midlands

River and sea levels are regularly checked by a network of monitoring stations. These levels can help you to understand your flood risk now and in a few days. The river level monitoring stations within the Forest of Dean can be found at: https://flood-warning-information.service.gov.uk/river-and-sea-levels

Flood warnings for tidal flooding can be predicted by the Environment Agency. Accurate predictions as to when tidal flooding will not occur can be made months in advance. However, predictions as to when tidal flooding will occur are more difficult and tend to be only 16 or 4 hours before high water. This is because the Met Office can only produce accurate forecasts within this timeframe. Extreme tidal conditions are also difficult to predict early. It is generally possible to predict at the start of the year when high tides large enough to result in flooding will occur. The Environment Agency will normally issue a Flood Alert or Flood Warning for a high tide between one and two hours after the previous high tide (approximately 10 hours before flooding begins). However, the lead time for a severe flood warning is generally less than 4 hours.

7.7 Flood Response Plan

7.7.1 County Council Flood Response Plan

Gloucestershire County Council heads up a Civil Protection Team to make sure that the local communities and local authorities are well prepared to respond to any major emergency, which includes flooding. This team makes plans and trains teams to respond closely with other agencies like the Fire, Police and Ambulance Services, as well as working through the Gloucestershire Local Resilience Forum. This complies with the statutory duties of the Civil Contingencies Act 2004.

Gloucestershire Local Resilience Forum - Gloucestershire Prepared
https://glosprepared.co.uk/

The Gloucestershire Local Resilience Forum (Glos LRF) is a multi-agency partnership made up from representatives from the emergency services, local authorities, the NHS, the Environment Agency and others (known as Category 1 Responder). The Glos LRF is however, also supported by organisations, known as Category 2 responders, such as the Highway Agency and public utility companies. It exists to plan and prepare for localised incidents and emergencies and works to identify potential risks and produce emergency plans to either prevent or mitigate the impact of any incident on their local communities. Some useful information on being prepared for a flood can be found at: https://glosprepared.co.uk/be-prepared-flooding/

GCC in association with District Councils and other partners has produced 'Your Essential Flood Guide – Information and Forward Planning' (https://glosprepared.co.uk/be-prepared-flooding/), which provides practical advice on preparing for and dealing with flooding.

GCC stresses that it is important that communities have a plan in place to avoid becoming isolated and to that end has produced a template and guidance notes, which explain how to form your own Community Response Team and how to create a Community Emergency Plan. More information on this service can be found at: https://www.gloucestershire.gov.uk/your-community/emergencies-and-your-safety/preparing-for-emergencies/

GCC acknowledges that everyone has their part to play with an emergency and therefore provides an Emergency Advice Leaflet for householders (https://www.gloucestershire.gov.uk/media/2974/household_emergency_plan_-3626.pdf) and an Emergency Kit leaflet (https://www.gloucestershire.gov.uk/media/2738/emergency_kit-65233.pdf).

These provide advice on the initial steps to take in the event of an emergency as well as a checklist of things to consider.

The primary role of local authorities in responding to any emergency is to provide care and support for those affected. They deliver through close working partnerships with the emergency services and other agencies involved in the combined response. In Gloucestershire, both the District Councils and the County Council's involvement may be required in responding to a flooding emergency. The District Councils, as land drainage authorities are primarily responsible for assisting with flooding to property, whereas the County Council is primarily responsible with flooding on the highway.

The Area Highways Managers within Gloucestershire Highways will deal with flooding of highways. Each of the Area Depots has a stockpile of sandbags and a supply of sand, which can be used to assist in preventing highway runoff entering houses, etc.

The public are expected to take reasonable measures to protect their own property. To this end, the Forest of Dean District Council does not provide a sandbag service to residential or commercial properties, but does provide advice on where to buy them and how best to use them.

GCC also promotes the Red Cross Emergency app (https://www.redcross.org.uk/get-help/prepare-for-emergencies/free-emergency-apps) where instant alerts about severe weather are available and responses to flooding may be provided at a County and/or District level as summarised in the table below. In principle, Districts will provide the service and the County will support unless the incident severely affects more than one District such that County resources are required.

Table 7.2 County and District Flood Response Responsibilities

Required Response	County Responsibility		District Responsibility
Co-ordination of the local authority response and liaison with other organisations, including provision if required of a representative to support Police arrangements for coordination.	√	Or	√
Emergency care including feeding, accommodation and welfare for those who have been evacuated from their homes or those affected by flooding but remaining in their homes.	√	And	√
Emergency transport for personnel, equipment, materials such as sandbags and, if necessary, evacuation.	√	And	√
Information services for liaison with the media on the local authority response and for information to the public, relatives of evacuees, etc.	√	Or	√
Flood alleviation – for flood prevention, such as issuing of sandbags, clearance of block culverts, for dealing with flooded roads and diversions and for other	√	And	√
Emergency environmental health advice for action relating to environmental problems caused by flooding			√
Joint agency co-ordination of non-life threatening floods and of the recovery phase following a flooding incident	√	Or	√
Co-ordination of the voluntary response	√		

7.7.2 Forest of Dean District Council Flood Response Plan

To comply with the Civil Contingencies Act, the Forest of Dean District Council has put plans in place and trained its staff in order to respond in an emergency, for example, setting up a rest centre for people that have been evacuated from their homes. The FoD District Council aims to ensure that it is prepared for any major emergency, in order to respond to support the emergency services as required, and assist those affected.

The District Council is part of the Gloucestershire Local Resilience Forum which provides a multi-agency response to major emergencies in the county (see above).

Chapter 8 - Flood Risk Management Policy Considerations

8.1 Overview

This chapter provides recommendations for what should be included in the Council's policy for flood risk management. Council policy is considered essential to ensure that the recommended Development Management conditions can be imposed consistently at the planning application stage.

The policy recommendations provided in this chapter are not exhaustive and it is therefore recommended that the Council refers to the following key flood risk management documents in order to fully inform their own flood risk management policies:

- National Planning Policy Framework (NPPF) & Planning Practice Guidance (PPG) – set out national policy and guidance for development and flood risk and supports the Governments objectives for sustainable communities.
- Flood Risk Management Strategies (FRMS) – produced by the Environment Agency and aims to deliver strategic options for flood risk management. The most relevant to this District is the Severn Estuary Flood Risk Management Strategy (SEFRMS) published in 2013. The Strategy is the starting point for ongoing collaboration between the Environment Agency, National Resources Wales, landowners, communities and organisations, to consider and plan for change for the next 100 years.
- Flood Risk Management Plans (FRMPs) - The study area is covered by the Severn River Basin Flood Risk Management Plan 2021-2027 (FRMP), which is a collaboration between the Environment Agency and relevant local and risk management authorities. It is a second cycle Flood Risk Management Plan which aims to manage significant flood risks in the Flood Risk Areas (FRAs) identified in the Severn River Basin District (RBD). The FRMP covers flood risk from fluvial, tidal, surface water and sewer sources.
- Shoreline Management Plan (SMP) – a high level non-statutory policy document which deals with the flood risk management of a shoreline rather than a river catchment. The Severn Estuary Shoreline Management Plan (SMP2) was updated in 2017. It is developed by the Severn Estuary Coastal group in partnership with the Environment Agency and other local authorities, regulators and other stakeholders. It provides a large-scale assessment of the risks associated with coastal erosion and flooding at the coast in the long-term. It proposes policies to manage these risks sustainably over the next hundred years.
- Water Framework Directive – European Union (EU) water legislation which requires all inland and coastal waters to reach good ecological status.

8.2 Policy Considerations

A key aim of an SFRA is to define flood risk management objectives and identify key policy considerations. It should be noted that it is ultimately the responsibility of the Council to formally formulate these policies and implement them.

It is recommended that the following flood risk objectives are taken into account during the policy making process and, where appropriate, used to strengthen or enhance the development management policies provided in Section 3.5.

8.2.1 Flood Risk Objective 1: To Seek Flood Risk Reduction through Spatial Planning and Site Design:

- Use the Sequential Test to locate new development in least risky areas, giving highest priority to Flood Zone 1. Climate change in relation to the sequential test when considering allocation sites, must be taken into account.
- Direct new development away from flood risk areas and areas that are currently defended along the Severn Estuary to enable the Environment Agency to achieve the long-term goal of 'retreating the line'
- Use the Sequential Test and approach within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits
- Ensure that a positive gain in floodplain storage capacity is provided on-site and ensure that there is no negative impact on flood conveyance routes
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels)
- Identify long-term opportunities to remove development from the floodplain through land swapping
- Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian access to and from the development should be possible without passing through the 1% AEP (1 in 100 year) plus climate change floodplain; emergency vehicular access should be possible during times of flood; and the development should include flood resistance and resilience measures to ensure it is safe. Residual risk, i.e. the risks remaining after taking the sequential approach and taking mitigating actions, during the 1 in 1000 year event, should also be 'safe'.
- Avoid development immediately downstream/adjacent to reservoirs/impounded water bodies which will be at high hazard areas in the event of failure.

8.2.2 Flood Risk Objective 2: To Reduce Surface Water Runoff from New Developments and Agricultural Land:

- SUDS are required on all new development. Section 10.6 outlines appropriate SUDS techniques for the District and Chapter 9 provides further guidance for developers on the application of SUDS.
- As part of any ongoing or future development within the District, the treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques as outlined in section 10.6.
- All sites should meet the following criteria:
- As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at a minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified
- Attenuation should be provided to a 1 in 100 year standard, taking account of climate change
- Attenuation features should be located outside areas of high risk (Flood Zone 3) that includes the appropriate potential impacts of climate change over the lifetime of the development on the flood zone extents.
- Space should be specifically set aside for SUDS and used to inform the overall site layout

- Promote environmental stewardship schemes to reduce water and soil runoff from agricultural land

However, a greater level of betterment may be required within specific locations or areas of the county where necessary due to local issues as identified by any local authority or other appropriate drainage authority.

- All sites require the following approach to be taken:
- Application of a SUDS management plan
- A hierarchical approach should be applied to SUDS used:
    1. Preventative measures to ensure that there are not unnecessary impermeable areas on-site
    2. Source control measures such as rainwater harvesting and infiltration systems provided site conditions are appropriate
    3. Site control measures where prevention and source control measures alone cannot deal with all on-site drainage. Above ground attenuation systems, such as balancing ponds and swales, should be considered in preference to below ground attenuation, due to the water quality, biodiversity and amenity benefits they offer.
    4. Regional control measures should only be considered where none of the above preferred options can be achieved.
- A hierarchical approach should also be applied to the disposal of surface water from the site taking the following order: rainwater harvesting systems, an adequate soakaway or other adequate infiltration system, a watercourse, a surface water sewer and, only as a last resort, a combined sewer.
- Exceedance design measures should be applied to ensure that extreme events above the design standards of the system do not pose adverse impacts
- SUDS should be designed for the lifetime of the development, with suitable provisions for likely future permitted and minor development (e.g. paving of front gardens or minor extensions (it may be possible to achieve this either through suitable planning or engineered solutions).

8.2.3 Flood Risk Objective 3: To Enhance and Restore the River Corridor:

- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets (e.g. de-culverting, the use of bioengineered river walls, raising bridge soffits to take into account climate change).
- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment or/and renewal should be made to ensure the lifetime is commensurate with lifetime of the development. Developer contributions should be sought for this purpose. When the structure is beyond its life, and/or no longer required, the first consideration should be to remove the structure. If it is identified that the structure is still required but still requires replacement, opportunities for further enhancement work should be sought.
- Existing structures should only be removed once it can be demonstrated that it will not cause an unacceptable increase in flood risk, on-site and elsewhere.

