AECOM

Level 1 Strategic Flood Risk Assessment

Final Report

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Quality information

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Abbreviations

Acronym	Definition
AIMS	Asset Information Management System
AEP	Annual Exceedance Probability
BGS	British Geological Survey
CFMP	Catchment Flood Management Plan
FCERM	Flood and Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FRR	Flood Risk Regulations
FSA	Flood Storage Area
FWMA	Flood and Water Management Act
HDC	Horsham District Council
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LLFA	Lead Local Flood Authority
LFRMS	Local Flood Risk Management Strategy
LFRZ	Local Flood Risk Zone
LPA	Local Planning Authority
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
RBD	River Basin District
RBMP	River Basin Management Plan
RFCC	Regional Flood and Coastal Committee
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SOP	Standard of Protection
SWMP	Surface Water Management Plan
SuDS	Sustainable Drainage Systems
WFD	Water Framework Directive
WSCC	West Sussex County Council
WWNP	Working with Natural Processes

Glossary of Terms

Glossary	Definition
1D Hydraulic Model	Hydraulic model which computes flow in a single dimension, suitable for representing systems with a defined flow direction such as river channels, pipes and culverts.
2D Hydraulic Model	Hydraulic model which computes flow in multiple dimensions, suitable for representing systems without a defined flow direction including topographic surfaces such as floodplains.
Asset Information Management System (AIMS)	Environment Agency database of assets associated with Main Rivers including defences, structures and channel types. Information regarding location, standard of service, dimensions and condition.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level plan through which the Environment Agency works with their key decisionmakers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Coastal Change Management Area	An area identified in plans as likely to be affected by physical change to the shoreline through erosion, coastal landslip, permanent inundation or coastal accretion.
Culvert	A channel or pipe that carries water below the level of the ground.
Design Flood	A flood event of a given annual probability against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed. The design event is generally taken as; a 1% AEP fluvial flooding event plus an appropriate allowance for climate change, a 0.5% AEP tidal flooding event plus an appropriate allowance for climate change, or a 1% AEP surface water flooding event plus an appropriate allowance for climate change.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are ‘at risk’ of sewer flooding more frequently than once in 20 years.
Exception Test	The Exception Test should be applied following the application of the Sequential Test. Conditions need to be met before the Exception test can be applied.
Flood Defence	Infrastructure used to protect an area against floods, such as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Resilience	Measures that minimise water ingress and promotes fast drying and easy cleaning, to prevent any permanent damage.
Flood Resistant	Measures to prevent flood water entering a building or damaging its fabric. This has the same meaning as flood proof.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption). Areas at risk of flooding are those at risk of flooding from any source, now or in the future. Flood risk also accounts for the interactions between these different flood sources.
Flood Storage Area	Natural or man-made areas that temporarily fill with water during periods of high river level, retaining a volume of water which is released back into the watercourse after the peak river flows have passed.
Flood Zone	Flood Zones show the probability of flooding, ignoring the presence of existing defences.
Fluvial	Relating to the actions, processes and behaviour of a watercourse (river or stream).
Freeboard	The difference between the design flood level and the finished floor level of a development or soffit level of a bridge/culvert.
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.

Lead Local Flood Authority (LLFA)	As defined by the Flood and Water Management Act, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the county council for the area, in this case West Sussex County Council (WSCC).
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'Main River Map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Ordinary Watercourse	A watercourse that does not form part of a Main River. This includes "all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows" according to the Land Drainage Act 1991.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	Also known as a recurrence interval is an estimate of the likelihood of an event, such as a flood to occur.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
Sequential Test	Aims to steer vulnerable development to areas of lowest flood risk.
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Surface Water	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Sustainable Drainage Systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
SuDS Approval Body (SAB)	An organisation within County Councils and Unitary Authorities specifically established to deal with the design, approval and adoption of sustainable urban drainage systems (SuDS) within any new development consisting of two or more properties.

1 Introduction

1.1 Background

AECOM has been commissioned by Horsham District Council (HDC) to prepare an updated Level 1 Strategic Flood Risk Assessment (SFRA). An SFRA is a live document which provides an overview of the risk of flooding from all sources in the planning authority area, taking into the account the impacts of climate change, as well as assessing the impact that land use changes and development in the area could have on flood risk.

This SFRA does not consider sections of HDC that are shared with the South Downs National Park (SDNP) Authority, for which a separate SFRA was completed by the SDNP in 2017[1]. The SDNP SFRA has been used to inform the identification of catchments spanning both LPA areas and to highlight the potential for developments in either LPA area to result in cross-boundary impacts to flood risk, as detailed in Section 7.2. The study area is shown in Figure 1-1*:*.

