Adur and Worthing Level 1 Strategic Flood Risk Assessment

Final Report

July 2024

Prepared for:
Adur & Worthing Councils

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ADUR & WORTHING COUNCILS

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Contract

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This report describes work commissioned by Adur & Worthing Councils, by an instruction dated 09 May 2023. The Client's representative for the contract was Catherine Hutchins of Adur & Worthing Councils. Amber Humphries, Harriet Freestone and Sophie Thorpe of JBA Consulting carried out this work.

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The methodology adopted and the sources of information used by JBA in providing its services are outlined in this Report. The work described in this Report was undertaken between May 2023 and December 2023 and is based on the conditions encountered and the information available during the said period. The scope of this Report and the services are accordingly factually limited by these circumstances.

Acknowledgements

We would like to acknowledge the assistance of

- Adur District and Worthing Borough Council
- West Sussex County Council
- Environment Agency
- Southern Water
- Neighbouring Authorities

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Abbreviations

A&WC	Adur & Worthing Councils
AEP	Annual Exceedance Probability
BGS	British Geographical Survey
CDA	Critical Drainage Area
CIA	Cumulative Impact Assessment
CSOs	Combined Sewer Overflows
Defra	Department for Environment, Food and Rural Affairs

DWMP	Drainage Water Management Plan
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FWMA	Flood and Water Management Act
GSPZs	Groundwater Source Protection Zones
JBA	Jeremy Benn Associates
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Area
mAOD	metres Above Ordnance Datum
NFM	Natural Flood Management
NVZs	Nitrate Vulnerability Zones
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
RBMP	River Basin Management Plan
RoFSW	Risk of Flooding from Surface Water
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SPD	Supplementary Planning Document
STWs	Sewage Treatment Works
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
WSCC	West Sussex County Council

Executive Summary

Introduction

The study area for this Strategic Flood Risk Assessment (SFRA) is the Adur and Worthing Council area excluding the South Downs National Park (SDNP) authoritative area. This 2023 SFRA document supersedes the previous 2020 Adur and Worthing Level 1 SFRA. This report only considered the Local Plan areas of Adur District Council and Worthing Borough Council and does not include the South Downs National Park authoritative area in the north of Adur and Worthing.

The report has been prepared to provide comprehensive and supporting evidence to inform future updates to the Adur Local Plan that was adopted in 2017. The Worthing Local Plan was adopted in 2023.

The SFRA update was required to be compliant with the latest guidance described in the revised 2023 National Planning Policy Framework (NPPF) and updated 2022 Planning Policy Guidance (PPG). The 2023 SFRA provides flood risk evidence and long term strategy to support the management and planning of development, protect the environment and deliver infrastructure. It also supports the selection of site allocations in the Local Plan reviews and provides information and guidance to be used in the preparation of Flood Risk Assessments in support of site specific planning applications.

SFRA Objectives

The key objectives of the 2023 SFRA update are:

- To provide up to date information and guidance on flood risk in Adur and Worthing, taking into account the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies
- To provide the basis for applying the flood risk Sequential Test, and if necessary the Exception Test. Revised National Planning Policy Framework (updated in 2023) includes a requirement to assess all sources of flooding.
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as part of the evidence base for the Local Plan Review and to support the preparation of Neighbourhood Plans.
- To inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.
- To identify and provide recommendations on opportunities to reduce the causes and impacts of flooding to existing communities and developments.

SFRA Outputs

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate change on flood risk

- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS)
- A review and update of any new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc)
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site-specific flood risk assessments
- Mapping of location and extent of functional floodplain
- Mapping areas at risk from other sources including surface water, sewer, ground water and reservoirs
- Mapping areas covered by an existing flood alert / warning
- Identification of opportunities to reduce flood risk
- High-level screening of proposed development sites against flood risk information
- Identification of flood defence infrastructure.

Summary of Assessment

Flood risk

- There have been several recorded flood incidents across the study area, with surface water the most frequent cause of flooding. There have been a number of fluvial and tidal incidents recorded in the past, as well as records of flooding from groundwater and sewers. These sources of flooding can also occur in combination, causing a cumulative effect.
- The most notable flooding incidents in the Local Plan areas occurred in 1980, 2000, 2007, 2012 and the winter of 2013/14. These incidents were largely caused by surface water flooding following heavy or prolonged rainfall.
- There have been no major fluvial events recorded in the Local Plan areas, though there have been several incidents of fluvial flooding around Teville Stream and Ferring Rife associated with surface water flooding during extreme rainfall events. Fluvial contributions from the River Adur are unlikely to result in fluvial flooding unless high flows coincide with high tides. The River Adur, Teville Stream and Ferring Rife are all susceptible to tidal locking in their lower reaches.
- The study area is bound by the English Channel to the south, with the coastline at risk of tidal flooding. Tidal flooding has been recorded in Lancing and Shoreham due to overtopping of defences, though tidal flooding is rare within Worthing Borough.
- Coastal flood risk will potentially increase where coastal erosion threatens the stability of tidal flood defences.
- The Risk of Flooding from the Surface Water dataset shows that surface water flood risk is predominantly concentrated along topographical flow paths

of existing watercourses, dry valleys or roads, with some areas of ponding in low lying areas along the coast and on the northern (upslope) side of the railway line. The last major surface water flood event occurred in June 2012, with widespread property flooding reported in Worthing.

- In coastal areas, surface water flood risk is also related to the tidal outfalls where tide-locking can restrict the discharge from gravity sewers and culverted watercourses.
- The JBA Groundwater Flood Map shows that large proportions of the Local Plan areas are potentially at risk of groundwater flooding, with the most vulnerable areas including Durrington, Goring, East Worthing, Sompting and Lancing.
- There are 309 historic incidents of sewer flooding in the study area that have been identified from Southern Water's records. The West Beach area in Lancing is noted to have frequently flooded as a result of wastewater.
- There are no Large Raised Reservoirs within the study area, however, Somerset Lake is located within the catchment.
- There are currently five Flood Alert Areas and four Flood Warning Areas in the Local Plan area.

Flood defences

There are tidal, coastal and tidal / fluvial flood defences located along the majority of the coastline and tidal watercourses in the study area. The standard of protection provided by these assets varies, as does their condition.

Development and flood risk

Information used to support the Sequential and Exception Tests for both Local Plans and Flood Risk Assessments has been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the Lead Local Flood Authority and the Environment Agency.

Relevant studies

There are many relevant regional and local key policies which have been considered within the SFRA, such as the Shoreline Management Plan for Beachy Head to Selsey Bill, the River Adur Catchment Flood Management Plan, the South East River Basin District Flood Management Plan, the West Sussex Local Flood Risk Management Strategy, the Lancing Surface Water Management Plan, the Preliminary Flood Risk Assessment and the Southern Water Drainage and Wastewater Management Plan. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

Policy recommendations

The following recommendations to support policy are to be considered by Adur and Worthing Councils as part of Flood Risk Management in the study area.

Development and planning considerations

Sequential approach to development

It is recommended that the sequential approach is adopted for all future developments within the study area where there is flood risk.

New development and re-development of land should seek opportunities to reduce the overall level of flood risk at the site where possible.

Sequential and Exception tests

The SFRA has identified that areas of Adur District and Worthing Borough are at high risk of flooding from fluvial, tidal and surface water (pluvial) sources. Proposed development sites at locations at risk of flooding will be required to satisfy the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Adur and Worthing Councils will use the information in this SFRA to inform future updates to the Local Plans.

Site-specific Flood Risk Assessments

Site specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development satisfies part 'b' of the Exception Test.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses and tidal areas to verify flood extents (including latest climate change allowances), inform floodplain and development zoning within the site and evidence, if required, that the Exception Test is satisfied. Where a site-specific FRA has produced modelling outlines which differ from the Flood Map for Planning a full evidence-based review would be required. Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

Any flood risk management measures required to reduce the risk of flooding to a development site should be consistent with the wider catchment policies set out in the Catchment Flood Management Plan, Flood Risk Management Plan, Local Flood Risk Management Strategy and other relevant strategies.

An updated NPPF (the Revised National Planning Policy Framework) was published in 2023, setting out the Government's planning policies for England and how these are expected to be applied. This revised framework replaces the previous NPPF published in 2019.

There are also several guidance documents which provide information on the requirements for site-specific Flood Risk Assessments:

- Standing Advice on Flood Risk (Environment Agency)
- Flood Risk Assessment for Planning Applications (Environment Agency)
- Site-specific Flood Risk Assessment: CHECKLIST (NPPG, Defra)

In 2018, the Met Office published new UK Climate Projections (UKCP18). The Environment Agency has since updated their guidance on climate change allowances for tidal uplifts (in

2019), river flow (in 2021) and rainfall intensity (in 2022) for new developments. This includes information on how these allowances should be included in both SFRAs and FRAs. The guidance adopts a risk-based approach considering the vulnerability of the development and (in the case of fluvial and rainfall intensity) considers risk allowances on a management catchment level, rather than a river basin level. Developers should check on the government website for the most recent guidance before undertaking a detailed FRA. To further support this, the Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice.

Surface water management and SuDS

Planners should be aware of the conditions set by West Sussex County Council as the Lead Local Flood Authority for surface water management and ensure development proposals and applications are compliant with the West Sussex County Council LLFA Policy for the Management of Surface Water.

It is also recommended that high density development should give consideration to the use of urban SuDS and developments in close proximity to the coast should consider discharging water directly to the sea. WSCC is investigating the feasibility of this through the 'Over the Wall' drainage project.

Review of planning applications

The Council should consult the Environment Agency's 'Flood Risk Assessment: Local Planning Authorities', last updated 8 February 2022, when reviewing planning applications for proposed developments at risk of flooding.

The Council will consult the relevant statutory consultees as part of the planning application assessment and they may, in some cases, also contact non-statutory consultees (e.g. Southern Water) that have an interest in the planning application.

Infrastructure and safe access

Where there is a residual risk of flooding (from any source) to properties within a development, residential and commercial minimum finished floor levels should be set at least 300mm above the estimated flood level, which is defined as the 1% AEP fluvial plus climate change or the 0.5% AEP tidal plus climate change where the new climate change allowances have been used. The 1% AP plus climate change should also be considered for surface water risk. An additional allowance may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine alternative approaches.

Safe access and egress will need to be demonstrated at all development sites. Emergency vehicular access should be possible during times of flood.

Residual risk

Residual risk is the risk that remains after the effect of mitigation measures are taken into account. The residual risk includes the consideration of flood events that exceed the design thresholds of the flood defences or circumstances where there is a failure of the defences, e.g. flood banks collapse. Residual risks should be considered as part of site-specific Flood Risk Assessments.

Future flood management

Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

Potential modelling improvements

The Environment Agency regularly reviews its flood risk mapping, with the Arun-Adur model currently being updated at the time of preparing this report. It is important that the Environment Agency are approached to determine what data is available prior to commencing a site-specific FRA.

Use of SFRA data

SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. This SFRA has been developed using the best available information, supplied at the time of preparation. This relates both to the current risk of flooding from rivers, the sea and surface water and where available the potential effects of future climate change.

It should be noted that the Environment Agency's Flood Map for Planning is correct as of the date of this report, therefore online datasets should be checked and where different the online datasets should be used as the latest available data.. When using the SFRA to prepare FRAs it is important to check that the most up to date information is used, as is described in amendments to the flood mapping prepared and issued by the Environment Agency at regular intervals.

Other datasets used to inform this SFRA may also be periodically updated and following the publication of this SFRA, new information on flood risk may be provided by Risk Management Authorities.

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

"Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards" (National Planning Policy Framework, paragraph 166).

This Level 1 Strategic Flood Risk Assessment (SFRA) 2023 document supersedes the previous Level 1 SFRA (2020). The SFRA study area is shown in Figure 1-1 and excludes the South Down National Park (SDNP). This report considers the Local Plan Areas of Adur District Council and Worthing Borough Council and additional mapping displaying district and borough wide outputs are located in the appendices.

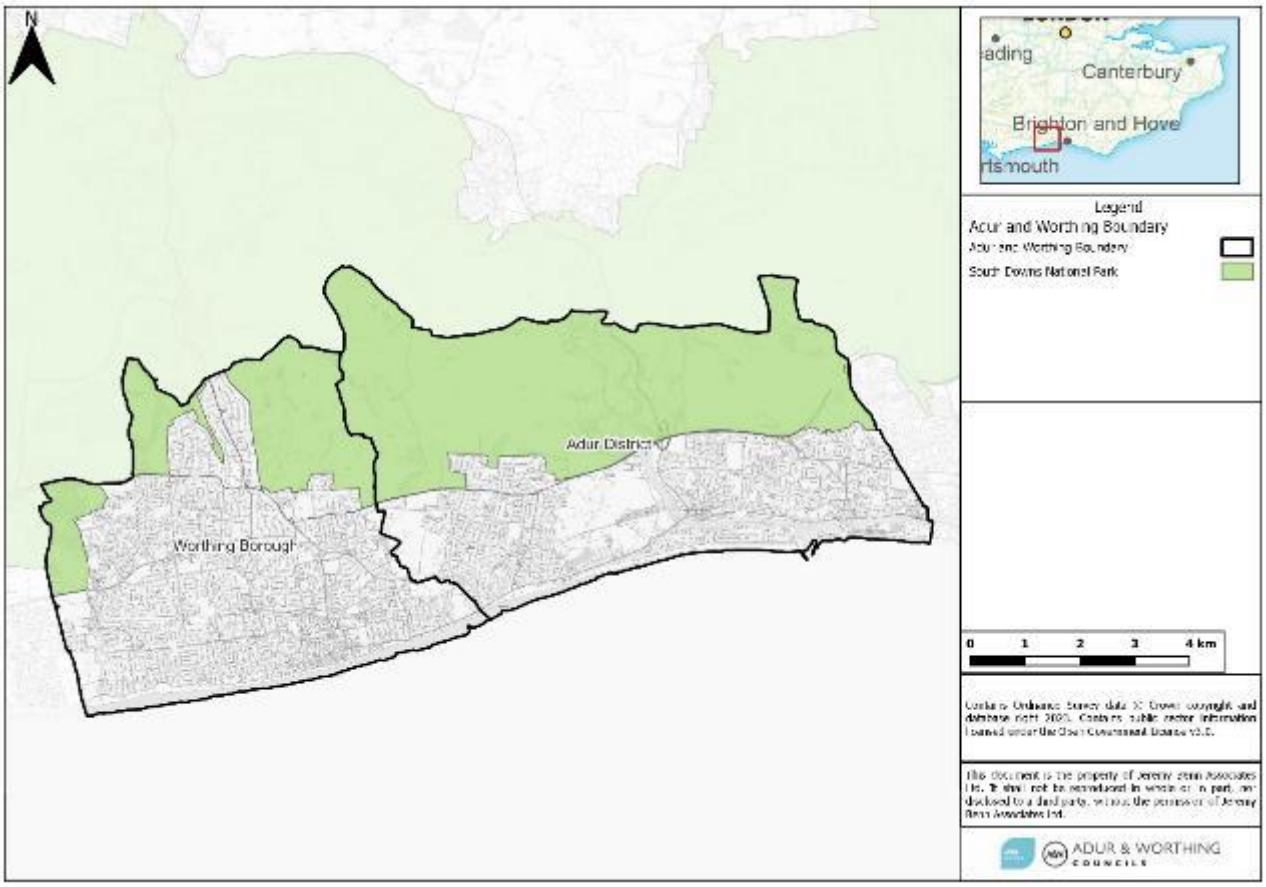


Figure 1-1: The SFRA study area and South Downs National Park.

The main purpose of the SFRA update is to prepare a document that can be used in decision making and to inform the preparation of sustainable policies for the long-term management of flood risk. The document provides comprehensive and supporting evidence to inform future updates to the Adur Local Plan, that was previously adopted in 2017. The Worthing Local Plan was adopted in 2023.

The SFRA update is also required to be compliant with the latest guidance described in the 2023 revision to the National Planning Policy Framework (NPPF), the implications of the August 2022 changes to the Planning Practice Guidance (PPG) and support the selection of site allocations in the Local Plan Review and to provide information and guidance to be used in the preparation of Flood Risk Assessments (FRAs) in support of site specific planning applications. The evidence in this SFRA shall also be used to support the formulation of Neighbourhood Plans.

The key objectives of the 2023 SFRA are:

- To provide up to date information and guidance on flood risk in Adur and Worthing, taking into account the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies
- To provide the basis for applying the flood risk Sequential Test, and if necessary the Exception Test
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as part of the evidence base for the Local Plan Review and to support the preparation of Neighbourhood Plans.
- To identify the requirements for site-specific flood risk assessments and the application of Sustainable Drainage Systems (SuDS).

1.2 Levels of SFRA

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

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

This report fulfils the Level One SFRA requirements.

1.3 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate change on flood risk
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS)
- A review and update of new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc)
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site-specific flood risk assessments
- Mapping of location and extent of functional floodplain
- Mapping areas at risk from other sources including surface water, sewer, ground water and reservoirs
- Mapping areas covered by an existing flood alert / warning
- Identification of opportunities to reduce flood risk
- High-level screening of proposed development sites against flood risk information
- Identification of flood defence infrastructure.

1.4 SFRA Study Area

Adur District Council and Worthing Borough Council cover an area of approximately 77km², with a population of approximately 176,000. The area is located between the South Downs National Park to the north and the English Channel to the south. The residential centres within the area are Goring, West Durrington, Broadwater, Worthing Town Centre, Lancing, Shoreham and Southwick.

Adur District and Worthing Borough are located within the West Sussex County Council administrative area and are bounded by four other authorities in addition to the South Downs National Park:

- Horsham District Council
- Brighton and Hove City Council
- Arun District Council
- Mid Sussex District Council

An overview of the study area and the neighbouring authorities is shown in Figure 1-2. The water and sewerage company for the area is Southern Water.

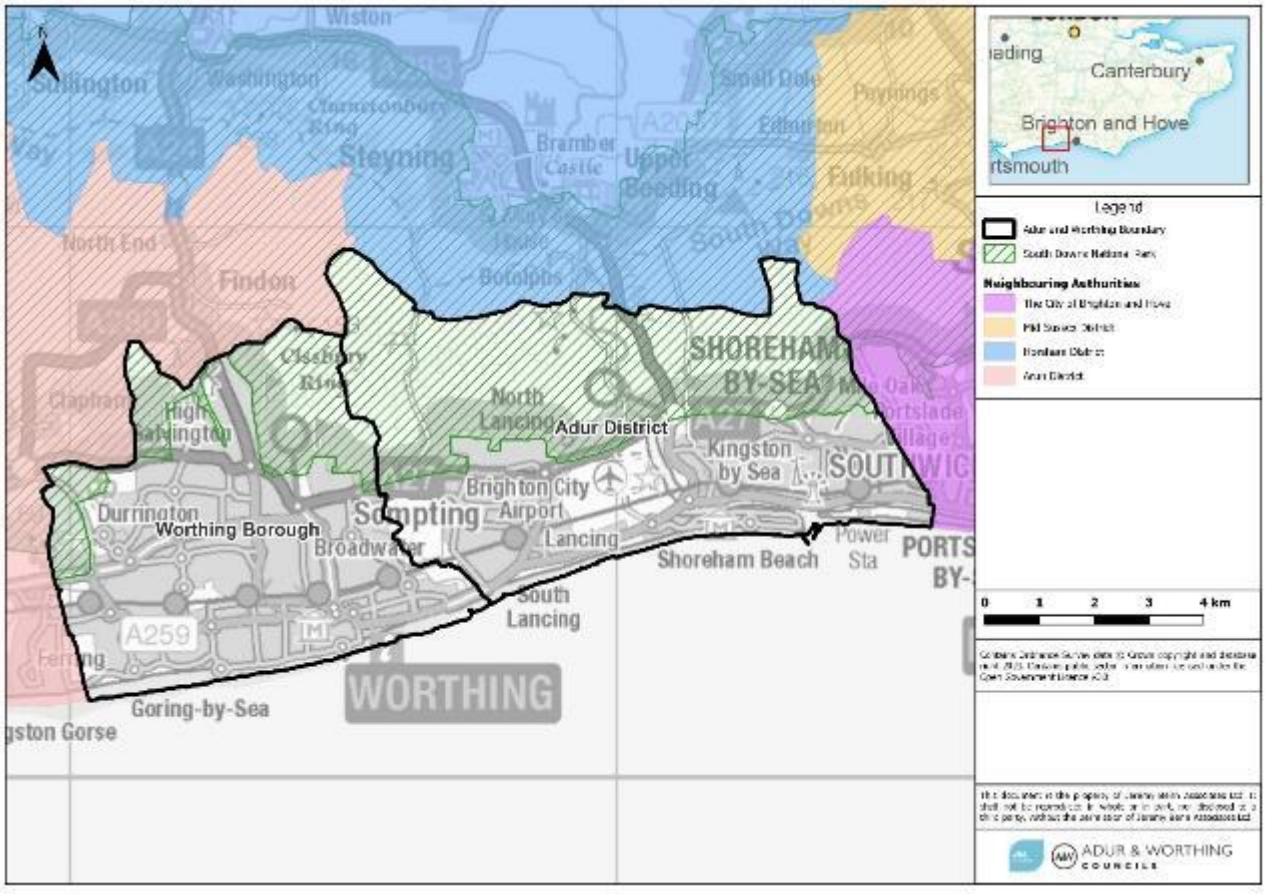


Figure 1-2: Worthing Borough Council and Adur District Council alongside its neighbouring authorities.

The main rivers that run through Adur and Worthing are the River Adur, Ferring Rife and Teville Stream (Appendix B).

1.5 Consultation

The following parties have been consulted during the preparation of this Level 1 SFRA:

- Adur & Worthing Councils
- Environment Agency
- West Sussex County Council (Lead Local Flood Authority)
- Southern Water
- Neighbouring authorities

1.6 Use of SFRA data

It is important to recognise that Level 1 SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The SFRA has been developed using the best available information at the time of preparation. This relates both

to the current risk of flooding from all sources, and the potential impacts of future climate change.

Hyperlinks to external guidance documents / websites are provided throughout the SFRA.

SFRAs should be a 'living document', and as a result should be updated when new information on flood risk, new planning guidance, or legislation becomes available. New information on flood risk may be provided by Adur District Council and Worthing Borough Council, West Sussex County Council, the Environment Agency and Southern Water. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a flood event
- Policy/ legislation updates
- Environment Agency flood map updates
- New flood defence schemes etc.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed internally, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information.

1.7 Understanding flood risk

This section provides useful background information on how flooding arises and how flood risk is determined.

1.7.1 Sources of flooding

Flooding can occur from many different and combined sources and in many different ways, as illustrated in Table 1-1. Major sources of flooding include:

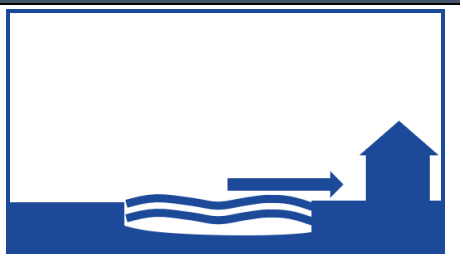
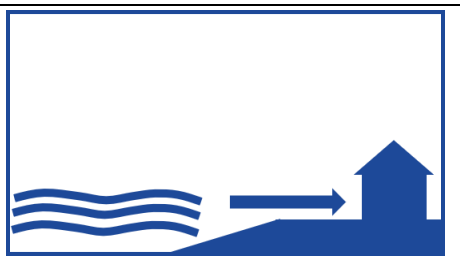
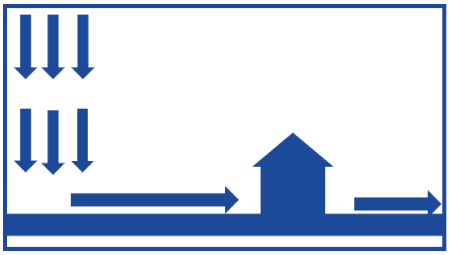
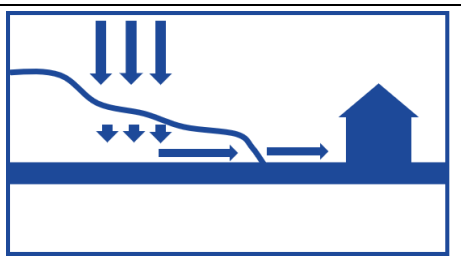
- **Fluvial (rivers)** - inundation of floodplains from rivers and smaller watercourses; inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels; overtopping or breaching of defences; blockages of culverts; blockages of flood channels/corridors.
- **Tidal (coastal)** – inundation of low-lying coastal areas from the sea or estuaries; overtopping of defences; breaching of defences; wave action; flooding caused by high tides and wave overtopping.
- **Surface water** - direct run-off from land due to exceeding the infiltration rate of the soil or the capacity of the drainage network. It is generally caused by intense short periods of rainfall and usually affects lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage

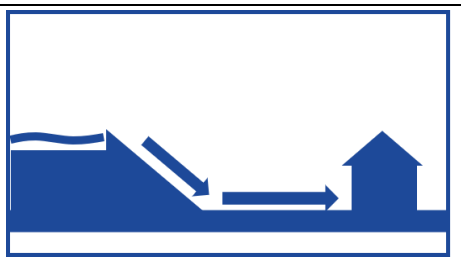
blockage by debris, sewer flooding and where surface water is draining to tidal outfalls, tide-locking.

- **Groundwater** – rising water table; most likely to occur in low-lying areas underlain by permeable rock (aquifers) or groundwater recovery after pumping for mining or industry has ceased.
- **Infrastructure failure** - reservoirs; canals; industrial processes; burst water mains; blocked sewers or failed pumping stations.

Flood hazards vary greatly between different sources of flooding due to variations in the speed of onset or inundation, flood water depths and duration. Interactions can also occur between different types of flooding, for example groundwater entering sewer systems, or raised tides meaning that rivers cannot flow into the sea. With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging.

Table 1-1: Description and illustration of each different type of flooding.

Flooding type	Description	Illustration
Fluvial (River)	River flows exceed the capacity of the river channel, with water spilling out on to the floodplain. Can include breach or overtopping of flood defences.	
Tidal (Coastal)	Inundation from the sea or tidal surges. Can include overtopping or breach of coastal defences.	
Surface water	Water falls onto the ground and is unable to soak into the ground due to impermeable surfaces or rainfall intensities exceeding the infiltration rate into the soil or the capacity of the drainage network.	
Groundwater	Water is stored in rock layers underground. The water table rises as infiltration exceeds the drainage from the aquifer or permeable layer, leading to the water table rising to the surface through springs or wetted areas.	

Flooding type	Description	Illustration
Residual risk	Breach or overtopping of a raised structure storing water, such as a sea wall.	

1.8 The source-pathway-receptor model

Flood risk is a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the source – pathway – receptor model as displayed in Figure 1-3. This is a standard environmental risk model common to many hazards and should be the starting point of any assessment of flood risk. It should be remembered that flooding could occur from many different sources and pathways, and not simply those shown in the illustration below.

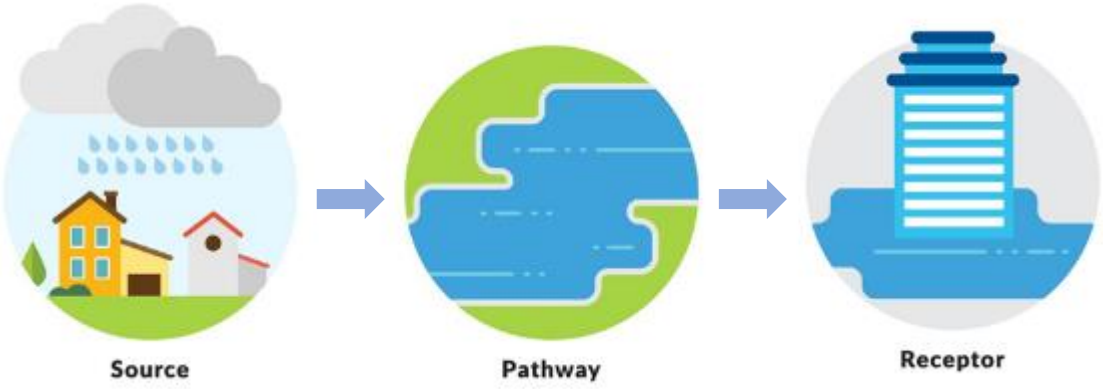


Figure 1-3: Diagram summarising the source – pathway – receptor model.

The Adur District and Worthing Borough study area is susceptible to flooding from all source areas. Pathways include the rivers themselves, drains, sewers, overland flows, floodplains and defence assets (for example through overtopping or breach). Receptors can include people, properties and the environment. All these elements must be present for flood risk to arise. Mitigation measures have little or no effect on the magnitude of the sources that cause flooding, but they can block or impede pathways, remove receptors or increase the resilience of receptors.

The planning process is primarily concerned with the appropriate location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk. It is therefore important to define the components of flood risk to apply this guidance in a logical and consistent manner.

1.9 Likelihood

The likelihood of flooding is often measured by a percentage probability or by stating how regularly it will occur. Many everyday practitioners refer to a 1% Annual Exceedance Probability (AEP) flood, or 1 in 100-year flood, however this does not mean that the flood will only happen once every 100 years. Instead, the chance of a flood of this magnitude occurring in any given year is 1% and it is therefore possible that two 100-year floods could happen within a single year. Higher probability flood events may occur between the larger events.

Drainage systems and flood defences are designed to provide standards of protection from events with specific magnitudes. Some examples of standard of protection are as follows:

- Surface water drains and sewers are designed to have a surcharged capacity (the water in the sewer system is at or below ground level) for a 3.3% AEP event.
- Coastal defences are generally built to protect against a 0.5% AEP event.
- Drainage for new highways is designed to a 3.3% AEP event, however the majority of the existing highway network is not built to modern standards. The probability of flooding the highway drainage network in some areas could be a 10% AEP rainfall event or lower.

1.10 Consequence

The consequences of flooding include fatalities, property damage and disruption to lives and businesses, with severe social and economic implications for people. Consequences of flooding depend on the hazards caused by flooding such as the depth of water, speed of flow, rate of onset and duration, and the vulnerability of receptors such as the type of development and population demographics.

1.11 Risk

Risk varies depending on the severity of the event, the source of the water, the pathways of flooding (such as the condition of flood defences) and the vulnerability of receptors as mentioned above. Flood risk as an equation is then expressed in terms of the following relationship, as displayed in Figure 1-4.

Figure 1-4: Conceptual model depicting how risk can be defined.

1.12 Resilience

Resilience to flood risk describes the capacity of people and places to plan for, better protect, respond to, and recover from flooding and coastal change. It includes making the

best land use and development choices, protecting people and places, responding to, and recovering from flooding and coastal change whilst also adapting to and planning for climate changes we are likely to see over the next 100 years.

Flood risk is constantly changing, and in the context of climate change we are likely to see flooding in areas which have not flooded historically. Approaches to managing flood risk must therefore be able to adapt to changes in our understanding, for example the introduction of non-stationarity fluvial flood frequency estimation into guidance for funding future flood risk reduction projects.

2 Flood risk policy and strategy

2.1 Roles and responsibilities

2.1.1 Adur District Council and Worthing Borough Council

As Local Planning Authorities, Adur and Worthing Councils assess, consult on and determine whether development proposals are acceptable, ensuring that flooding and other, similar, risks are effectively managed in line with planning policy.

The councils will consult relevant statutory consultees as part of planning application assessments and may, in some cases, also contact non-statutory consultees, such as Southern Water, that have an interest in the planning application.

Adur District Council and Worthing Borough Council are also the Coast Protection Authorities, primarily managing coastal erosion through defences. These defences are dual purpose and often serve to manage the coastal flood risk.