- Avoid further culverting and building over of culverts. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit.
- Set development back from rivers, seeking a minimum 8 metre wide undeveloped buffer strip from the top of the bank.

8.2.4 Flood Risk Objective 4: To Protect and Promote Areas for Future Flood Alleviation Schemes

- Protect Greenfield functional floodplain from future development (our greatest flood risk management asset) and reinstate areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones).
- Develop appropriate flood risk management policies for the Brownfield functional floodplain, focussing on risk reduction.
- Identify sites where developer contributions could be used to fund future flood risk management schemes or can reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

8.2.5 Flood Risk Objective 5: To Improve Flood Awareness and Emergency Planning

- Seek to improve the emergency planning process using the outputs from the SFRA.
- Encourage all those within Flood Zone 3a and 3b (residential and commercial occupiers) to sign-up to Floodline Warnings Direct service operated by the Environmental Agency, where this service can be provided.
- Ensure robust emergency (evacuation) plans are implemented for new developments in areas at risk of flooding.
- Identify sites where developer contributions could be used to fund maintenance or improvements to the existing Flood Warning Service, especially where safe access is reliant on this service.

8.3 Development Management Policies

For the purposes of development management, detailed policies will need to be set out to ensure that flood risk is taken account of appropriately for both allocated and non-allocated 'windfall' sites. In all Flood Zones, developers and local authorities should realise opportunities to reduce the overall level of flood risk in the area and beyond through the location, layout and design (in that order) of development.

The following reflects the minimum requirements under PPG:

8.3.1 Future Development within Flood Zone 1

There is no significant flood risk constraint placed upon future developments within the Low Probability Flood Zone 1 (unless the issues outline in Section 9.5 are identified), although the vulnerability from other sources of flooding should be considered as well as the effect of the new development on surface water runoff.

Typically a Drainage Impact Assessment will be required to demonstrate that the treatment and control of surface water runoff can provide a level of betterment, incorporating the use of various SUDS techniques, which should take into account the local geological and groundwater conditions. As a minimum, there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.

Consideration must be given to the effect of the new development in terms of off-site consequences from all sources of flooding.

For sites where the access and egress routes are within Flood Zone 3 or 2, the site should be considered as if being within that higher Flood Zone itself.

8.3.2 Future Development within Flood Zone 2

Land use within Medium Probability Flood Zone 2 should be restricted to the 'water compatible', 'less vulnerable' and 'more vulnerable' category, though it will be necessary to undertake the Sequential Test. Should the Exception Test be required a Level 2 SFRA should be carried out.

Where other planning pressures dictate that 'highly vulnerable' land uses should proceed, it will be necessary to ensure that the requirements of the Exception Test are satisfied.

The following is required:

- A detailed site-specific FRA should be prepared in accordance with PPG and Council Development Management policies.
- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 600mm.
- Safe dry pedestrian access to and from the development should be possible above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for climate change and emergency vehicular access should be possible during times of flood.
- Flood resistance and resilience should be incorporated into the design.
- People (including those with restricted mobility) should be able to remain safe inside the new development up to a 0.1% AEP (1 in 1000 year) event; and rescue and evacuation of people from a development (including those with restricted mobility) to a place of safety is practicable up to a 0.1% AEP (1 in 1000 year) event.
- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.
- The proposed development should be set-back from the watercourse with a minimum 8m wide undeveloped buffer zone from top of bank, to allow appropriate access for routine maintenance and emergency clearance.

8.3.3 Future development within High Probability Flood Zone 3a

Land use with High Probability Flood Zone 3a should be restricted to the 'less vulnerable' or 'water compatible' uses to satisfy the requirements of the Sequential Test. For 'more vulnerable' or 'essential infrastructure' uses it is necessary to ensure that the requirements of the Exception Test are satisfied, which will require a Level 2 SFRA.

The following should be considered:

- A detailed site-specific FRA should be prepared in accordance with PPG and Council Development Management policies. Properties situated within close proximity to formal defences or water retaining structures (reservoirs/canals) will require a detailed breach and overtopping assessment to ensure that the potential risk to life can be safely managed throughout the lifetime of the development. The nature of any breach failure analysis should be agreed with the Council, the Environment Agency and/or the operating authority, as appropriate.
- The development should not increase flood risk elsewhere, and opportunities should be taken to decrease overall flood risk (such as use of SUDS and de-culverting). This should be optimised by developing land sequentially, with areas at risk of flooding favoured for green space. There should be a positive gain in the floodwater storage capacity provided and there should not be any detrimental impact on floodwater flow conveyance.
- Floor levels should be situated above the 100 year plus climate change predicted maximum level plus a minimum freeboard of 300mm. Within defended the areas the maximum water level should be assessed from a breach analysis. Where there is sufficient depth between the underside of the floor slab and existing ground level, under-flood voids should be included with adequate void openings.
- The development should allow safe dry pedestrian access to and from the development above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for climate changes emergency vehicular access should be possible during times of flood.
- An evacuation plan should be prepared. With respect to new developments, those proposing the development should take advice from the LPAs emergency planning officer and for large-scale developments, the emergency services, when producing an evacuation plan as part of a FRA. All access requirements should be discussed and agreed with the Council Emergency Planners.
- Basements should not be used for habitable purposes. Where basements are permitted for commercial use, it is necessary to ensure that the basement access points are situated 300mm above the 1 in 100 year flood level plus climate change.
- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified. Space should be set aside for SUDS.
- The proposed development should be set-back from the watercourse with a minimum 8m. wide undeveloped buffer zone from top of bank, to allow appropriate access for routine maintenance and emergency clearance.
- For sites where the access and egress routes are within Flood Zone 3 or 2, the site should be considered as if being within that higher Flood Zone itself.

8.3.4 Future development within Functional Floodplain Zone 3b

This zone comprises land where water has to flow or be stored in times of flood (land which would flood with an annual probability of 5% (1 in 20 year) or greater in any year or is designed to flood in an extreme (0.1%) flood, including water conveyance routes). Where a modelled outline for Flood Zone 3b has not been produced, its extent is equal to Flood Zone 3a. Therefore for any

development site falling in Flood Zone 3a with no 3b available, this section should be used to understand the requirements of development.

- Development in High Probability Flood Zone 3b should be restricted to 'water-compatible uses' only.
- PPG dictates that 'essential infrastructure' can be located in Flood Zone 3b if the Exception test is passed (this would require a Level 2 SFRA). However, appropriate judgement should be exercised when attempting the Exception Test for essential infrastructure in Flood Zone 3b. Essential infrastructure includes: essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk; and strategic utility infrastructure, including electricity generating power stations and grid and primary substations. Essential transport infrastructure may be appropriate if designed in such a way that flood flow routes and flood storage areas are not affected (e.g. designing a bridge to cross the flood risk area). However, utility infrastructure may be less appropriate due to the potential consequences that may occur should the utility site become flooded.
- 'Essential infrastructure' in this zone must be designed and constructed to remain operational in times of flood and not impede water flow as well accounting for the potential impacts of climate change using the higher central allowances published on the DEFRA website.
- Associated buildings, such as boathouses, should be situated outside 3b and should follow the guidance for development in the relevant Flood Zone (as outlined above).
- Building extensions proposed in 3b should be discouraged. Where permitted, they should follow the guidelines of 3a (as outlined above). The local authority should request and review an FRA for the extension. The FRA should demonstrate that the extension will minimise the impact on flow conveyance and lost storage.

8.4 Council Specific Policy Issues

There are distinct areas in the Forest of Dean District covered by different policies and options for flood risk management in the future (which are discussed in detail in Chapter 6).

In the western half of the District there are steep-sided valleys which contribute to catchments' rapid response to storms and high surface water runoff. Here, the Environment Agency's overall policy is to realise opportunities to reduce flood risk by providing increased flood storage, opportunities to promote natural flood management and improvement management of surface water (i.e. promoting the use of SUDs). Improvements in river management including the restoration of river channels and functioning floodplains and the creation of buffer zones adjacent to rivers will all help manage flood risk in the area. This policy will have implications for future development in the District; indeed, Council can help deliver this policy by: seeking to ensure that Flood Zones 2 and 3 remain undeveloped, reinstating areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones) and promoting the use of SUDS. The main aims of the Lower Wye Catchment which falls within the Forest of Dean District includes the improvement of the condition and connectivity to flood plain meadows to provide flood storage and improved biodiversity, and eradicate non-native invasive plants.

In the eastern half of the District (including Lydney) the area has extremely flat tidal floodplain, with some areas protected by existing defences. In the short term, the Environment Agency's policy is to continue to protect features or assets by maintenance of the existing defences (Hold the Line),

however, this does not necessarily mean that all the defences will be improved/maintained over time, as this will depend on how funds allow. Generally, many areas along the Severn Estuary are determined for No Active Intervention by the EA, and therefore, in the long term, the policy is to retreat the line. This will be reappraised and planned for in the near future. This will involve moving defences away from their current position to a location further away from the riverbank, particularly in agricultural areas away from settlement or major infrastructure (e.g. Awre peninsula). The policy of retreat will, however, be constrained by how much settlements, infrastructure of other interests can be defended locally. Again, this policy will have implications for future development in the District. Indeed, Council can help deliver this policy, by ensuring new development does not take place in areas along the estuary which are shown to be at risk and/or are currently defended. Such areas are likely to be exposed to greater flood risk in the future (due to climate change) and may well be earmarked for long term retreat in the future. When buildings within defended areas reach the end of their natural life, the Council should consider the option of not re-developing the site. It is also highlighted that the EA will no longer invest in the long term in the culverts in the railway embankment and TID1 area has a policy of No Active Intervention, thus putting the railway track into danger of flooding (unless Network Rail invest in flooding defences). In the Action Plans in the SMP2 it is expected that the EA will encourage Network Rail and water and utility providers to undertake an assessment of the current and future risks and resilience to flooding of the railway line and to develop a flood resilience and adaptation plan as appropriate.

8.5 Sensitive Development Locations

The Severn Estuary will be subject to increased storm surges and wave height in the future, and the Environment Agency plans to implement managed retreat. Development proposals in this area should be treated with caution; indeed, the Council should seek to ensure that development does not take place in areas along the Severn estuary which are currently defended or shown to be at risk.

In light of the District's susceptibility to climate change (deeper flooding in the Lyd catchment, increased in flood extent in the Cinderford streams) developments in Flood Zones 2 and 3 should be discouraged, not least because of the detrimental impact this will have on flood storage and flood flows.

In addition, a number of artificial lakes, formed from past aggregate extractions, can be found in several areas on the Severn floodplain, many of which are important sites for wildlife and recreation. Often these sites maintain high water levels and provide little capacity for flood water storage. Any increase in runoff to these areas may result in a further loss of storage capacity, and subsequent increase to flood risk at downstream locations.

Assuming that future site allocations and windfall sites are guided by PPG and the recommendations provided in this report, there are few other locations in which development would significantly increase flood risk.

In general, any development (including developments in Low Probability Flood Zone 1) which does not incorporate appropriate SUDS methods may increase the risk of surface and/or fluvial flooding both on-site and off-site (downstream). As such effective development management policies to incorporate SUDS on all new development should be implemented. Site-specific assessments will be required to ensure the appropriate SUDS method is implemented in accordance with geological conditions.

Areas within the District which are protected by defences, are resultant residual risk areas. Any development situated behind defences will need careful consideration. The following paragraph comes from the PPG (https://www.gov.uk/guidance/flood-risk-and-coastal-change#assessment-cover-flood-defence):

Areas behind flood defences are at particular risk from rapid onset of fast-flowing and deep water flooding, with little or no warning if defences are overtopped or breached.