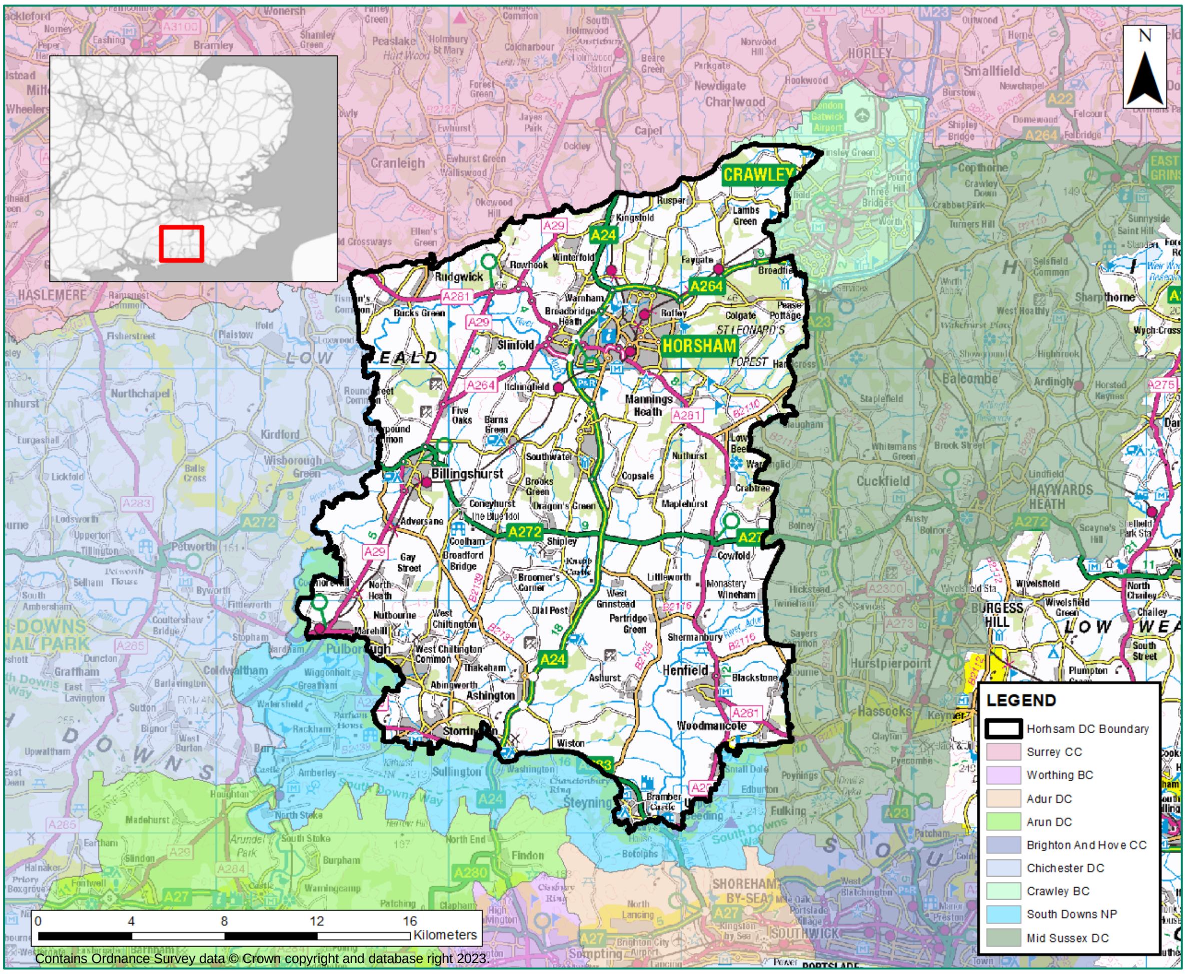

Figure 1-1: Horsham SFRA Study Area

The HDC SFRA was previously published in 2020 and is now being updated following a number of changes in planning policy and improvements in available flood mapping and modelling datasets. This updated HDC SFRA has been prepared in line with the requirements of the National Planning Policy Framework (NPPF)[2], supporting Planning Practice Guidance (PPG)[3], and Environment Agency guidance 'How to prepare a Strategic Flood Risk Assessment'[4].