2.1.2 West Sussex County Council

As the Lead Local Flood Authority (LLFA) for the area, West Sussex County Council's duties include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (known as Section 19 investigations).
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: When appropriate LLFAs will perform consenting of works on ordinary watercourses.
- Enforcement: The LLFA has enforcement powers under the Land Drainage Act 1991 and FWMA 2010.

WSCC is also the Local Highway Authority and manages highway drainage, carrying out maintenance and improvement works on an on-going basis, as necessary, to maintain existing standards of flood protection for highways, making appropriate allowances for climate change. It also has the responsibility to ensure road projects cause no increase flood risk. WSCC are consultees with respect to drainage and SuDS for proposed new developments.

2.1.3 Environment Agency

The Environment Agency is responsible for protecting and enhancing the environment and contributing to the government's aim of achieving sustainable development in England and Wales. The Environment Agency has powers to work on Main Rivers to manage flood risk. These powers are permissive, which means they are not a duty, and they allow the Environment Agency to carry out flood and coastal risk management work and to regulate the actions of other flood risk management authorities on main rivers and the coast.

The Environment Agency also has powers to regulate, and consent works to Main Rivers. Prior written consent is required from the Environment Agency for any work in, under, over or within eight metres of a Main River or between the high-water line and the secondary line of defence e.g. earth embankment. Written consent is also required from the Environment Agency for any work within 16m of a sea defence. The Environment Agency also has a strategic overview role across all types of flooding as well as other types of water management matters.

2.1.4 Water and wastewater providers

Southern Water is the water and sewerage undertaker for the Local Plan area. They have the responsibility to maintain surface, foul and combined public sewers to ensure the area is effectively drained. When flows (foul or surface water) are proposed to enter public sewers, Southern Water will assess whether the public system has the capacity to accept these flows as part of their pre-application service. If there is not available capacity, they will provide a solution that identifies the necessary mitigation. Southern Water also comments on the available capacity of foul and surface water sewers as part of the planning application process.

National mapping by Water UK in the Assessing the Available Capacity in UK Sewerage Systems (2018) report identifies areas with potential capacity constraints within the sewerage systems According to the mapping, the area around Shoreham is located within 'Risk level 4'. This identifies the area as having widespread capacity constraints for pipes in the foul and combined sewer network, inhibiting sewerage systems in the area from achieving their peak performance and requiring medium term intervention.

Worthing is largely located within 'Risk level 3', and therefore indicates some localised capacity constraints which are likely to negatively affect sewerage system performance, while the area around Lancing and Sompting is identified as being within 'Risk Level 2', showing a generally good level of capacity with some potential localised issues.

Additional information regarding principles for better rainwater management by water companies can be found in DEFRA's Storm Overflows Discharge Reduction Plan.

Southern Water provides potable water to the Local Plan area. Consent, prior to commencing work, is required from the relevant provider if installing water systems, or altering existing systems, is intended.

2.2 Key legislation for flood and water management in the study area

2.2.1 Floods Directive (2007) & Flood Risk Regulations (2009)

At the time of this report, it is understood that the UK Government intends to repeal the Flood Risk Regulations 2009 as part of a review into retained EU legislation. It is proposed to repeal this by 31 December 2023, as the Flood Risk Regulations duplicate existing domestic legislation, namely the Flood and Water Management Act 2010.

The Flood Risk Regulations (2009) translate the current EU Floods Directive into UK law and place responsibility upon all Lead Local Flood Authorities (LLFAs) to manage localised flood risk. West Sussex County Council is the LLFA for the Adur District and Worthing Borough SFRA.

2.2.2 Preliminary Flood Risk Assessments

LLFAs have the task of preparing a Preliminary Flood Risk Assessment (PFRA) report every 6 years. The PFRA document that covers the study area was first published by WSCC in 2011. In 2017, WSCC prepared an addendum to the PFRA which updated the 2011 report.

The PFRA reports on significant past and future flooding from all sources except from Main Rivers and tidal reservoirs, (which are covered by the Environment Agency) and the adopted sewer network (in this instance, under the remit of Southern Water). PFRAs are a high-level screening exercise and consider floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage.

2.2.3 Flood and Water Management Act (FWMA) (2010)

The Flood and Water Management Act (2010) aims to create a simpler and more effective means of managing both flood risk and coastal erosion and implements some of Sir Michael Pitt's recommendations following his review of the 2007 floods.

The FWMA established Lead Local Flood Authorities (LLFAs). West Sussex County Council is the LLFA for the study area. Further information on the LLFA role and responsibilities are provided in Section 2.1.

2.2.4 Water Framework Directive (2000)

The purpose of the Water Framework Directive (WFD), which was transposed into English Law by the Water Environment Regulations (first published in 2003 and updated in 2017), is to deliver improvements across Europe in the management of water quality and water resources. This is enforced through a series of plans called River Basin Management Plans (RBMP) (see section 0)

2.2.5 Environmental Permitting

The Environmental Permitting Regulations (2016) set out where developers will need to apply for additional permission (as well as Planning Permission) to undertake works to an Ordinary Watercourse or Main River. Developers are required to contact the Environment Agency for permits regarding main river and sea defences. This includes flood risk activities, for example:

- on or within 8 metres of a main river (16 metres if tidal);
- on or within 8 metres of a flood defence structure or culvert (16 metres if tidal);
- on or within 16 metres of a sea defence;
- involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert; and
- in a floodplain more than 8 metres from the riverbank, culvert or flood defence structure (16 metres if it is a tidal main river) and you don't already have planning permission.

Environmental permits may also be required from the Environment Agency to discharge runoff, trade effluent or sewage into a main river. They may also be required in relation to groundwater activities, where there may be a risk of groundwater contamination.

2.2.6 Byelaws

Land Drainage Byelaws outline legal obligations and responsibilities when undertaking works on or close to a watercourse, for the purpose of preventing flooding, or mitigating any damage caused by flooding.

The Adur and Worthing Local Plan area is covered by the Southern Region Land Drainage and Sea Defence Byelaws enforced by the Environment Agency. These Byelaws have effect on functions relating to land drainage in the Southern Water Authority area for any Main River or sea and tidal defences.

Byelaws relating to Main Rivers within the Southern Region cover river control works, the flow of water in rivers, the duties of riparian owners, operations in rivers/ on banks and the placing of vessels in rivers. Byelaws relating to sea and tidal defences within the region cover the prevention of interference with defences, the maintenance and alteration of defences and the control of animals, vessels or acts affecting sea defences (e.g. erections and excavations).

Compliance to these standards must be demonstrated by any developer planning works within proximity of a Main River or sea/tidal defence within the Local Plan area.

2.2.7 Additional Legislation

Additional legislation relevant to development and flood risk in the study area include:

- The Town and Country Planning Act (1990) and the Water Industry Act (1991). These set out the roles and responsibilities for organisations that have a role in Flood Risk Management (FRM).

- The Localism Act outlines plans to shift and re-distribute the balance of decision making from central government back to councils, communities and individuals. The Localism Act was given Royal Assent on 15 November 2011.
- Other environmental legislation such as the Habitats Directive (1992), Environmental Impact Assessment Directive (2014) and Strategic Environmental Assessment Directive (2001) also apply as appropriate to strategic and site-specific developments to guard against environmental damage.

2.3 Key national, regional and local policy documents and strategies

Table 2-1 summarises key national, regional and local flood risk policy and strategy documents and how these apply to development and flood risk. Hyperlinks are provided to external documents. These documents may:

- provide useful and specific local information to inform Flood Risk Assessments within the local area;
- set the strategic policy and direction for Flood Risk Management (FRM) and drainage – they may contain policies and action plans that set out what future flood mitigation and climate change adaptation plans may affect a development site. A developer should seek to contribute in all instances to the strategic vision for FRM and drainage in Adur and Worthing; and
- provide guidance and/or standards that inform how a developer should assess flood risk and/or design flood mitigation and SuDS.

Table 2-1: National, regional and local key flood risk policy and strategy documents

Document, lead author and date	Relevant direct legislation	Information	Policy and measures	Development design requirements	Next update due
National Flood and Coastal Erosion Management Strategy (Environment Agency) 2020	FWMA (Section 2.2.3)	No	Yes	No	2026
Natural Flood Management Plans (Environment Agency)	N/A	Yes	No	No	-
National Planning Policy Framework (MHCLG) 2023	Planning and Compulsory Purchase Act 2004 as amended & The Town and Country Planning (Local Planning) (England) Regulations 2012 as amended	No	Yes	Yes	-
Planning Practice Guidance (MHCLG) 2022		Yes	No	Yes	-
South East River Basin Management Plan: (Environment Agency) 2022	N/A	No	Yes	No	2028
River Adur Catchment Flood Management Plan (Environment Agency) 2009	N/A	Yes	Yes	No	-
Beachy Head to Selsey Bill Shoreline Management Plan (2006)	N/A	Yes	Yes	No	-
Climate Change guidance for development and flood risk (Environment Agency) 2022	N/A	No	No	Yes	-
Drainage and Wastewater Management Plan (Southern Water)2023	N/A	Yes	Yes	Yes	-
Flood Risk Management Guide (2015)	N/A	Yes	No	Yes	-
Surface Water Management Plan (2015)	N/A	Yes	Yes	No	-
Local Flood Risk Management Strategy (WSCC) 2021-2026. (Draft)	FWMA (Section 2.2.3)	Yes	No	No	Pending

Document, lead author and date	Relevant direct legislation	Information	Policy and measures	Development design requirements	Next update due
West Sussex LLFA Policy for the Management of Surface Water (WSCC) 2018	N/A	Yes	No	Yes	-

2.3.1 The National Flood and Coastal Erosion Risk Management Strategy for England (2020)

The National Flood and Coastal Erosion Risk Management Strategy (FCERM) for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. The Environment Agency brought together a wide range of stakeholders to develop the strategy collaboratively. The Strategy is much more ambitious than the previous one from 2011 and looks ahead to 2100 and the action needed to address the challenge of climate change. A progress update to the Strategy was published in 2022 outlining what had been achieved by 2022 and the roadmap to achieving the goals set out in the Strategy until the year 2026.

The Strategy has been split into 3 high level ambitions: climate resilient places, today's growth and infrastructure resilient in tomorrow's climate and a nation ready to respond and adapt to flooding and coastal change. Measures include updating the national river, coastal and surface water flood risk mapping and the understanding of long term investment needs for flood and coastal infrastructure, trialling new and innovative funding models, flood resilience pilot studies, developing an adaptive approach to the impacts of climate change, seeking nature based solutions towards flooding and erosion issues, integrating natural flood management into the new Environmental Land Management scheme, considering long term adaptive approaches in Local Plans, maximising the opportunities for flood and coastal resilience as part of contributing to environmental net gain for development proposals, investing in flood risk infrastructure that supports sustainable growth, aligning long term strategic planning cycles for flood and coastal work between stakeholders, mainstreaming property flood resilience measures and 'building back better' after flooding, consistent approaches to asset management and record keeping, updating guidance on managing high risk reservoirs in light of climate change, critical infrastructure resilience, education, skills and capacity building, research, innovation and sharing of best practise, supporting communities to plan for flood events, develop world leading ways of reducing the carbon and environmental impact from the construction and operation of flood and coastal defences, development of digital tools to communicate flood risk and transforming the flood warning service and increasing flood response and recovery support.

The Strategy was laid before parliament in July 2020 for formal adoption and published alongside a New National Policy Statement for Flood and Coastal Erosion Risk Management. The statement sets out five key commitments which will accelerate progress to better protect and better prepare the country for the coming years:

1. Upgrading and expanding flood defences and infrastructure across the country,
2. Managing the flow of water to both reduce flood risk and manage drought,
3. Harnessing the power of nature to not only reduce flood risk, but deliver benefits for the environment, nature, and communities,
4. Better preparing communities for when flooding and erosion does occur, and
5. Ensuring every area of England has a comprehensive local plan for dealing with flooding and coastal erosion.

The Flood and Coastal Erosion Risk Management Strategy Roadmap to 2026 describes how the National Flood and Coastal Erosion Risk Management Strategy for England will be translated into practical actions until the year 2026, and what aspirations it hopes to achieve. By defining actions, the Strategy Roadmap supports the government's £5.2 billion Flood and Coastal Erosion Risk Management Investment Programme in decision making for allocating funds.

The Strategy Roadmap also incorporates innovating programmes to improve evidence on the costs and benefits of new resilience actions. Improving the knowledge base will help inform future approaches and investments in flood and coastal risk management. The three programmes which will address this are:

- The Flood and Coastal Resilience Innovation Programme which enables local authorities, businesses and communities to test and demonstrate innovative actions.
- The Adaptive Pathways Programme which develops long term investment plans for managing flood and coastal change to 2100 and beyond.
- The Coastal Transition Accelerators Programme which supports communities in areas at significant risk of coastal erosion to transition and adapt to changing climate.

The Strategy Roadmap describes a cross-disciplinary, multi-organisational approach to assessing and addressing flood and coastal erosion risk in England, including the funding structures, and with sensitivity to sustainability and the environment.

2.3.2 Natural Flood Management (NFM) Plans

The Environment Agency has developed Natural Flood Management (NFM) mapping which displays opportunities for NFM. These maps are to be used as a guide and supplemented with local knowledge to provide a starting point for discussions about NFM. NFM aims to protect, restore and emulate the natural functions of catchments, floodplains, rivers and the coast. NFM should be used on a catchment wide scale and is the linking of blue and green infrastructure.

The maps identify NFM opportunities on different catchment scales:

- National River Basin Districts
- River Basin Districts showing Management Catchments
- Management Catchments showing Water Body Catchments
- Water Body Catchments

These catchments cross boundaries between the Adur and Worthing Local Plan areas and other neighbouring authorities. Discussions about NFM should be had with catchment stakeholders in combination with local knowledge. West Sussex County Council as the LLFA has an NFM lead officer and it is recommended that they are contacted to promote collaborative working.

2.3.3 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the Water Framework Directive (WFD) and assess the pressure facing the water environment in River Basin Districts. The Adur and Worthing Local Plan area falls within the South East River Basin District RBMP (2022).

The plan provides a summary of programmes of measures that help prevent deterioration to protect and improve the beneficial use of the water environment in the river basin district.

Measures are presented for each significant water management issue in the river basin district which are:

- Physical modifications
- Managing pollution from wastewater
- Managing pollution from towns, cities and transport
- Changes to natural flow and levels of water
- Managing invasive non-native species
- Managing pollution from rural areas

2.3.4 Flood Risk Management Plans

Under the Regulations, the Environment Agency exercised an 'Exception' in 2011 and did not prepare a PFRA for risk from rivers, reservoirs and the sea. This then made it a requirement for the Environment Agency to prepare and publish a Flood Risk Management Plan (FRMP). The FRMP process adopts the same catchments as used in the preparation of River Basin Management Plans, in accordance with the Water Framework Directive.

Accordingly, more detailed strategic information on proposed strategic measures and approaches can be found in the South East River Basin District Flood Risk Management Plan (FRMP) (2016) – Parts A, B and C. The FRMP draws on previous policies and actions identified in the Catchment Flood Management Plans and also incorporates information from Local Flood Risk Management Strategies.

The Worthing Local Plan area lies within the Adur and Ouse and the Arun and Western Streams Management Catchment Areas, while the Adur Local Plan area is solely within the Adur and Ouse Management Catchment Area. The FRMP summarises the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations.

2.3.5 Catchment Flood Management Plans

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

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

The Local Plan area is covered by the River Adur Catchment Flood Management Plan (2009). The primary policy units for the area are:

- Policy 3 – Worthing / Brighton and Hove. Areas of low to moderate flood risk where existing risk is generally being managed effectively
- Policy 4 – Shoreham and Adur Estuary. Areas low, moderate or high flood risk where existing risk is generally being managed effectively but further actions may be needed due to climate change
- Policy 6 – Adur Valley / Adur South Downs West / Adur South Downs East. Areas of low to moderate flood risk where other people and groups will be worked with to manage landscapes in locations that provide overall flood risk reductions or environmental benefits.

2.3.6 Shoreline Management Plans

The Shoreline Management Plan (SMP) forms part of Defra's strategy for flood and coastal defence. It provides a large-scale assessment of risks associated with coastal evolution and presents the policy framework to address these risks in a sustainable manner. The SMP policies defined by DEFRA are:

- **Hold the line** – maintain or upgrade the level of protection provided by defences.
- **Advance the line** – build new defences seaward of the existing defence line.
- **Managed realignment** – allowing retreat of the shoreline, with management to control or limit the movement.
- **No active intervention** – a decision not to invest in providing or maintaining defences.

Not all policies are guaranteed funding and over time the Environment Agency along with other partners will identify the cost. The SMPs are currently undergoing a refresh.

The Beachy Head to Selsey Bill Shoreline Management Plan (2006) covers the length of the coastline in the Adur and Worthing Local Plan areas, and sets out to define flood risk in this area, identify policies which can be utilised to best manage these risks, and use these policies to inform future development across the coastline. The preferred policy selected for the entirety of the Beachy Head to Selsey Bill area is to 'Hold the Line'.

2.3.7 Coastal defence strategies

Shoreham Harbour Flood Risk Management Guide (2015)

The Shoreham Harbour Flood Risk Management Guide (SPD) was created as part of the evidence base for the Shoreham Harbour Joint Area Action Plan (JAAP) which is a 15-year regeneration plan for the harbour area. The SPD will help developers to demonstrate through the planning process that new development will be safe for its lifetime; that flood

risk has not been increased elsewhere as a result of new development; and that wherever possible, flood risk overall has been reduced.

Rivers Arun to Adur flood and erosion management strategy 2010-2020 (2010)

The Rivers Arun to Adur flood and erosion management strategy 2010-2020 (2010) covers the Local Plan areas between Ferring and the Shoreham Port lock gates. The strategy details the planned works and management approaches that will be used to achieve the 'Hold the Line' strategy at Goring, Worthing, Brooklands and Shoreham by Sea. The Environment Agency has now begun to implement the recommended options.

Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review (2014)

The Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy Review (2014) includes coastline managed by Adur District within Shoreham Lock and east of the mouth of the River Adur to the boundary with Brighton & Hove City Council. The strategy details proposals to increase the standard of flood protection in the Adur District Council area by improving existing defences, including information on the planned management options and the associated costs. The initial phase of improvements began in 2020.

2.3.8 West Sussex Local Flood Risk Management Strategy

The West Sussex Local Flood Risk Management Strategy was published in 2013. The Strategy sets out how West Sussex County Council will manage local flood risk i.e. from surface water runoff, groundwater and ordinary watercourses, for which they have a responsibility as LLFA and the work that other Risk Management Authorities are doing to manage flood risk in the County.

The Strategy sets out four objectives to guide local focus and progress, which are to:

- Understand the areas that flood
- Manage the flood risk in West Sussex
- Enable people, communities, business and public bodies to work together more effectively and;
- Put communities at the heart of what we do and help West Sussex residents during flood events and recover as quickly as possible after incidents.

2.3.9 West Sussex LLFA Policy for the Management of Surface Water

On 18 December 2014 a Written Ministerial Statement laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply for major development from 6 April 2015.

Major developments are defined as:

- Residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and

- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of 1 hectare or more.

When considering planning applications, Local Planning Authorities should consult the LLFA on the management of surface water so that:

- the proposed minimum standards of operation are appropriate.
- there are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

As LLFA, WSCC is responsible for local flood risk, which involves flooding from surface water, groundwater and ordinary watercourses. The West Sussex LLFA Policy for the Management of Surface Water outlines the requirements that WSCC has for SuDS Design Specification and Implementation Strategies and surface water management provisions, relating to development applications.

2.3.10 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

One Surface Water Management Plan (SWMP) has been completed within the Local Plan areas which is summarised below. The outcomes and actions from this SWMP should be considered in the context of proposed developments within the study area.

Lancing Surface Water Management Plan (2015)

The Lancing Surface Water Management Plan (2015) was developed as part of a commission by WSCC, which involved producing SWMPs for five areas with a significant history of flooding in West Sussex. The plan identifies locations at risk of flooding in Lancing, summarising the causes and impacts associated with flood events. The plan then outlines potential actions and measures for managing the identified flood risks at several locations in Lancing, detailing the costs and benefits of different potential options. The actions identified include short-term approaches and 'quick wins', as well as longer term approaches requiring monitoring and maintenance.

2.3.11 Southern Water Drainage and Wastewater Management Plans

Required as per the 2021 Environment Act, Drainage and Wastewater Management Plans (DWMPs) are strategic documents produced by sewerage undertakers. They consider current and future sewerage capacity, sewerage pressures and risks to sewerage networks

including climate change and population groups. Southern Water's DWMP was published in May 2023.

A review of the DWMP has been completed as part of this SFRA.

3 Planning policy for flood risk management

3.1 National Planning Policy Framework and Guidance

The revised National Planning Policy Framework (NPPF) was published in February 2019 (and subsequently amended in December 2023), replacing the previous versions published in July 2018 and March 2012. The NPPF sets out Government's planning policies for England. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions. The NPPF defines Flood Zones, how these should be used to allocate land and flood risk assessment requirements. The NPPF states that:

"Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards"

Planning Practice Guidance (PPG) on flood risk was published in March 2014 and was updated in August 2022 and sets out how the NPPF should be implemented. Diagram 1 in the PPG sets out how flood risk should be considered in the preparation of Local Plans.

3.2 The risk-based approach

National policy advocates a risk-based approach; this approach is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas, where possible. In the long term this will strategically reduce the reliance on flood risk management measures and avoid commitment to the long-term investment required to maintain measures and appropriate standards of safety under climate change conditions.

When drawing up a Local Plan, it is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps, which show the extent of fluvial and/or tidal inundation without the presence of defences, are too simplistic. Thus, a greater understanding of the scale and nature of the actual flood risks is required as the Flood Zones do not take account of the effect of flood risk management measures or flood risk from other sources such as surface water or groundwater.

3.2.1 The Flood Zones

Maps of Flood Zones are used in this SFRA to illustrate the land at risk of fluvial and/or tidal flooding if there were no defences present. The NPPF Flood Risk and Coastal Change Guidance identifies four main Flood Zones, which apply to both Main River and Ordinary Watercourses. The four main Flood Zones are summarised below:

- **Flood Zone 1 (low probability):** Land having a less than 0.1% annual probability of river or sea flooding. All land uses are appropriate in this zone. For development proposals on sites comprising one hectare or above, the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
- **Flood Zone 2 (medium probability):** Land having between a 1% and 0.1% annual probability of river flooding; or having land between a 0.5% and 0.1% annual probability of sea flooding. Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) are appropriate in this zone. Highly vulnerable land uses are permitted provided they pass the Exception Test. All developments in this zone require an FRA.
- **Flood Zone 3a (high probability):** Land having between 1% or greater annual probability of river flooding; or land having a 0.5% or greater annual probability of sea flooding. Developers and the local authorities should seek to reduce the overall level of flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage. Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable land uses and essential infrastructure are only permitted if they pass the Exception Test. All developments in this zone require an FRA.
- **Flood Zone 3b (functional floodplain):** this zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. They must also be safe for users and not increase flood risk elsewhere. Essential Infrastructure will only be permitted if it passes the Exception Test. Where development is appropriate in this flood zone all applications require an FRA. Functional floodplain will normally comprise:
    - land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or
    - land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).
    - Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

Flood Zone 3b, unlike other Zones, shows flood risk that accounts for the presence of existing flood risk management features and flood defences, as land afforded this standard of protection is not appropriately included as functional flood plain.

3.3 Sequential Test

Firstly, land at the lowest risk of flooding and from all sources should be considered for development. A test is applied called the 'Sequential Test' to do this. Figure 3-1 summarises the Sequential Test. The LPA will apply the Sequential Test to strategic allocations. For all other developments in areas of medium or high flood risk developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test.

The LPA should work with the Environment Agency to define a suitable area of search for the consideration of alternative sites in the Sequential Test. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of a Housing and Economic Land Availability Assessment (HELAA).

Whether any further work is needed to decide if the land is suitable for development will depend on both the vulnerability of the development and the Flood Zone it is proposed for. Table 2 of the PPG shows whether, having applied the Sequential Test first, the vulnerability of development is not compatible with a particular Flood Zone and where the exception test is required to determine the suitability of that vulnerability of development to the flood zone.

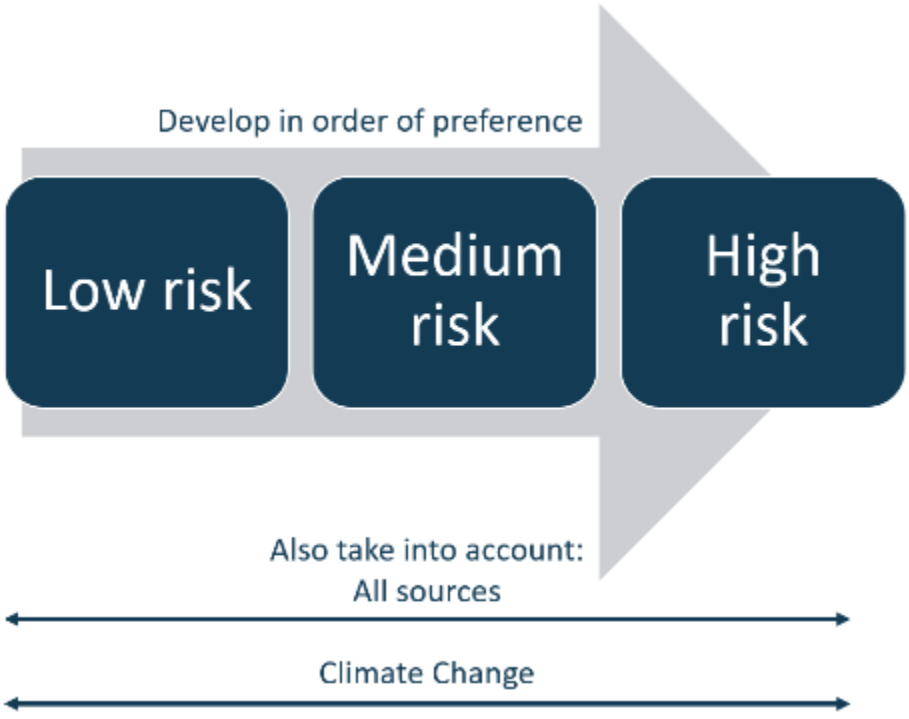
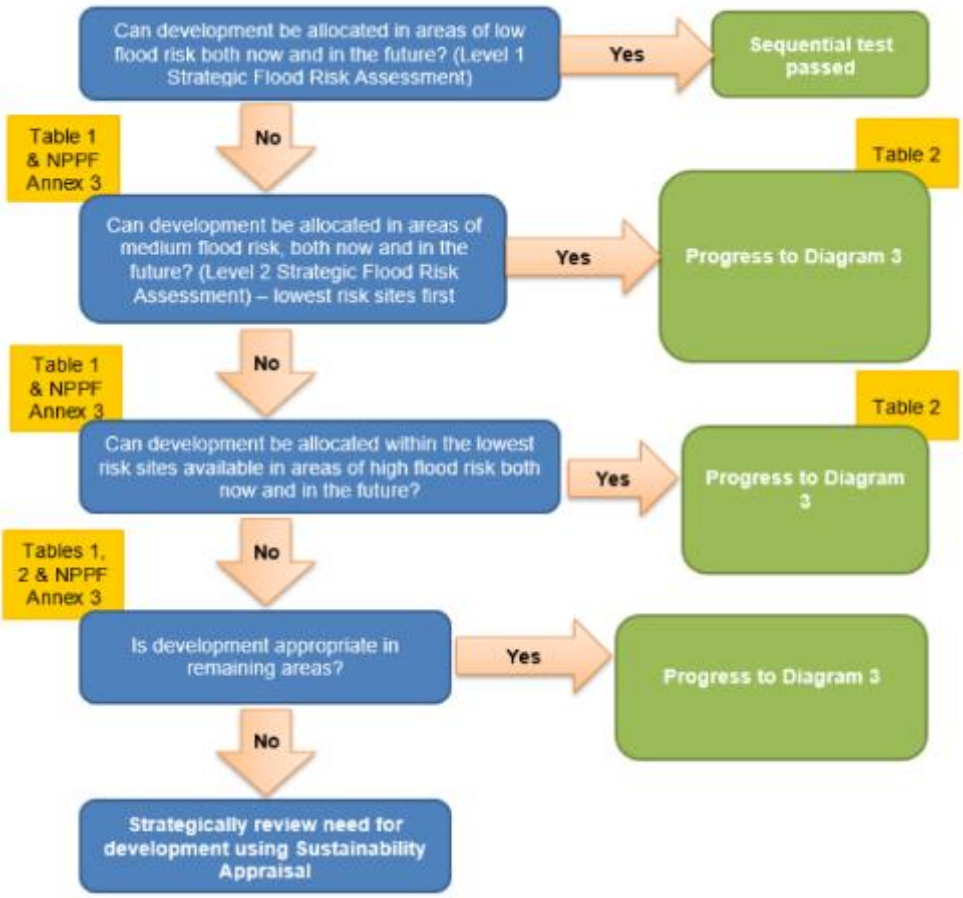


Figure 3-1 The Sequential Test

Figure 3-2 illustrates the Sequential Test as a process flow diagram using the information contained in this SFRA to assess potential development sites against flood zones and development vulnerability compatibilities.

This is a stepwise process, but a challenging one, as a number of the criteria used are qualitative and based on experienced judgement. The process must be documented, and evidence used to support decisions recorded.

In addition, the risk of flooding from other sources and the impact of climate change must be considered when assessing which sites are suitable to allocate.



† Diagram 2 of NPPG: Flood Risk and Coastal Change (paragraph 026, Reference ID 7-026-20220825) Revised August 2022.

Figure 3-2: Application of the Sequential Test for plan preparation

3.4 The Exception Test

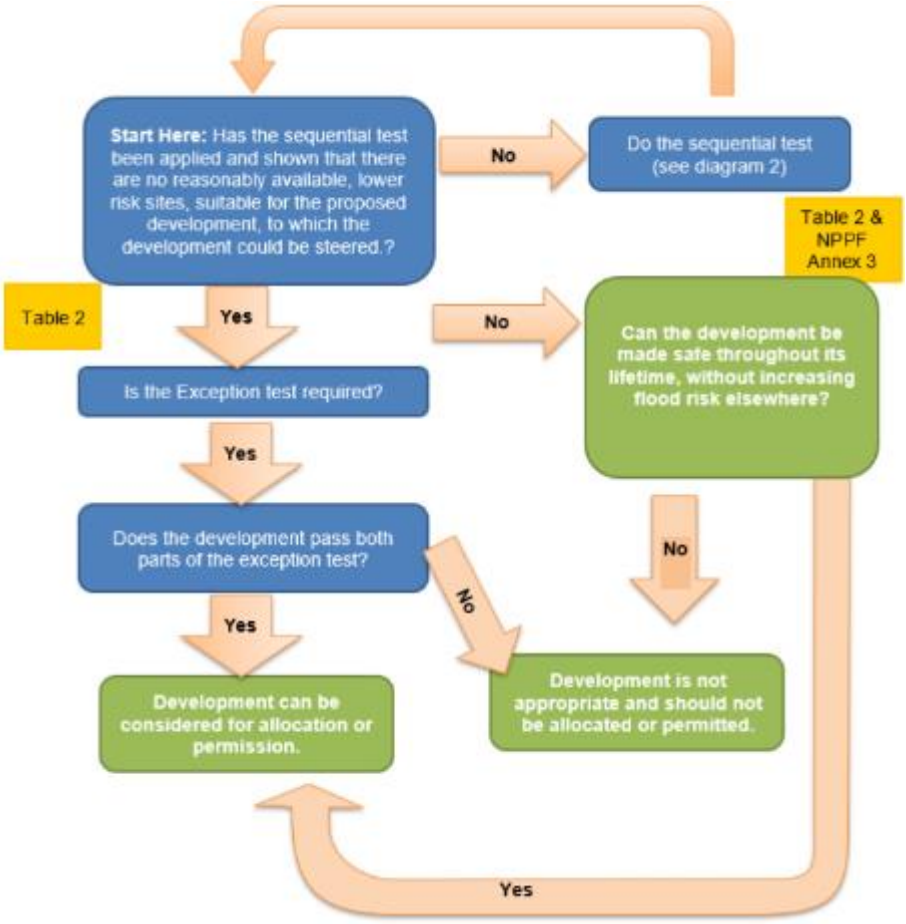
It will not always be possible for all new development to be allocated on land that is not at risk from flooding. To further inform whether land should be allocated, or Planning Permission granted, a greater understanding of the scale and nature of the flood risks is required. In these instances, the Exception Test will be required. Diagram 3 of the PPG (Figure 3-3) summarises the Exception Test.