How should residual risk be addressed?

Where residual risk is relatively uniform, such as within a large area protected by embanked flood defences, the Strategic Flood Risk Assessment should indicate the nature and severity of the risk remaining, and provide guidance for residual risk issues to be covered in site-specific flood risk assessments. Where necessary, local planning authorities should use information on identified residual risk to state in Local Plan policies their preferred mitigation strategy in relation to urban form, risk management and where flood mitigation measures are likely to have wider sustainable design implications.

Therefore any development behind defences should be appropriately assessed through a Level 2 SFRA, to ensure no increased risk elsewhere in the event of a defence breach or overtopping. The Environment Agency's advice on development and flood risk should be taken into account.

The natural floodplain of watercourses in the study area is an important feature in terms of flood risk management. Future development sites should be guided away from these areas using the Sequential Test, and in line with recommended policies, should be safeguarded for the future. Any development in these areas would have detrimental effect on flood risk in the immediate vicinity and downstream, by the displacement of flood water.

Finally, it is clear that numerous culverts exist in the study area. Culverts pose a residual risk if river flows are greater than their capacity, if they become blocked, or if they collapse. Any development upstream of culverts should appropriately assess the structural integrity, clearance and maintenance regime and capacity, to ensure all residual risks to the development are minimised. All options for de-culverting should be explored.

Key Recommendation: Chapter Eight

- The suggested flood risk management policies outlined in Section 8.2 should be taken into account during the policy making process and, where appropriate, used to strengthen or enhance the development management policies provided in Section 8.3.
- For the purposes of development management, detailed policies will need to be set out to ensure that flood risk is taken account of appropriately for both allocated and non-allocated 'windfall' sites. Recommendations are outlined in Section 8.3 which should be followed.
- Sections 8.4 and 8.5 should be referred to when considering council-specific policies and sensitive development locations respectively.

Chapter 9 - Guidance on Application of the Sequential Approach & Sequential Test

9.1 Introduction

This section provides guidance on how to apply the Sequential Approach and Sequential Test. Guidance on how windfall sites should be dealt with is given in Section 9.7.

9.2 The Sequential Approach

The Sequential Approach is a simple decision-making tool designed to ensure that areas at little or no risk of flooding are developed in preference to areas at higher risk. The NPPF (para. 162), Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825 set out the requirements to apply the Sequential Approach. The aim of the Sequential Approach should be to keep all new development out of medium and high risk areas (Flood Zones 2 and 3) and away from locations affected by other sources of flooding. Opportunities to locate new developments in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

9.3 The Sequential Test

The Sequential Test refers to the application of the Sequential Approach, by the Council. The Sequential Test is a key component of the hierarchical approach to avoiding and managing flood risk. The Sequential Test is outlined in PPG (including Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825.) and governmental advice on flood risk assessments and the sequential test (whether one is required and how to carry it out) can be found at https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants.

When allocating land for development, the LPA must demonstrate that it has applied the Sequential Test and has attempted to place all new development in Flood Zone 1 (and away from other sources of flooding).

When assessing any 'windfall' application the sequential test should be undertaken prior to registration of any application and further detailed consultation.

Guidance as to how to apply the Sequential Test is also outline herein:

9.3.1 Step One: Strategic Overview of flood risk across all potential development areas

The recommended initial step is to determine the extents of potential land allocations on a GIS system. GIS layers of the most up-to-date Flood Zones, main and minor watercourses, canals, flooding from other sources data, defences, culverts and Areas Benefitting from Defences (ABDs) should then be superimposed on the site layers. Summary tables of flood risk issues should then be prepared for each location, indicating if the potential sites overlap Flood Zones 2, 3, localised flooding areas or if there are records of historic fluvial flood incidents showing in the maps (a template table to assist with this process is provided in Appendix A). For the site allocations process, it is then recommended that the summary tables and proposed locations are sent to the Environment Agency for verification. Particular care should be taken by identifying locations that could increase flood risk elsewhere (flood incident points, localised flooding areas, Flood Zones) and lack of dry access.

9.3.2 Step Two: Flood Risk Issues in Zone 1

The next step should be to analyse all potential sites within Zone 1 identifying those that:

- Have watercourses without Flood Zone information
- Area affected by flooding from sources other than rivers or have been affected by historic flood events
- Do not have safe dry access routes during flood events (i.e. a site with its access and egress route being within Flood Zone 3 would be sequentially considered as being within Flood Zone 3 itself)

Each of these points is addressed below.

For any development site containing or located adjacent to a watercourse without Flood Zone information, it is recommended that a minimum 8m. development easement from the top of the bank is applied, and a site specific FRA is undertaken.

For sites with evidence of flooding from other sources, or have been affected by historic flood events where the source may be unknown), the Sequential Approach should be used to steer new development away from these areas. An assessment of likely significance of flood risk should be carried out in terms of likely probability of flooding and potential consequences/flood damages (advice from a drainage specialist may be required, the Environment Agency, a highways drainage engineer and/or the planning authority drainage specialist). The purpose is to identify sites with significant flood risk, which may need to be facilitated by a Level 2 SFRA. If a site with significant flood risk is identified within Zone 1, this should be considered as if it was in the High Probability Zone 3a, for further application of the Sequential Test in Zone 3a (see Section 8.5), bearing in mind that is more vulnerable land use is required for the site, it will have to pass the Exception Test. Where these tests are passed, the development must include flood resilience and resistance measures. The potential site owners/residents must also be made aware that they live/work in a localised flood risk area.

Sites without safe dry access routes during flood events are not likely to be able to proceed unless road raising works could be identified that would not impede flood flows or cause a loss in the floodplain storage capacity of the floodplain. This may not always be possible.

It is important to note that most potential sites that pass the Sequential Test in Zone 1 will still require site-specific FRAs. The vulnerability to flooding from other sources (as well as from river flooding) and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, with appropriate mitigating action, should be incorporated in an FRA. This need only be brief unless the factors above or other local considerations require particular attention. It is recommended that FRAs are produced for Zone 1 sites of less than one hectare, at locations where there are records of previous flood incidents.

9.3.3 Step Three: Sequentially Test in Zones 2 and 3

The third step is to sequentially allocate sites as part of a SA. It is recommended that prior to incorporating the Sequential Test within the SA, the following actions take place:

a) Apply the measure of avoidance/prevention by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, ensuring flood risk areas remain as open space and river enhancements are undertaken (such as the removal of culverts) as part of the regeneration process.

b) Provisionally adopt land uses that are fully compatible the vulnerability classification of Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825, to try to avoid the need to apply the Exception Test where possible.

Once this has all been carried out, the need to apply the Exception Test might be identified. It is important to note that the Exception Test should only be carried out when it is not possible, or consistent with wider sustainability objectives, for the development to be located in zones of lower probability of flooding. The Exception Test is also only appropriate for use when there are large areas in Flood Zones 2 and 3, where the Sequential Test along cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons (the need to avoid social or economic blight and the need for essential civil infrastructure to remain operational during floods). It may also be appropriate to use it where restrictive national designations such as landscape, heritage and nature conservation designations, eg. Areas of Outstanding Natural Beauty (AONBs), Sites of Specific Scientific Interest (SSSIs) and World Heritage Sites (WHS), prevent the availability of unconstrained sites in lower risk areas.

The need to apply the Exception Test should always prompt the production of a Level 2 SFRA.

9.4 Application of the Sequential Approach to Other Sources of Flooding

Development proposals in any location (Flood Zones 1, 2, 3a and 3b) must take into account the likelihood of flooding from sources other than rivers and the sea (where applicable). The principle of locating development in lower risk areas should therefore be applied to other sources of flooding.

The information collated within the SFRA has identified areas in which risk from other sources of flooding is likely to be an important consideration. The Council should therefore use the Sequential Approach to steer new development away from areas at risk from other sources of flooding, as well as fluvial.

The SFRA has highlighted areas where information of flooding from other sources is currently poorly understood or will require further refinement in the future. Of particular relevance is the fact that the Environment Agency now requires further investigation/mapping of surface water flooding to be carried out as part of a Level 2 SFRA, to ensure that potential allocations can be Sequentially Tested against this source of flooding.

9.5 Dealing with Windfall Sites

Any proposal for development on a 'windfall' site will differ to a site allocated in a development plan that has been specifically tested. Following the completion of the SFRA, the LPA should develop policies in the Local Development Plan on how windfall sites should be treated in flood risk terms (refer to Section 8.3 for suggested policies). LPAs should, through application of the Sequential Test, identify areas where windfall development would be considered as appropriate i.e. defining the type of windfall development which would be acceptable in certain flood risk areas and what the broad criteria should be for submitting a planning application under these circumstances. Windfall sites should be subject to the same consideration of flood risk as other housing development.

The Sequential Test must be applied to windfall sites, unless the area and the flood risk vulnerability proposed in which they occur has been sequentially tested on the basis of a SFRA. Where the

Sequential Test has not been applied to the area, proposals will need to provide evidence to the LPA that they have adequately considered other reasonably available sites. This will involve considering windfall sites against other sites allocated as suitable for housing in plans.

It should also be noted that a Sequential Test may also be required for redevelopment or regeneration, redevelopment of an existing property and change of use, and further information on applying the test can be found on the www.gov.uk website (https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants).

The sequential test will need to be passed for any windfall proposals by the local planning authority before a formal application can be registered and further consultation undertaken with appropriate statutory consultees.

Key Recommendations: Chapter Nine

- The Sequential Test must be carried out on all potential development sites. The aim is to keep all new development out of medium and high risk areas (Flood Zones 2 and 3) and away from locations affected by other sources of flooding.
- GIS layers of all the data depicted on the interactive online map is available and provides an effective means of assessing sites in regard to the Sequential Approach. Using the GIS information, summary tables of flood risk issues should be prepared for each site, indicating if the potential sites overlap Flood Zones 2, 3, localised flooding areas or if there are records of historic fluvial flood incidents shown in the maps (a template table to assist with this process is provided in the Appendix). Particular attention should be paid to identifying flood risk issues in Flood Zone 1 (Section 9.5).
- Prior to incorporating the Sequential Test and Exception Test within the Sustainability Appraisal, the following actions must take place:
  a) Apply the measure of avoidance/prevention by moving the boundaries of the potential sites away from Zones 2, 3a and 3b, ensuring flood risk areas remain as open space and river enhancements are undertaken (such as the removal of culverts) as part of the regeneration process.
  b) Provisionally adopt land uses that are fully compatible with the vulnerability classification of the PPG, to try to avoid the need to apply the Exception Test where possible.
- Following application of the Sequential Test, if any sites are identified for application of the Exception Test, a Level 2 SFRA should be progressed.
- Most potential sites that pass the Sequential Test, if any sites are identified for application of the Exception Test, a Level 2 SFRA should be progressed.
- It is recommended that FRAs are produced for Zone 1 sites of less than one hectare, at locations where there are records of previous flood incidents.
- The Sequential Test must be applied to windfall sites, unless the area and the flood risk vulnerability proposed in which they occur has already been sequentially tested on the basis of a SFRA.
- https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants gives government guidance on applying the Sequential Test to areas requiring redevelopment or regeneration, redevelopment of an existing property and change of use.

Chapter 10 - Guidance for Developers

10.1 FRA Requirements

Site-specific FRAs will be required for most proposed developments and the level of detail will depend on the level of flood risk at the site (see general details about FRA requirements at https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications). A FRA should assess flooding from all other sources at the site-specific level and offer appropriate mitigating options for the management of the risk, without increasing the flood risk elsewhere. The onus is on the developer to provide this information in support of a planning application. Prior to undertaking a formal application including a detailed FRA, developers should ensure that the Sequential Test has been passed at the site to ensure necessary time and expenditure is avoided.