The Exception Test should only be applied following the application of the Sequential Test. It applies in the following instances:

- Essential infrastructure in Flood Zone 3a or 3b
- More vulnerable in Flood Zone 3a (this is NOT permitted in Flood Zone 3b)

- Highly vulnerable in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b)

An LPA should apply the Exception Test to strategic allocations. For all developments, developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test. This is because when a site-specific Flood Risk Assessment is done, more information on the exact measures that can manage the risk is available.



† Diagram 3 of NPPG: Flood Risk and Coastal Change (paragraph 033, Reference ID 7-033-20220825) Revised August 2022.

Figure 3-3: Application of the Exception Test to plan preparation.

3.5 Cross-boundary considerations

The topography and location of Adur District and Worthing Borough means that there are several watercourses and overland flow routes that cross the boundary of the Local Plan areas. As such, future development, both within and outside the borough and district, can have the potential to affect flood risk to existing development and surrounding areas, depending on the effectiveness of SuDS and drainage implementation.

Figure 3-4 shows the Adur and Worthing boundary area mapped against the topography. The catchments largely drain in from other local authorities. Consequently, development within other local authorities is more likely to have the potential to increase flood risk within Adur and Worthing rather than development within Adur and Worthing itself.

All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing developments comply with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory they should not increase flood risk downstream. An assessment into the cumulative impacts has been made within Section 12.4. This will help ensure there are no incremental increases in flood risk both within and downstream of Adur District and Worthing Borough.

During consultation, Brighton and Hove City Council, South Downs National Park Authority, Horsham District Council and Arun District Council were contacted to gain additional information about any cross-boundary sites or issues that should be considered as part of the SFRA.

3.5.1 Brighton and Hove City Council

Brighton and Hove City Council's adopted City Plan Part 1 site allocations and City Plan Part 2 site allocations can be viewed online within the Adopted Brighton & Hove City Plan Part 2 Adopted Policies Map (west, east) along with policy details within the Adopted City Plan Part 2.

3.5.2 Arun District Council

The Arun Local Plan (2011 – 2031) Adopted July 2018 outlines site allocations within the district. An online interactive Strategic Development District Map details the location of strategic development sites within the district. The Ferring Rife watercourse crosses both Worthing Borough and the Arun District boundary.

3.5.3 South Downs National Park Authority

The South Downs Local Plan was formally adopted by the South Downs National Park Authority on July 2019. It sets out how development will be managed over the period 2014 to 2033. An online Local Plan Policies Map details the location of site allocations.

3.5.4 Horsham District Council

The Horsham District Planning Framework (2015 - 2031) Adopted in 2015 outlines site allocations within the district. An online interactive Mapping Tool details the location of strategic development sites within the district. Cross boundary development sites have not been considered within this assessment since the South Downs National Park sits between the area covered by this SFRA and the Horsham District boundary.

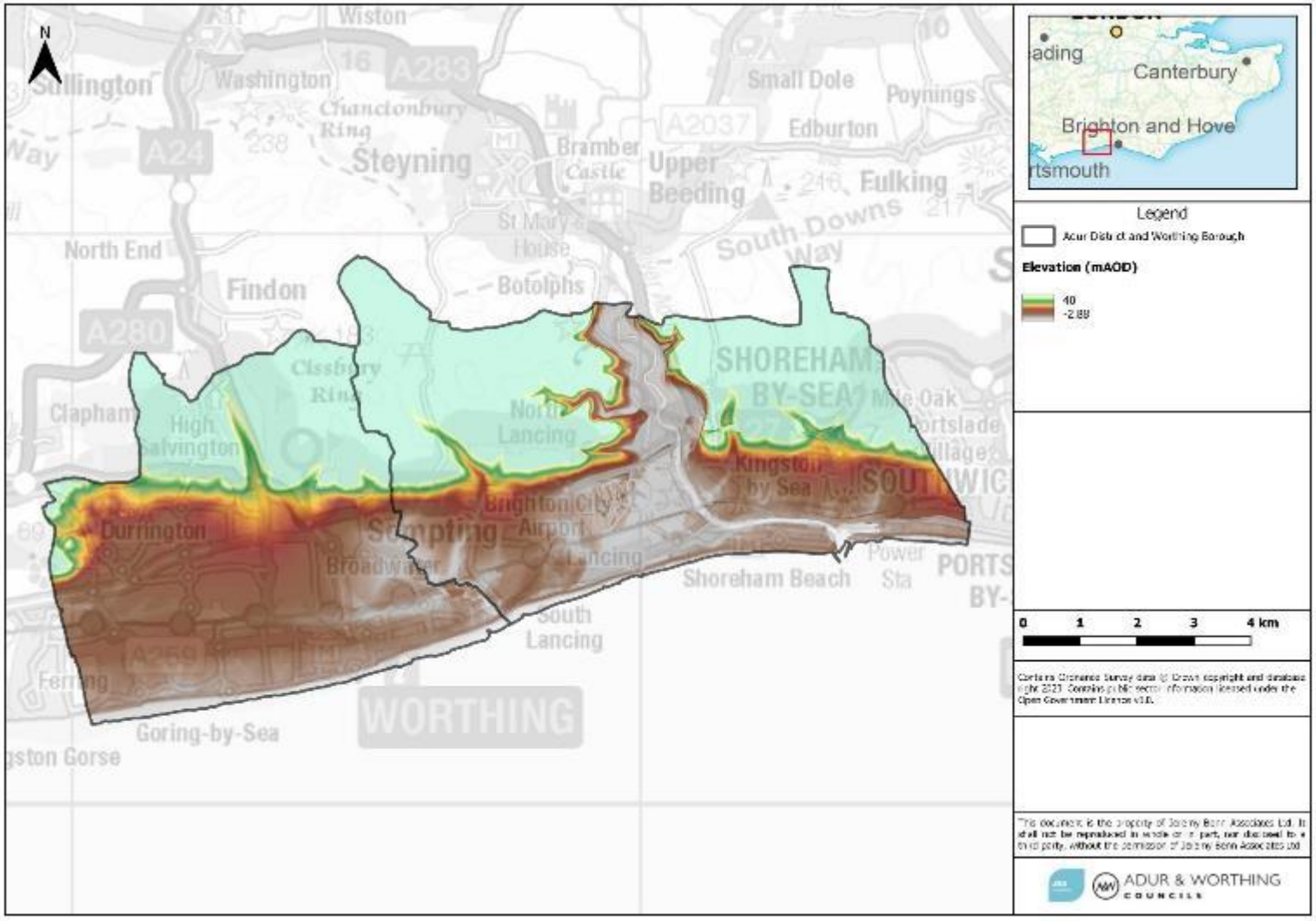


Figure 3-4: Elevation and surrounding river catchments

4 Climate change

4.1 Climate change and the NPPF

The revised NPPF (July 2023) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and PPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

The revised 2023 NPPF also states that the 'sequential approach should be used in areas known to be at risk now or in the future from any form of flooding' (para 162).

4.2 Climate change guidance and allowances

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050. Planning policy and decisions on planning applications have roles in mitigating climate change and adapting to its impacts.

In 2018, the Met Office published new UK Climate Projections (UKCP18). The Environment Agency has since updated their guidance on climate change allowances for tidal (in 2019), river flow (in 2021) and rainfall intensity (in 2022) for new developments. This includes information on how these allowances should be included in both SFRAs and FRAs. The guidance adopts a risk-based approach considering the vulnerability of the development and (in the case of fluvial and rainfall intensity) considers risk allowances on a management catchment level, rather than a river basin level.

Developers should check on the government website for the most recent guidance before undertaking a detailed FRA. To further support this, the Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice.

4.3 Peak river flows

Climate change is expected to increase the frequency, extent and impact of flooding, reflected in peak river flows. Wetter winters and more intense rainfall may increase fluvial flooding and surface water runoff and there may be increased storm intensity in summer. Rising river levels may also increase flood risk.

The peak river flow allowances provided in the guidance show the anticipated changes to peak flow for the management catchment (sub-catchment of river basin districts) within which the subject watercourse is located. Once the management catchment has been identified, guidance on uplift in peak flows are provided for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 95th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the flood zones within which it is located.

These allowances (increases) are provided in the form of figures for the total potential change anticipated, for three climate change periods:

- The '2020s' (2015 to 2039)
- The '2050s' (2040 to 2069)
- The '2080s' (2070 to 2125)

The time period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years, whilst the lifetime of a non-residential development depends upon the characteristics of that development but a period of at least 75 years is likely to form a starting point for assessment. Further information on what is considered to be the lifetime of development is provided in the NPPG.

Land within the Local Plan area is located within the 'Adur and Ouse' and 'Arun and Western Streams' management catchments. Maps showing the extent of the management catchments are published by the Environment Agency.

4.4 Peak river flow allowances for Adur District and Worthing Borough Council

Table 4-1 and Table 4-2 display the peak river flow allowances that apply to the Adur and Ouse Management Catchment and the Arun and Western Streams Management Catchment respectively for fluvial flood risk. Climate change scenarios have been run for relevant fluvial models for the 3.3%, 1% and 0.1% AEP events in line with the PPG requirements to assess high, medium and low risk both now and in the future.

Table 4-1 Peak river flow allowances for the Adur and Ouse Management Catchment

Allowance Category	Total potential change anticipated for the 2020s (2015 to 2039)	Total potential change anticipated for the 2050s (2040 to 2069)	Total potential change anticipated for the 2080s (2070 to 2115)
Upper end	40%	57%	107%
Higher central	23%	28%	55%
Central	16%	18%	37%

Table 4-2 Peak river flow allowances for the Arun and Western Streams Management Catchment

Allowance Category	Total potential change anticipated for the 2020s (2015 to 2039)	Total potential change anticipated for the 2050s (2040 to 2069)	Total potential change anticipated for the 2080s (2070 to 2115)
Upper end	27%	36%	64%
Higher central	16%	19%	36%
Central	11%	13%	25%

4.4.1 Which peak river flow allowance to use?

The Flood Zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. Vulnerability classifications are found in the PPG. The Environment Agency guidance states that both the central and higher central allowances should be assessed in strategic flood risk assessments. Specific guidance for which climate change allowance estimates should be applied can be found in the Environment Agency guidance on climate change allowances. For site specific Flood Risk Assessments, the central allowances should be used in most instances with the exception of 'essential infrastructure' where the guidance is to use the 'higher central' allowance.

Currently there in no guidance on considering the impact of climate change on flood risk to development located within Flood Zone 1.

4.5 Peak rainfall intensity allowance

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems. The Environment Agency have developed a peak rainfall allowances map which shows anticipated changes in peak rainfall intensity which can be used for site-scale applications (like urban drainage design) and surface water flood mapping in small catchments (<5km^2).

The guidance suggests that direct rainfall modelling may not be suited to larger (>5km^2) catchment with rural land use. In these instances, the guidance states that the fluvial flood risk affected by climate change should be assessed using uplifts from peak river flow allowances (Section 4.4).

Adur District and Worthing Borough Council are located within the Adur and Ouse Management Catchment and the Arun and Western Streams Management Catchment for peak rainfall intensity. The Environment Agency's peak rainfall climate change allowances

by management catchment mapping provides the allowances that should be used (Table 4-3 and Table 4-4).

Table 4-3 Peak rainfall intensity allowances for the Adur and Ouse Management Catchment

% Annual Exceedance Probability event	Epoch	Central allowance	Upper end allowance
3.3%	2050s	20%	35%
3.3%	2070s	25%	40%
1%	2050s	20%	45%
1%	2070s	20%	45%

Table 4-4 Peak rainfall intensity allowances for the Arun and Western Streams Management Catchment

% Annual Exceedance Probability event	Epoch	Central allowance	Upper end allowance
3.3%	2050s	20%	35%
3.3%	2070s	25%	40%
1%	2050s	20%	45%
1%	2070s	25%	45%

For this SFRA, the following climate change uplifts have been applied to the Environment Agency Risk of Flooding from Surface Water dataset:

- 3.3% AEP 2070s upper end climate change allowance – 40% uplift
- 1% AEP 2070s upper end climate change allowance – 45% uplift

4.5.1 Which peak rainfall intensity allowance to use?

All rainfall intensity climate change uplifts should be applied to both the 3.3% and 1% AEP events. The recommended epoch and use of either the central or upper end allowances should be based on the design lifetime of the proposed development. Further details are provided within the Environment Agency guidance on climate change allowances. For development with a lifetime beyond 2100 the Upper end allowance should be used. For development with a shorter lifetime the Central allowance can be used.

4.6 Tidal/coastal change

Under all UKCP18 scenarios, sea levels are expected to rise with the greatest increases in the UK being in the South. The flood risk posed by extreme sea levels increased as a direct result of the increasing coastal water levels Rates of increase vary with time and location (Flood and Coastal Erosion Risk Management Research Programme).

The Environment Agency's 2019 sea level allowances have been used in the preparation of this report as confirmed by the Environment Agency. The higher cumulative rise (2000-2125) for the South East is 1.20m.

4.6.1 Which sea level allowance to use?

There are a range of allowances for each river basin district and epoch for sea level rise. The higher central is based on the 70th percentile and the upper end allowances is based on the 95th percentile. For flood risk assessments, assessments of both the higher central and upper end allowances should be undertaken.

4.7 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is much more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months. Where groundwater is tidally influenced, there is likely to be an increase in groundwater elevations with sea level rise that may in turn affect groundwater flood risk. The effect of climate change on groundwater levels for sites in areas where groundwater is known to be an issue should be considered at the planning application stage.

4.8 The impact of climate change in the Local Plan

4.8.1 Previous studies

The UKCP18 provides a number of future projections for different variables across the UK.

South East England

- Increased mean summer temperatures of over 8ºC by 2099.
- Increased mean winter temperatures of up to 7ºC or a decrease of up to 1ºC by 2099.
- Summer rainfall could decrease by over 80% or it could increase up to 10% by 2099.
- Winter rainfall could decrease by up to 10% or it could increase over 60% by 2099.

Whilst changes in trends and mean values is important, the more influential effect of climate change with respect to flood risk and drought is to increase the chance of occurrence and severity of more extreme wet and dry events.

4.8.2 Adapting to climate change

NPPG Climate Change contains information and guidance for how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change. Examples of adapting to climate change include:

- Considering future climate risks when allocating development sites to ensure risks are understood over the development's lifetime.

- Considering the impact of and promoting design responses to flood risk and coastal change for the lifetime of the development.
- Considering availability of water and water infrastructure for the lifetime of the development and design responses to promote water efficiency and protect water quality.
- Promoting adaptation approaches in design policies for developments and the public realm for example by building in flexibility to allow future adaptation if needed, such as setting new development back from watercourses.

At county level, WSCC adopted the Climate Change Strategy 2020-2030 in 2020. This was supplemented by the Climate Change Strategy Delivery Plan which was published in 2021. These two documents outline the pledge by the County Council to reach net zero carbon emissions by 2030. This will be achieved by integrating long term sustainable thinking in to all policies and procedures employed by West Sussex County Council, as well as cutting pollution in the district. Commitments include:

Reducing carbon emissions

Employing climate change resilience and adaptation strategies (including updating flood risk data, improving highways drainage, and developing a tree strategy)

Sourcing and using resources sustainably

Growing the local green economy

These objectives are further supported the West Sussex County Council's Carbon Management Plan which is a detailed report outlining specific actions and policies which will be employed to reach net zero by 2030.

A West Sussex Life report is published annually providing statistics and information about West Sussex that is used by the council when delivering services.

At the local level the Adur Local Plan (2017) and the Worthing Local Plan (2023) outline the policies of the District and Borough for meeting the challenges of climate change. Adur and Worthing Councils have also produced the SustainableAW 2021-23 action plan which identifies a number of actions related to planning and land use. The councils also declared a climate emergency in 2019 and set a target to be carbon neutral by 2030.

5 Sources of information used in preparing the SFRA

5.1 Historic flood risk

The historic flood risk in the Local Plan areas have been assessed using point information of recorded incidents provided by Adur District and Worthing Borough Councils, the Environment Agency's recorded flood outline dataset and Southern Water's Sewer Incident Report Form (SIRF) dataset.

This has been supplemented with other information from the 2020 SFRA, SWMPs, West Sussex County Council's PFRA, LFRMS, Flood Investigation reports and news reports. The key considerations from these sources are outlined in Section 6.1.

5.2 Flood Zones

Flood Zones are based on the undefended scenario with the exception of Flood Zone 3b, which includes the presence of defences on the basis that land behind existing defences is not functional floodplain. The Flood Zones described in this SFRA should be used as the basis for informing updates to the Adur District Local Plan or Worthing Borough Local Plan.

The details of the categories used to define each Flood Zone can be found in section 3.2.

5.2.1 Functional floodplain (Flood Zone 3b) definition

The mapping in the SFRA identifies Flood Zone 3b as land which would flood with a 3.3% chance (Annual Exceedance Probability) in each and every year (a 1 in 30-year return period event), where detailed modelling exists.

Where 3.3% Annual Exceedance Probability (AEP) outputs are not available (the event normally used to represent the functional floodplain / Flood Zone 3b), a precautionary approach has been taken using Flood Zone 3a (1% AEP flood event). The functional flood plain is show in the mapping in Appendix C. Where the precautionary approach has been taken, this area has been mapped as 'Precautionary Flood Zone 3b'. If a proposed development is shown to be within this area, further investigation should be undertaken as part of a detailed site-specific FRA to define and confirm the extent of Flood Zone 3b.

If existing development or infrastructure is shown in Flood Zone 3b, additional consideration should be given to whether the specific location is appropriate for designation as 'functional' with respect to the storage or flow of water in time of flood. For existing private developments have constructed flood walls around their development, where the flood defences are detailed to be above the height of modelled water levels these sites (if known) have been removed from the flood zones.

The effect of wave overtopping along the coastline has been included in the Flood Zone 3b delineation. As a result, in some locations Flood Zone 3b covers a greater area than Flood Zone 3a and Flood Zone 2 where still water levels are used.

Flood Zone mapping for the Local Plan area can be found in Appendix D.

Care should be taken when interpreting how Flood Zone 3b is predicted to change as a consequence of climate change effects, particularly at locations where the risk of flooding is affected by a change to the mean sea level. At such locations it is possible that the assessment performed to estimate the frequency of inundation (3.33% AEP for Flood Zone 3b) will not include an allowance for the potential increase in standard of protection provided by flood risk management features. In these circumstances more detailed assessments should be performed when considering whether development is appropriate to understand the commitment required to improve the standard of protection and how this affects the extent of Flood Zone 3b.

5.3 Flood risk models used in this SFRA

Table 5-1 lists the flood risk modelling used to inform the SFRA.

The most recent version of the Shoreham Adur Tidal Walls model, updated by JBA Consulting in 2018/19 as part of the Shoreham Tidal Walls modelling project, was used to understand flood risk in the Shoreham area. Flood Zone 3b was delineated using the defended 3.3% AEP results for the scenario where the construction of all defences in the Shoreham Tidal Walls project has been completed. The model has been rerun as part of this SFRA. The River Adur Modelling undefended results were used for the delineation of Flood Zones 2 and 3a, as well as mapping the predicted impacts of climate change on flood extents.

Updated modelling of Ferring Rife was undertaken by JBA Consulting for the Environment Agency in 2019/20. As part of this SFRA the model was rerun for the 3.3% defended model run and used to define Flood Zone 3b in this area.

Teville Stream modelling was not available for inclusion within this SFRA. As a result, existing Flood Zones were used as a proxy. When undertaking an FRA, the Environment Agency should be contacted for the most up to date Flood Zone information.

Table 5-1 Flood risk models used in the Level 1 SFRA

Model Name	Year	Software (type)
River Adur (Shoreham Adur Tidal Walls) (Fluvial / Tidal)	2018/19	ISIS/TUFLOW
Teville Stream (Fluvial)	2012	ISIS/TUFLOW
Ferring Rife (Fluvial)	2019/20	ISIS/TUFLOW
Arun to Adur (Coastal / Tidal)	2016	ISIS/TUFLOW/SWAN

5.4 Climate change modelling for fluvial, tidal and coastal flood risk

The Environment Agency climate change guidance shows that for watercourses in the Adur and Ouse Water Management Catchment that the 37% and 55% allowances should be considered. As part of this SFRA, the models were run with these uplifts.

Where there is no fluvial model available, Flood Zone 2 has been used to provide indicative information on the potential effects of climate change. This level of assessment is suitable for a Level 1 SFRA. However, detailed hydraulic modelling using topographic survey would be required at a site-specific level to confirm the flood risk to these sites.

Table 5-2 summarises which datasets have been used to determine future flood risk within Adur and Worthing.

Table 5-2: Summary of modelling datasets used to inform climate change

Climate change datasets	
Ferring Rife	Ferring Rife Fluvial 3.3%, 1% and 0.1% AEP + Central and Higher Central CC
Teville Stream	Flood Zone 2 used as a proxy for future Flood Zone 3
River Adur	Arun-Adur Central and Higher Central, and Shoreham Adur Tidal Walls Higher Central and Upper End

5.5 Surface Water

Mapping of surface water flood risk in the Local Plan areas has been taken from the Risk of Flooding from Surface Water (RoFSW) dataset, published online by the Environment Agency. These maps are intended to provide a consistent standard of assessment for surface water flood risk across England in order to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk. The different surface water risk categories used in the RoFSW mapping are defined in Table 5-3.

The RoFSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water. It is worth noting that Adur and Worthing are known to contain a number of dry valleys that are identified on the RoFSW mapping.

Table 5-3: Surface water risk categories used in the RoFSW mapping

Category	Definition
High	Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year (3.3% AEP)
Medium	Flooding occurring as a result of rainfall of between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP) chance in any given year.
Low	Flooding occurring as a result of rainfall of between 1 in 1,000 (0.1% AEP) and 1 in 100 (1% AEP) chance in any given year.
Very low	Flooding occurring as a result of rainfall with less than 1 in 1,000 (0.1% AEP) chance in any given year.

Although the RoFSW offers an improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be considered to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the RoFSW in partnership with other sources of local flooding information, to confirm the presence of a surface water risk at that particular location.

The RoFSW map for the Local Plan areas can be found in Appendix F.

A Flood Investigation report prepared by West Sussex County Council reviewed the major surface water flood event of June 2012. This report has been referred to in the preparation of this SFRA.

5.5.1 Surface water flood risk with climate change uplifts

JBA has carried out additional modelling to account for the impact of climate change on surface water flood risk in the SFRA study area. Based on the updated 2021 climate change allowances for peak rainfall intensity, the recommended uplifts for the Central and Upper end allowances for the 1% AEP event during the 2070s epoch are 25% and 45% respectively.

Mapping showing the extents of the 1% AEP plus the climate change scenarios can be found in Appendix G.

5.5.2 Impact of sea level rise on surface water

A technical assessment of the impact of sea level rise upon surface water has been conducted as part of the SFRA. Details of the methodology of this is outlined within Appendix H. Criteria used to score the present and future tidally influenced surface water flood risk (Tidal Drainage Risk Zones) is displayed in Table 5-4. Mapping of outputs of this assessment can be found in Appendix I.

Table 5-4: Criteria used to score present day and future tidally influenced surface water flood risk

Score	Criteria used to score and present future risk
SW0	Above the future tidal level
SW1	Not at risk of SW flooding and above the current tidal level but below the future tidal level
SW2	Not at risk of SW flooding but below the present-day tidal level OR at risk of SW flooding from climate change only and above the current day tidal level but below future tidal level
SW3	At risk of SW flooding from climate change only and below the present-day tidal level OR At risk of SW flooding without climate change and above current day tidal level but below future tidal level
SW4	At risk of SW flooding without climate change and below present-day tidal level

5.6 Groundwater

JBA has developed a Groundwater Flood Map product at the national scale. The 5m resolution JBA Groundwater map has been used within the SFRA. The modelling involves simulating groundwater levels for a range of return periods (including 75, 100 and 200-years). Groundwater levels are then compared to ground surface levels to determine the head difference in metres. The JBA Groundwater Map categorises the head difference (m) into five feature classes based on the 100-year model outputs.

It should be noted that the JBA Groundwater Flood Emergence Map is suitable for general broad-scale assessment of the groundwater flood hazard in an area but is not explicitly designed for the assessment of flood hazard at the scale of a single property. The dataset also shows the risk of emergence of groundwater rather than the actual flood risk from groundwater flooding. As a result, in high risk areas a site-specific risk assessment for groundwater flooding is recommended to fully inform the likelihood of flooding. There may also be locations, such as Lancing, where localised ground conditions and features are not fully represented in the mapping. As a result, this should be used in conjunction with any other relevant local information. For this study, the Lancing SWMP has also been used as a source of information on groundwater flood risk.

The JBA Groundwater Map for the Local Plan areas can be found in Appendix J.

5.6.1 Groundwater flood risk – climate change

JBA has carried out a technical assessment of the future impact of sea level rise upon groundwater emergence risk within Adur and Worthing. Details of this methodology is outlined within Appendix H. Criteria used to score the present and future tidally influenced groundwater flood risk (Tidal Groundwater Risk Zones) is displayed in Table 5-5. Mapping of outputs of this assessment can be found in Appendix K.

Table 5-5: Criteria used to score present day and future tidally influenced groundwater flood risk

Zone	Criteria used to score present and future risk
GW0	Above the future tidal level
GW1	Groundwater level more than 0.5m below the surface and region is above the current tidal level but below the future tidal level
GW2	Groundwater level more than 0.5m below the surface and region is below the present-day tidal level OR groundwater level between 0.025m and 0.5m below the surface and region is above the current tidal level but below the future tidal level
GW3	Groundwater level between 0.025m and 0.5m below the surface and region is below the present-day tidal level OR Groundwater level within 0.025m of the surface and region is above the current tidal level but below the future tidal level
GW4	Groundwater level within 0.025m of the surface and region is below the present-day tidal level

5.7 Sewers

Historical incidents of flooding are detailed by Southern Water through their Sewer Incident Report Form (SIRF) Data. This database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons, this data has been supplied on a postcode basis from the SIRF hydraulic overload database for incidents recorded in Adur District and Worthing Borough. The events included are limited to those that are linked to capacity issues.

In May 2023, Southern Water published their DWMP for both the Arun and Western Stream area and the Adur and Ouse area. The DWMP describes the basis for long term investment proposals by Southern Water that span the next 25 years and set out the commitment needed to ensure they’re robust and resilient to future pressures. East Worthing and Shoreham are highlighted as medium areas of concern by Southern Water as part of the Baseline Risk and Vulnerability Assessment (BRAVA) process within the DWMP.

5.8 Reservoirs

The risk of inundation due to reservoir breach or failure of reservoirs within the area has been assessed using the Environment Agency's Reservoir Flood Maps (2021).

The Reservoir Flood Maps describe two reservoir flooding scenarios. A "dry day" scenario and a "wet day" scenario.

The "dry day" scenario shows the predicted flood extents if a reservoir failure were to occur when river levels are at normal levels. The "wet day" scenario shows the predicted flood extents if reservoir failure were to occur when river levels are already high and extreme fluvial flooding is already occurring. The "wet day" scenario is used to demonstrate the combined effect of fluvial and reservoir flooding due to the potential probability of reservoir failure occurring due to extreme rainfall.

Analysis of the datasets found no areas at risk within Adur and Worthing.

5.8.1 Somerset's Lake

Somersets Lake is a raised reservoir located in West Durrington, Worthing. The lake is situated west of Fulbeck Avenue, and east of Titnore Lane. Somerset's lake was constructed in the 1940s as a fishing amenity lake.

A high-level assessment of the lake's capacity has been carried out as part of this SFRA using survey cross sections of the lake and upstream watercourses to determine storage capacity of the lake (between the minimum outlet level and the embankment crest level).

Using this information, the storage capacity of Somerset's Lake has been estimated to be approximately 14,500m^3, meaning it is not defined as a large raised reservoir under the 1975 Reservoirs Act (i.e. a structure with a capacity of over 25,000 m^3). However, the impact of failure of this structure would be significant and therefore any future development proposals downstream of the lake should give consideration to the residual risks. Mapping for a breach at the southern end of Somerset Lake for a wet day and dry day scenario is included in Figure 5-1

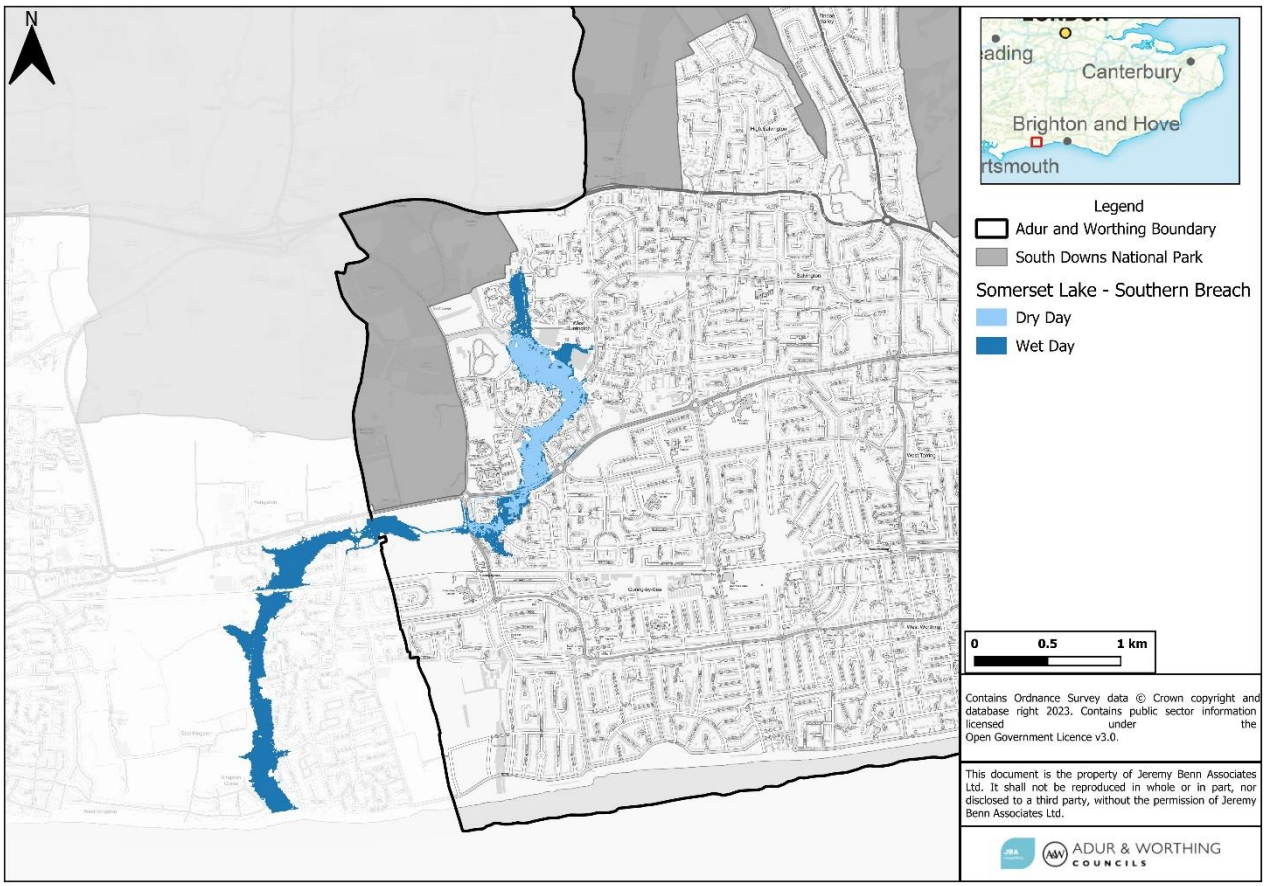


Figure 5-1: Flood extent following a breach at the southern end of Somerset Lake in wet day and dry day scenario

5.9 Suite of maps

All the mapping can be found in the appendices to this SFRA. These are presented in the following structure:

- Appendix A: Historic Flooding
- Appendix B: Adur and Worthing Watercourses
- Appendix C: Flood Zone 3b
- Appendix D: Flood Zone Mapping
- Appendix E: Fluvial and Tidal Flood Risk Mapping with Climate Change allowances
- Appendix F: Risk of Flooding from Surface Water
- Appendix G: Surface Water flooding with Climate Change allowances applied
- Appendix H: Tidal Risk Zones Methodology
- Appendix I: Surface Water Tidal Risk Zones
- Appendix J: JBA Groundwater Mapping
- Appendix K: Groundwater Tidal Risk Zones
- Appendix L: Defences
- Appendix M: Flood Alert and Warning Areas
- Appendix N: Site Screening Spreadsheet

5.10 Other relevant information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. This information includes:

Lancing Surface Water Management Plan – see 2.3.10 for details

River Adur Catchment Flood Management Plan – see 2.3.5 for details

West Sussex Local Flood Risk Management Strategy (2013) – see 2.3.8 for details

South East River Basin District Flood Risk Management Plan (2016) – see 0 for details

Beachy Head to Selsey Bill Shoreline Management Plan (2006) – see2.3.6for details

6 Understanding flood risk in the Local Plan areas

6.1 Historical flooding

The Local Plan areas have a long history of recorded flood events caused by multiple sources of flooding. The most notable flooding incidents occurred in 1980, 2000, 2007, 2012 and the winter of 2013/14.

Information collated from the Environment Agency's recorded flood outlines, WSCC's recorded flood incidents and Southern Water's SIRF datasets were assessed to understand the historic flooding the Local Plan areas. The data shows surface water flooding is the most frequent cause of flooding within Adur District and Worthing Borough, with recorded incidents in Worthing, Goring, Durrington, Salvington, Lancing, Shoreham and Southwick.

Lancing and Shoreham have been susceptible to tidal flooding in the past due to the overtopping of coastal defences. Fluvial flood events have been recorded along the River Adur, Teville Stream and Ferring Rife, with flooding from Ordinary Watercourses also reported.

Groundwater flooding has been recorded in Sompting, North Lancing and Durrington. There have been several recorded incidents of sewer flooding across the Local Plan areas, with Durrington, Salvington and Lancing some of the most frequently affected areas.

This information was supplemented by information collected from the 2012 SFRA, SWMPs, and West Sussex County Council's PFRA, LFRMS, Flood Investigation reports and news reports.

The key historical incidents of flooding identified are summarised as follows:

- **October 1980** – Surface water flooding following intense rainfall led to widespread flooding in Durrington and Worthing, impacting gardens, roads and 488 properties[1].
- **October 2000** – Surface water flooding of around 20 commercial properties in Worthing Town Centre due to surface water and highway drainage systems being overwhelmed by intense rainfall[1].
- **June 2007** – Widespread surface water flooding in Worthing following 4 inches of rain within one hour, impacting properties including Worthing hospital[1].
- **June 2012** – An extreme rainfall event resulted in widespread surface water flooding across West Sussex, with Flood Alerts issued for the River Adur. Worthing was one of the worst affected areas, with two clusters of properties in West Worthing and Central Worthing affected by the flooding[2].

[1] West Sussex County Council, West Sussex Preliminary Flood Risk Assessment, 2011. Available: https://www.westsussex.gov.uk/media/1626/west_sussex_pfra.pdf
[2] West Sussex County Council, Report on June 2012 Flood Event, 2012. Available: https://www.westsussex.gov.uk/media/1623/final_report.pdf

- **Winter 2013/14** – Flooding was reported across the Local Plan areas during a particularly wet winter. A small number of properties were impacted in Lancing, as well as the A27 and Shoreham Airport[3].

Appendix A shows the recorded historic flood points and historic flood events provided by WSCC and the Environment Agency respectively. WSCC data only includes flood events prior to 2020. Not all the historic data provided had a source of flooding and was therefore classified as 'Unknown'. Additionally, not all the data provided had dates or a description of flooding recorded.

6.1.1 West Sussex County Council June 2012 Flood Investigation Report

A Flood Investigation Report reviewing the major flood event in June 2012 across West Sussex was prepared by West Sussex County Council in November 2012. The report identifies the event as a 1 in 200-year event (0.5% AEP) that overwhelmed the drainage network, resulting in widespread surface water flooding. Worthing was one of the worst affected areas, with 19 properties in West Worthing and 17 properties in Central Worthing affected by flooding. Just one property in Adur District in Southwick was reported to have been affected.

6.2 Topography, geology and soils

Adur District Council and Worthing Borough Council cover an area of approximately 77km^2, with a population of approximately 176,000. The South Downs National Park covers a proportion of the SFRA study area (roughly 23km^2 of Adur District and 8km^2 of Worthing Borough) which is excluded from the Local Plan areas. The largest settlements in the Local Plan areas are Worthing, Shoreham and Lancing.

6.2.1 Topography

As shown in Figure 3-4, the topography of the Local Plan areas comprises low-lying ground in the south running along the coast and areas of higher elevations in the north. The South Downs runs along much of the north of Adur District and Worthing Borough, wherein the highest elevation is approximately 184m AOD at Cissbury Ring. The majority of the Local Plan areas are low-lying, with much of the land located below 10m AOD.

6.2.2 Geology and soils

The geology of a catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

Figure 6-1and Figure 6-2 show the bedrock (solid permeable) formations and the superficial deposits (permeable, unconsolidated) in the Local Plan areas respectively.

[3] CH2M, Lancing Surface Water Management Plan, 2015. Available: https://www.westsussex.gov.uk/media/6139/lancing_swmp_final_technical_report.pdf

The bedrock layers and superficial deposits are identified as being aquifers that are classified as follows and are shown in Figure 6-3 and Figure 6-4 respectively:

Principal: layers of rock or drift deposits with high permeability and, therefore, provide a high level of water storage

Secondary A: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers

Secondary B: lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater

Secondary undifferentiated: rock types which do not fit into either category A or B.

Unproductive Strata: rock layers and drift deposits with low permeability and, therefore, have a negligible impact on water supply or river base flow.

The bedrock geology in the Local Plan areas is classified as a mixture of Principal and Secondary A aquifers and unproductive strata.

The superficial deposits in the study area are classified as Secondary B and Secondary (undifferentiated) aquifers, with smaller areas of Secondary A aquifers and unproductive deposits.

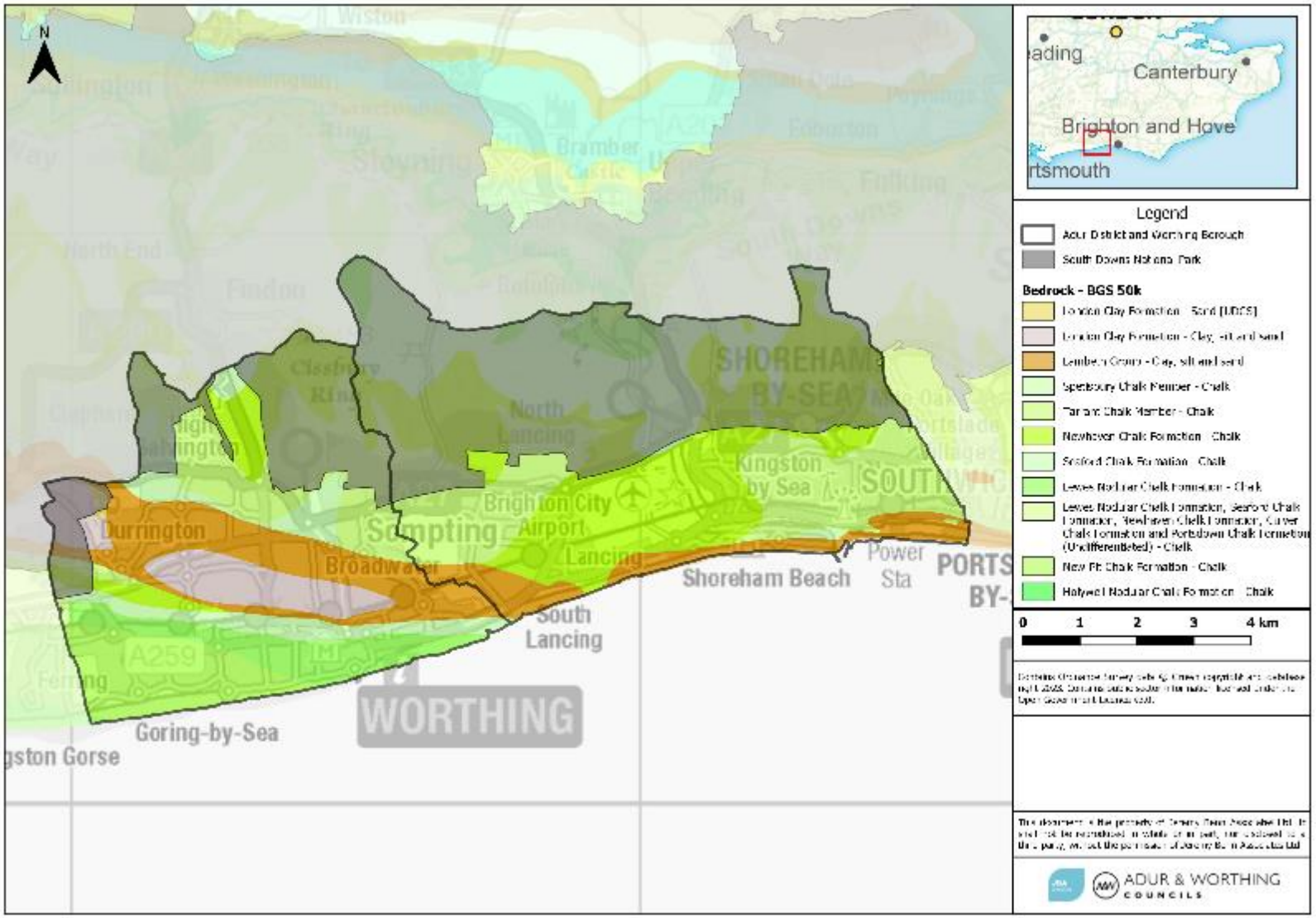


Figure 6-1 Bedrock geology in the Local Plan areas

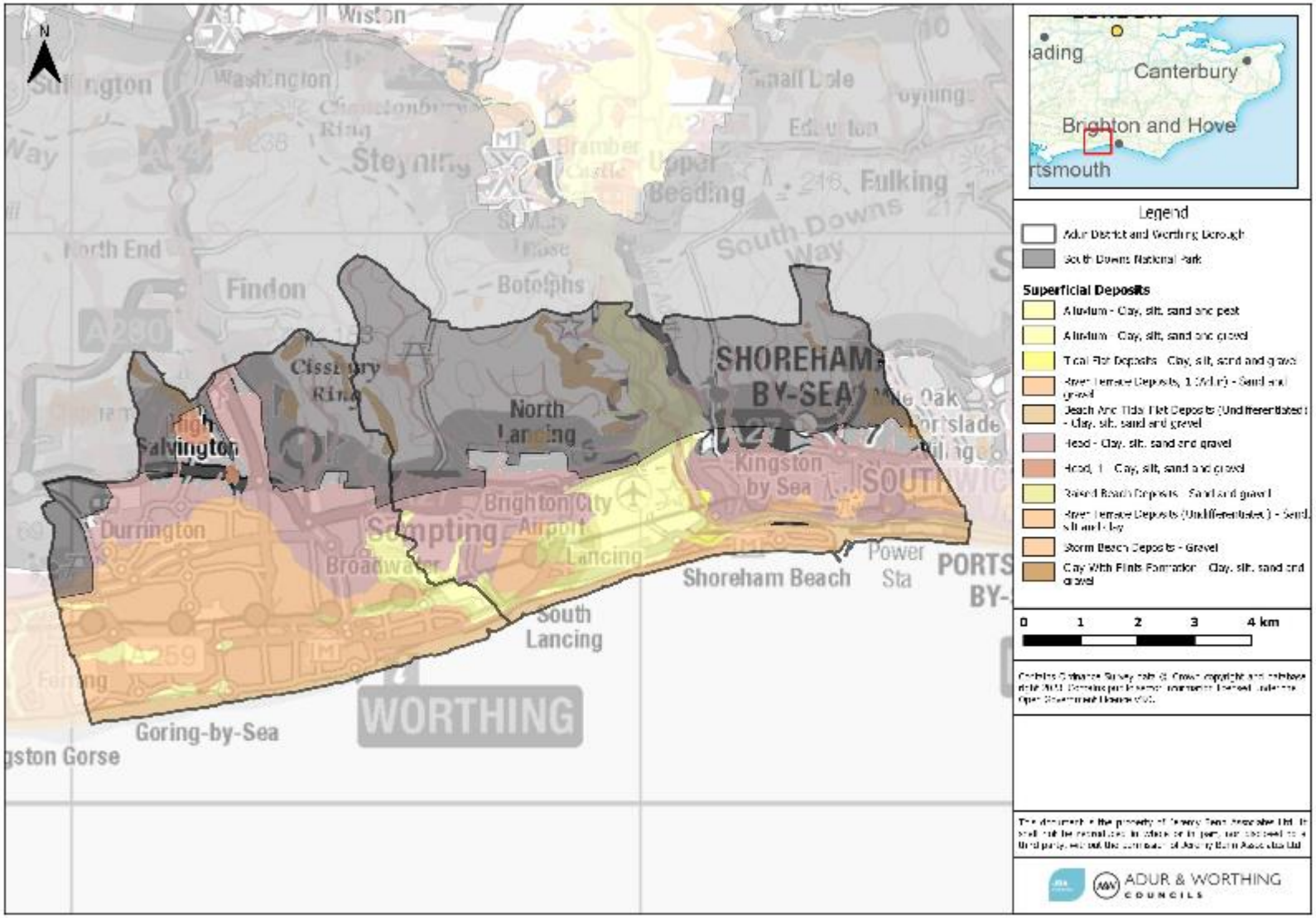


Figure 6-2 Superficial deposits in the Local Plan areas

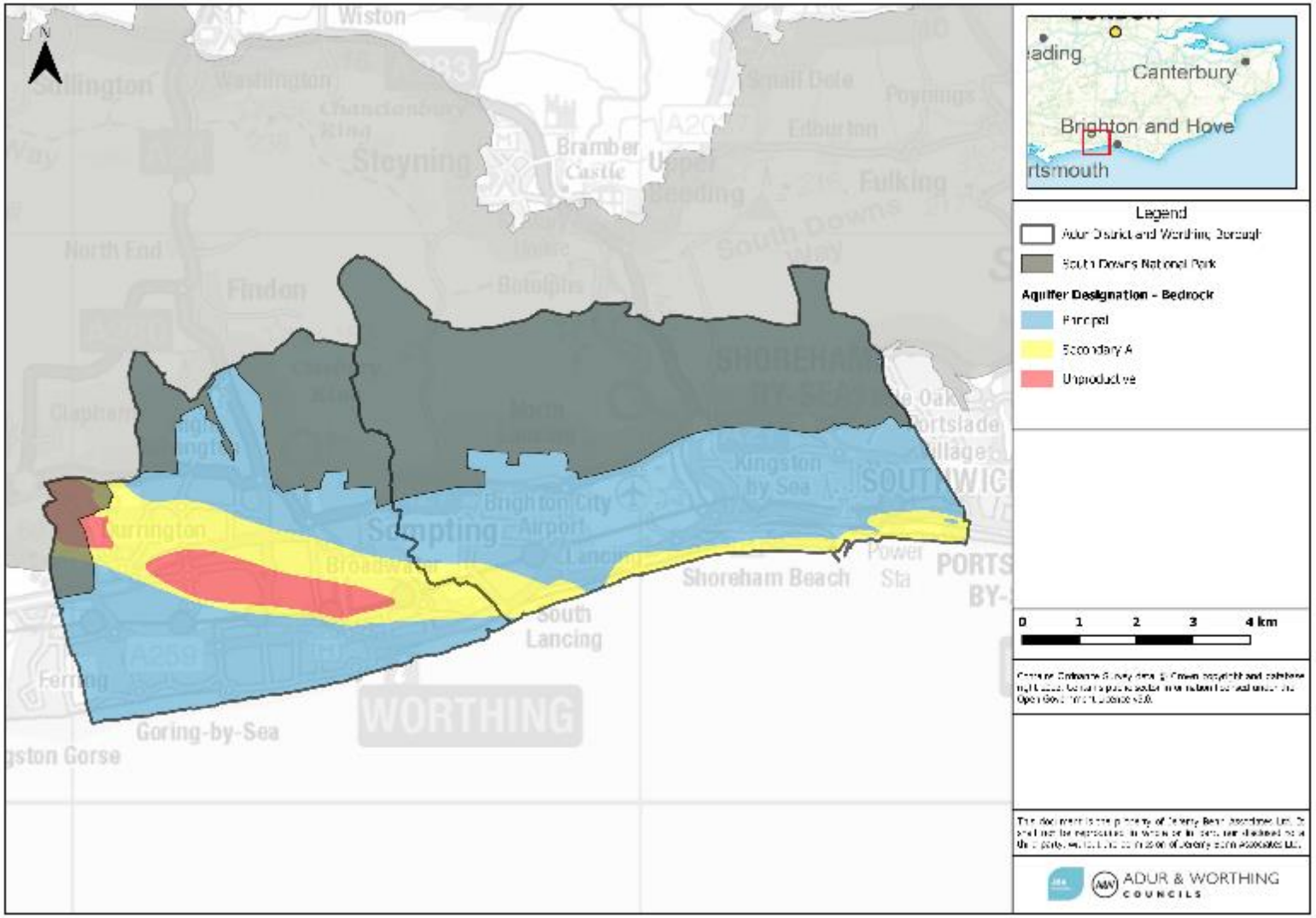


Figure 6-3 Bedrock aquifer designations in the Local Plan areas

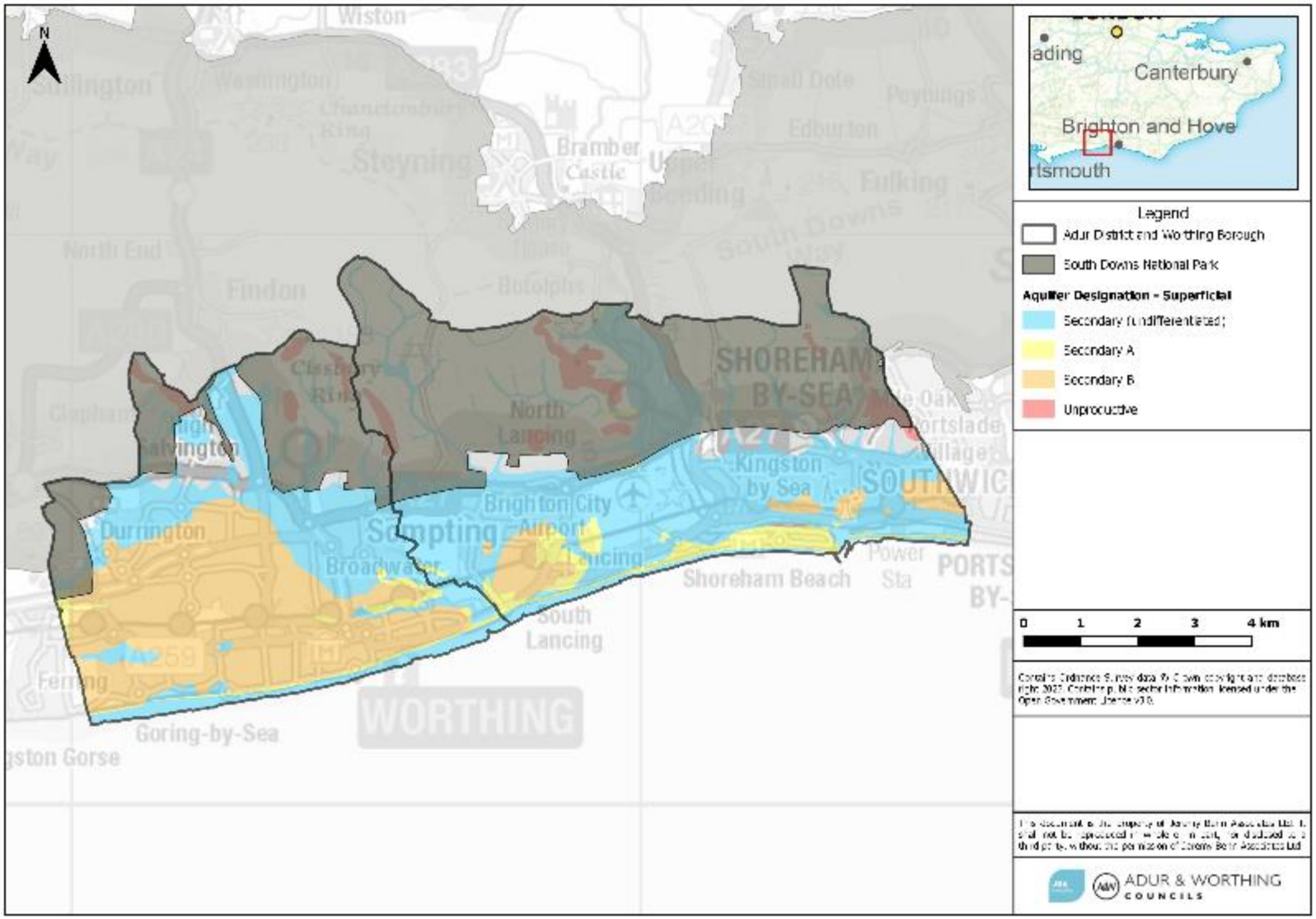


Figure 6-4 Superficial aquifer designations in the Local Plan areas

6.2.3 Watercourses

The largest watercourse flowing through the Local Plan areas is the River Adur, which enters the north of Adur District flowing south and east through Shoreham by Sea where it enters the English Channel. There are two smaller principal watercourses in the study area, Teville Stream and Ferring Rife.

A summary of the main watercourses in the Local Plan areas is provided below in Table 6-1. Mapping indicating the location of the Main Rivers and Ordinary Watercourses can be found in Appendix B.

Table 6-1: Watercourses in the study area

Watercourse	Description
Adur	
Teville Stream	Teville Stream runs along the border of Adur District and Worthing Borough, flowing south and entering the English Channel between East Worthing and Lancing.
Ferring Rife	

6.3 Fluvial flood risk

There have been no major fluvial flood events recorded in the Local Plan areas, with the West Sussex County Council LFRMS report stating that flooding from the River Adur is unlikely to be caused solely by rainfall, though has the potential to be significant if an event coincides with high tides[4].

Flooding around Teville Stream and Ferring Rife generally occurs concurrently with surface water flooding as a rapid response to extreme rainfall events, as with the June 2012 flood event where surface water flooding occurred over and along the route of Teville Stream[2].

Flooding on the lower River Adur, Teville Stream and Ferring Rife is influenced by tidal levels[5], with the potential for tidal locking to occur where incoming high tides prevent fluvial flows from discharging into the sea.

Additionally, flooding from Ordinary Watercourses has reportedly affected the Amberley Drive and Aldsworth Avenue area of Goring[6].

[4] West Sussex County Council, Local Flood Risk Management Strategy, 2014. Available: https://www.westsussex.gov.uk/media/1595/local_flood_risk_management_strategy.pdf
[5] Environment Agency, River Adur Catchment Flood Management Plan, 2009. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/293867/Adur_Catchment_Flood_Management_Plan.pdf
[6] AECOM, Worthing Surface Water Management Plan – Unadopted, 2012.

The key areas at fluvial flood risk are summarised in Table 6-2, with high risk locations in each ward identified in Table 6-5.

Table 6-2: Areas at risk of fluvial flooding

Area	Source of fluvial flood risk
Shoreham	River Adur
Lancing	Teville Stream
East Worthing	Teville Stream
Durrington	Ferring Rife
Goring	Ferring Rife / Ordinary watercourses

6.4 Tidal flood risk

Tidal flooding is caused by extreme tide levels exceeding ground and / or defence levels. The tidal flood risk to the Local Plan areas has been based on the River Adur Tidal model and the Arun to Adur Coastal model. Flood Zone mapping can be found in Appendix D and the effects of climate change can be found in Appendix E.

The Local Plan areas are bounded to the south by the English Channel. As such, the coastline is at risk of tidal flooding, though the WSCC LFRMS states that tidal flooding is rare within Worthing Borough[4]. High risk locations within the wards at risk of tidal flooding are identified in Table 6-5.

The watercourses mentioned in Table 6-1 are all at risk of tidal flooding in their lower reaches.

6.4.1 Wave overtopping

Tidal flood risk along much of the Adur District and Worthing Borough coastlines is characterised by the presence of risk associated with wave overtopping of defences. Areas at risk of wave overtopping include the Old Fort Road area of Shoreham and Marine Crescent, West Parade and Marine Parade in Worthing.

6.5 Coastal flood risk

In coastal locations the risk of flooding is linked to the stability of the coastline. If the coast is eroding, then the potential effect is that tidal flood defences near to the sea will be lost and flood risk will increase. To maintain an appropriate standard of safety from flooding it is sometimes necessary to implement works to slow down or stop the rate of coastal erosion and so maintain the integrity of the tidal defences.

The current long-term plan for the length of the coastline within the Local Plan areas is to 'Hold the Line', with works proposed to manage and mitigate the risk of coastal erosion and flooding[7]. Currently, there are a total of 9,800 properties at risk of flooding and erosion along the coast between the River Arun and River Adur, with locations at risk within the Local Plan areas including Goring, Worthing, Brooklands, Shoreham by Sea and the River

[7] Beachy Head to Selsey Bill Shoreline Management Plan, 2006. Available: https://se-coastalgroup.org.uk/shoreline-management-plans/beachy-head-to-selsey-bill/

Adur[8]. Additionally, Shoreham Lock and the eastern side of the mouth of the River Adur are at risk of flooding and erosion, with a large number of commercial and residential properties at increased risk due to climate change[9].

6.6 Surface water flood risk

Surface water flooding poses the greatest risk to properties in Worthing, Shoreham, Lancing and Sompting[4]. Within Adur District, surface water flooding caused by runoff from the South Downs can impact properties in Bramber, Lancing, Sompting, Shoreham Airport and the West Beach Estate[10]. Worthing is also identified as being at high risk of surface water flooding due to the high level of urbanisation and the prevention of drainage by high tides or groundwater. Surface water flood events within the Local Plan areas are frequent, with recent flooding of roads or properties in Worthing reported in July 2014[11], May 2018[12] and July 2018[13], as well as the major event of June 2012.

Lancing has previously been identified as an area with a particularly significant history of flooding, with surface water flooding occurring during extreme rainfall events (e.g. June 2012) and long wet periods (e.g. Winter 2013/14), largely due to the influence of high groundwater levels and poor maintenance of surface water or highway drainage networks[14].

Tide locking is also an issue where high tides prevent surface water from draining from gravity outfalls along the defended coastal plain.

The Risk of Flooding from Surface Water (RoFSW) map shows predicted flood extents that predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. Mapping of the RoFSW throughout the Local Plan area is provided in Appendix F and high risk areas within each ward are identified in Table 6-5.

[8] River Arun to Adur flood and erosion management strategy 2010-2020, Environment Agency, 2010. Available: https://drive.google.com/file/d/1I7zD4uI-p3Tma84CBbmeSCOGo1sYhSsR/view

[9] Brighton and Hove Council, Brighton Marina to River Adur Flood and Coastal Erosion Risk Management Strategy, 2014. Available: https://www.brighton-hove.gov.uk/sites/brighton-hove.gov.uk/files/Marina%20Adur%20exec%20summary%20v3%20final_0.pdf

[10] Local Flood Risk Management Strategy, West Sussex County Council, 2014. Available: https://www.westsussex.gov.uk/media/1595/local_flood_risk_management_strategy.pdf

[11] BBC News, 'Torrential rain and flash flooding cause travel chaos', 2014. Available: https://www.bbc.co.uk/news/uk-england-sussex-28520520

[12] The Argus, 'Flash floods hit Worthing, Littlehampton and Adur', 2018. Available: https://www.theargus.co.uk/news/16254618.flash-floods-hit-worthing-littlehampton-and-adur/

[13] The Argus, 'Heavy rain causes flash flooding in Brighton and Sussex', 2018. Available: https://www.theargus.co.uk/news/16412272.heavy-rain-causes-flash-flooding-in-brighton-and-sussex/

[14] Lancing Surface Water Management Plan, CH2M, 2015. Available https://www.adur-worthing.gov.uk/media/media,144310,en.pdf

6.6.1 Impact of climate change on surface water flood risk

Mapping showing the extents of the RoFSW 1% AEP event with the rainfall intensities uplifted by 25% and 45% can be found in Appendix G. Areas where predicted flood depths and extents increase in the uplifted scenarios are typically small and restricted to roads. However, there are several areas across Adur District and Worthing Borough that are more sensitive to climate change, where the predicted flood depths and extents increase more notably once rainfall intensities have been uplifted. Table 6-3 details some examples of the locations that are identified as being more sensitive to climate change.

Table 6-3: Areas sensitive to increased rainfall intensities

Goring	Marine Crescent, Marine Drive, West Parade
West Worthing	Tarring Road, Sea View Road
East Worthing	Dominion Road
Durrington	Palatine Road, The Strand, Essenhigh Drive, Edmonton Road
Lancing	Burnside Crescent, Barfield Park, West Way
Shoreham	Hebe Road, Old Shoreham Road, Rosslyn Road
Southwick	Kingston Lane, Victoria Road, Albion Street

6.6.2 Impact of sea level rise on surface water

A technical assessment of the impact of sea level rise upon surface water has been conducted as part of the SFRA. Details of methodology of this is outlined within Appendix H. Mapping of outputs of this assessment can be found in Appendix I.

Areas of high risk were identified to be on the coastline around Marine Crescent and West Parade, East Worthing, East and North Lancing, East Southwick and East Shoreham.

6.7 Groundwater flood risk

Groundwater flooding is the term used to describe flooding caused by unusually high groundwater levels. It occurs as excess water emerges at the ground surface or within manmade underground structures such as basements. Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months, and it can result in significant damage to property.