It is important that developers hold discussions over the need for FRAs early on in the planning process (preferably at pre-application stage). Consultation should be undertaken with the Environment Agency and the relevant Local Planning Authority to ensure that the Council's policies on flood risk management are respected and taken account of, and that the scope of the FRA is commensurate with the level of flood risk. The following reflects best practice on what should be addressed within a detailed FRA. Those proposing development should also be directed towards the governmental advice https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications.

10.2 Proposed Development within Flood Zone 1

The risk of other sources of flooding (surface water drainage, sewers, impounded water bodies, groundwater) must be considered, and SUDS techniques must be employed to ensure no worsening of existing flooding problems elsewhere within the area.

The SFRA provides specific recommendations with respect to the provision of sustainable flood risk mitigation opportunities that will address both the risk to life and the residual risk of flooding to development within particular 'zones' of the area. These recommendations should form the basis for the site-based FRA.

10.3 Proposed Development within Medium Probability Zone 2

For all sites within Medium Probability Zone 2, a scoping level FRA should be prepared based upon readily available existing flooding information, sourced from the Environment Agency. If there is a significant flood risk from other sources (surface water drainage, sewers, impounded water bodies, groundwater) identified then a more detailed FRA should be prepared. It will be necessary to demonstrate that the residential risk of flooding to the property is effectively managed throughout, for example, the provision of raised flood levels and the provision of planned evacuation routes or safe havens.

10.4 Proposed Developments within High Probability Flood Zone 3a

All FRAs supporting proposed development within High Probability Zone 3a should assess the proposed development against all elements of the Council's flood policy, and include an assessment of the following:

- The risk of flooding to and from the development from other sources (eg. surface water, sewers, impounded water bodies, groundwater) as well as from river flooding. This will involve discussion with the Council, Environment Agency and/or operating authority to confirm whether a localised risk of flooding exists at the proposed site. Localised flooding

may also occur typically associated with local catchment runoff following intense rainfall passing directly over the area. This localised risk of flooding must also be considered as an integral part of the detailed FRA.

- The risk of flooding to and from the development over its lifetime (including the potential impacts of climate change as well as changes that may occur, such as permitted development), i.e. maximum water levels and depths, flow paths and flood extents within the property and surrounding area. The Environment Agency may have carried out detailed flood risk mapping within localised areas that could be used to underpin this assessment. Where available, this will be provided at a cost to the developer. Where detailed modelling is not available, hydraulic modelling by suitably qualified engineers will be required to determine the risk of flooding to the site.
- The potential of the development to increase flood risk elsewhere through the addition of impermeable surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property. This will require a detailed assessment to be carried out by a suitably qualified engineer.
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable. Measures may include flood defences, flood resistant and resilient design, escape/evacuation, effective flood warning and emergency planning.
- Details of existing site levels, proposed site levels and proposed ground flood levels should be provided on maps. A topographic survey and flood extents must be shown on maps to show the full extent of the 1% AEP (1 in 100 year) flood with and without an appropriate allowance for climate change and, where relevant, the extent of the functional floodplain. In addition, where safe access and egress is required, it must be demonstrated on the maps that it can be provided from the property to an area wholly outside of the floodplain.
- Demonstration that a positive gain in floodplain storage capacity is provided. This should be provided through 'level for level' floodplain compensation. Further guidance can be found through the Construction Information Service document 'Development and Flood Risk' (the use of floor-voids will not normally, by itself, by considered as mitigation).
- Demonstration that that the layout and design of the development will not have a detrimental impact upon floodwater flow conveyance.
- Demonstration that opportunities to reduce flood risk and enhance river corridors have been maximised, for example, through the removal of unnecessary obstructions such as culverts or low bridges (subject to these works not causing in themselves an unacceptable increase in flood risk).
- Demonstration that the development is consistent with the relevant FRMP.

It is essential that developers thoroughly review the existing and future structural integrity of informal defences, if present, upon which the development will rely (ie. over the lifetime of the development), and ensure that emergency planning measures are in place to minimise risk to life in the unlikely event of a defence failure. This would be particularly important for development that could potentially be affected as a result of a breach of any canals in the study area.

10.5 Proposed Developments within Functional Floodplain Flood Zone 3b

In line with the NPPF and associated PPG, after having applied the Sequential Test, development will not normally be allowed in the Functional Floodplain unless it is classified as a 'water compatible' or

'essential infrastructure' use. Flood risk vulnerability classification (Annexe 3 of the NPPF) (refer to Table 1.2 in Section 1.7 of this report) details the type of developments classified as 'water compatible' or 'essential infrastructure'.

10.6 SUDS Requirements

The NPPF and PPG require the implementation of sustainable drainage systems. Government guidance (Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems, March 2015, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf) outlines a range of SUDs options which could be applied to new development sites. Although not all will be appropriate for individual development sites, a suitable drainage approach should be possible on almost every site. All new development sites will require the following:

- To obtain the most benefit, SUDS must be considered as early as possible in the planning process.
- The drainage system to be designed to accommodate all storm events up to and including the 1% AEP (1 in 100 year) event, with an appropriate allowance for climate change.
- Application of a SUDS management train.
- A hierarchical approach should be applied to the SUDS used, in order of priority:
    1) Preventative measures should be the preferred option i.e. ensuring there are not unnecessary impermeable areas on-site.
    2) Source control measures such as rainwater harvesting and infiltration systems should be the next preferred option, provided the site conditions are appropriate.
    3) Site control measures should be the next preferred option, where prevention and source control measures along cannot deal with all on-site drainage. Above ground site control attenuation systems, such as balancing ponds and swales, should be considered in preference to below ground attenuation, due to the water quality, biodiversity and amenity benefits they offer.
    4) Regional control measures should only be considered where none of the above preferred options can be achieved.
    5) A hierarchical approach should be applied to the disposal of surface water from the site referencing in order of priority:
        1) Rainwater harvesting systems
        2) An adequate soakaway or other adequate infiltration system
        3) A watercourse
        4) A surface water sewer
        5) A combined sewer, only as a last resort
- Where prevention, source control/infiltration cannot deal with all on-site drainage, as a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.
- Exceedance design measures to be applied to ensure that extreme events above the design standards of the system do not pose adverse impacts.
- A sequential approach should be applied to the site layout to specifically set aside space for SUDS.

- They should be designed for the lifetime of the development, with suitable provisions for like future permitted and minor development, eg. paving of front gardens or minor extensions (it may be possible to achieve this either through suitable planning or engineered solutions).

10.7 Raised Floor Levels and Basements (Freeboard)

The raising of floor levels above the 1% AEP (1 in 100 year) peak flood level will ensure that the damage to property is minimised. Given the anticipated increase in flood levels due to climate change, the adopted flood level should be raised above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for the potential impacts of climate change.

It is highlighted that many of those areas currently situated within Medium Probability Zone 2 could become part of the High Probability Zone 3. This is important as it means that properties that are today at relatively low risk will, in 20 to 100 years, be within High Probability Zone 3a. It is imperative therefore that planning and development management decisions take due consideration of the potential risk of flooding in future years.

Wherever possible, floor levels should be situated a minimum of 600mm above the 1% AEP (1 in 100 year) flood level with an appropriate allowance for the potential impacts of climate change, determined as an outcome of the site-based FRA. Additional freeboard may be required because of the risk of blockages to channel, culverts or bridges. The height that the floor level is raised above the flood level is referred to as the 'freeboard', and is determined as a measure of residual risks. Where the depth between the underside of the floor slab and the existing ground level will allow, under-floor voids should be included with openings. In these instances the voids and openings should reach between the existing ground level and the 1% annual probability (1 in 100 year) flood level with an appropriate allowance for the potential impacts of climate change.

The use of basements within flood risk areas should be discouraged. Where basements are permitted, however, it is necessary to ensure that the basement access points are situated a minimum of 600mm above the 100 year plus climate change flood level. The basement must have unimpeded access and waterproof construction to avoid seepage during flooding conditions. Habitable uses of basements within Flood Zone 3 should not be permitted, while basement dwellings can be allowed in Flood Zone 2 provided they pass the Sequential and Exception Tests.

10.8 Development Behind Defences

Prior to the development of areas behind defences, the Sequential and Exception Tests must be undertaken in the first instance. Where the need to apply the Exception Test is identified, this should be supported by a Level 2 SFRA.

Areas behind defences are at particular risk due to breach or overtopping, resulting in the rapid on-set of fast-flowing, deep water flooding with little or no warning. Risks will therefore be highest closest to these defences and as such it is recommended that the LPAs should set back developments and ensure that those proposing developments develop robust evacuation plans as part of their FRA in consultation with the Environment Agency.

Consideration of flood risk behind defences should be made as part of detailed FRAs. Developers should review the online map to determine the location of structures and defences in proximity to the site and therefore identify the possibility of localised residual flood risk. The FRA should take into account:

- The potential mechanisms of failure of flood defence infrastructure
- The standard of protection and design freeboard
- The asset condition of the flood defence
- The height of the flood defence infrastructure and retained water levels compared to ground levels
- The potential location, width and invert level of breach(es) in the flood defences
- The duration of water levels during a flood event or tidal cycle
- The period it would take the operating authority to close the breach
- The period it would take for water to drain from the flooded area following a breach or overtopping event
- The residual risk from failure through demountable defences or pumps not being in position/operation when they are used

In addition to this it is recommended that should any development be proposed in a defended flood area, the potential cumulative impact of loss of storage on flood risk elsewhere should be considered.

10.9 Car Parks

Car parking may be appropriate in areas subject to shallow, low velocity flooding where there is not a risk of the vehicles being washed away or the surrounding transport network becoming unsafe to drive through (eg. High Probability Zone 3a), provided sufficient flood warning is available, and appropriately located and worded signs are in place.

Car parking that supports built development will be considered to have the same flood risk vulnerability classification and hence will be required to meet the same principles within the exception test.

However, this would still need to consider the sequential approach and be discussed and agreed with the LPA and/or the Environment Agency. As part of an FRA, the developer should consider the likelihood of people being able to move their cars within the flood warning time.

10.10 Developer Contributions

If new developments are placed on Flood Zones 2 or 3, it might be necessary for local infrastructure to be increased. With regards to flood risk, it might also be necessary to extend flood warning system coverage where appropriate, or increase the maintenance of flood defences. The LPA and other authorities might wish to request developer contributions to cover the cost of this, and if so this should be achieved through a Section 106 Legal Agreement. The LPA and the Environment Agency may wish to work in conjunction with each other to formulate a consistent process for obtaining developer contribution.

Key Recommendations: Chapter Ten

- FRAs will be required for most proposed developments.
- The onus is on the developer to provide an FRA in support of a planning application.
- Prior to undertaking a FRA, developers should ensure that the Sequential Test has been passed at the site.
- Developers should consult with the Environment Agency and the Council to ensure that the Council's policies on flood risk management are respected and taken account of, and that the scope of the FRA is commensurate with the level of flood risk.
- Section 8.2-8.5 of the SFRA reflects best practice on what should be addressed within a FRA.
- A suitable drainage approach should be possible on almost every site. All new development sites must follow the guidance outlined in Section 10.6. The FRA must demonstrate that these requirements have been achieved.
- Floor levels for developments in flood risk areas must be situated a minimum of 600mm above the 1% AEP (1 in 100 year) plus climate change flood level, determined as an outcome of the site-based FRA.
- The use of basements within flood risk areas should be discouraged. Where basements are permitted however, it is necessary to ensure that the basement access points are situated a minimum of 600mm above the 100 year plus climate change flood level.