As illustrated in the mapping, a large proportion of Worthing Borough is predicted to be at risk of groundwater flooding emergence, with some of the highest risk areas around Durrington, Goring and East Worthing. In Adur District the areas predicted to be at the highest risk of groundwater flooding emergence are Sompting and Lancing, as well as areas of Shoreham. The majority of the study area is underlain by chalk bedrock, including the elevated land in the north of Adur and Worthing that forms the South Downs. Rain can infiltrate the chalk through large fissures into the underlying aquifers and is released slowly through springs further downslope. As such, many of the areas identified as being at the highest risk of groundwater flooding emergence are at the base of the South Downs.

As the mapping has been produced on a national scale, there are known to be a number of localised features which affect groundwater levels and which have not been captured in the groundwater mapping. In particular, there is a localised high risk of groundwater flooding across an area to the east of Lancing between Old Shoreham Road and Brighton Road. Across this area there are two distinct groundwater aquifers, one in the lower chalk strata and the other within a layer of superficial deposits (mainly Alluvium) which overlay the chalk. These two aquifers are separated by layers of clay forming an “aquitard” which limits movement between the two aquifers. The Alluvium aquifer is largely recharged by rainfall and is drained by evapotranspiration and through lateral flow to surface water. However, there are locations where the separation between the aquifers is less marked due to the presence of more permeable “windows” between the chalk and upper aquifers. Under conditions of high winter recharge there may be upward leakage from the chalk to the upper aquifer and surface water through the more permeable “windows” in the Superficial Deposits. Finally, diurnal changes in the chalk piezometric surface have been observed near the coast in response to the rise and fall of the tide level. This saline intrusion has a significant effect on groundwater flood risk and the ability to drain surface water within these areas.

As part of the Lancing Surface Water Management Plan a detailed assessment of the geology and hydrogeology was carried out for this area and more details of this localised risk can be found within the report.

6.7.1 Groundwater flood risk - climate change

JBA has carried out a technical assessment of the future impact of groundwater flood risk within Adur and Worthing. Details of methodology of this is outlined within Appendix H. Mapping of outputs of this assessment can be found in Appendix K. The assessment has identified that increases in sea level may increase the risk of groundwater flooding along much of the coastline in Worthing Borough and along the River Adur, with the highest risks identified in East and North Lancing.

6.8 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and / or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment (such as pumps) failure occur in the sewerage system. Surface water inundation of manhole openings and entry of groundwater may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that most new surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year (3.33% AEP), although until recently this did not apply to smaller private systems. This means that, even where sewers are built to current specifications, they can still be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of

occurring in any given year 1% AEP). Existing sewers can also become overloaded as new development adds to their catchment, even with restrictions in place on permitted discharge, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

Information from the Southern Water SIRF database is shown in Table 6-4.

The SIRF database indicates a total of 309 recorded flood events between 01/2013 and 05/2023 in the Local Plan areas. The most frequently flooded postcode is BN13 2 in Worthing Borough (45 incidents) and BN42 4 in Adur District (45 incidents). The data included within the dataset has been limited to events linked to capacity issues. Also, the register represents a snap shot in time and may become outdated following future rainfall events, when new properties are added. Risk of flooding may be reduced in some locations by capital investment to increase of the capacity of the network. As such, the sewer flooding flood risk register is not a comprehensive 'at risk register' and updated information should be sought to enhance understanding of flood risk from sewers at a given location.

Table 6-4: Sewer Incident Report Form database for Adur District and Worthing Borough SFRA areas

Post code	Recorded flood incidents	Post code	Recorded flood incidents
BN11 1	6	BN14 0	1
BN11 2	25	BN14 8	1
BN11 3	12	BN14 9	7
BN11 4	3	BN15 0	27
BN11 5	11	BN15 8	10
BN12 4	13	BN15 9	45
BN13 1	3	BN42 4	65
BN13 2	65	BN43 5	8
BN13 3	2	BN43 6	5
Total: 309			

6.9 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from large raised reservoirs is relatively low, although there is also potentially considerable risk within the study area from other reservoirs that fall below the volume threshold. Legislation under the Flood and Water Management Act requires the flood risk from these reservoirs to be designated.

National risk mapping for reservoir breach has been found to not impact Adur and Worthing.

Table 6-5 Fluvial, tidal, surface water and groundwater risk by ward.

Ward		Fluvial/tidal/coastal flood risk	Surface water flood risk	Susceptibility to groundwater flooding, according to JBA map				
				No risk	5m below surface	0.5m to 5m below surface	0.025m to 0.5m below surface	Within 0.025m of surface
Adur District	Buckingham	Buckingham ward is located on the right bank of the River Adur. The west of Buckingham is clipped by Flood Zones whereas the majority of the ward is located within Flood Zone 1. Steyning Road is clipped by Flood Zone 3 as well as part of the A27 which is located within Flood Zone 3b.	Mapping shows that surface water flood risk in the Buckingham ward is relatively low within the Adur District Local Plan area. The areas predicted to have the highest risk of surface water flooding include Upper Shoreham Road, Rosemary Drive and Wolstonbury Walk.	✓	✓	✓		
	Churchill	Churchill ward is located on the coast, with the areas south of Brighton Road at risk of tidal flooding and located within Flood Zones 3 and 2.	There is a large area of high surface water flood risk around Leconfield Road and Hurstfield where flows pond to the north of the railway line. There are also areas of high risk around Wembley Avenue, Elm Grove and Spencer Road.	✓		✓	✓	✓
	Cokeham	Cokeham ward is located entirely within Flood Zone 1.	Mapping shows there is a surface water flow path along the west of Cokeham ward, flowing north to south from the South Downs along a dry valley. There is a high surface water flood risk associated with this around Busticle Lane and Western Road. There is also a high risk in the ward around Halewick Lane. This risk is exacerbated by a former landfill site, associated with Chestwood Mushrooms, where groundworks appear to have increased soil erosion from the site, affecting the efficiency of a WSCC run-off attenuation area downhill. These flow paths lead into the Cokeham Brooks where there is a retention pond.	✓	✓	✓	✓	✓
	Eastbrook	Eastbrook is located on the coast, with areas of Southwick Port, Basin Road South at risk of tidal flooding and is located within Flood Zone 3b.	Surface water flow paths in Eastbrook ward generally follow roads, with high risk areas around Southwick Street, Albion Street and The Crescent. There are also areas of surface water ponding predicted to the north of the railway line.	✓		✓	✓	✓
	Hillside	Hillside ward is located entirely within Flood Zone 1.	There are several surface water flow paths flowing north to south in Hillside ward that follow the surface topography and roads. The locations predicted to have the highest risk of surface water	✓	✓	✓		

Ward		Fluvial/tidal/coastal flood risk	Surface water flood risk	Susceptibility to groundwater flooding, according to JBA map				
				No risk	5m below surface	0.5m to 5m below surface	0.025m to 0.5m below surface	Within 0.025m of surface
			flooding include the areas around the A270, Upper Kingston Lane and Overhill.					
	Manor	Manor ward is located on the left bank of the River Adur. Shoreham By-Pass is located here and is partially situated within Flood Zone 3b. Coombes Road is located within in Flood Zone 3 and Long Acre Farm within Flood Zone 3b.	Mapping shows there are several surface water flow paths from north to south in Manor ward that follow the surface topography and roads. Areas predicted to be at a high risk of surface water flooding include Manor Road, Mill Road and the A27.	✓	✓	✓	✓	✓
	Marine	Marine ward is located on the coast and with the River Adur bounding to the north. Areas of West Beach Road, Kings Walk, Beach Road, Weald Dyke, Raleigh Close, Havenside and Benbow Close are at risk of tidal flooding within areas of Flood Zone 3b. Britannia Avenue, Brighton Road and Sussex Wharf are at fluvial flood risk situated within Flood Zone 3b.	Mapping shows that surface water flood risk is generally restricted to roads within Marine ward, though there are relatively large areas of surface water ponding around Harbour Way, Riverside Road, and Beach Green.	✓		✓	✓	✓
	Mash Barn	Mash Barn ward is situated to the west of the River Adur. Large areas are situated within fluvial and tidal flood risk areas such as New Monks Farm, Brighton City Airport and residential areas in the south west corner and north boundary located within Flood Zone 3.	Mapping shows there is high surface water flood risk in the areas adjacent to the ordinary watercourses in the south of Mash Barn ward, around Barfield Park and Monks Avenue. There is also a large area of high risk in the north of the ward, south of Old Shoreham Road, with properties around Manor Way, Manor Close and First Avenue within the area of highest surface water flood risk. The spring line runs close to the properties along Old Shoreham Road.	✓			✓	✓
	Peverel	There is fluvial flood risk from Teville Stream within Peverel Ward. Flood Zones 3 and 2 are generally restricted to open land west of Sompting, though a small number of properties around St Paul's Avenue are located within Flood Zone 2.	There are large areas of surface water flood risk in the open areas around the Teville Stream drainage network. There is also a large area of high risk around Tower Road where flows pond to the north of the railway line. Other high-risk areas include around Commerce Way and Ullswater Road.	✓		✓	✓	✓
	Southlands	Southlands ward is located entirely within Flood Zone 1.	Mapping shows there is an area of surface water flood risk through the centre of Southlands ward where flows follow the surface topography and roads. Additionally, there are areas of high surface water flood risk around Middle Road and Williamson Road.	✓		✓	✓	

Ward		Fluvial/tidal/coastal flood risk	Surface water flood risk	Susceptibility to groundwater flooding, according to JBA map				
				No risk	5m below surface	0.5m to 5m below surface	0.025m to 0.5m below surface	Within 0.025m of surface
	Southwick Green	The majority of Southwick Green Ward is located within Flood Zone 1, however the south border of the site along Brighton Road is situated within Flood Zone 3 with small pockets of development within Flood Zone 3b.	Mapping shows there is a large area of surface water ponding in the area around Southwick Green. There are also smaller areas of ponding north of the railway line in the west of the ward and north of Albion Street. In all these locations there is a relatively large area of land predicted to be at the highest risk of surface water flooding.	✓		✓	✓	✓
	St. Mary's	St Mary's ward is bounded by the River Adur to the south. Areas along the A259, Brighton Road are located within Flood Zone 3b.	There are large areas where there is a high surface water flood risk in St. Mary's ward as flows pond north of the railway line. These high risk areas include Gordon Road, Dolphin Road and The Finches.	✓		✓	✓	✓
	St. Nicolas	St Nicholas ward is bounded by the River Adur to the west. The south west corner of the ward is situated within Flood Zone 3 largely affecting Old Shoreham Road, Swiss Gardens and Freehold Street.	Mapping shows there is a large surface water flow path flowing through a dry valley in the east of St. Nicholas ward. There is a relatively high risk of surface water flooding in this area around Overmead and Northbourne Close. There is a large area of surface water ponding near the River Adur around Old Shoreham Road and Connaught Avenue.	✓	✓	✓		
	Widewater	Widewater ward is located on the coast with the south of the ward at risk of tidal flooding. Areas along and behind Brighton Road to the east of the ward stretching to the north of the ward are located within Flood Zone 3. West of the ward in Lancing is located within Flood Zone 1.	Mapping shows there are areas of surface water flood risk around the ordinary watercourses in the north of Widewater ward. Additionally, there is high surface water flood risk around Beachcroft Place and Penhill Road.	✓		✓	✓	✓
Worthing Borough	Broadwater	There are small areas at risk of fluvial flooding from Teville Stream in the east of Broadwater ward, with some commercial properties adjacent to the watercourse located within Flood Zones 3 and 2.	There is an area of high surface water flood risk in the area around Dominion Road where surface water is predicted to pond. Additionally, there is a large area of high risk around Sompting Road, Penfold Road and Southdownview Road where several residential, commercial and industrial properties may be affected by surface water flooding.	✓		✓	✓	✓
	Castle	There is fluvial flood risk in Castle ward from the Ferring Rife in the areas between the A2032 and Ferring Lane.	Mapping shows there is high surface water flood risk in the same area that is at risk of fluvial flooding to the south of the Ferring Rife between the A2032 and Goring Street (Boxgrove and Patching Close). Elsewhere in Castle Ward, areas				✓	✓

Ward		Fluvial/tidal/coastal flood risk	Surface water flood risk	Susceptibility to groundwater flooding, according to JBA map				
				No risk	5m below surface	0.5m to 5m below surface	0.025m to 0.5m below surface	Within 0.025m of surface
			of high surface water flood risk include The Strand, Limbrick Lane, and Raleigh Crescent.					
	Central	Central ward is located on the coast, with the south of the ward at risk of tidal flooding. A large area of Worthing town centre is located within Flood Zones 3 and 2.	There is a relatively large area of high surface water flood risk in the north of Central ward around Teville Road, Howard Street and Worthing Hospital. In the south of the ward flow paths generally follow the roads, with the highest risk areas including South Street, Marine Parade and Montague Street.	✓		✓	✓	✓
	Durrington	Durrington ward is located entirely within Flood Zone 1.	Mapping shows there is a relatively wide surface water flow path through areas of residential properties in Durrington ward, flowing southwest from around Salvington Road to the area by Montreal Way. The areas of highest surface water flood risks include New Road, Durrington Lane, Montreal Way and Pond Lane.	✓		✓	✓	✓
	Gaisford	Gaisford ward is located entirely within Flood Zone 1.	Mapping shows surface water flood risk in Gaisford Ward largely follows roads, with areas of high risk including South Farm Road, Broadwater Road and Balcombe Road.	✓			✓	
	Goring	Goring ward is located on the coast, with the south of the ward at risk of tidal flooding. The areas at risk of flooding include Marine Crescent and Marine Drive, with these areas both located within Flood Zones 3 and 2.	Mapping shows that surface water flood risk largely follows roads in Goring ward, such as Goring Way and Sea Lane. There is also a large area at high risk of surface water flooding around Marine Crescent and Marine Drive.	✓		✓	✓	✓
	Heene	Heene ward is located on the coast, with the south of the ward at risk of tidal flooding around the West Parade and Eirene Road. These areas are located within Flood Zones 3 and 2.	Surface water flood risk is largely concentrated to the north and south of the ward in the areas of lower lying land. Surface water flow paths generally follow the routes of roads, with the areas at highest risk of surface water flooding including Tarring Road, Heene Road and Manor Road.			✓	✓	✓
	Marine	Marine ward is located on the coast, with the south of the ward at risk of tidal flooding. The areas around Marine Parade and Heene Road are located within Flood Zones 3 and 2.	Surface water flood risk is largely concentrated to the north and south of the ward in the areas of lower lying land. Areas of high surface water flood risk include south of Tarring Road, West Parade, Marine Gardens and Gerald Road.	✓		✓	✓	✓

Ward		Fluvial/tidal/coastal flood risk	Surface water flood risk	Susceptibility to groundwater flooding, according to JBA map				
				No risk	5m below surface	0.5m to 5m below surface	0.025m to 0.5m below surface	Within 0.025m of surface
	Northbrook	A relatively large area of Northbrook ward is at risk of fluvial flooding from Ferring Rife, with the areas around Romany Road, Fulbeck Avenue and Yeoman Road located within Flood Zones 3 and 2.	Mapping shows surface water flow paths through Northbrook ward generally follow the route of Ferring Rife, with areas of the highest surface water flood risk around Tulip Tree Road and Essenhigh Drive. There is also a significant area of high risk around Romany Road where the watercourse is culverted.	✓	✓	✓	✓	✓
	Offington	Offington ward is located entirely within Flood Zone 1.	Surface water flood risk in Offington ward is largely concentrated around the route of the A24 through Findon Valley and then through the residential areas around Offington Drive and Offington Avenue. This flow path follows the route of a dry valley and is the area of the highest surface water flood risk in the ward.	✓	✓	✓	✓	✓
	Salvington	Salvington ward is located entirely within Flood Zone 1.	Mapping shows there are several surface water flow paths from north to south in Salvington ward that follow the topography and roads. Areas that are predicted to be at a high risk of surface water flooding include the A27, Cotswold Road, Exmoor Drive, and around Meadowfield hospital.	✓	✓	✓	✓	✓
	Selden	Selden ward is located on the coast and the south of the ward is at risk of tidal flooding, with the area along Brighton Road located within Flood Zones 3 and 2. Additionally, there if fluvial flood risk from Teville Stream in the east of the ward, with areas Brooklands Park located in Flood Zones 3 and 2.	Mapping shows the areas of highest surface water flood risk in Selden ward are in the north of the ward around Thurlow Road, the Davison Leisure Centre and Meadow Road. There are also areas of surface water flood risk near the coast along Brighton Road.	✓		✓	✓	✓
	Tarring	Tarring ward is located entirely within Flood Zone 1.	Mapping shows surface water flow paths through Tarring wards generally follow the route of roads, with high surface water flood risk predicted around South Street, Castle Road and Beckett Road. There is also an area of surface water ponding mapped in the southwest of the ward around the allotments.				✓	

7 Fluvial and coastal defences

A high-level review of flood defences was carried out for this SFRA, involving an interrogation of existing information on asset condition and standard of protection.

Defences are categorised as either raised flood defences (e.g. walls/embankments) or Flood Storage Areas (FSAs). The assessment of the Environment Agency Spatial Flood Defence dataset has considered defences which potentially provide a standard of protection from a 5% AEP event or more. The dataset includes man-made and natural defences which may arise for instance due to the presence of naturally high ground adjacent to a settlement have been considered. The defences and their locations are summarised in the following sections.

7.1 Defence standard of protection and residual risk

One of the principal aims of the SFRA is to outline the present risk of flooding across the Adur District and Worthing Borough Local Plan areas including consideration of the effect of flood risk management measures (including flood banks and defences). The modelling that informs the understanding of flood risk within the Local Plan areas is typically of a catchment wide nature, suitable for preparing evidence on possible site options for development. In cases where a specific site risk assessment is required, detailed studies should seek to refine the results used to provide a strategic understanding of flood risk from all sources.

Consideration of the residual risk behind flood defences has been undertaken as part of this study. Residual risk includes the consideration of flood events that exceed the design thresholds of the flood defences or circumstances where there is a failure of the defences, e.g. flood banks collapse. Developers should also consider the standard of protection provided by defences and residual risk when preparing detailed Flood Risk Assessments.

7.2 Defence condition

Formal structural defences are given a rating by the Environment Agency based on a grading system for their condition[15]. A summary of the grading system used by the Environment Agency for condition is provided in Table 7-1.

[15] Condition Assessment Manual, Environment Agency (2012)

Table 7-1: Defence asset condition rating

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

The condition of existing flood defences and whether they are planned to be maintained and/or improved in the future must be considered with respect to the safety and sustainability of development over its intended life and also with respect to the financial and economic commitment to the long-term provision of appropriate standards of protection. In some cases, the relevant strategy may suggest that it is not appropriate to maintain the condition of the assets, which may prove influential for the development over its intended life. In addition, detailed FRAs undertaken by developers (if a defence is influential to the proposed development) will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired in accordance with the policy and strategy for Flood Risk Management.

7.3 Coastal, tidal and fluvial defence in the Local Plan area

The majority of the River Adur in Adur District has fluvial and tidal defences along its length, while the Ferring Rife and Teville Stream have fluvial defences in places. The coastline in Adur District is protected by coastal defences.

The majority of defences in Adur District and Worthing Borough provide a standard of protection of at least 4% AEP, with many of the defences in Adur District providing a standard of protection of 1% AEP or greater. However, there are also several areas with a standard of protection of less than 4% AEP, largely along Teville Stream. The Environment Agency defence data shows that most defences within the Local Plan areas are in ‘Good’ or ‘Fair’ condition.

When considering defences along the coastline, it is important to differentiate between those which are constructed to protect the coastal frontage from erosion and those which are designed to protect the coast from flood risk from the tide levels in the sea e.g. still water levels exceeding the defence crest, or waves overtopping the defence. Each of these

types of defence are present in the Adur District Local Plan area but are not designed to necessarily fulfil the dual purpose of managing flood risk and coastal protection. However, with climate change, it is likely that many locations with coastal defences will need to include provision for tidal defence in the future.

New developments along the Western Harbour Arm have been constructed with flood defences. Whilst deriving Flood Zone 3b, the areas benefitting from defences have been manually removed from these areas at risk.

The maps shown in Appendix L provide a summary of the defences with a standard of protection against a 5% AEP event or greater in the Local Plan areas using the spatial defence data provided by the Environment Agency.

7.4 Alleviation schemes

There are a limited number of alleviations schemes within the Local Plan areas, and there are no Flood Storage Areas recorded in the Local Plan areas in the Environment Agency's 'Flood Map for Planning – Flood Storage Areas' dataset.

Within the study area, the Environment Agency has completed construction of the Shoreham Adur Tidal Walls flood defence scheme. The scheme was to update existing flood defences in the Adur estuary which did not provide high enough level of protection and were in poor condition leaving Shoreham-by-Sea, Lancing and the surrounding areas at risk of flooding. The scheme provides protection of extreme events with 0.33% probability (1-in-300-year), allowing for 50 years of sea level rise.

7.5 Residual flood risk

Residual risks are those remaining after applying the sequential approach and taking mitigating actions. The residual risk can be:

- the effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges; and/or
- failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner, or failure of pumping stations – the Reduction in Risk of Flooding from Rivers and Sea due to Defences dataset[16] can be used to identify areas of residual risk.

In circumstances where measures are put in place to manage the flood risk there remains a possibility of flooding being experienced, either as a consequence of the event exceeding the design capacity or the failure of the asset providing the appropriate standard of

16 https://www.data.gov.uk/dataset/dcdcf96b-3293-4987-8ca8-9b8827f5ccf8/reduction-in-risk-of-flooding-from-rivers-and-sea-due-to-defences

protection. It is the responsibility of the developer to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks can be safely managed.

This SFRA does not assess the probability of failure other than noting that such events are very rare. However, in accordance with NPPF, all sources of flooding need to be considered. If a breach or overtopping event were to occur, then the consequences to people and property could be high. Developers should be aware that any site that is at or below defence level may be subject to flooding if an event occurs that exceeds the design capacity of the defences, or the defences fail, and this should be considered when building resilience into low level properties.

7.5.1 Overtopping

In exposed locations along the coast, landward flooding is more likely to occur as a consequence of wave overtopping than inundation. Wave overtopping is a term, which encompasses a number of complex physical processes, which result in the transfer of water from the sea onto the coastal floodplain. Overtopping conditions occur when a wave meets a structure lower than the maximum wave height or when the mean sea level exceeds the top of the defences.

The risk from overtopping of defences is based on the relative heights of property or defence, the distance from the defence level and the height of water above the crest level of the defence. The Defra and Environment Agency Flood Risks to People guidance document provides standard flood hazard ratings based on the distance from the defence and the level of overtopping.

The risk of waves overtopping sea walls in particular can lead to a significant flood hazard. As part of this SFRA, the effect of wave overtopping along the coastline has been included in the Flood Zone 3b delineation. Any sites located next to defences or perched ponds / reservoirs, may need overtopping modelling or assessments to be completed at the site-specific FRA stage.

7.5.2 Defence breach

A breach of a defence occurs when there is a failure in the structure and a subsequent ingress of flood water occurs.

Where defences are present, risk of breach events should be considered as part of the site-specific flood risk assessment. Flood flows from breach events can be associated with significant depths and flow velocities in the immediate vicinity of the breach location and so FRAs must include assessment of the hazards that might be present so that the safety of people and structural stability of properties and infrastructure can be appropriately taken into account. Whilst the area in the immediate vicinity of a breach can be subject to high flows, the whole flood risk area associated with a breach must also be considered as there may be areas remote from the breach that might, due to topography, involve increased depth hazards.

Considerations include the location of a breach, when it would occur and for how long, the depth of the breach (toe level), the loadings on the defence and the potential for multiple breaches. There are currently no national standards for breach assessments and there are various ways of assessing breaches using hydraulic modelling. Work is currently being undertaken by the Environment Agency to collate and standardise these methodologies. It is recommended that the Environment Agency are consulted if a development site is located near to a flood defence, to understand the level of assessment required and to agree the approach for the breach assessment.

8 FRA requirements and flood risk management guidance

8.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within the Adur District and Worthing Borough Local Plan areas. Prior to any construction or development, site-specific FRAs will need to be undertaken as set out in the NPPF (see Section 8.2.1) to assess all sources of flood risk.

Some sites may additionally require the application of the Exception Test following the Sequential Test if there are safety and sustainability issues to be addressed. If the Exception Test is applied, it must be informed by a detailed FRA to ensure it is safe and will not increase flooding elsewhere. Any site that does not pass the Exception Test should not normally be allocated or permitted for development. It is the responsibility of the developer to provide an FRA with an application.

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

8.2 Requirements for site-specific flood risk assessments

8.2.1 What are site specific FRAs?

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

Paragraph 080 of the NPPF Flood Risk and Coastal Change Planning Practice Guidance sets out a checklist for developers to assist with site specific flood risk assessments.

Site specific FRAs are required in the following circumstances:

- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency)
- Proposals of 1 hectare or greater in Flood Zone 1
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding
- Proposals of less than one hectare in Flood Zone 1 where they could be affected by sources of flooding other than rivers and the sea (e.g. surface water)

An FRA may also be required for some specific situations:

- If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1)
- Where evidence of historical or recent flood events have been passed to the LPA
- On land in the vicinity of small watercourses or drainage features that might not have been demarcated as being in a Flood Zone on the national mapping
- At locations where proposals could affect or be affected by substantial overland surface water flow routes

8.2.2 Objectives of site specific FRAs

The aim of an FRA is to demonstrate that the development is protected to the 1% AEP fluvial or surface water and 0.5% AEP tidal flood scenario and is safe for its intended life span during the 'design' flood event, including an allowance for climate change. This includes assessment of mitigation measures required to safely manage flood risk. Development proposals requiring FRAs should establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether a proposed development will increase flood risk elsewhere;
- whether the measures proposed to deal with the effects and risks are appropriate;
- the potential cumulative impact of development on flood risk;
- how surface water runoff from the site will be managed (see Section 9)
- the evidence, if necessary, for the Local Planning Authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs for sites located in the Local Plan area should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and West Sussex County Council. This includes:

- Site-specific Flood Risk Assessment: Checklist (NPPF PPG, Defra)
- Standing Advice on Flood Risk (Environment Agency)
- Flood Risk Assessment for Planning Applications (Environment Agency)
- West Sussex County Council LLFA Policy for the Management of Surface Water (West Sussex County Council)
- Using modelling for flood risk assessments - GOV.UK (www.gov.uk)

When undertaking an FRA, developers should refer to the most up to date climate change allowances as provided by the Environment Agency. More information on the updated climate change allowances, based on the UKCP18 projections, is available in Section 4.2. Developers are encouraged to seek planning advice from the Environment Agency at pre-application stage. By making an allowance for climate change it will help reduce the vulnerability of the development and provide resilience to flooding in the future. See section 4 for further details.

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

8.3 Mitigation measures

Mitigation measures should be regarded as a last resort to address flood risk issues where the site has passed the Exception Test and therefore has strong planning/sustainability reasons for development. Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

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

Attention must also be paid to the provision of safe access and egress during flood events (see section 10.3), including climate change, and how this is linked to flood warning and emergency evacuation where necessary. The Emergency Services and local authority should be consulted on the evacuation and rescue capabilities and any advice or requirements included. Consideration should also be given to residual risk to understand the safety implications during events where the design capacity is exceeded or there is a failure.

There should normally be no interruption to flood flows or loss of flood storage as a result of any proposed development. Flood storage compensation may be appropriate for sites on the edge of the existing floodplain or within a flood cell. However this would need to be provided level for level. Resilience rather than resistance measures should be used if flood plain compensation is not being provided.

Whilst it might be possible to identify appropriate flood mitigation measures for some sites, it is worth noting that in some instances the findings of individual FRAs may determine that the risk of flooding to a proposed development is too great and mitigation measures are not feasible or appropriate.

The minimum acceptable standard of protection against flooding for new residential property within flood risk areas is the 1% AEP event plus climate change for fluvial flooding, 0.5% AEP plus climate change event for tidal flooding, and 1% AEP plus climate change storm for surface water flooding. Developments susceptible to flood risk resulting from blockage or exceedance of structures should be protected beyond the 1% AEP plus climate

change scenario. An allowance for climate change over the lifetime of the development must be made when assessing each of these scenarios and be conducted in line with latest guidance for climate change.

8.4 Reducing flood risk

8.4.1 Site layout and design

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

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from high risk areas, to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas. However, vehicular parking in floodplains should consider the nature of parking, flood depths, velocities and hazard including evacuation procedures and flood warning. The nature of risk to water quality also needs to be considered and mitigated to ensure that accumulated hydrocarbons and other vehicle related pollutants are not released to the aquatic environment.

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

8.4.2 Raised floor levels

The raising of internal floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood.

Minimum finished floor levels for development that does not include sleeping accommodation on the ground floor should normally be set to whichever is higher of the following:

- a minimum of 300mm above the design flood event level
- if finished floor levels cannot be raised in this way, additional flood resistance and resilience measures should be added to the property to protect it to at least 300mm above the estimated flood level.

Please note that the design flood level should be estimated as part of a site specific Flood Risk Assessment.

Finished floor levels for vulnerable developments (e.g., dwellings and for sleeping accommodation) should be a minimum of whichever is higher of 300mm above the:

- average ground level of the site
- adjacent road level to the building

- estimated flood event level (1% AEP fluvial plus climate change or the 0.5% AEP tidal plus climate change)

The design flood event is defined as a flood event of a given annual flood probability, which is generally taken as:

- river flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year); or
- tidal flooding with a 0.5% annual probability (1 in 200 chance each year); or
- surface water flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year),

plus an appropriate allowance for climate change.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine alternative approaches.

The additional height that the floor level is raised above the maximum water level is referred to as the “freeboard”. Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

Allocating the ground floor of a building for less vulnerable development, such as for non-residential use, is an effective way of raising living space above flood levels.

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress may still be an issue, particularly when flood duration covers many days.

Similarly, the use of basements should be avoided in areas of flood risk. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test. Access should be situated 300mm above the design flood event level and waterproof construction techniques used.

8.4.3 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain if they are overtopped or breached. Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution.

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

8.4.4 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property.

In most areas of fluvial flood risk, raising land above the floodplain would reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land. Wholesale land raising also contravenes the West Sussex Policy for the Management of Surface Water.

Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels within areas of flood risk will need to be discussed at an early stage with the Environment Agency and its impacts assessed as part of a detailed FRA. This is likely to require flood modelling.

8.4.5 Developer contributions

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

DEFRA's Flood and Coastal Risk Management Grant in Aid (FCRMGiA) can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

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

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

The appropriate route for the consideration of strategic measures to address flood risk issues is the LFRMS prepared by the Lead Local Flood Authority. The LFRMS should describe the priorities with respect to local flood risk management, the measures to be taken, the timing and how they will be funded. It will be preferable to be able to demonstrate that strategic provisions are in accordance with the LFRMS, can be afforded and have an appropriate priority.

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

8.5 Buffer strips

The provision of a buffer strip or easement to 'make space for water', allows additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes. It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult.

Various buffer strip Byelaws are in place within the SFRA study area, these should be consulted when allocating new development. Under the Environmental Permitting Regulations 2018 (England and Wales), the Environment Agency specifies that no development is permitted within 8m of any Main River without previous consent from the Authority. This distance is measured horizontally from the foot of any bank of the river on the landward side, or where there is no such bank, measured horizontally from the top edge of the batter enclosing the river. A great buffer strip (i.e. more than 8m) may be required by the Environment Agency if access for maintenance is required. In addition, there is encouragement for 10m buffer strips to provide multiple benefits for ecology, flood risk management and water quality.

Furthermore, the LLFA currently works on a buffer strip of 3.5m either side of an ordinary watercourse within which no development should be permitted without previous consent from the Lead Local Flood Authority.

Additionally, Southern Water, under the Water Industry Act (1991) which granted their ownership over all public sewers within their administrative area, have restricted easement within 3m of their sewer systems without prior consent.

8.6 Resistance and resilience measures

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk during the

0.1% AEP scenario. In these cases, (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not normally be relied on for new development as an appropriate mitigation method.

Resistance measures aim to reduce the amount of floodwater entering the building and resilience measures aim to reduce the damage caused by flood water which has entered the property.

Guidance on best practice can be located within the Department for Communities and Local Government 'Improving the Flood Performance of New Buildings: Flood Resilient Construction' (2007) and the CIRIA Property Flood Resilience Code of Practice (2021).

8.6.1 Resistance measures

Most of the resistance measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sandbags. They are often deployed with small scale pumping equipment to control the flood water that does seep through these systems. The effectiveness of these forms of measures is often dependant on the availability of a reliable forecasting and warning system, so the measures are deployed in advance of an event. The following resistance measures are often deployed:

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

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

As these measures will reduce the storage within the floodplain compensatory storage provision is likely to be required to prevent incremental detriment to the flood risk elsewhere.

8.6.2 Resilience measures

Resilience measures should be regarded as reducing the impact the flood water has once it has entered a property. These typically include:

Water resistant materials: floors, walls and fixtures can be finished with water resistant materials to help reduce the damage and greatly shorten the recovery time after a flood. Materials can include waterproof plaster, solid concrete floors and tiled flood coverings.

Electrical installation: electrical circuitry can be installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level to reduce the likelihood of the circuitry being affected by flood water.

Resistance and resilience measures will be specific to the nature of flood risk, and as such will be informed and determined by a site specific FRA. Further guidance relating to appropriate resistance and resilience measures can be found on the Environment Agency's Flood risk assessment in flood zones 2 and 3 webpage. The Sussex Resilience Forum provides information and advice for individuals on Preparing for Emergencies. West Sussex County Council's Guide to Flooding also provides advice on how to prepare for flood events, as well as on how to make properties more flood resilient.

8.6.3 Community resistance and resilience measures

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

West Sussex County Council's 'What if?' community resilience programme has been working with communities at the Parish Council level providing training and advice to enable communities to prepare, respond and recover in time of emergency. WSCC has also encouraged the preparation of community emergency plans to help support emergency response arrangements[17]. Local Parish Council's should be contacted to see if a community has an Emergency Plan in place. Additionally, Adur and Worthing Councils website provides an overview of what Community Resilience is and where further information is available.

8.6.4 Emergency Planning

Safe access and egress from the site should be provided to reduce the residual risks to a development. The developer should seek to incorporate an emergency plan and a safe refuge point if the development site has been identified to be at risk of flooding. The local authority and Emergency Services should be consulted when designing an emergency plan. For further details on emergency planning, see Section 10.

[17] Your essential Flood Guide: Information and forward planning. West Sussex County Council. Available at: https://www.westsussex.gov.uk/media/2184/guide_to_flooding.pdf

8.7 Making space for water

The PPG sets out a clear aim to make use of natural and sustainable flood risk management methods wherever they may be effective when opportunities are presented by new developments. The documentation encourages consideration of net gains and multiple benefits of applying such measures. Strategic Flood Risk Assessments are to identify opportunities for nature-based solutions. Developments subject to the exception test must reduce overall flood risk where possible.

All new development should consider the opportunity presented to improve and enhance the river environment, seeking opportunities for river restoration and enhancement as part of the development. A sustainable drainage approach can alleviate flood risk as well as increase surface water infiltration, increasing vegetation (and improving biodiversity), providing additional flood storage, and reducing the surface water load of the existing sewerage network.
Natural flood Management (NFM) techniques work with natural processes to protect, restore, and emulate natural functions of catchment, floodplains, rivers, and coasts. Examples include land management to improve soil health and infiltration rates and soil moisture storage, river restoration, restoring or creating wetland areas, and woodland creation. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

8.8 Reducing flood risk from other sources

8.8.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce groundwater flood risk would be through building design (development form), ensuring floor levels are raised above the water levels caused by a 1% AEP plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream.

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk on or off the site. Developers should provide evidence and ensure that this will not be a significant risk.

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

8.8.2 Surface water flooding

Existing surface water flow routes on site must be managed using SuDS. If residual surface water flood risk remains, the likely flow routes and depths across the site should be

modelled. The site should be designed so that these flow routes are preserved and building design should provide resilience against this residual risk. Consideration should also be given to the impacts of tide locking.

It is also recommended that high density development should give consideration to the use of urban SuDS and developments in close proximity to the coast should consider discharging water directly to the sea. The feasibility of this is currently being investigated in WSCC's 'Over the Wall' drainage project which explores the feasibility, design challenges and potential benefits of directing rooftop drainage for waterfront developments over the sea wall rather than to traditional underground gravity drainage networks.

During the redevelopment of brownfield sites, the Drainage Hierarchy should be used to direct surface water to natural outfall routes such as infiltration to the ground or into watercourses, before utilising sewers (surface water or combined), as supported by the PPG. Surface water should also not be permitted to connect to a foul sewer.

More detailed guidance on managing surface water flood risk and the use of SuDS is provided in Section 9.

8.8.3 Sewer flooding

Developers should discuss public sewerage capacity with the water utility company (Southern Water) at the earliest possible stage. If a development increases flood risk on site or the wider area then the drainage infrastructure will need to be improved to prevent this. It is important that a drainage impact assessment demonstrates that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

When redeveloping existing buildings, the installation of some permanent or temporary flood-proofing and resilience measures could protect against sewer flooding. Non-return valves prevent water entering the property from drains and sewers. These can be installed within gravity sewers or drains in a property's private sewer upstream of the public sewerage system. They need to be carefully installed and must be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 1% AEP plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques. Particular consideration should be given to designing drainage systems that reduce the risk of groundwater ingress where this is a known existing problem.

8.8.4 Cumulative effects

At some locations it will be necessary to include consideration in an FRA of not only the flood risk at a particular site, but also the cumulative effects of all proposed plan allocations. Reference should be made to Section 12.4 with respect to the consideration that should be given in these circumstances.

9 Surface water management and SuDS

9.1 Introduction

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

9.2 What is meant by surface water flooding?

Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall. Surface water flooding includes:

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

9.3 Role of the LLFA and Local Planning Authorities

From April 2015 local planning policies and decisions on planning applications relating to major development or major commercial development should make provision for sustainable drainage systems to manage run-off, where major developments are defined as:

- **Residential development:** 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known.
- **Non-residential development:** provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of one hectare or more.

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

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

In their respective roles as LLFA and LPA West Sussex County Council and Adur and Worthing Councils should:

- promote the use of SuDS for the management of run off;
- ensure their policies and decisions on applications support and compliment the building regulations on sustainable rainwater drainage, giving priority to infiltration over watercourses and then sewer conveyance;
- incorporate favourable policies within development plans;
- adopt policies for incorporating SuDS requirements into Local Plans; and
- encourage developers to utilise SuDS whenever practical, if necessary, through the use of appropriate planning conditions.

9.3.1 Implementation of Schedule 3 of the Flood and Water Management Act (2010)

In January 2023, DEFRA released 'The review for implementation of Schedule 3 to The Flood and Water Management Act 2010'. In England, Schedule 3 was not commenced as part of the Act's ratification in 2010. The implementation of Schedule 3 in England will follow that of Wales where the schedule was commenced into law in January 2019.

The Jenkins review of the arrangements for determining responsibility for surface water and drainage assets (2020), a precursor to the review for implementation of Schedule 3, suggested the existing planning-led approach alone in England is not effective, and recommended that non-statutory technical standards for sustainable drainage systems be made statutory. The review indicated that in general there are no specific checking systems in place to ensure that SuDS are constructed as agreed, leading to concerns surrounding unsatisfactory standards of design and construction, and of difficulties associated with ensuring proper maintenance once construction is complete.

Schedule 3 provides a framework for the approval and adoption of drainage systems by a SuDS Approving Body (SAB), and national standards on the design, construction, operation, and maintenance of SuDS.

Government will now consider how Schedule 3 will be implemented, with the schedule expected to be implemented in 2024.

9.4 Sustainable Drainage Systems (SuDS)

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the design brief or master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles (the four pillars of SuDS design - Figure 9-1) enabling solutions that deliver multiple long-term benefits. These principles are:

- **Quantity**: should be able to cope with the quantity of water generated by the development at the agreed rate and volume with due consideration for climate change via a micro-catchment based approach. Where frequency of flood risk, steepness of topography or permeability of geology has a significant impact on the volume or rate of surface water being discharged from a site, the LLFA should be contacted, as a review of the greenfield runoff rate to be achieved may be needed.
- **Quality**: should utilise SuDS features in a “treatment train” that will have the effect of adequately treating the water before infiltration or passing it on to a subsequent water body
- **Amenity**: should integrate greenery or water features to improve the visual characteristics of the area. These can be incorporated within “open space” or “green corridors” within the site and designed with a view to performing a multifunctional purpose.
- **Biodiversity:** should include a range of natural features such as plants, trees and other vegetation which will provide additional filtration of surface water runoff. These can be designed to complement and improve the ecology of the area.

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

SuDS must be considered at the outset and during preparation of the initial conceptual site layout to ensure that enough land is given to design spaces that will be an asset to the development as opposed to an ineffective afterthought. For SuDS to work effectively appropriate techniques should be selected based on the objectives for drainage and the site-specific constraints. It is recommended that on all developments source control is implemented as the first stage of a management train allowing for improvements in water quality and reducing or eliminating runoff from smaller, more frequent, rainfall events.

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

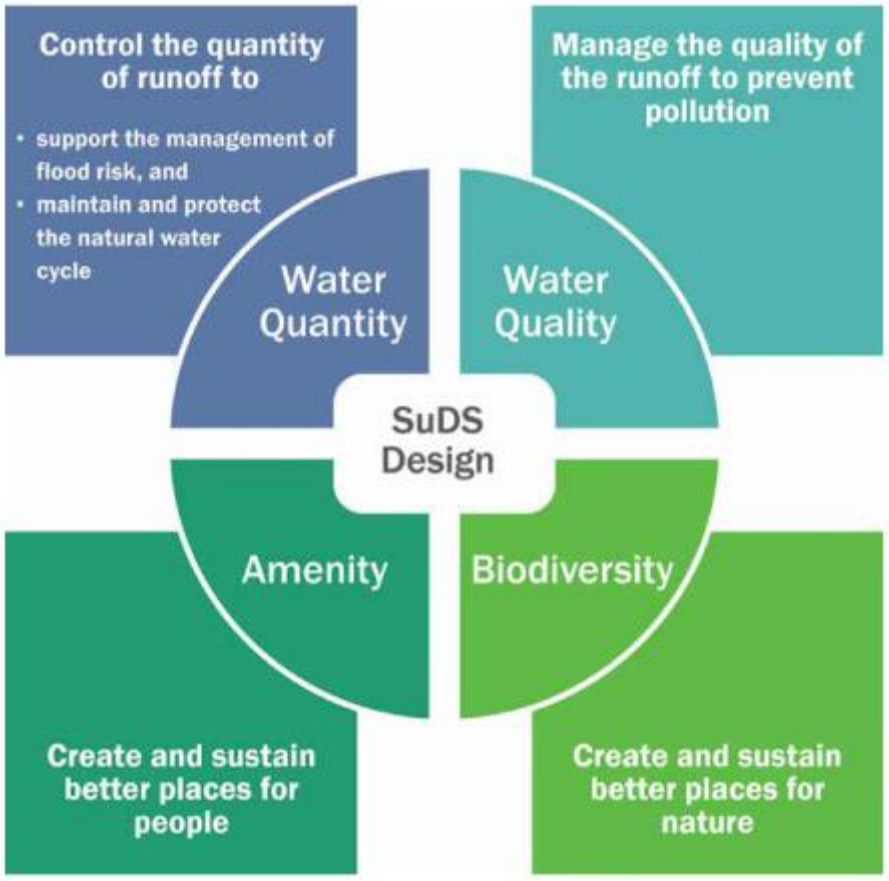


Figure 9-1: Four pillars of SuDS design (The SuDS Manual C753, 2015)

9.5 Types of SuDS System

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (Table 9-1). Techniques can include soakaways, infiltration trenches, permeable pavements, grassed swales, green roofs, ponds and wetlands, which do not necessarily need to take up a lot of space. The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA) e.g. the CIRIA SuDS Manual C753 (2015).

Table 9-1: Examples of SuDS techniques and potential benefits

SuDS Technique	Flood Reduction	Water Quality Treatment & Enhancement	Landscape and Wildlife Benefit
Living roofs	✓	✓	✓
Basins and ponds	✓	✓	✓
Constructed wetlands	✓	✓	✓
Balancing ponds	✓	✓	✓
Detention basins	✓	✓	✓
Retention ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices	✓	✓	✓
Soakaways	✓	✓	✓
Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains	✓	✓	
Gravelled areas	✓	✓	
Solid paving blocks	✓	✓	
Porous pavements	✓	✓	
Tanked systems	✓		
Over-sized pipes/tanks	✓		
Storm cells	✓		

9.5.1 SuDS Management

SuDS should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to a discharge location. Collectively this concept is described as a SuDS Management Train (see Figure 9-2). The number of treatment stages required within the Management Train depends primarily on the source of the runoff and the sensitivity of the receiving waterbody or groundwater. A Surface Water Drainage Strategy will need to demonstrate that an appropriate number of treatment stages are delivered to ensure that there is no negative impact on the receiving watercourse.

A Surface Water Drainage Strategy is also required to set out extent, position, function and future management arrangements for the sustainable drainage system for a proposed site. This information is required by the Local Planning Authority at the time that an application is made.

SuDS components should be selected based on design criteria and how surface water management is to be integrated within the development and landscaping setting. By using a number of SuDS features in series it is possible to reduce the flow and volume of runoff as it passes through the system as well as minimising pollutants which may be generated by a development.

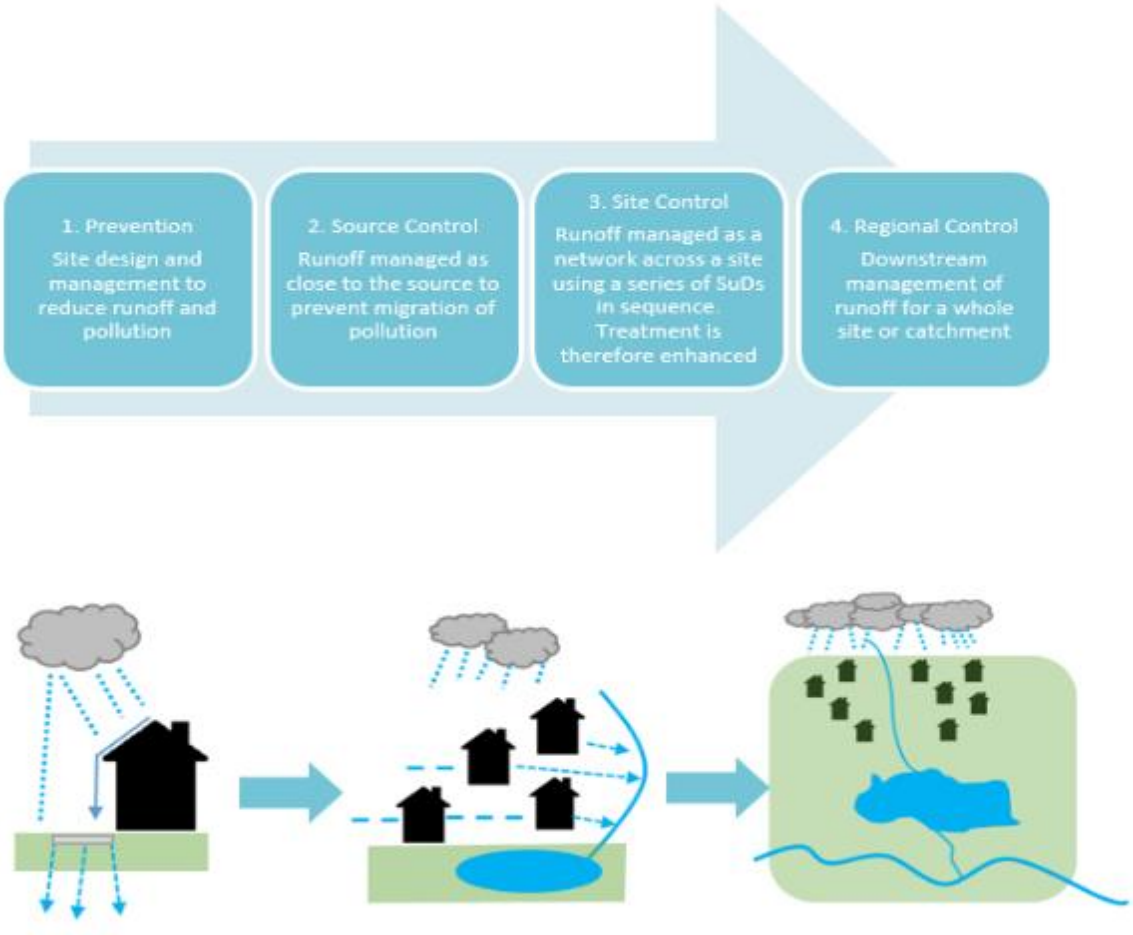


Figure 9-2: SuDS Management Train

9.5.2 Treatment

A key objective of the four pillars of SuDS is to provide the maximum improvement to water quality through the use of the "SuDS management train". To maximise the treatment within SuDS, CIRIA recommends[18] the following good practice is implemented in the treatment process:

1. **Manage surface water runoff close to source:** This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area.
2. **Treat surface water runoff on the surface:** This allows treatment performance to be more easily inspected and managed and enables sources of pollution and potential flood risk to be more easily identified. It also helps with future maintenance work and identifying damaged or failed components.
3. **Treat a range of contaminants:** SuDS should be chosen and designed to deal with the likely contaminants from a development and be able to reduce them to acceptably low levels.

18 C753 CIRIA SuDS Manual (2015)

4. **Minimise the risk of sediment remobilisation:** SuDS should be designed to prevent sediments being washed into receiving water bodies or systems during events greater than what the component may have been designed.
5. **Minimise the impact of spill:** Designing SuDS to be able to trap spills close to the source or provide robust treatment along several components in series.

The number of treatment stages required depends primarily on the source of the runoff. A Surface Water Drainage Strategy will need to demonstrate that an appropriate number of treatment stages are delivered. This involves determining a pollutant hazard score for each pollutant type. An index is then used to determine the treatment potential of different SuDS features for different pollutant types. This is known as the mitigation index. The Total SuDS mitigation index should be equal or greater than the pollution hazard score to deliver adequate treatment.

9.5.3 Overcoming SuDS constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints. These should be taken into account and reflected upon during the conceptual, outline and detailed stages of SuDS design. Table 9-2 details some possible constraints and how they may be overcome.

Table 9-2: Example SuDS design constraints and possible solutions

Considerations	Solution
Land availability	
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.
High groundwater levels	
Steep slopes	Check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows.
Shallow slopes	
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and dictate whether infiltration would be suitable or not.
Sites with deep backfill	
Open space in floodplain zones	Design decisions should be done to take into consideration the likely high groundwater table and possible high flows and water levels. Features should also seek to not reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Facts such as siltation after a flood event should also be taken into account during the design phase.
Future adoption and maintenance	

For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough to receive surface run-off waters. A site-specific infiltration test will need to be conducted early on as part of the design of the development in order to determine the impact of groundwater levels on the effectiveness of the drainage system. Groundwater monitoring is also encouraged. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to

groundwater source protection zones (GSPZs) or aquifers, further restrictions may be applicable and guidance should be sought from the LLFA and the Environment Agency.

9.5.4 Managing surface water risk for waterfront developments

The coastline of Adur and Worthing presents a significant challenge for managing storm run-off following heavy rainfall. Storm water typically enters public sewers or piped (culverted) watercourses that drain via gravity to outfalls through the sea defences. These outfalls have tidal flaps to prevent seawater entering into the drains. When the sea level is higher than the base of the tidal flap, water in the drains begins to back up and results in flooding.

West Sussex County Council are investigating this issue in the 'Over the wall' drainage project. The project looks to explore the feasibility, design challenges and potential benefits of directing rooftop drainage for waterfront developments over the sea wall rather than to traditional underground gravity drainage networks.

9.6 Sources of SuDS guidance

C753 CIRIA SuDS Manual (2015)

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

Defra Non-Statutory Technical Guidance (2015)

The guidance was developed by Defra to sit alongside PPG to provide non-statutory standards as to the expected design and performance for SuDS.

In March 2015, the latest guidance was released, providing amendments as to what the LPA should expect from development in order to meet the National standards. The guidance provides a valuable resource for developers and designers, outlining peak flow control, volume control, structural integrity of the SuDS, and flood considerations both within and outside the development as well as maintenance and construction considerations.

The LPA will make reference to these standards when determining whether proposed SuDS are considered reasonably practicable.

DEFRA launched a consultation on a new set of standards intended to supersede this, although as of December 2023 there has been no confirmation of a publication date.

Water, People, Places: A guide for master planning sustainable drainage into developments

West Sussex County Council and partner LLFAs produced a document on SuDS design and guidance, aimed at developers and planners involved in designing small and large developments in the South East of England.

West Sussex County Council LLFA Policy for the Management of Surface Water

This policy outlines the specific requirements that WSCC has for drainage strategies and surface water provisions that development applications within the county should adhere to. The policy statement contains 10 SuDS policies and should be used by developers, professionals and local authorities involved in the development of new or brownfield sites; drainage schemes for major developments; and local planning and land-use policy.

More information and guidance on SuDS is available on the Susdrain website.

9.6.1 Groundwater vulnerability zones

The Environment Agency published groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise the underlying bedrock. The maps show the vulnerability of groundwater at a location based on the hydrological, hydrogeological and soil properties within a one-kilometre grid square.

Two maps are available:

- **Basic groundwater vulnerability map:** this shows the likelihood of a pollutant discharged at ground level (above the soil zone) reaching groundwater for superficial and bedrock aquifers and is expressed as high, medium and low vulnerability.
- **Combined groundwater vulnerability map:** this map displays both the vulnerability and aquifer designation status (principal or secondary). The aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

The groundwater vulnerability maps, which can be viewed on Defra's MAGIC map portal, should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the types of SuDS appropriate to certain areas.

9.6.2 Groundwater Source Protection Zones (GSPZ)

The Environment Agency also defines Groundwater Source Protection Zones in the vicinity of groundwater abstraction points, as shown on Defra's MAGIC map portal. These areas are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks, from any activity that may cause pollution. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. The definition of each zone is shown below:

- **Zone 1 (Inner Protection Zone)** – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.
- **Zone 1c (Inner Protection Zone – subsurface activity only)** – Extends Zone 1 where the aquifer is combined and may be impacted by deep drilling activities.
- **Zone 2 (Outer Protection Zone)** – Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a 250 or 500 meter minimum radius around the source, depending on the size of the abstraction.
- **Zone 2c (Outer Protection Zone – subsurface activity only)** – Extends Zone 2 where the aquifer is confined and may be impacted by deep drilling activities.
- **Zone 3 (Total Catchment)** - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to

aquifer recharge (average recharge multiplied by outcrop area) is >0.75. Individual source protection areas will still be assigned to assist operators in catchment management.

- **Zone 4 (Zone of special interest)** – A fourth zone; SPZ4 or 'Zone of Special Interest' usually represents a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone.

The locations of Groundwater SPZs in the Local Plan areas are shown in Figure 9-3, covering parts of the areas around Shoreham, Broadwater and Salvington to the south of the South Downs National Park.

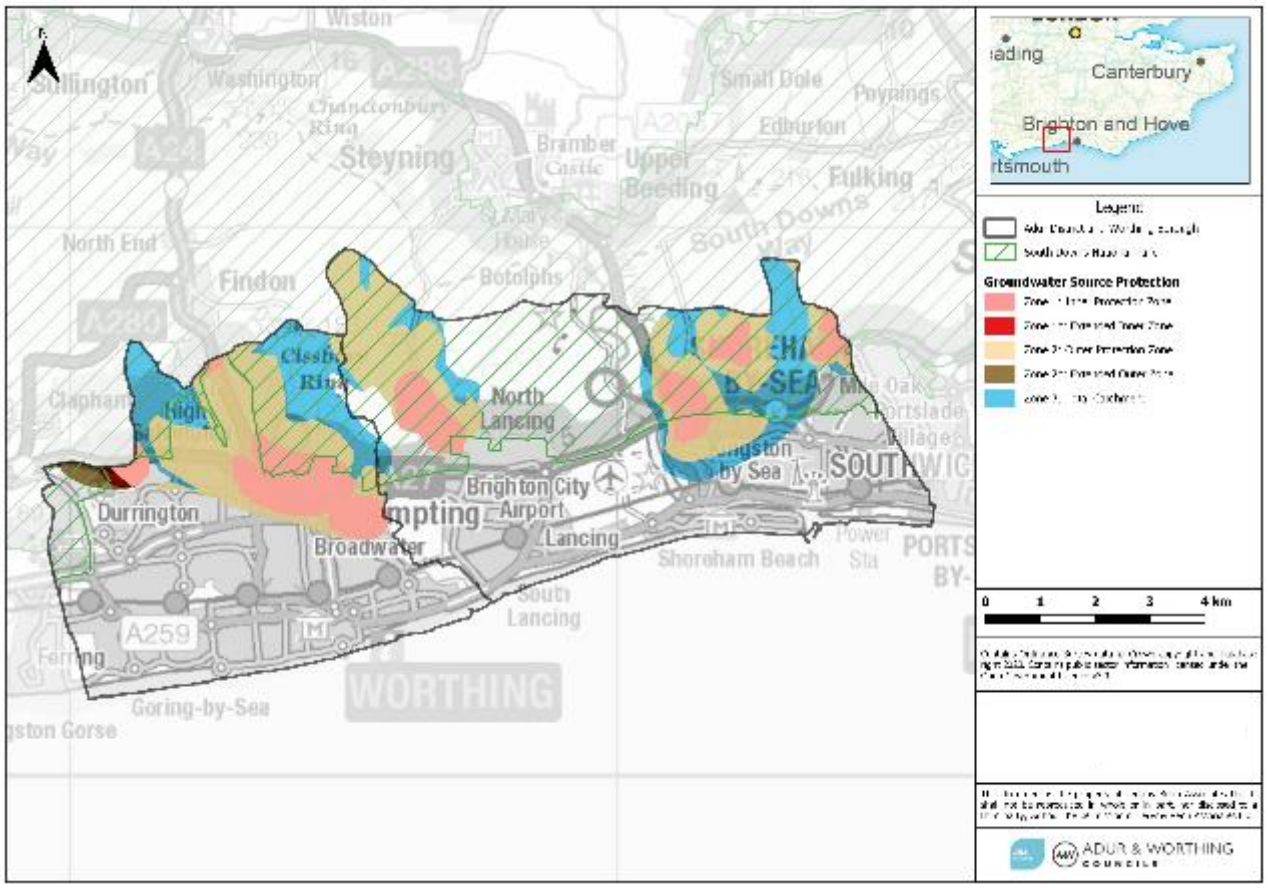


Figure 9-3: Groundwater Source Protection Zones in the Local Plan area

9.6.3 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies. The level of nitrate contamination will potentially influence the choice of SuDS and should be assessed as part of the design process.

The definition of each NVZ is as follows:

- **Groundwater NVZ** – an area of land where groundwater supplies are at risk from containing nitrate concentrations exceeding the 50mg/l level dictated by the EU's Surface Water Abstraction Directive (1975) and Nitrates Directive (1991).
- **Surface Water NVZ** – an area of land where surface waters (in particular those used or intended for the abstraction of drinking water) are at risk from containing nitrate concentrations exceeding the 50 mg/l dictated by the EU's Surface Water Abstraction Directive (1975) and Nitrate Directive (1991).
- **Eutrophic NVZ** – an area of land where nitrate concentrations are such that they could/will trigger the eutrophication of freshwater bodies, estuaries, coastal waters and marine waters.

The locations of the Nitrate Vulnerable Zones in the Local Plan areas are shown in Figure 9-4. There are only groundwater NVZ's in the study area, covering most of Adur District and parts of Worthing Borough.

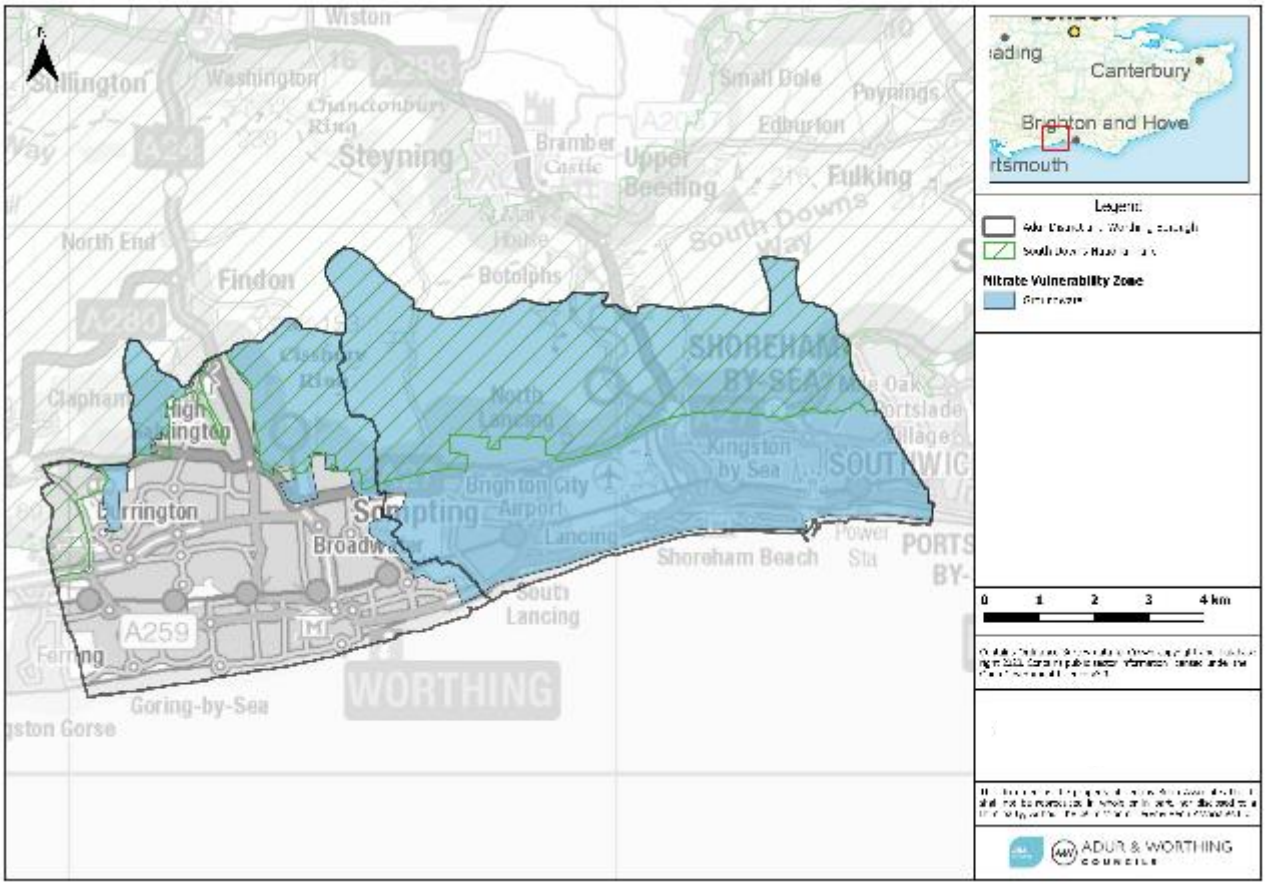


Figure 9-4: Nitrate Vulnerability Zones in the Local Plan area

10 Flood Warning and Emergency Planning

10.1 Emergency planning

Emergency planning is one option to help manage flood related incidents. From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding.