Chapter 11 - Guidance for the Application of Sustainable Drainage Systems

11.1 Introduction

The NPPF and PPG require that LPAs should promote SUDS. LPAs should therefore ensure policies encourage sustainable drainage practices in their LDP. SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. The management of rainfall (surface water) is considered an essential element of reducing future flood risk to both the site and its surroundings. Indeed, reducing the rate of discharge from urban sites to Greenfield runoff rates is one of the most effective ways of reducing and managing flood risk within the area.

SUDS systems need to be considered at an early stage, prior to defining the layout of a proposed site, in accordance with the Sequential Approach. This is likely to lead to a reduction in the overall cost of draining the site as it much more difficult and expensive to retrofit SUDS to a site that has a development layout already designed. For major development schemes proposed where there are likely to be many competing issues, SUDS should ideally be discussed at pre-application to maximise the on-site opportunities. This in return should result in a reduced cost to the developer for the system.

11.2 Effective application of SUDS techniques

A hierarchical approach is recommended for selection of SUDS techniques to dispose of surface runoff. The SUDS Manual (Ciria 697) states that 'wherever possible, stormwater should be managed in small cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas'. This is illustrated by the SUDS Management Train (Fig 11.1).

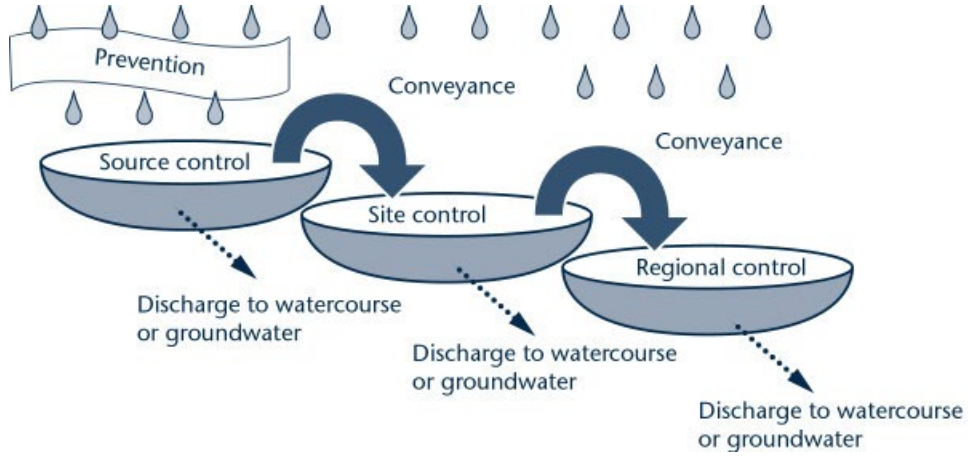


Fig 11.1 SUDS Management Train (from the Environment Agency website)

The first stage, 'prevention' stresses the benefit of avoiding runoff in the first place, and also refers to the need to prevent pollution. Prevention of runoff can be achieved by maintaining a permeable area. This can be achieved by avoiding paving a surface, instead using permeable materials which allow rainfall to soak directly into the ground. It may also be possible to allow roof water to discharge

straight onto a lawn in order to soak into the ground, but infiltration must avoid pollution of the soil and groundwater. This includes ensuring minimal use of herbicides on lawns, secure storage of oils and chemicals to avoid leakage and dog litter policies.

If prevention methods are not sufficient to avoid runoff, the next preferred option is to store and dispose of it on site. This includes measures such as permeable paving or rainwater harvesting, which has the added benefit of reducing demand on public water supply, and reduces costs for the infiltrated into the ground, it may be conveyed some distance before infiltration or alternatively, discharged into a watercourse. As the runoff is conveyed further, it moves from source control to site control and then regional control.

Infiltration is preferred over disposal to a watercourse or the public sewer system as this more commonly deals with runoff nearer to source and serves to replenish groundwater. This recommendation is reinforced by the requirements of the Building Regulations Part H3. If infiltration is not viable (due to a high water table, local impermeable soils, contamination issues including source protection zones etc.), then the next option of preference is the runoff to be discharged into a nearby watercourse. Only if neither of these options is possible should the water be discharged into the public sewer system.

11.3 Types of SUDS Systems

SUDS may improve the sustainable management of water for a site by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream
- Reducing volumes of water flowing directly to watercourses or sewers from developed sites
- Improving water quality compared with conventional surface water sewers by removing pollutants from diffuse pollutant sources
- Reducing potable water demand through rainwater harvesting
- Improving amenity through the provision of public open space and wildlife habitat
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained

Any reduction in the amount of water that originates from any given site is likely to be small, however, if applied across the catchment, the cumulative effect from a number of sites could be significant.

There are numerous different ways that SUDS can be incorporated into a development. The appropriate application of a SUDS scheme to a specific development is heavily dependent upon the topography and geology of the site and the surrounding areas. Careful consideration of the site characteristics is necessary to ensure the future sustainability of the adopted drainage system. When designing surface water drainage systems, the NPPF states that climate change should be taken into account appropriate to the predicted lifetime of the development, and designed to account for the predicted increases in rainfall intensity, as outlined in Chapter 5.

The most commonly found components of a SUDS system are described below:

- Pervious surfaces: Surfaces that allow inflow of rainwater into the underlying construction or soil.

- Green roofs: Vegetated roofs that reduce the volume and rate of runoff and remove pollution. They comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover/landscaping/permeable car parking, over a drainage layer. They are designed to intercept and retain precipitation, reduce the volume of runoff and attenuate peak flow.
- Filter drains: Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they also permit infiltration.
- Filter strips: Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
- Swales: Shallow vegetated channels that conduct and retain water and may also permit infiltration; the vegetation filters particulate matter.
- Basins: Ponds and wetlands areas that may be utilised for surface runoff storage.
- Infiltration Devices: Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins or soakaways.
- Bioretention areas: Vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground.
- Pipes and accessories: A series of conduits and their accessories normally laid underground, that convey surface water to a suitable location for treatment and/or disposal (although sustainable, these techniques should be considered where other SUDS techniques are not practicable).

The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.

For more guidance on SUDS, the following documents and websites are recommended as a starting point:

- The SuDS Manual (C753) 2015 – free download from CIRIA bookshop (www.ciria.org). Provides the best practice guidance on the planning, design, construction, operation and maintenance of SUDS and facilitates their effective implementation within developments.
- CIRIA c644 – Green Roofs (2007) – Free download from CIRIA bookshop (www.ciria.org). Provides guidance on the design, construction and operation of Green Roofs. The guidance also describes how 'quick wins' for biodiversity can be achieved in the built environment by incorporating nesting and roosting boxes for birds, bats and other animals.
- Interim Code of Practice for Sustainable Drainage Systems (National SUDS Working Group, 2004). Free download from CIRIA website (www.ciria.org) or from Susdrain (www.susdrain.org).
- Preliminary rainfall runoff management for developments (DEFRA/Environment Agency R&D Technical Report Q5-074/A/TR/a Revision D) - Free download from www.gov.uk website.
- C625 Model agreements for sustainable drainage systems (Shaffer et al, 2004 – available from CIRIA bookshop www.ciria.org)
- C539 Rainwater and grey water use in buildings – best practice guide – available from www.waterwise.org.uk

- C582 Source control using constructed previous surface: hydraulic, structural and water quality performance issues (Pratt et al, 2002) – available from CIRIA bookshop www.ciria.org
- C635 Designing from exceedance in urban drainage – good practice – free download from CIRIA bookshop www.ciria.org
- Report 156 Infiltration drainage – manual of good practice (Bettess R, 1996 – available from CIRIA bookshop www.ciria.org)
- Harvesting rainwater for domestic uses: an information guide (Environment Agency, 2003) – Available from www.waterwise.org.uk
- www.susdrain.org.uk

The Forest of Dean District Council also has its own Planning Stage Guidance for Drainage Requirements for Domestic Extensions and Single Dwellings. This can be found on the FoDDC website: https://www.fdean.gov.uk/media/hsyphihy/drainage-policy-guidance-for-planning-applications.pdf

11.4 Application of SUDS for Forest of Dean District Council

The District has predominantly slowly permeable slightly acidic loamy and clayey soils, with some areas of freely draining acidic loamy soils and others with lime-rich soils with impeded drainage. The more permeable sites should have priority given to infiltration drainage techniques, as opposed to discharges surfaces to watercourses. Where less permeability is found and infiltration techniques that rely on discharge into the existing soils are not viable (also due to a high water table, source protection zones, contamination, etc.), discharging site runoff to watercourses is preferable to the use of sewers. Integrated urban drainage should also be used throughout the design process.

Approximately one third of the district has been highlighted by DEFRA as a Nitrate Vulnerable Zone (NVZ) and several areas have been classified as groundwater Source Protection Zones (SPZ) by the EA. Any boreholes, water wells or other extraction points should also be identified and taken into account in the design process.

NVZs are generally indicative of the agricultural nature of the surrounding land and the use of fertilisers. Nitrate levels in many English waters are increasing principally due to surface water runoff from agricultural land entering receiving water bodies. The level of nitrate contamination will have an impact on the choice of SUDS and will have to be assessed for specific sites.

The SPZs are situated near the Jurassic Limestone Aquifer and are designated as inner (zone 1), outer (zone 2) and total catchment (zone 3) areas. The Inner Zones of the GSPZ are the most sensitive areas and vary in diameter from 0.1 to 8.2 kilometres. The Outer Zones are also sensitive to contamination and vary in diameter from 0.1 to 6.3 kilometres. The GSPZ requires attenuated storage of runoff to prevent infiltration and contamination.

Nine GSPZ Inner Zones have been identified by the EA in the Forest of Dean District and they are situated in the following areas (depicted in Fig 11.2):

- Northern area of the district: Bromesberrow Heath, Ryton, Redmarley D'abitot and Oxenhall

- Southern area of the district: Cinderford, Coleford, Hewelsfield, Redbrook and Lydbrook/Joys Green