In development planning, a number of emergency planning activities are already integrated in national building control and planning policies e.g. the NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. Flood warning and emergency planning is a last resort after using this SFRA to undertake the Sequential Test appropriately first.

However; safety is a key consideration for any new development and includes residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.

The Association of Directors of Environment, Economy, Planning and Transport (ADEPT) and the Environment Agency have published a Flood Risk Emergency Plans for New Development document which provides guidance for Local Planning Authorities regarding their decisions over planning applications.

The NPPF Planning Practice Guidance outlines how developers can ensure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test. As part of an FRA, the developer should review the acceptability of the proposed access in consultation with the LPA and the Environment Agency.

There are circumstances where a flood warning and evacuation plan[19] is required and / or advised:

- It is a requirement under the NPPF that safe access and escape routes are included in an FRA where appropriate, for example where escape routes are at risk of flooding, as part of an agreed emergency plan.
- The Environment Agency and Defra's standing advice for undertaking flood risk assessments for planning applications states that details of emergency escape plans will be required for any parts of the building that are below the estimated flood level.

It is recommended that Emergency Planners at Adur and Worthing Councils are consulted prior to the production of any emergency flood plan.

[19] Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

In addition to the flood warning and evacuation plan considerations listed in the NPPF / PPG, it is advisable that developers also acknowledge the following:

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided e.g. managing the residual risk of a breach.
- Proposed new development that places additional burden on the existing response capacity of the Councils will not normally be considered to be appropriate.
- Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.
- The vulnerability of site occupants.
- Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain “in-situ” and / or move to a higher floor or safe refuge area (e.g. at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment should be carried out by a developer to help develop emergency plans.

Further emergency planning information links:

- 2004 Civil Contingencies Act
- DEFRA (2014) National Flood Emergency Framework for England
- Sign up for Flood Warnings with the Environment Agency
- National Flood Forum
- GOV.UK Make a Flood Plan guidance and templates
- FloodRe

10.2 Flood warning systems

Flood warnings can be derived and, along with evacuation plans, can inform emergency flood plans or flood response plans. The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers) and coastal flooding in England. Flood Warnings are supplied via the Flood Warning Service (FWS), to homes and business within Flood Zones 2 and 3. The different levels of warnings are shown in

Table 10-1.

Table 10-1: Environment Agency Warnings

Flood Warning Symbol	What it means	What to do
	Flood Alerts are used to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early preparations. It is issued earlier than a flood warning, to give customers advance notice of the possibility of flooding, but before there is full confidence that flooding in Flood Warning Areas is expected.	• Be prepared to act on your flood plan • Prepare a flood kit of essential • items • Monitor local water levels and the flood forecast on the Environment Agency website • Stay tuned to local radio or TV • Alert your neighbours • Check pets and livestock • Reconsider travel plans
	Flood Warnings warn people of expected flooding and encourage them to take action to protect themselves and their property.	• Move family, pets and valuables to a safe place • Turn off gas, electricity and water supplies if safe to do so • Seal up ventilation system if safe to do so • Put flood protection equipment in place • Be ready should you need to evacuate from your home • 'Go In, Stay In, Tune In'
	Severe Flood Warnings warn people of expected severe flooding where there is a significant threat to life.	• Stay in a safe place with a means of escape • Co-operate with the emergency services and local authorities • Call 999 if you are in immediate danger
Warnings no longer in force	Informs people that river or sea conditions begin to return to normal and no further flooding is expected in the area. People should remain careful as flood water may still be around for several days.	• Be careful. Flood water may still be around for several days • If you've been flooded, ring your insurance company as soon as possible

It is the responsibility of individuals to sign-up to this service in order to receive the flood warnings via FWS. Registration and the service is free and publicly available through https://www.gov.uk/sign-up-for-flood-warnings or by calling 0345 988 1188.

It is recommended that any household considered at risk of flooding signs-up. Developers should also encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.

10.2.1 Flood Alert and Warning Areas in the Local Plan area

There are currently four Flood Alert Areas (FAAs) and four Flood Warning Areas (FWAs). These are displayed in Appendix M. A list of the FAAs in the study area are shown in

Table 10-2 and a list of FWAs are shown in Table 10-3.

Table 10-2: Flood Alert Areas within the Adur and Worthing study area

Flood Alert Code	Flood Alert Name	Waterbody	Description
065WAC407	Coastal areas of Rustington to Shoreham	English Channel	Coastal areas of Rustington to Shoreham fort including Ferring, Worthing, Lancing and Shoreham Beach
065WAC408	Tidal areas of Shoreham Harbour	English Channel	Tidal areas of Shoreham Harbour including Shoreham Airport, Shoreham High Street, areas of Riverside Road and Shoreham Harbour
065WAC409	Inland areas of Shoreham, Lancing and Southwick	English Channel	Areas of Shoreham at risk from a high tide including Eastern parts of North and South Lancing, Broadway and Willowbrook caravan parks, Adur recreation ground, Old Shoreham Road, Beach Green and Aldrington Basin
065WAF434	Lower Adur	River Adur	The Lower Adur and tributaries from Henfield to Shoreham-by-Sea

Table 10-3: Flood Warning Areas within the Adur and Worthing Local Plan areas

Flood Warning Code	Flood Warning Name	Waterbody	Description
065FWC2801	Rustington, Worthing and Lancing	English Channel	Coastal areas of Rustington, Ferring, Worthing and Lancing
065FWC2901	Shoreham Beach	English Channel	Beach front areas of Shoreham Beach
065FWC3001	Shoreham Harbour	English Channel	Tidal areas of Shoreham Harbour including Shoreham Airport, Shoreham high street, areas of Riverside Road and Shoreham Harbour East arm
065FWC3002	Shoreham Town and Lancing	English Channel	Areas of Shoreham at risk from a high tide including Eastern parts of North and South Lancing, Broadway and Willowbrook caravan parks, Adur recreation ground, Old Shoreham Road, Beach Green and Aldrington Basin

10.2.2 Local arrangements for managing flood risk

The public copy of the Adur and Worthing Council Emergency Plan details the responsibilities of the councils during a flood event in their role as a Category 1 Responder under the Civil Contingencies Act. The Sussex Resilience Forum have a Part 1 Multi-Agency Flood Plan (MAFP) that is prepared and maintained with assistance from West Sussex County Council, setting out the framework for the response of different responders' council to a flood event. Additionally, Adur and Worthing Councils have a Part 2 MAFP that is tailored to their Local Authority areas.

The West Sussex County Council Guide to Flooding provides information on emergency planning, property level and community resilience and advice for how to respond to flooding. Additionally, the Sussex Resilience Forum website contains information on how to prepare for and respond to emergencies in the local area.

10.3 Emergency planning and development

10.3.1 NPPF

The NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. It is essential that any development which will be required to remain operational during a flood event is located in the lowest flood risk zones to ensure that, in an emergency, operations are not impacted upon by flood water, or that such infrastructure is resistant to the effects of flooding such that it remains serviceable/operational during 'upper end' events, as defined in the Environment Agency's Climate Change allowances. For example, the NPPF classifies police, ambulance and fire stations and command centres that are required to be operational during flooding as Highly Vulnerable development, which is not permitted in Flood Zones 3a and 3b and only permitted in Flood Zone 2 providing the Exception Test is passed. Essential infrastructure located in Flood Zone 3a or 3b must be operational during a flood event to assist in the emergency evacuation process. All flood sources such as fluvial, surface water, groundwater, sewers and artificial sources (such as canals and reservoirs) should be considered.

The outputs of this SFRA should be compared and reviewed against any emergency plans and continuity arrangements. This includes the nominated rest and reception centres (and prospective ones), so that evacuees are outside of the high-risk Flood Zones and will be safe during a flood event.

10.3.2 Safe access and egress

The NPPF Planning Practice Guidance outlines how developers can secure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test[20]. Access considerations should include the voluntary and free movement of people during a 'design flood' as well as for the potential of evacuation before a more extreme flood. The access and egress must be functional for changing circumstances over the lifetime of the development. The NPPF Planning Practice Guidance sets out that:

- Access routes should allow occupants to safely access and exit their dwellings in design flood conditions. In addition, vehicular access (no more than 300mm depth along access routes or 1.5m/s velocity) for emergency services to safely reach development in design flood conditions is normally required.
- Where possible, safe access routes should be located above design flood levels and avoid flow paths including those caused by exceedance and blockage. Where this is unavoidable, limited depths of flooding may be acceptable providing the proposed access is designed with appropriate signage etc. to make it safe. The acceptable flood depth for safe access will vary as this will be dependent on flood velocities and risk of

[20] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 039, Reference ID: 7-056-20140306) March 2014

debris in the flood water. Even low levels of flooding can pose a risk to people in situ (because of, for example, the presence of unseen hazards and contaminants in floodwater, or the risk that people remaining may require medical attention).

The depth, velocity and hazard mapping from hydraulic modelling, which should form part of a site specific Flood Risk Assessment, should help inform the provision of safe access and egress routes.

As part of an FRA, the developer should review the acceptability of the proposed access in consultation with Adur and Worthing Councils and the Environment Agency. Site and plot specific velocity and depth of flows should be assessed against standard hazard criteria to ensure safe access and egress can be achieved.

10.3.3 Potential evacuations

During flood incidents, evacuation may be considered necessary. The NPPF Planning Guidance states practicality of safe evacuation from an area will depend on[21]:

1. the type of flood risk present, and the extent to which advance warning can be given in a flood event;
2. the number of people that would require evacuation from the area potentially at risk;
3. the adequacy of both evacuation routes and identified places that people could be evacuated to (and taking into account the length of time that the evacuation may need to last); and
4. sufficiently detailed and up to date evacuation plans being in place for the locality that address these and related issues.

The vulnerability of the occupants is also a key consideration. The NPPF and application of the Sequential Test aims to avoid inappropriate development in flood risk areas. However, developments may contain proposals for mixed use on the same site. In this instance, the NPPF Planning Practice Guidance states that layouts should be designed so that the most vulnerable uses are restricted to higher ground at lower risk of flooding, with development which has a lower vulnerability (parking, open space etc.) in the highest risk areas, unless there are overriding reasons to prefer a different location[22]. Where the overriding reasons cannot be avoided, safe and practical evacuation routes must be identified.

The Environment Agency and Defra provide standing advice for undertaking flood risk assessments for planning applications. Please refer to the government website for the criteria on when to follow the standing advice. Under these criteria, you will need to provide details of emergency escape plans for any parts of the building that are below the estimated flood level.

[21] NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 044, Reference ID: 7-057-20140306) August 2022

[22] NPPF Planning Practice Guidance, Reducing the causes and impacts of flooding (Paragraph: 004 Reference ID: 7-053-20140306) August 2022

The plans should show that:

- single storey buildings or ground floors that do not have access to higher floors can access a space above the estimated flood level, e.g. higher ground nearby;
- basement rooms have clear internal access to an upper level, e.g. a staircase; and
- occupants can leave the building if there is a flood and there is enough time for them to leave after flood warnings[23].

Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. developments located immediately behind a defence and at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop appropriate emergency plans.

10.3.4 Flood warning and evacuation plans

Flood warning and evacuation plans are potential mitigation measures to manage the residual risk, as stated in the NPPF Planning Practice Guidance. It is a requirement under the NPPF that a flood warning and evacuation plan is prepared for sites at risk of flooding that are used for holiday or short-let caravans and camping and it is important at any site that has transient occupants (e.g. hostels and hotels). While not specifically stated within the NPPF PPG, flood warning and evacuation plans should also be prepared for sites used by gypsies, travellers and travelling show people where these sites are at risk of flooding.

A flood warning and evacuation plan should detail arrangements for site occupants on what to do before, during and after a flood as this will help to lessen its impact, improve flood response and speed up the recovery process. The Environment Agency provides practical advice and templates on how to prepare flood plans for individuals, communities and businesses (see box below for useful links).

It is recommended that emergency planners at Adur and Worthing Councils are consulted prior to the production of any emergency flood plan. West Sussex County Council and the Environment Agency provide guidance to help local communities to protect their home and valuables and understand what to do before, during and after a flood.

Once the emergency flood plan is prepared, it is recommended that it is distributed to emergency planners at Adur and Worthing Councils and the emergency services. When developing a flood warning and evacuation plan, it is recommended that it links in with any existing parish / community level plan. Local Parish Council's should be contacted to establish a community level plan exists for an area.

[23] Environment Agency and DEFRA (2012) Flood Risk Assessment: Standing Advice: https://www.gov.uk/flood-risk-assessment-standing-advice

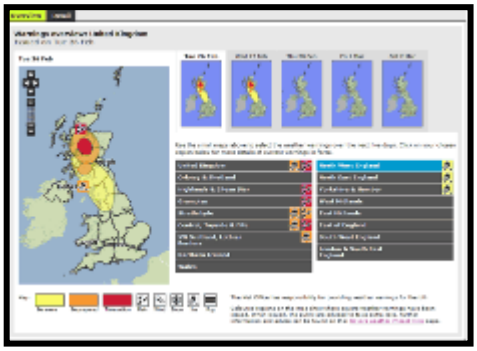
Guidance documents for preparation of flood response plans

- Environment Agency (2012) Flooding – minimising the risk, flood plan guidance for communities and groups
- Environment Agency Personal flood plans (2017)
- Association of Directors of Environment, Economy, Planning & Transport (ADEPT) /EA Flood Risk Emergency Plans for New Development (2019)

10.3.5 Other sources of information

The joint guidance on flood risk emergency plans for new development which has been produced between the Environment Agency and the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) aims to support robust consideration of whether proposed development will be safe. The guidance will help developers and their consultants produce suitable emergency plans.

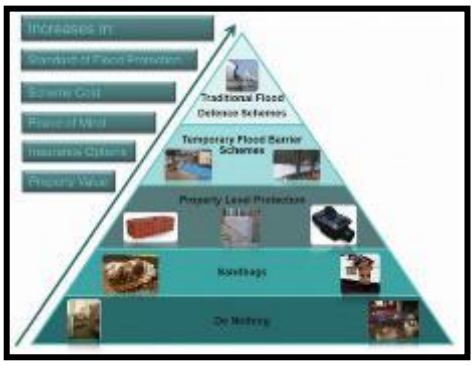
As well as being a statutory consultee for new development at risk of flooding, the Environment Agency can offer independent technical advice. The Environment Agency website contains a breadth of information on flood risk and there are numerous publications and guidance available. For example, the "flooding from groundwater" guide has been produced by the Environment Agency and Local Government Association to offer practice advice to reduce the impact of flooding from groundwater.



The Met Office provides a National Severe Weather Warning Service about rain, snow, wind, fog and ice. The severity of warning is dependent upon the combination of the likelihood of the event happening and the impact the conditions may have. In simplistic terms, the warnings mean: Yellow: Be Aware, Amber: Be Prepared, Red: Take Action. This service does not provide flood warnings. The

Met Office provide many other services and products. For further information, please visit their website.

The National Flood Forum (NFF) is a national charity, set up in 2002 to support those at risk and affected by flooding. The NFF helps people to prepare and recover from flooding as well as campaigning on behalf of flood risk communities, including providing advice on matters such as insurance.



Individual property flood resilience protection (PFR) measures are designed to help protect homes and businesses from flooding. These include a combination of flood resistance measures - trying to prevent water ingress – and flood resilience measures - trying to limit the damage and reduce the impact of flooding, should water enter the building. It is important that any measures have the BSI Kitemark. This shows that the measure has been tested and ensures that it meets industry standards. Please visit the Government website: “Prepare for flooding” for more information.

11 Strategic flood risk solutions

11.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the Local Plan areas. The following sections outline different options which could be considered for strategic flood risk solutions. Any strategic solutions should ensure they are consistent with wider catchment policy and the local policies. It is important that the ability to deliver strategic solutions in the future is not compromised by the location of proposed development. When assessing the extent and location of proposed development, consideration should be given to the requirement to secure land for flood risk management measures that provide wider benefits. Funding for these solutions could be sought via S106 agreements or the Community Infrastructure Levy (CIL).

11.2 Flood storage schemes

Flood storage schemes aim to reduce the flows passed down river to mitigate downstream flooding. Development increases the impermeable area within a catchment, creating additional and faster runoff into watercourses. Flood storage schemes aim to detain this additional runoff, releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include[24]:

- Enlarging the river channel
- Raising the riverbanks
- Constructing flood banks set back from the river

Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area.

11.2.1 Promotion of SuDS

By considering SuDS at an early stage in the development of a site, the risk from surface water can be mitigated to a certain extent within the site as well as reduce the risk that the site poses to third party land. Regionally, SuDS should be promoted on all new developments to ensure the quantity and quality of surface water is dealt with sustainably in order to reduce flood risk. The policies and guidance produced by WSCC as the LLFA (summarised in Section 9) should be used by developers to produce technically proficient and sustainable drainage solutions that conform with the non-statutory standards for SuDS (2015).

[24] Environment Agency: Fluvial Design Guide – Chapter 10 (2010)

11.3 Natural Flood Management

Development can provide opportunities to work with natural processes to help reduce flood and erosion risk, benefit the natural environment and reduce costs of schemes. This is known as Natural flood management, a process whereby action is taken to mitigate flood risk by protecting, restoring and emulating natural processes. This approach aims to reduce flow volumes and delay the arrival of peak flood flow downstream.

This requires integrated catchment management and the involvement of those who use and shape the land, as well as partnership working with neighbouring authorities, organisations and water management bodies. The Environment Agency has developed Natural Flood Management (NFM) mapping which displays opportunities for NFM.

Conventional flood prevention schemes may be preferred, but consideration of 'rewilding' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example. With flood prevention schemes, consideration needs to be given to the impact that flood prevention has on the WFD status of watercourses. It is important that any potential schemes do not have a negative impact on the ecological and chemical status of waterbodies.

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

The opportunities within Adur District and Worthing Borough are limited by the lack of open space. However, there are opportunities for tree planting on the riparian zone, floodplain and wider catchment around Ferring Rife, Broadwater Brook and the River Adur, as well as potential floodplain reconnection and runoff attenuation features.

11.3.1 Catchment and Floodplain restoration

Compared to flood defences and flood storage, floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains working with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures should be adopted:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the river and the floodplain
- Apply the Sequential Approach to avoid new development within the floodplain.

For sites considered for development that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these

watercourses. This will ensure the watercourses retain their connectivity to the floodplain, with any losses of floodplain connectivity potentially increasing flooding.

Broadwater Brook (Teville Stream) underwent a restoration scheme involving the realignment of the channel to increase the capacity of the channel for flood flows, improve the water quality and enhance biodiversity.

11.3.2 Structure Removal and/ or modification (e.g. Weirs)

Structures, both within watercourses and adjacent to them can have significant impacts upon rivers including alterations to the geomorphology and hydraulics of the channel through water impoundment and altering sediment transfer regime, which over time can significantly impact the channel profile including bed and bank levels, alterations to flow regime and interruption of biological connectivity, including the passage of fish and invertebrates.

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose and opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring natural river processes, habitats and connectivity are vital adaptation measures. However, it also must be recognised that some artificial structures may have important functions or historical/cultural associations, which need to be considered carefully when planning and designing restoration work.

In the case of weirs, whilst weir removal should be investigated in the first instance, in some cases it may be necessary to modify a weir rather than remove it. For example, by lowering the weir crest level or adding a fish pass. This will allow more natural water level variations upstream of the weir and remove a barrier to fish migration.

In line with the PPG, proposals to introduce new culverting or to build on top of existing culverting are likely to have adverse impacts on flood risk and is likely to oppose the objectives of River Basin Management Plans and as a result is discouraged.

11.3.3 Bank Stabilisation

Bank erosion should be avoided, and landowners are encouraged to avoid using machinery and vehicles close to or within the watercourse unless in the circumstances where machinery and vehicles are required for watercourse maintenance such as desilting. Care should be taken not to destabilise the banks.

There are several techniques that can be employed to restrict the erosion of the banks of a watercourse. In an area where bankside erosion is particularly bad and/or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow spiling, can be particularly effective. Live willow stakes thrive in the moist environment and protect the soils from further erosion allowing other vegetation to establish and protect the soils. Other approaches include the planting of brash or small trees, large wood, large trees and roots wads.

11.3.4 Re-naturalisation

There is potential to re-naturalise a watercourse by re-profiling the channel, removing hard defences, re-connecting the channel with its floodplain and introducing a more natural morphology (particularly in instances where a watercourse has historically been modified through hard bed modification). Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response to any proposed channel modification.

11.4 Flood defences

There are a number of formal flood and coastal defences present within the study area (see Section 7 for further information). The flood risk at several potential sites identified within Adur District and Worthing Borough could be influenced by the presence of these defences. At these locations it will be important to understand the benefit that defences can have on reducing flooding, and consequences if their design standard is exceeded or they fail. Residual risk of these defences should be understood and managed.

For new development, flood mitigation measures should only be considered if, after application of the Sequential Approach, development sites cannot be located away from higher risk areas. If defences are specifically constructed to protect a development site, it will need to be demonstrated that the defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage. Maintenance arrangements, including funding mechanisms, for the defences will need to be evidenced for the lifetime of development.

11.5 Land raising

Increasing the elevation of land for whole or parts of the sites could be implemented to prevent flood flows affecting the land up to the design level. The elevation selected could be determined to coincide with the re-designation of the site (or part of the site) from one Flood Zone to another (e.g. from Flood Zone 3a to Flood Zone 2). Raising of land which floods would reduce the volume of storage on the fluvial floodplain in a flood event. Such ground level adjustments would therefore require level for level and volume for volume floodplain compensation (so no loss of floodplain storage occurs) and also analysis, to evidence that the increase in ground levels does not result in adverse changes in flood risk (or other environmental issues) elsewhere, e.g. through deflection of flood water or loss of conveyance.

In low-lying areas of land with little topographic gradient it is likely that conveyance of fluvial flood water may be less critical than the loss of floodplain volume, whereas in areas with greater topographic gradient, conveyance may become more critical. For tidal/coastal areas, flood volumes may be less critical given the role of the tidal ingress or coastal water levels. However, conveyance and constriction may be a critical consideration if the development obstructs the ingress or outflow of tidal water potentially leading to deflection of water and elevation of water levels from the pre-development case.

11.6 Green infrastructure

Green infrastructure (GI) is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe and consist of:

- Open spaces – parks, woodland, nature reserves, lakes
- Linkages – River corridors and canals, and pathways, cycle routes and greenways
- Networks of “urban green” – private gardens, street trees, verges and green roofs.

The identification and planning of Green Infrastructure is critical to achieving sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. GI is also central to climate change action and is a recurring theme in planning policy. With regards to flood risk, green spaces can be used to manage storm flows and free up water storage capacity in existing infrastructure to reduce risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. Green infrastructure can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity.

The adopted Adur Local Plan (2017) and Worthing Local Plan (2023) both contain a policy on GI (Policy 30 and Policy DM19 respectively) encouraging the creation of a Green Infrastructure network in and around the area. Both policies state that all major developments are required to demonstrate how they will contribute to the implementation of GI.

With Green Infrastructure, connectivity to the wider GI networks is quintessential. In this regard, all opportunities to further GI through flood risk management measures should exploit to the full opportunities to further the quality of wider GI networks, not least that embodied within the Southern People & Nature Network. Adur and Worthing Council has formally endorsed the South Downs GI Framework and formed part of the Technical Working Group that developed it.

11.7 Engaging with key stakeholders

Flood risk to an area or development can often be attributed to a number of sources including fluvial, surface water and/or groundwater. In rural areas the definition between each type of flood risk is more distinguished. However, within urban areas flooding from multiple sources can become intertwined. Where complex flood risk issues are highlighted, it is important that all stakeholders are actively encouraged to work together to identify issues and provide suitable solutions.

Engagement with riparian owners is also important to ensure they understand their rights and responsibilities including:

- maintaining the riverbed and banks
- allowing the flow of water to pass without obstruction; and
- controlling invasive alien species e.g. Japanese knotweed.

More information about riparian owner responsibilities can be found in the Environment Agency's guidance on Owning a Watercourse (2018).

12 Level 1 summary assessment of potential development locations

12.1 Introduction

This section details the site screening of potential development sites that was carried out as part of the Level 1 SFRA. Please refer to Appendix N which displays the site screening for Adur District Council, Worthing Borough sites have not been included as part of the site screening as the Local Plan for Worthing has already been published.

A total of 37 sites were provided by Adur District Council as displayed in Figure 12-1. They have been screened against a suite of available flood risk information and spatial data to provide a summary of flood risk to each site.

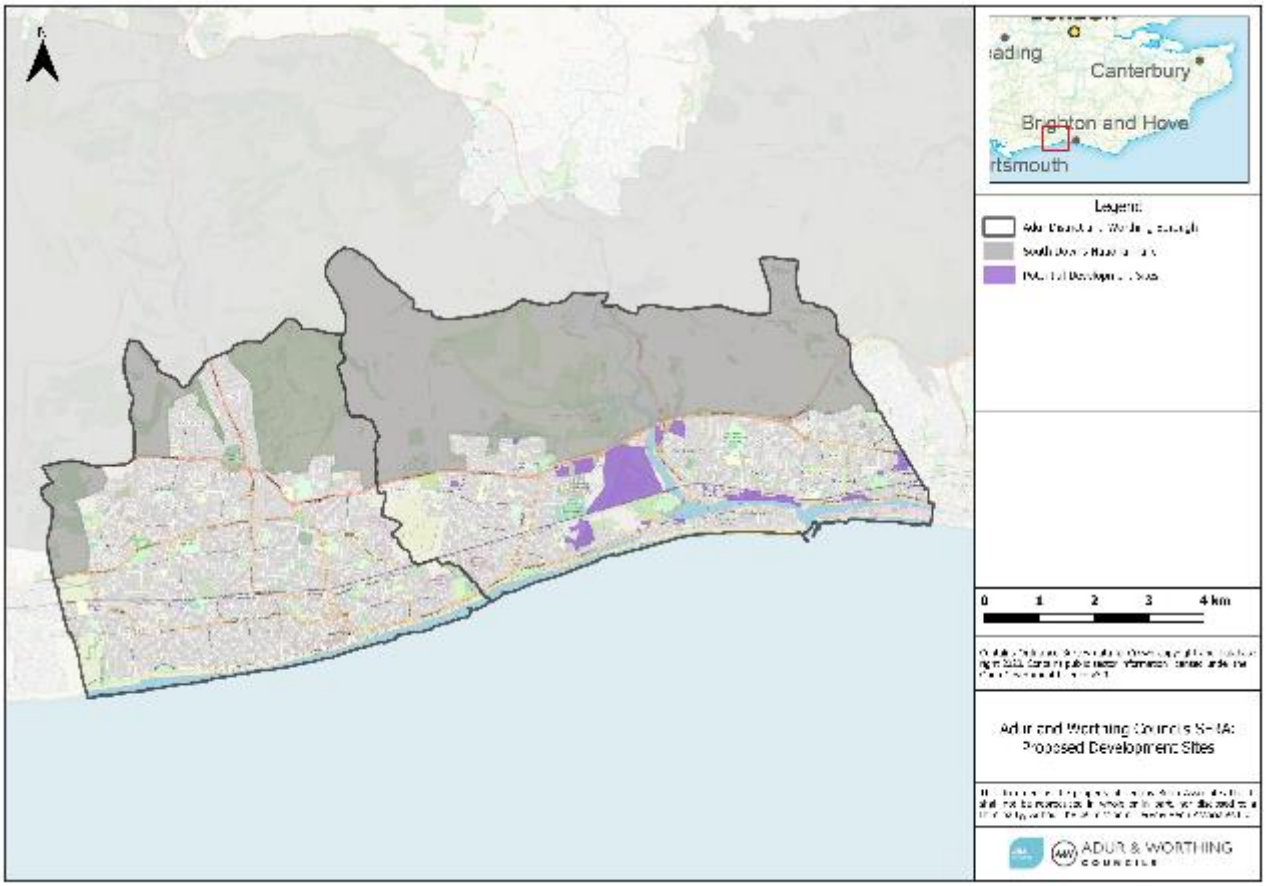


Figure 12-1: The 37 sites within Adur District Council screened as part of this Level 1 SFRA.

The information considered includes the flood risk datasets listed below (Table 12-1).

Table 12-1: Datasets screened as part of this Level 1 SFRA.

Flood Risk	Dataset	Layers Screened
Fluvial and tidal	Flood Map for Planning	Flood Zones 1, 2 and 3
	Present Day SFRA Flood Zones	Flood Zones 1, 2, 3a and 3b
	Fluvial and Tidal Flood Risk plus Climate Change	
Surface Water	Environment Agency Risk of Flooding from Surface Water	3.3% AEP 1% AEP 0.1% AEP
	Climate change uplifted Environment Agency Risk of Flooding from Surface Water	

Flood Risk	Dataset	Layers Screened
		0.1% AEP plus 25% climate change (2070s central allowance) 0.1% AEP plus 45% climate change (2070s upper end allowance)
Reservoir	Environment Agency's Risk of Flooding from Reservoirs	Dry day Wet Day
Groundwater	JBA Groundwater Emergence Flood Risk	High Risk (within 0- 0.025m of ground surface, grid code 4) Moderate risk (within 0.025- 0.05m of ground surface, grid code 3)
Historic Flooding	Environment Agency's Historic Flood Map	
	West Sussex County Council's Flood Incident Database (pre-2020)	
Tidally Influenced Risk Zones	Tidally influenced drainage risk zone	
	Tidally influenced groundwater risk zone	

A site screening spreadsheet has been prepared which identifies the proportion of each site that is affected by the different sources of flooding. The information provided is intended to enable a more informed consideration of the sites when applying the sequential approach. The site screening spreadsheet has been used to determine whether more detailed assessment of sites is needed to further identify those that should be taken forward as potential development allocations for a Level 2 assessment.

12.2 Overview of identified sites

A summary of flood risk at each of the sites in light of the screening is provided below:

- Half of all screened sites have SFRA Flood Zone 1 comprising the largest proportion of their area, with 14 sites completely located within SFRA Flood Zone 1.
- 21 sites are wholly or partially located in SFRA Flood Zone 2.
- 20 sites are wholly or partially located in SFRA Flood Zone 3a.
- Five sites are partially located in SFRA Flood Zone 3b.
- 27 sites are predicted to be at risk during a present day 0.1% AEP surface water flood event.
- 13 sites are predicted to be at risk during a current day 1% AEP surface water flood event.
- Five sites are predicted to be at risk during a current day 3.3% AEP surface water flood event.

- Four sites intersect with the Environment Agency's Historic Flood Map outlines.
- Eight sites are classed as being partially located within a 'high risk' groundwater emergence flood risk zone (groundwater within 0-0.025m of the ground surface).
- Nine sites are classed as being in the maximum risk tidally influenced drainage risk zone, and eight sites are classed as being in the maximum risk tidally influenced groundwater risk zone.

12.3 Sequential Testing

This SFRA does not include the Sequential Test of the development sites that were screened, as this is described under separate cover. However, Appendix N summarises the flood risk to the potential and confirmed development sites and provides evidence for use in the completion of the Sequential Test.