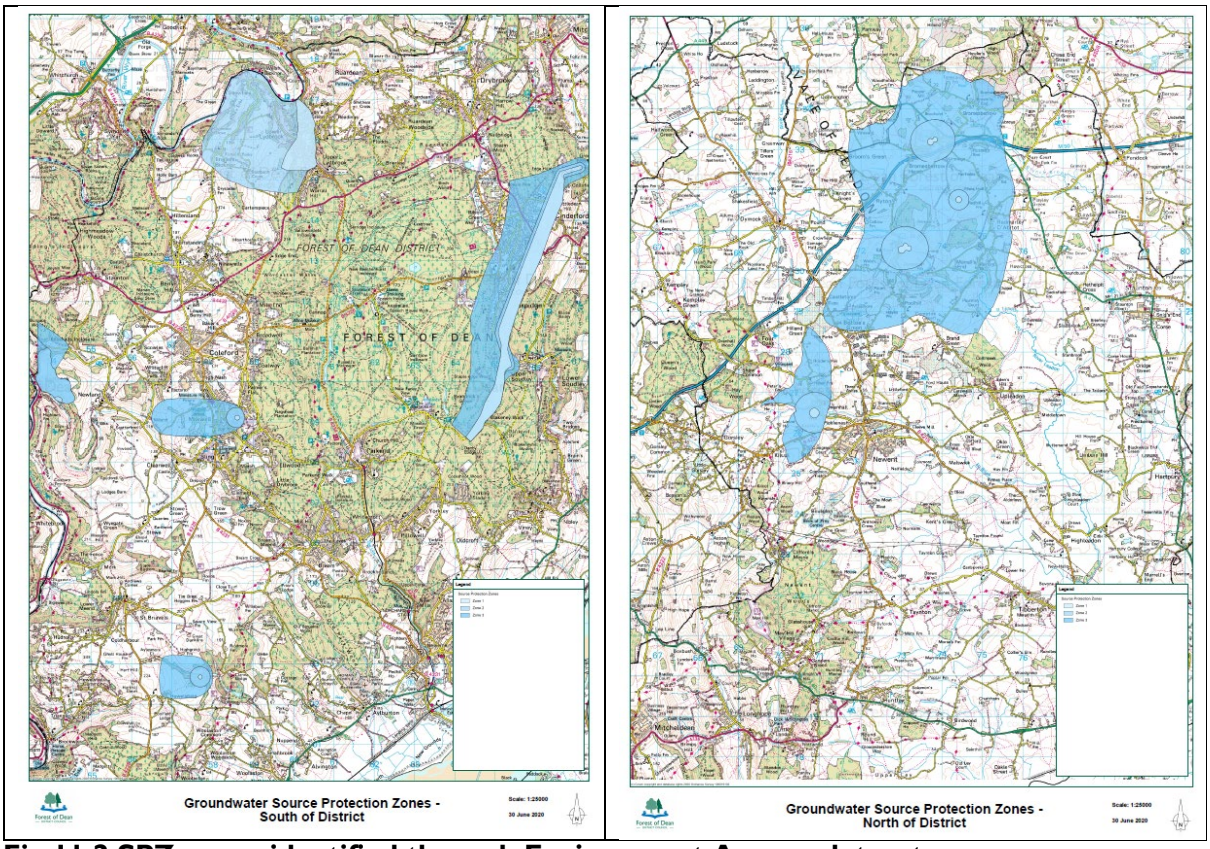


Fig.11.2 SPZ zones identified through Environment Agency datasets

Runoff which is likely to be heavily contaminated must be treated by a proprietary device, which should be carefully considered to ensure the correct system is selected to remove pollutants. The NPPF and associated PPG states that source control SUDS must be considered and incorporated where suitable. For example, surface water drained from a car park should implement a filter bed wherever possible before considering an interceptor device to remove contaminants.

If the local soil is contaminated then a lined system is generally required. This may include a drainage design which allows infiltration in the upper layer, but should incorporated an impermeable layer at its base to prevent contamination. In such cases lined underground attenuation storage is used to store a 1% AEP (1 in 100 year) +20% (for climate change) storm event and discharges into a nearby watercourse.

Regardless of the underlying geology identified in the SFRA, where there are no reasons why infiltration is not possible (e.g. contaminated land), soakage tests must be undertaken on site in accordance with either CIRIA 156 or BRE365). The SFRA will only provide an early indicator to enable decisions as to the best way forward to be formulated for the design site.

11.5 Adoption and Maintenance of SUDS

The NPPF and associated PPG states that when planning SUDS, it is important that developers carefully consider maintenance to ensure that SUDS continue to function over time. Poorly maintained SUDS could lead to an increase in flood risk rather than a reduction.

The future ownership and management of all elements of the SUDS system will need to be addressed at an early stage as the maintenance responsibility must be given to durable and accountable bodies which have the resources to meet the long term needs of the system.

Ensuring developers make a full contribution to the costs of both building and maintaining such systems is vital to their long term effectiveness. The costs of maintaining SUDS devices will be dependent on the types of system used and this should be considered by the developer at an early stage.

Traditional drainage systems are criticised that problems are often hidden underground and take time to be eventually be discovered. The majority of SUDS devices are at the surface and pollution or silt build up can be observed as it happens. This means that any issues can be dealt with as they occur, but requires a regular monitoring regime and suitable body to provide the maintenance support.

As the majority of SUDS are at the surface elements, they are best incorporated into local landscape maintenance regimes where possible. An advantage of this is that the site managers and landscape contractors will have a good knowledge of the site through regular maintenance operations such as grass cutting and litter removal. This should also ensure regular monitoring and a quick response to any maintenance needs.

Water companies such as Severn Trent Water Ltd are currently only willing to adopt hard structures and not softer SUDS systems, such as swales or ponds, which provide a break between pipe networks. Until this process changes there will be issues with adoption and developers will have to consult with local authorities to establish the best long term maintenance plan.

SUDS in new developments are usually constructed by the developer and offered for adoption to the responsible organisation. There are currently four main options for determining who might take responsibility for adoption and maintenance of SUDS for a site: Local Planning Authorities, Sewerage Undertakers, Highway Authority or Specialist SUDS undertakers or companies.

Existing legislation (e.g. Section 38 of the Highways Act, 1980 and Section 106 of the Town and Country Planning Act, 1990) can provide a mechanism for SUDS adoption. It is recommended that early consultation with the relevant stakeholders is made to establish and agree responsibilities for long-term maintenance. In addition, the National SUDS Working Group (NSWG) developed an Interim Code of Practice for SUDS (NSWG, 2004) which provides a set of planning model agreements for use between those public organisations with statutory or regulatory responsibilities relating to SUDS. The model agreements are based on current legislation and the current planning system. This code of practice is complemented by CIRIA publication C625 Model agreements for SUDS.

Key Recommendations: Chapter Eleven

- The Council should endeavour to ensure that SUDS are applied for all new developments, and retro-fitted wherever possible.
- The treatment and control of surface water should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.
- SUDS systems need to be considered at an early stage, prior to defining the layout of a proposed site, in accordance with the Sequential Approach. For major development proposals there are likely to be many competing issues, SUDS should be discussed pre-application to maximise the on-site opportunities.
- The SUDS management train should be followed (Section 11.2).
- The future ownership and management of all elements of the SUDS system will need to be addressed at an early stage as the maintenance responsibility must be given to durable and accountable bodies which have the resources to meet the long term needs of the system. Ensuring developers make a full contribution to the costs of both building and maintaining such systems is vital their long term effectiveness.

Chapter 12 - Summary

This section summarises the findings of the SFRA, recommendations and further work. Key recommendations are summarised at the end of each chapter and should also be reviewed by the reader.

12.1 Summary: Flood Risk Issues

Based on the findings of the SFRA, flood risk issues within the District can be summarised as follows:

- The Forest of Dean District occupies an area of varied topology and geology. Gently sloping lower lying areas near the Severn Estuary are contrasted with steep hills in the West of the District. Catchments can be categorised as large upstream catchments forming large watercourses (the Severn and Wye) and small catchments originating in the general vicinity of the District. All the rivers in the District eventually drain into the Severn Estuary.
- Within the Lower Severn Valley, flooding can occur from a combination of both tidal and fluvial processes. Many of the Main Rivers within the District discharge into the River Severn estuary and as such can be affected by tide locking. The main urban area at risk from tide locking is Lydney, with tide locking also extensive on the Cinderford Streams.
- In general, Flood Zone maps in the upper reaches are narrow, confined by steep sided valleys where catchments can respond quickly to rainfall, increasing the risk of flash flooding. As the watercourses flow towards the coastal floodplains of the River Severn, the Flood Zone maps widen significantly, and extend onto vast areas of flat, coastal floodplain.
- Tidal Flood Zone maps for the River Severn extend for large distances into the District incorporating a number of properties at locations including: Walmore Common (SO 7403 1513), Rodley (SO 7413 1145), Westbury on Severn (SO 7172 1394), Newnham (SO 6925 1190) and Lydney (SO 6340 0176).
- In the lower lying parts of the District the risk of the Severn coming out of the bank and flooding some areas during periods of high flows or tidal events has been substantially mitigated by the presence of defences along the estuary. The remaining small catchments also pose flood risk, depending on the characteristics of any localised storms. Inspection of the Environment Agency's Flood Zones in the District indicate that areas of flood risk from the smaller catchments are small and dispersed, including Parkend, Whitecroft, Drybrook, Cinderford and Newent.
- In general the level of flood risk from artificial drainage systems within the District is medium to low.
- Flooding from surface water is a problem within the District, with the geology and topography contributing to the rainfall response and therefore the likelihood and nature of surface water flooding. The upper reaches of river catchments within the District, although underlain by permeable limestone and sandstone, are often steep, promoting rapid surface runoff which can lead to localised flooding. In addition, the clays and mudstones found within the Severn Valley lie close to the groundwater table for much of the year and are frequently saturated.
- Areas with an abundance of impervious surfaces are also at risk of surface water flooding, especially when local intense rainstorms occur. Surface water flooding associated with poor urban drainage and backing up within urban drainage systems under high river flows also affects Coleford and Lydney in particular.

- There are no canals located within the District, nor are there any raised sections of canal. Assessment of the OS maps indicates that there are no canals located adjacent to watercourses that flow through the District.
- There are no records of breaching/overtopping from reservoirs within the Forest of Dean District.
- The catchment area of the River Severn contains numerous groundwater springs. These can respond to prolonged periods of rainfall and seasonal variations in climate, impacting on the contribution to flow in adjacent watercourses. In addition, the clays and mudstones of the Severn Valley lie close to the groundwater table for much of the year and as such, are frequently saturated with water across the floodplain. This can lead to increased surface runoff and localised flooding, even when the River Severn is not in flood.
- There are a number of locations at risk of both fluvial and tidal flooding that are currently protected by permanent defences within the District. Most of the Lower Severn catchment is now protected by some form of defence, whether it is a floodwall, earth embankment, infrastructure acting as a defence or high ground. Within the District, along the west bank of the Severn, a number of locations are protected by natural high ground, including locations from Rodley to Newnham. A flood defence was also constructed between Cone Pill and Lydney Harbour.
- There are a number of areas of extended floodplain acting as natural storage within the District. For example, at Russelsend Coppice (SO 7500 3324) the Glynch Brook is confined by the M50 to the north. Downstream of Russelsend Coppice, Flood Zone 2 widens significantly on the left bank, extending appropriately 600m up to the M50, due to the constraining nature of the road bridge at Blackford Mill Farm. This area acts as natural floodplain during times of high flow.
- A number of flood storage areas are situated along the River Severn in Gloucestershire. These are areas of natural, low lying topography bounded by high ground, with earth embankments along the edge of the river. Key storage cells located within the Forest of Dean District include: Oakle Street (SO 7626 1775), Walmore Common (SO 7382 1557), Rodley (SO 7382 1183) and Northington (SO 7148 0853).

12.2 Summary: Flood Zone Data Issues

The accuracy of the Flood Zones in some areas can be poor, they can be misaligned from the channel, show flood risk when a culvert is present or follow a path which does not have a watercourse. Appropriate judgement should be exercised when applying the Sequential Test. It may be prudent for a suitably qualified flood risk management specialist to review and assess preliminary site allocations, to advice on local Flood Zone issues and areas where modelling, or alternative solutions, might have to be carried out to adequately assist the Sequential Test process.

12.3 Summary: Climate Change Issues

The floodplains in the western upland areas of the District are generally narrow and well defined, though they widen and flatten towards the Severn Estuary. However, it is important to note that as a result of climate change, the depth of flooding is likely to increase in well-defined floodplains. This is particularly likely in the Lyd catchment, mainly at Whitecroft and Lydney. In particularly steep areas the velocity might also increase. This will have a significant impact on the flood hazard. A Level 2 SFRA, which assesses flood hazard, will therefore be required for site allocations which need to satisfy the Exception Test.

By contrast, the effect of climate change on flood risk in flat areas can be dramatic. Flood extents are expected to increase in the Cinderford streams, through the main changes affect the agricultural land in the downstream area of the catchment. Where climate change is expected to increase flood risk considerably, for example, where current Flood Zones are large (usually on wider, flatter floodplains), the LPA should consider using the climate change maps to carry out the Sequential Test, in order to give a particularly long-term risk-based approach to planning. Locations where it might be prudent to do so are at the south eastern side of the District, namely along the Severn Estuary and its downstream tributaries. The climate change maps do not show a climate change scenario for Flood Zone 2. For the purpose of spatial planning it is recommended that a buffer of 10m (measured from the edge of the existing Flood Zone 2) is added to represent future climate change. This area will be subject to increased storm surges and wave height future, and the Environment Agency plans to implement managed retreat. Development proposals in this area should be treated with caution.

A Level 2 SFRA should assess climate change impacts in detail.

12.4 Recommendation: Site Allocation Process

It is recommended that the outputs from this study are used as an evidence base from which to direct new development to areas of low flood risk (Flood Zone 1). Where development cannot be located in Flood Zone 1, the Council should use the flood maps to apply the Sequential Test to their remaining land use allocations. The following should be considered:

- Flood Zone 3b has been mapped where it exists. Where it does not exist, Flood Zone 3a has been used to represent Flood Zone 3b.
- The Council should take note of outline areas where the existing Flood Zones outlines are deemed to be of poor resolution. Where emerging site allocations are located in these areas, the Sequential Test process should be verified by a technical expert.
- Following application of the Sequential Test, a detailed interrogation of emerging allocations should be carried out, using the template table in Appendix A. This will ensure that all potential flood risk issues to the site are identified, such as incorrect Flood Zones, residual risk areas and so on. The review should identify resultant required works if necessary (Level SFRA, FRA etc.).

The Sequential Approach should also be applied within development sites to inform site layout, by locating the most vulnerable elements of a development in the lowest risk areas (in accordance with Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825). The use of Flood Zones 2 and 3 for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.

The Environment Agency will require a Level 2 SFRA to be carried out in order to provide a detailed assessment of the risk of flooding from non-fluvial sources, in areas where new development is proposed.

With regard to fluvial sources of flood risk, a Level 2 SFRA will be required where the need to apply the Exception Test is identified (as outlined in Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825). This cannot be determined until the Sequential Test has been carried out on all proposed development sites. It is recommended that as soon as the need for the

Exception Test is established, the Level 2 SFRA is undertaken by a suitably qualified expert so as to provide timely input to the overall Local Plan process. The following should be noted:

- Breach and overtopping assessments will be required for development situated behind defences and immediately adjacent to raised canals
- The effects of structures in the vicinity of development sites (culverts, etc.) might need to be assessed to determine the capacity and identify residual risk areas that might result from blockage. This will inform the appropriate placement of development and ensure appropriate mitigation is put in place. This could also address any mitigation works that might be deemed appropriate.

12.5 Recommendations: Council Policy

It is recommended that for the purpose of clarity, a Supplementary Planning Document should be developed in light of the suggested policies and guidance notes, outlining the minimum requirement of the Environment Agency in response to the NPPF and associated PPG.

It is recommended that the following core considerations should be included within the Council's flood risk management policy documents:

- Use the Sequential Test to locate new development in the least risky areas, giving highest priority to Flood Zone 1.
- Direct new development away from flood risk areas and area that are currently defended along the Severn Estuary to enable the Environment Agency to achieve the long-term goal of 'retreating the line'.
- Seek to ensure Flood Zones 2 and 3 remain undeveloped and protect the functional floodplain from development, promote the use of green corridors in flood risk areas and restore the natural course of rivers. These will all act as a means of risk reduction.
- Use the Sequential Approach within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas, in accordance with Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825.
- Protect the functional floodplain from development, promote the use of green corridors in flood risk areas and restore the natural course of rivers. These will all act as a means of risk reduction.
- Seek to reinstate functional floodplain wherever possible (e.g. reduce building footprints or relocate to lower flood risk zones).
- Ensure all new development is 'safe', meaning that dry pedestrian access to and from the development is possible without passing through the 1% AEP (1 in 100 year) plus climate change floodplain, emergency vehicular access is possible, and flood resistance and resilience is incorporated.
- No new building should be allowed in a flood risk area that is not flood resilient.
- The treatment and control of surface water runoff should provide a level of betterment, incorporating the use of various SUDS techniques. As a minimum, there should be no increase in the peak discharges/volumes from any existing Greenfield site and at minimum a 20% reduction of peak discharges/volumes from any existing Brownfield site where an existing positive drainage system has been identified.
- Further culverting and building over of culverts should be avoided. All new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit.

- Seek developer contributions (to be determined in consultation with the Environment Agency) via S106 planning obligations to fund (or part fund) strategic flood risk management facilities (such as storage areas) and bring benefit to the wider community.

12.6 Recommendations: Environment Agency Policies Relevant to the Council

Particularly, in the western half of the District there are steep-sided valleys which contribute to catchments' rapid response to storms and high surface water runoff. Here, the Environment Agency's overall policy is to realise opportunities to reduce flood risk by providing increased flood storage, introduction of NFM measures and improved management of surface water (i.e. promoting the use of SUDS). Improvements in river management including the restoration of river channels and functioning floodplains and the creation of buffer zones adjacent to rivers will all help manage flood risk in the area. This policy will have implications for future development in the District; indeed, Council can help deliver this policy by: seeking to ensure that Flood Zones 2 and 3 remain undeveloped, reinstating areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones) and promoting the use of SUDS.

In the eastern half of the District (including Lydney) the area has extremely flat coastal floodplain, with some areas protected by existing defences. In the short term, the Environment Agency's policy is to continue to protect features or assets by maintenance of the existing defences. In the long term, however, the policy is for no active intervention, and to retreat the line. This will be confirmed by work planned for the near future. This will involve either leaving the defences to be overcome (no further maintenance) or moving defences away from their current position to a location further away from the river bank, particularly in agricultural areas away from settlements or major infrastructure. The policy of retreat will, however, be constrained by how much settlements, infrastructure or other interests can be defended locally. Again, this policy will have implications for future developments in the District. Indeed, Council can help deliver this policy by: ensuring new development does not take place in areas along the estuary which are shown to be at risk and/or are currently defended. Such areas are earmarked for long term retreat in the future. When buildings with defenced areas reach the end of their natural life, the Council should consider the option of not re-developing the site. The forthcoming SMP2 should also be taken into account with policy making and changes may need to be made to local policy when the document is finalised.

The Severn River Basin District Flood Risk Management Plan (FRMP) provides up-to-date information and advice on what flooding can be expected (including climate changes scenarios) and how best to work as a partnership to prevent, protect and prepare for flooding scenarios. Both the River Severn Partnership and the Severn Estuary Partnership are integral to this and the Council should be aware of and participate in meetings/training/events.

Close communication between the Environment Agency and the Local Planning Authority is required to ensure that development does not occur in areas of flood risk. The application of the Sequential Test to new development is therefore vital.

12.7 Recommendations: Emergency Planning

It is recommended that the Council's Emergency Response Plan is reviewed and updated if necessary in light of the findings of this updated SFRA to ensure that safe evacuation and access for emergency services is possible during times of flood both for existing developments and those being promoted as possible sites within the LDF process. It is further recommended that the Council works with the

Environment Agency to promote the awareness of flood risk, especially to those living in flood risk areas, and encourage communities at risk to sign-up to the Environment Agency Flood Warning service and the Gloucestershire Local Resilience Forum.

A review of designated rest centres and other major facilities should be carried out to ensure that they have the necessary levels of resilience to enable them to be used in the response to flooding and other major emergencies, or that alternative arrangements are put in place. A review of current local arrangements for water rescue should also be carried out to consider whether they are adequate and the community risk register. Further, Local Resilience Forums should consider the vulnerability of motorways and trunk roads to flooding and consider the potential for warnings and strategic road clearance and closures to avoid people becoming stranded. Finally, the community risk register should reflect risks to critical infrastructure from flooding and other hazards.

12.8 Recommendations: General

A number of general issues and resultant recommendations have come forward through the SFRA process, and should be taken into account by the Council. These are:

- Not all minor watercourses have had Flood Zone maps produced for them, specifically, those with a catchment area of less than 3km^2. Any development site located adjacent to an unmapped watercourse within Flood Zone 1 should apply an 8m. development easement from the top of bank, and a site specific FRA undertaken.
- In the future it is likely that the Environment Agency will take strategic direction over managing inland flood risks. The Local Authority should adopt a leadership and scrutiny role, overseeing flood risk management within the local area.
- Although the flood proofing of utilities should be carried out by the service provider, the Council should review the vulnerability of critical infrastructure in the local area and take steps to work with service providers to initial retrospective FRAs and subsequent flood proofing works if required.
- Incorporate requirements for flood resistant and resilient refurbishment of flooded properties in high flood risk areas.

12.9 Recommendations: Future Updates to the SFRA

The SFRA should be retained as a 'living' document and reviewed on a regular basis in light of better flood risk information and emerging policy guidance. It is recommended that outputs from the following studies are used to update future versions of the SFRA report and associated maps:

- Future Flood Risk Mapping Studies
- Future updates to Environment Agency datasets (particularly with regards to climate change allowances)
- Future Flood Risk Management Strategies
- Future groundwater flood risk maps, surface water flood risk maps and reservoir inundations maps. These should also feed into emergency planning documents.

12.10 Recommendations: Next Stage of Work

It is recommended that a detailed interrogation of emerging allocations is carried out using the SFRA data and the template table supplied in the Appendix. The flood risk posed to each site should be assessed, as well as the presence of defences and culverts. Any issues with the Flood Zone in each development site (mis-alignments etc.) should be identified. The Sequential Test should then be

carried out for sites in Flood zones 2 and 3, or where sites in Flood Zone 1 are affected by other sources of flooding. Where the resolution of flood risk data is poor, appropriate development easements, or further modelling work, should be put identified in consultation with the Environment Agency, to assist the Sequential Test process.

The Environment Agency will require a Level 2 SFRA to be carried out in order to provide a detailed assessment of the risk of flooding from non-fluvial sources, in areas where new development is proposed.

With regard to fluvial sources of flood risk, a Level 2 SFRA will be required where the need to apply the Exception Test is identified (as outlined in Annexe 3 of the NPPF along with Table 2 of 079 Reference ID: 7-079-20220825).

12.11 Recommendations: Level 2 SFRA

A Level 2 SFRA should be viewed as rather more site specific than a Level 1 SFRA, addressing flood risk potential development sites which have gone through the Sequential Test and have been located in Flood Zones 2 or 3, or behind existing defences. The data required for a Level 2 SFRA will therefore depend upon which, if any, of the Council's final list of preferred sites remain in Flood Zones 2 and 3 following the application of the Sequential Test and hence where the Exception Test needs to be applied.

In addition, the Environment Agency will require a Level 2 SFRA to be carried out in order to provide a detailed assessment of the risk of flooding from non-fluvial sources, in areas where new development is proposed.

It is important that a Level 2 SFRA considers the variation of flood risk in a Flood Zone. This increased scope involves a more detailed review of flood hazard (flood probability, flood depth, flood velocity, rate of onset of flooding). If development is to be located behind defences, it would be necessary to model constructional failure of the defence (breach) and water levels rising to exceed the level of the defence (overtopping). In some instances improvements to existing flood defences may be required to manage residual flood risks. Here, the SFRA should include an appraisal of the extent of works to provide or raise the flood defence to appropriate standard.