Inclusion of the potential development sites in the SFRA does not imply that development can be permitted without further consideration of the Sequential Test. The required evidence should be prepared as part of a Local Plan Review Sustainability Appraisal or alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPF Planning Practice Guidance for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a Local Plan Review. The assessments undertaken for this SFRA will assist Adur District and Worthing Borough Council in the preparation of the Sequential Test.

12.4 Cumulative impacts of development on flood risk

Cumulative impacts are defined as the effects of past, current and future activities on the environment. Under the NPPF, strategic policies and their supporting SFRAs, are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para 166).

When allocating land for development, consideration should be given to the potential cumulative impact on flood risk within a catchment. Development increases the impermeable area within a catchment, which if not properly managed, can cause loss of floodplain storage, increased volumes and velocities of surface water runoff, and result in heightened downstream flood risk. Whilst individual development with appropriate site mitigation measures should not result in measurable local effects with respect to hydrology and flood risk, the cumulative effect of multiple development may be more severe at sensitive downstream locations in the catchment. Locations where there are existing flood risk issues with people, property or infrastructure will be particularly sensitive to cumulative effects.

The cumulative impact should be considered throughout the planning process, from the allocation of sites within the Local Plan, to the planning application and development design stages.

Site-specific FRAs must consider the cumulative impact of the proposed development on flood risk within the wider catchment area if there are potentially material effects.

As part of the Level 1 SFRA, an assessment of the cumulative effects within catchments in Adur and Worthing Councils boundary has been undertaken.

12.4.1 Approach and methodology

The approach is based on providing an assessment of catchments where the allocation of more than one site could result in effects that increase the flood risk to third parties. At a strategic level this involves comparison of catchments, to assess the quantum of proposed development and the sensitivity of the catchment to changes in flood risk. Historic flooding incidents are also included in the assessment, as these are an indicator of the actual sensitivity of locations within a catchment to flood events.

The methodology deploys a range of metrics to assess the potential cumulative impacts, which provide a balance between predicted and observed flooding data recorded by West Sussex County Council and the Environment Agency. In addition, it was considered important to identify those catchments where an increase in flows (as a result of development) would potentially have the greatest impact upon downstream flood risk.

12.4.2 Datasets

Catchments

The WFD river catchments defined in the River Basin Management Plans and LIDAR data were used to divide Adur and Worthing Councils' boundary and surrounding local authorities into manageable areas on which to base a cumulative impact assessment. The surrounding local authorities and LPAs included in the CIA are:

- Arun District
- Brighton and Hove
- Horsham
- South Downs National Park Authority (SNPA)

The catchments used in this CIA are displayed in Figure 12-2.

Current developed area

OS Open Zoomstack data buildings layer was used to assess the current developed area in each catchment.

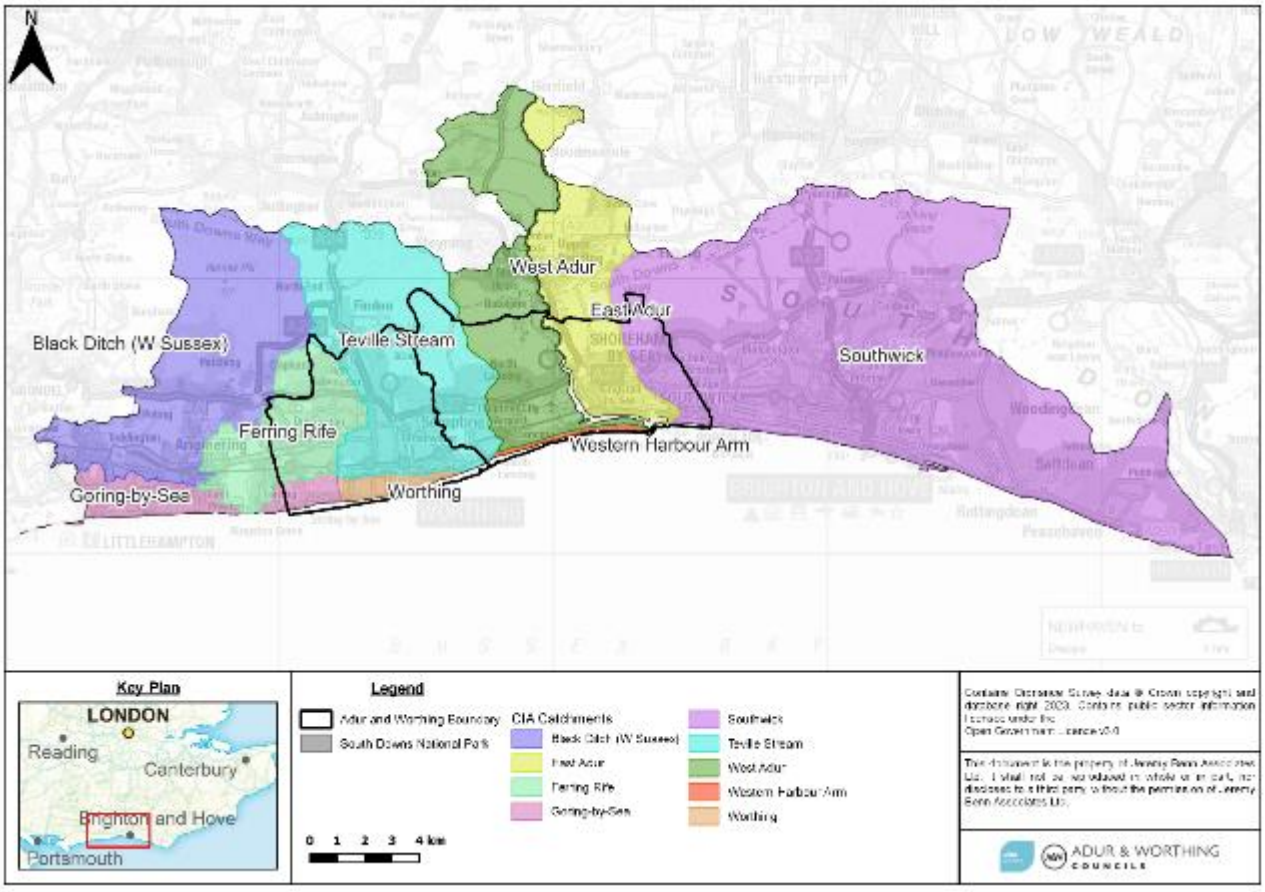


Figure 12-2: Catchments assessed within the Cumulative Impact Assessment for this Level 1 SFRA.

Proposed level of growth

To understand areas of Adur and Worthing Councils boundary that are likely to experience the greatest pressure for future growth, all potential future development sites received for consideration have been analysed. The sites allocated through the Local Plans of neighbouring authorities have also been taken into account within the proposed level of growth for each catchment.

This allowed the calculation of the overall increase in development from the existing scenario to identify catchments likely to be under the greatest pressure from development. The context for this being that in circumstances where the proportion of proposed new development is greater, then it is more likely to give rise to cumulative effects.

It should be noted that it was assumed that all sites will be developed, and that the entire site footprint would be developed.

Historic Flood Risk

A historic flood risk score was derived for each catchment within the study area using the total area of 'buildings' from the OS Open Zoomstack data within the Environment Agency's historic flood map extent for each catchment.

Properties sensitive to increased flood risk

It is important to understand which catchments are most sensitive to increases in flood flows which may theoretically be caused by new development. Predicted flood risk was assessed using the following datasets:

- Total number properties within the merged 1% AEP surface water flooding extent and Flood Zone 3a for each catchment.
- Total number properties within the merged 0.1% AEP surface water flooding extent and Flood Zone 2.

The difference in the number properties at risk in these two datasets has then been used as an indicator to identify which catchments are more sensitive to increases in flood flows.

12.4.3 Ranking of catchments

To identify which catchments are more sensitive to cumulative impacts, each catchment was given a ranking for each of the three metrics (proposed level of growth, historic flood risk and properties sensitive to growth). These rankings were then combined to give an overall ranking which was divided into three categories - high, medium, and low according to how sensitive each catchment is to cumulative impacts relative to one another.

12.4.4 Conclusions from the Cumulative Impact Assessment

A summary of the Cumulative Impacts Assessment results is shown in Figure 12-3. The Cumulative Impact Assessment highlights areas where there is a high chance of encountering cumulative effects from planned development. In these catchments this should be considered by developers and specifically addressed within FRAs for proposed development.

Including consideration of cumulative effects requires that FRAs should assess:

- The location and sensitivity of receptors to cumulative effects and the mechanisms that potentially result in flooding (e.g., locations that are reliant on the performance of pumped drainage systems to manage flood risk, locations where existing flooding is experienced and can be exacerbated by relatively small changes in flood flow magnitude, volume, or flood duration, etc).
- The potential quantum of proposed cumulative development within a River Basin and assessment of the effect on sensitive receptors of the cumulative benefit afforded by piecemeal mitigation at the respective allocation sites.
- The requirement for measures to address potential cumulative effects (these can be both 'on-site' measures and contributions to strategic 'off-site' measures).

- The opportunity to integrate site mitigation measures with strategic flood risk management measures planned in the River Basin.
- The long-term commitments to management and maintenance.

12.4.5 Next steps

The Cumulative Impact Assessment is used in the following ways:

- The assessment highlights the catchments in Adur and Worthing Council's boundary where the cumulative impacts of development on flood risk could potentially be greatest. Developers and Adur and Worthing Councils should take the assessment into consideration when identifying appropriate sites for development.
- For sites in catchments identified as being at high or medium risk of cumulative impacts FRAs should contain an assessment of the potential cumulative impacts of development further.

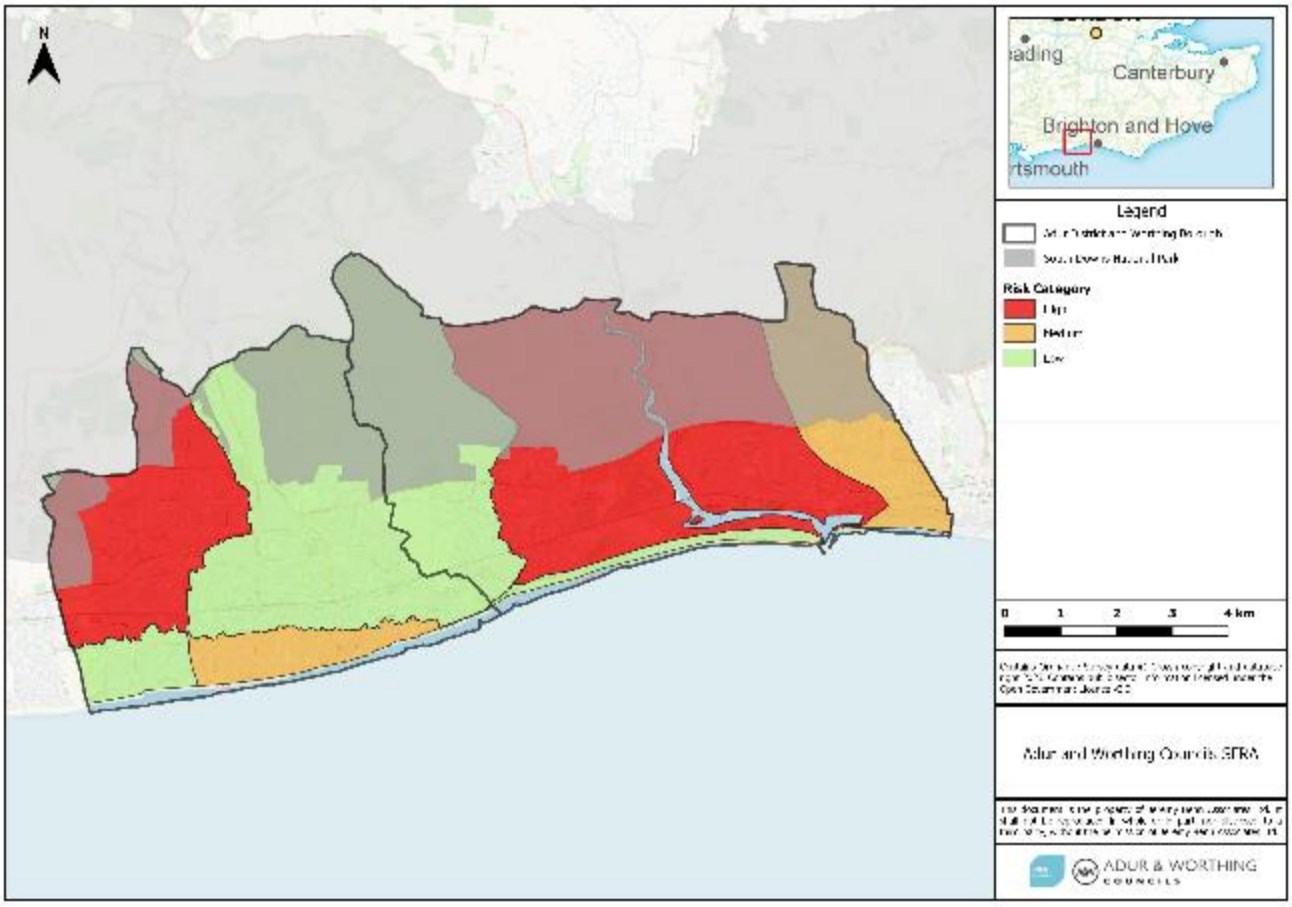


Figure 12-3 Results of Cumulative Impact Assessment

13 Summary

13.1 Overview

This Level 1 SFRA delivers a strategic assessment of all sources of flooding in the Local Plan area. It also provides an overview of policy and provides guidance for planners and developers.

The study area comprises the administration area of Adur District and Worthing Borough Councils.

13.2 Sources of flood risk

13.2.1 Historic flooding

There have been several recorded flood incidents across the area of Adur District and Worthing Borough Councils. The most notable flooding incidents occurred in 2012 where an extreme rainfall event resulted in widespread surface water flooding. Worthing was one of the worst affected areas, with two clusters of properties in West Worthing and Central Worthing affected by the flooding.

13.2.2 Fluvial flood risk

The River Adur, Ferring Rife and Teville Stream are three main watercourses within the study area which are identified to contribute to fluvial flood risk. Flooding on the lower River Adur, Teville Stream and Ferring Rife is influenced by tidal levels, with the potential for tidal locking to occur where incoming high tides prevent fluvial flows from discharging into the sea.

Flood Zone mapping and climate change mapping of the fluvial flood risk in the Local Plan area has been prepared as part of the Level 1 SFRA. The key areas identified to be at risk from fluvial flooding include Shoreham, Lancing, East Worthing, Durrington and Goring. Flooding from ordinary watercourses is also identified to impact Amberley Drive and Aldsworth Avenue areas of Goring.

13.2.3 Tidal flood risk

The study area is bounded to the south by the English Channel. As such, the coastline is at risk of tidal flooding, though the WSCC LFRMS states that tidal flooding is rare within Worthing Borough. However, tidal flooding has been recorded in Lancing and Shoreham due to overtopping of defences. The tidal flood risk to the Local Plan areas has been based on the River Adur Tidal model and the Arun to Adur Coastal model. The River Adur, Ferring Rife and Teville Stream are all at risk of tidal flooding in their lower reaches.

13.2.4 Coastal flood risk

In coastal locations the risk of flooding is linked to the stability of the coastline. If the coast is eroding, then the potential effect is that tidal flood defences near to the sea will be lost and flood risk will increase. The Rivers Arun to Adur flood and erosion management strategy 2010-2020 (2010) identifies a total of 9,800 properties at risk between the River Arun and River Adur. These are located within Goring, Worthing, Brooklands, Shoreham By Sea and the River Adur.

13.2.5 Surface water flood risk

The Risk of Flooding from Surface Water dataset shows that surface water predominantly follows topographical flow paths of existing watercourses, dry valleys or roads, with some areas of ponding in low lying areas, often upslope of railway lines or roads. The areas of greatest risk within the study area include properties within Worthing, Shoreham, Lancing and Sompting. Tide locking is also an issue where high tides prevent surface water from draining from gravity outfalls along the defended coastal plain.

Areas sensitive to increased rainfall intensities and are predicted to be at an increased surface water flood risk in the future include; West Worthing, East Worthing, Durrington, Lancing, Shoreham and Southwick.

An assessment into the impact of sea level rise upon surface water flood risk highlighted areas on the coastline around Marine Crescent and West Parade, East Worthing, East and North Lancing, East Southwick and East Shoreham to have an increase in surface water flood risk due to sea level rise.

13.2.6 Groundwater flood risk

The JBA Groundwater Flood Map identifies a large proportion of the Worthing Borough to be at risk of groundwater emergence flooding with areas of the highest risk within Durrington, Goring and East Worthing. In the Adur District, areas at the highest risk are within Sompting and Lancing, as well as areas of Shoreham. High risk within the study area is as a result of the underlain chalk bedrock and elevated land in the form of the South Downs. Rain can infiltrate the chalk through large fissures into the underlying aquifers and is released slowly through springs further downslope. As such, many of the areas identified as being at the highest risk of groundwater emergence are at the base of the South Downs.

A technical assessment into the impact of sea level rise upon groundwater found that areas located in the East and North Lancing to be most at risk in the future of groundwater risk due to sea level rise.

13.2.7 Sewer flood risk

Historical incidents of sewer flooding are detailed by the Southern Water SIRF. This database records incidents of flooding related to public foul, combined or surface water sewers and identifies which postcode areas have been impacted by flooding. A total of 309 incidents have been recorded.

The sewer flood risk in the Local Plan area is exacerbated by groundwater and tidal water infiltrating into the sewer network and outfalls that can experience tidal locking or back-flow through the system.

13.2.8 Flooding from reservoirs

Outlines from the Risk of Flooding from Reservoirs dataset (informed from the National Reservoir Inundation Mapping study) were used to assess the risk to the study area for worst case inundation of reservoir failure. No risk to the study area was identified from large raised reservoirs.

13.3 Flood defences

A high-level review of formal flood defences was carried out using existing information to provide an indication of their condition and standard of protection. Details of the flood defence locations and condition were provided by the Environment Agency for the purpose of preparing this assessment.

The majority of the River Adur has fluvial and tidal defences along its length, while Ferring Rife and Teville Stream have fluvial defences in some places. The coastline within the Adur District is protected by coastal defences. The majority of defences in Adur District and Worthing Borough provide a standard of protection of at least 4% AEP, with many of the defences in Adur District providing a standard of protection of 1% AEP or greater. However, there are also several areas with a standard of protection of less than 4% AEP, largely along Teville Stream. The Environment Agency defence data shows that most defences within the Local Plan areas are in ‘Good’ or ‘Fair’ condition.

The Environment Agency has recently completed construction of the Shoreham Adur Tidal Walls flood defence scheme. The scheme was designed to update existing flood defences in the Adur estuary which did not provide high enough level of protection and were in poor condition, leaving Shoreham-by-Sea, Lancing and the surrounding areas at risk of flooding. The scheme provides protection of extreme events with 0.33% probability (1-in-300-year), allowing for 50 years of sea level rise.

13.4 Key policies

There are many relevant regional and local key policies which have been considered within the SFRA, such as the Shoreline Management Plans for Beachy Head to Selsey Bill, the River Adur Catchment Flood Management Plan, South East River Basin Management Plan, the Preliminary Flood Risk Assessment and the West Sussex Local Flood Risk Management Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

13.5 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments have been documented, along with guidance for planners and developers.

Links have been provided for various guidance documents and policies published by other Risk Management Authorities, such as the LLFA and the Environment Agency.

14 Recommendations for planners

A review of national and local policies has been conducted against the information collected on flood risk in this SFRA. Following this, several recommendations have been made for Adur District and Worthing Borough Councils to consider as part of Flood Risk Management in the study area.

14.1 Development management

14.1.1 Sequential approach to development

The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the borough.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by:

- Locate new development in areas of lowest risk, in line with the Sequential Test, by steering sites to Flood Zone 1. If a Sequential Test is undertaken and a site at risk of flooding is identified as the only appropriate site for the development, the Exception Test shall be undertaken.
- After application of Exception Test, a sequential approach to site design must be used to reduce risk. Any re-development within areas of flood risk which provide other wider sustainability benefits should provide flood risk betterment and be made resilient to flooding.
- Identify long-term opportunities to remove development from the floodplain and to make space for water.
- Ordinary watercourses not currently afforded flood maps should be modelled to an appropriate level of detail to enable a sequential approach to the layout of the development.
- Reducing volume and rate of runoff through the use of SuDS, as informed by the Water, People, Places: A guide for master planning sustainable drainage into developments, national and local guidance. The revised 2021 NPPF states that: ‘Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate’ (Para 175).
- Creating space for flooding – include consideration of Green Infrastructure to provide mitigation and risk reduction for surface water flooding.
- Consideration must be given to the potential cumulative impact of development on flood risk.

14.1.2 Site-specific flood risk assessments

Site specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extents (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk. Any flood risk management measures should be consistent with the wider catchment policies set out in the CFMP, FRMPs and LFRMS.

Where a site-specific FRA has produced modelling outlines which differ from the Flood Map for Planning then a full evidence-based review would be required. Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

All new development within the 1% AEP (Annual Exceedance Probability) fluvial flood extent including an allowance for climate change (for the lifetime of the development) must not normally result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage. Where proposed development results in a change in building footprint, the developer should ensure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment. Similarly, where there are no other alternatives and ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should normally be provided so the total volume of the floodplain storage is not reduced. Any flood risk management measures should be consistent with the wider catchment policies set out in the Catchment Flood Management Plan, Flood Risk Management Plan and Local Flood Risk Management Strategy.

An updated NPPF was published in 2021 setting out the Government's planning policies for England and how these are expected to be applied. This revised framework replaces the previous NPPF published in July 2018.

There are also several guidance documents which provide information on the requirements for site-specific Flood Risk Assessments:

Standing Advice on Flood Risk (Environment Agency)

Flood Risk Assessment for Planning Applications (Environment Agency)

Site-specific Flood Risk Assessment: CHECKLIST (NPPG, Defra)

It should be noted that the UKCP18 was published on 26 November 2018. The UKCP18 projections replace the UKCP09 projections and UKCP18 is the official source of information on how the climate of the UK may change over the rest of this century. The Environment Agency have already updated the climate change allowances for sea level rise

to take account of the UKCP18 projections and further updates for peak river levels rainfall intensity are expected by the end of 2020. When undertaking an FRA, please refer to the most up to date climate change allowances provided by the Environment Agency.

Developers should consult with Adur District and Worthing Borough Council, West Sussex County Council, the Environment Agency and Southern Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

14.1.3 Sequential and Exception tests

The SFRA has identified that areas of Adur District and Worthing Borough are at high risk from tidal, surface water, groundwater and fluvial sources. Developers should consult with Adur District and Worthing Borough Councils, the Environment Agency and Southern Water at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed overland flow modelling, consideration of climate change and drainage assessment and design.

It is expected that several proposed development sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Adur District Council should use the information in this SFRA when deciding which development sites to take forward in the emerging Local Plan. It is the responsibility of Adur District Council to be satisfied that the Sequential Test has been passed.

14.1.4 Council review of planning applications

The Council should consult the Environment Agency's 'Flood Risk Assessment: Local Planning Authorities', last updated 1 March 2019, when reviewing planning applications for proposed developments at risk of flooding.

When considering planning permission for developments, planners may wish to consider the following:

- Will the natural watercourse system which provides drainage of land be adversely affected?
- Will a minimum 3.5m and 8m width access strip be provided adjacent to the top of both banks, of Ordinary Watercourses and Main Rivers, respectively, for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits?
- Will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up?
- Will the site be at risk of coastal flooding in the present or future as a result of climate change?
- Have SuDS been given priority as a technique to manage surface water flood risk?

- Will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk?
- Will the site be at risk of tidally induced flooding from groundwater or surface water either in the present day or future as a result of climate change.
- Is the application compliant with the policy set out by the LLFA?

The Council will consult the relevant statutory consultees as part of the planning application assessment and they may, in some cases, also contact non-statutory consultees (e.g. Southern Water) that have an interest in the planning application.

14.1.5 Drainage strategies and SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan. Wherever possible, SuDS should be promoted:

- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration
- Where sites lie within or close to Groundwater SPZs or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual and the LLFA's SuDS guidance and requirements on the level of water quality treatment required for drainage via infiltration.
- Consideration should also be given to areas at risk of tide locking.
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure

14.1.6 Cumulative impact of development and cross-boundary issues

The cumulative impact of development should be considered at the planning application and development design stages and the appropriate mitigation measures undertaken to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk to the surrounding area. Additionally, development management should ensure that the impact on receiving watercourses from development in the Adur District and Worthing Borough has been sufficiently considered during the planning stages, with consideration of cross boundary issues, and appropriate mitigation measures put in place to ensure there is no adverse impact on flood risk or water quality.

14.1.7 Residual risk

Residual risk is the risk that remains after mitigation measures are considered. The residual risk includes the consideration of flood events that exceed the design thresholds of the flood defences or circumstances where there is a failure of the defences, e.g. flood banks collapse. Residual risks should be considered as part of site-specific Flood Risk Assessments.

Further, any developments located within an area protected by flood risk management measures, where the condition of those defences is 'fair' or 'poor', where the standard of protection is not of the required standard or where the failure of the intended level of service gives rise to unsafe conditions should be identified.

14.1.8 Safe access and egress

Safe access and egress will normally need to be demonstrated at all development sites and emergency vehicular access should be possible during times of flood. Where development is located behind flood defences, consideration should be given to the potential safety of the development, finished floor levels and for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

Where there is a residual risk of flooding (from any source) to properties within a development, residential and commercial minimum finished floor levels should be set at least 300mm above the 100-year plus climate change peak flood level, where the new climate change allowances have been used. An additional allowance may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency will be required to determine alternative approaches.

Resilience measures will be required if buildings are situated in the flood risk area, and opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought.

14.1.9 Future flood management

Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

The information provided in the SFRA should be used as a basis for investigating potential strategic flood risk solutions within the study area. Opportunities could consist of the following:

- Catchment and floodplain restoration – Floodplain restoration represents a sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state.
- Flood storage areas – Upstream storage schemes are often considered as one potential solution to flooding. However, this is not a solution for everywhere. Upstream storage should be investigated fully before being adopted as a solution.
- Sequential approach to site layout
- Opening up culverts, weir removal, and river restoration;
- The Regional Habitat Creation Programme; and
- Green infrastructure.

For successful future flood risk management, it is recommended that local planning authorities adopt a catchment partnership working approach in tackling flood risk and environmental management.

14.2 Technical recommendations

14.2.1 Potential modelling improvements

The Environment Agency regularly reviews its flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA. The Environment Agency is currently updating the coastal modelling for the area, this is expected to be completed in late 2024.

Due to the publication of the UKCP18 the Environment Agency should be contacted for the latest guidance on climate change modelling outputs for Flood Risk Assessments.

14.2.2 Updates to SFRA

The Environment Agency regularly reviews its hydrology, hydraulic modelling and flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA. It should be noted that the Environment Agency's Flood Zones, on their Flood Map for Planning website, may differ to the maps in the SFRA for a short period of time, whilst new modelling is incorporated into the Environment Agency's flood maps. Additionally, in time, the Flood Map for Planning website may be the most up to date for current day Flood Zones as the

Environment Agency will update when any further modelling is undertaken in the Plan area and this may be before the SFRA is updated.

Other datasets used to inform this SFRA may also be periodically updated and following the publication of this SFRA, new information on flood risk may be available from Risk Management Authorities.

A Historic Flooding

B Adur and Worthing Watercourses

C Flood Zone 3b

D Flood Zone Mapping

E Fluvial and Tidal Flood Risk Mapping with Climate Change allowances

F Risk of Flooding from Surface Water

G Surface Water flooding with Climate Change allowances applied

H Tidal Risk Zones Methodology

I Surface Water Tidal Risk Zones

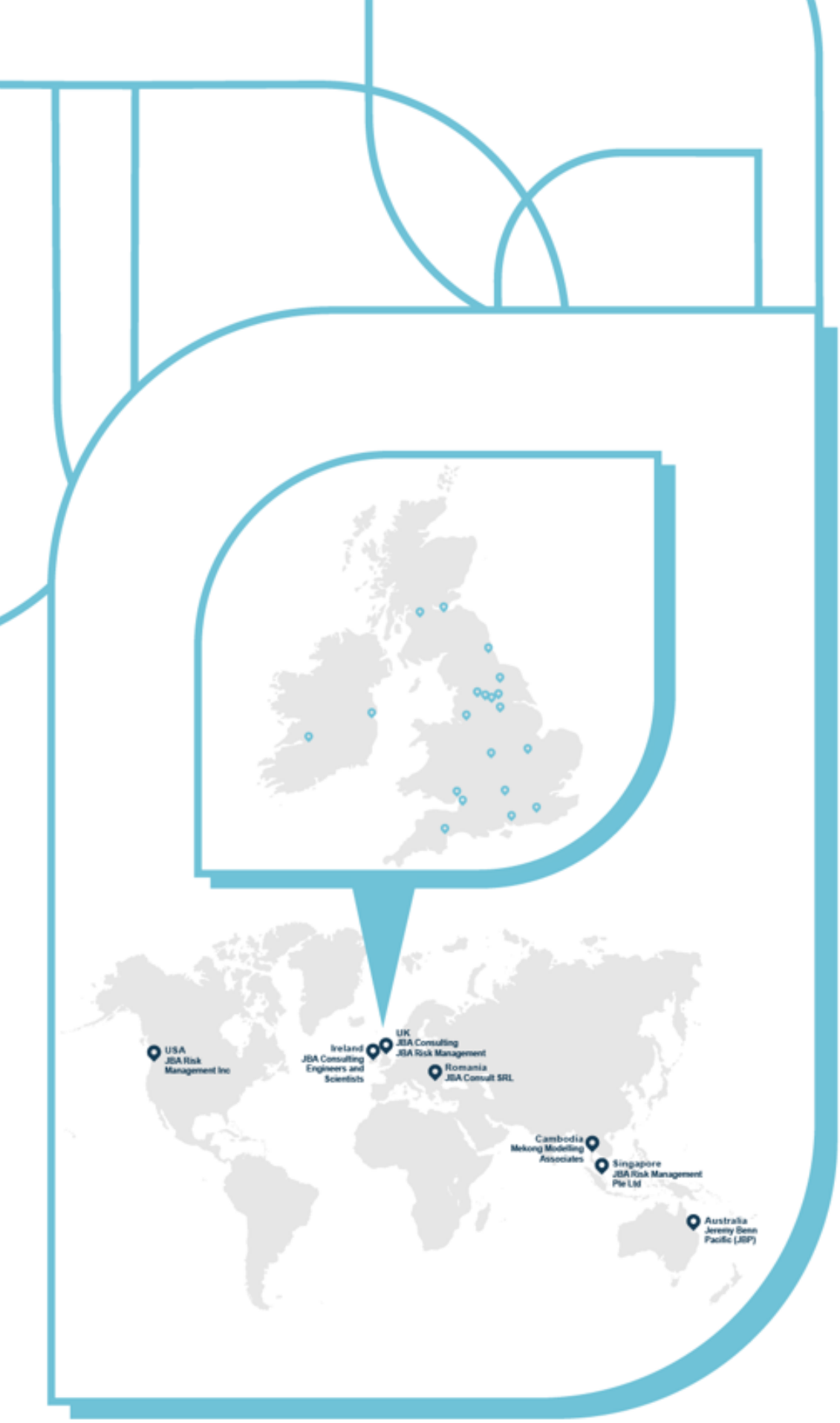
J JBA Groundwater Mapping

K Groundwater Tidal Risk Zones

L Defences

M Flood Alert and Warning Areas

N Site Screening Spreadsheet



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