Level 2 SFRA outputs would include:

- Maps showing distribution of flood risk across zones (depth, velocity, rate and onset of flooding)
- An appraisal of the probability and consequence of breach or overtopping of flood defence infrastructure
- An appraisal of the condition of flood defence infrastructure and likely future policy
- Guidance on appropriate policies for making sites which satisfy parts a) and b) of the Exception Test, and the requirements for satisfying part c) of the Exception Test
- Guidance on the preparation of FRAs for sties with varying flood risk across the Flood Zone

As soon as the need to apply the Exception Test is identified, a Level 2 SFRA should be initiated.

Glossary

1) **ABD** - Area Benefiting from Defences. Such areas are defined as areas benefiting from formal flood defences specifically in the event of flooding from rivers with a 1% (1 in 100 year) chance in a given year, or flooding from the sea with a 0.5% (1 in 200 year) chance in any given year. If the defences were not there these areas would be flooded. An area of land may benefit from the presence of a flood defence even if the defence has overtopped, if the presence of the defence means that the flood water does not extend as far as it would if the defence were not there (Source: Environment Agency Policy Number 132_06)

2) **AONB** – Area of Outstanding Natural Beauty. These are areas of countryside with significant landscape value.

3) **BFIHOST** – Base Flood Index derived from the Hydrology of Soil Types classification as described in the Flood Estimation Handbook.

4) **Breach Hazard** – Hazard attributed to flooding caused by the constructional failure of a flood defence or other structure that is acting as a flood defence.

5) **CFMP** – Catchment Flood Management Plan. Now superseded by Flood Risk Management Plans (FRMPs).

6) **Core Strategy** – The Development Plan Document which sets the long-term vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development. It works alongside the Allocations Plan, which provides more detailed policies for the district. The new Local Plan (2021-2041) will override both the Core Strategy and the Allocations Plan.

7) **Culvert** – A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal, or other impediment.

8) **Defra** – Department of Environment, Food and Rural Affairs

9) **DG5 Register** – A register of properties at risk from sewer flooding maintained by UK water companies.

10) **DPSBAR** – Mean drainage path slope

11) **Dry pedestrian egress** – Routes to and from buildings that will remain dry and allow pedestrian/wheelchair evacuation to dry land in times of flood.

12) **Environment Agency** – The leading public body for protecting and improving the environment in England and Wales.

13) **Environmental Stewardship** – Environmental Stewardship is an agri-environment scheme which provides funding to farmers and other land managers in England who deliver effective management on their land. The scheme is intended to build on the recognised success of the Environmental Sensitive Areas scheme and the countryside Stewardship Scheme. Flood risk management is among its secondary objective.

14) **Exception Test** – If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. Paragraph 160 of the NPPF and PPG (Paragraph: 023 Reference ID: 7-023-20140306) set out strict requirements for the application of the Test.

15) **Flood Estimation Handbook (FEH)** – The latest hydrological approach for the estimate of flood flows in the UK.

16) **Flood Defence** – Natural or man-made infrastructure used to reduce the risk of flooding.

17) **Flood Risk** – Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred.

18) **FRA** – Flood Risk Assessment. Assessment of flood risk posed to a defined area (usually a new development site) as defined above.

19) **Flood Risk Management** – Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences and reduce the impact through influencing development on flood risk areas, flood warning and emergency response.

20) **FWD** – Floodline Warnings Direct. FWD is a system maintained by the Environment Agency which sends out warning messages to homeowners and businesses over the telephone network when floods are likely.

21) **Flood Risk Vulnerability** – PPG provides a vulnerability classification to assess which uses of land may be appropriate in each flood risk zone.

22) **Formal Flood Defence** – A structure built and maintained specifically for flood defence purposes.

23) **Flood Zones** – Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

24) **Functional Floodplain Zone 3b** – Defined as areas at risk of flooding in the 5% AEP (1 in 20 year) design event. In any one year the chance of a 5% AEP (1 in 20 year) event occurring is 5%.

25) **GIS** – Geographic Information System. GIS is any system which stores geographical data, such as elevations, location of buildings and extent of flood outlines.

26) **High probability Zone 3a** – Defined as areas at risk of flooding in the 1% AEP (1 in 100 year) design event. In any one year the chance of a 1% AEP (1 in 100 year) event occurring is 1%.

27) **Informal Flood Defence** – A structure that provides a flood defence function however has not been built and/or maintained for this purpose (e.g. boundary wall).

28) **Integrated urban drainage** – An integrated approach to surface water management.

29) **JFLOW** – A computer river model based on routeing a flood calculated by Flood Estimation Handbook methodology along a river corridor the levels of which are derived from a Side Aperture Radar (SAR) remote sensed Digital Terrain Model.

30) **Land Swapping** – Looking for long term opportunities to remove development from areas that flood at present and relocated in lower risk locations which is essentially restoration of the floodplain.

31) **LiDAR** – Light Detection and Ranging. LiDAR is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground.

32) **Low Probability Zone 1** – The area outside Zone 2. Defined as an area with less than 0.1% AEP (1 in 1000 year) chance of flooding. In any one year the chance of a 1% AEP (1 in 100 year) event occurring is less than 01.%.

33) **LPA** – Local Planning Authority

34) **Main River** – All watercourses shown on the statutory main river maps held by the Environment Agency and the Department for Environment, Food and Rural Affairs. This can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel. The Environment Agency has permissive power to carry out works of maintenance and improvement on these rivers.

35) **Medium Probability Zone 2** – Defined as an area at risk of flooding from flood events that are greater than the 1% AEP (1 in 100 year), and less than the 0.1% AEP (1 in 1000 year) design event. The probability of flooding occurring in this area in anyone year is between 1% and 0.1%.

36) **Minor River** – Every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river. The local authority or Internal Drainage Board (IDB) where relevant, has powers for ordinary watercourses.

37) **mAOD** – Metres Above Ordnance Datum

38) **NGR** – National Grid Reference

39) **NFCDD** – National Flood and Coastal Defence Database. Owned by the Environment Agency, NFCDD containing details of this location, standard and condition of all Environment Agency maintained defences.

40) **NPPF** – National Planning Policy Framework. It sets out the government's planning policies for England and how these are expected to be applied.

41) **OS** – Ordnance Survey.

42) **Ordinance Watercourse (non-main river, minor watercourse**) – Any section of watercourse not designated as a Main River.

43) **PPG** – Planning Practice Guidance. Technical guidance to the NPPF.

44) **Previously Developed (Brownfield) Land** – Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land.

45) **Residual Risk** – The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented.

46) **Return Period** – The probability of a flood of a given magnitude occurring within any one year e.g. a 1% AEP (1 in 100 year) event has a probability of occurring once in 100 years, or a 1% chance in any one year. However, a 1% AEP (1 in 100 year) event could occur twice or more within 100 years, or not at all.

47) **Sequential Test** – Informed by a SFRA, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.

48) **SFRA** - Strategic Flood Risk Assessment. An SFRA is used as a tool by a planning authority to assess flood risk for spatial planning, producing development briefs, setting constraints, informing sustainability appraisals and identifying locations of emergency planning measures and requirements for flood risk assessments.

49) **SFRM** – Strategic Flood Risk Management. An Environment Agency Framework which facilitates the implementation of **Flood Risk Management**.

50) **SPD** – Supplementary Planning Document. An SPD provides supplementary guidance to policies and proposals contained within Development Plan Documents. They do not form part of the development plan, nor are they subject to independent examination.

51) **SPR** – Standard percentage runoff from the Hydrology of Soil Types classification.

52) **SA** – Sustainability Appraisal. An SA is an appraisal of plans, strategies and proposals to test them against broad sustainability objectives.

53) **SoP** – Standard of Protection. The return period against which a defence offers protection.

54) **SSSI** – Site of Special Scientific Interest. SSSIs are designated protected areas in the UK. NNRs and SACs are both SSSIs.

55) **SUDs** – Sustainable Urban Drainage Systems. SUDS are drainage systems which are designed to reduce the impact of urbanisation on the hydrology of a river system.

56) **Sustainable Development** – "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987)

57) **Wrack Mark** – a recorded level following a flood event.

Some useful links

CIRIA SUDS Manual - https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

Environment Agency - https://www.gov.uk/government/organisations/environment-agency

Environmental Permitting Regulations 2016 (http://www.legislation.gov.uk/uksi/2016/1154/contents/made)

Flood and Water Management Act (2010) - http://www.legislation.gov.uk/ukpga/2010/29/contents)

Floodline - Call Floodline (24-hour service) on 0345 988 1188 or type-talk (for the hard of hearing) on 0345 602 6340 to find out if they are active in your area.

Flood Risk Management Strategy (2013) - https://severnestuarycoastalgroup.org.uk/severnestuaryfrms/

Flood Warning - https://www.fws.environment-agency.gov.uk/app/olr/register

Flood warning information - https://flood-warning-information.service.gov.uk/river-and-sea-levels

FODDC online flooding maps - https://experience.arcgis.com/experience/b030cd30a73c4fd7994421c299c46aa4/page/Page/

Forest of Dean District Council - www.fdean.gov.uk

Forest of Dean District Council Core Strategy & Allocations Plan - https://www.fdean.gov.uk/planning-and-building/planning-policy/our-current-local-plan/

Gloucestershire Lead Local Flood Authority - https://www.gloucestershire.gov.uk/planning-and-environment/flood-risk-management/flooding-information/information-for-developers/local-flood-risk-management-strategy-lfrms/lead-local-flood-authority-llfa/#main

Gloucestershire Local Resilience Forum - Gloucestershire Prepared https://glosprepared.co.uk/

Government Advice - https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment and https://www.gov.uk/guidance/flood-risk-and-coastal-change#Strategic-Flood-Risk-Assessment-section

Local Resilience Forum Contact Details - https://www.gov.uk/guidance/local-resilience-forums-contact-details

Lower Severn Internal Drainage Board - https://lowersevernidb.org.uk/

National Planning Policy Framework (NPPF) - https://www.gov.uk/government/publications/national-planning-policy-framework--2

Natural Resources Wales - https://naturalresources.wales/evidence-and-data/research-and-reports/flooding-reports-evidence-and-data/flood-risk-management-plans/?lang=en

River Severn Partnership - http://www.riversevernpartnership.org.uk/

Sequential Test Advice - https://www.gov.uk/guidance/flood-risk-assessment-the-sequential-test-for-applicants.

Severn River Basin Flood Risk Management Plan 2021-2027 (FRMP) - https://www.gov.uk/government/publications/severn-river-basin-district-flood-risk-management-plan

Shoreline Management Plan - https://severnestuarycoastalgroup.org.uk/shoreline-management-plan/

Susdrain - www.susdrain.org

The Land Drainage Act (1991) -https://www.legislation.gov.uk/ukpga/1991/59/contents

The Localism Act (2011) (UK Parliament (2011) - http://www.legislation.gov.uk/ukpga/2011/20/contents/enacted

The Water Act (2003) (https://www.legislation.gov.uk/ukpga/2003/37/contents)

Water Wise - www.waterwise.org.uk

APPENDIX A

Template to Assist with Sequential Test Process

Appendix A – Site Assessment Template Table

Site	Site Description	Land Use	Vulnerability Classification	Watercourse(s)	Flood Zone Information	Method used to derive Flood Zones	Fluvial Flood Risk Posed to Site	Canals	Flooding from 'Other Sources' Description	Sewer Flooding	Defences							Culverts				Flood Watch/Warning Coverage?	LIDAR Coverage?	Notes
											Summary	Asset Ref	Location	Type	Protection Type	Length (m)	Residual Risk from defences	Location	Watercourse	Occurs under	Residual Risk from culverts			