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[1] South Downs National Park Level 1 Update and Level 2 Strategic Flood Risk Assessment September 2017: https://www.southdowns.gov.uk/wp-content/uploads/2017/02/Level-1-Update-and-Level-2-Strategic-Flood-Risk-Assessment.pdf [Accessed May 2024].
[2] National Planning Policy Framework (NPPF): https://www.gov.uk/government/publications/national-planning-policy-framework--2 [Accessed May 2024].
[3] Planning Practice Guidance (PPG): https://www.gov.uk/government/collections/planning-practice-guidance [Accessed May 2024].
[4] 'How to prepare a Strategic Flood Risk Assessment': https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment [Accessed May 2024].

1.2 Stakeholders

Table 1-1 identifies the stakeholders that have been involved in the preparation of this SFRA, either directly through consultation or by providing publicly available data, and their roles and responsibilities with respect to flood risk management.

Table 1-1: Stakeholders

Stakeholder	Role/Responsibility
Local Planning Authority (LPA): Horsham District Council	Responsible for preparing Local Plans including flood risk policies and development allocations. Local Drainage Authority under the Land Drainage Act. Risk Management Authority (RMA) under the Flood and Water Management Act. Category 1 responder under the Civil Contingencies Act.
Environment Agency	Lead RMA for the management of fluvial and tidal flooding. Strategic role in setting the direction for managing risks through the national Flood and Coastal Erosion Risk Management (FCERM) strategy for England, regulating activities that may affect the risk of flooding from main rivers, and to act as a statutory consultee to the planning system for certain types of applications.
Lead Local Flood Authority (LLFA): West Sussex County Council (WSCC)	Lead RMA for the management of local sources of flooding (surface water, groundwater, Ordinary Watercourses). Responsibility to develop a Local Flood Risk Management Strategy (LFRMS), investigate flood incidents, maintain a register and record of flood risk management structures and features, regulate works in Ordinary Watercourses, and to act as a statutory consultee to the planning system.
Water and Sewerage Companies: Southern Water	Responsible for public water supply and sewerage systems. Statutory consultee for SuDS that connect to the public network. Required to co-operate and share flood risk information with the LLFA.
Adur and Ouse Catchment Partnership	Partnership hosted by the Ouse & Adur Rivers Trust formed in 2011. Its role is to offer stakeholders a point of contact and place to set out actions to improve the management and health of the Adur & Ouse Catchment.
Local Planning Authorities (LPAs)	Neighbouring LPAs with the same responsibilities as Horsham District Council within their respective areas.
Natural England	The government's advisor for the natural environment in England. Responsible for providing guidance regarding land usage and environmental management.

1.3 Objectives

The objectives of the SFRA are as follows:

- Assess and describe all potential sources of flooding, both now and in the future as a result of climate change, based on readily available datasets;
- Review existing coastal and river models to confirm whether these need to be updated with the latest climate change allowances;
- Identify existing flood risk management measures as well as areas that need to be safeguarded for future flood risk management features and structures (where applicable), through reference to Environment Agency data;
- Identify opportunities to reduce the causes and impacts of flooding;
- Provide guidance for applying the Sequential Test and developing flood risk policies in the preparation of the HDC Local Plan;
- Provide recommendations of how to address flood risk in development; and
- Demonstrate how the adaptation to climate change has been undertaken.

1.4 User Guide

It is anticipated that the SFRA will have a variety of end users, including LPA officers, developers, planning consultants, neighbourhood planning bodies, LLFAs, emergency planners and local resilience forums. This Section sets out the structure of the SFRA and describes how to use it (Table 1-2). It should be noted that Appendix A contains maps while Appendix B provides an overview of the hydraulic models used within the SFRA.

Table 1-2: SFRA User Guide

Section Name and No.	Content
1. Introduction	Explains the need for the study and the objectives. Provides a user guide and identifies who has been consulted and where data has been collected. Identifies when the SFRA may need to be updated in the future.
2. Legislation and Policy Framework	Provides an overview of the latest legislation and national and regional policies in relation to flood risk and coastal change.
3. Datasets and Methodologies	Identifies the datasets used to inform the SFRA and describes the approaches taken to use and update data as part of the SFRA.
4. Applying the Sequential Test	Describes how the Sequential Test should be applied using the SFRA.
5. Preparing Flood Risk Assessments	Describes how site specific Flood Risk Assessments (FRAs) should be prepared.
6. Sources of flood risk and expected effects of climate change	Describes the local geology and hydrology in the study area, and assessment of the risk of flooding from all sources based on available datasets.
7. Cumulative impact of development and land use change	Identifies the potential for cumulative impacts on flood risk within the catchment, and cross-boundary impacts on flood risk in catchments downstream, resulting from land-use change.
8. Flood Management and Defences	Describes flood defences and flood warning services within the district.
9. Opportunities to reduce the causes and impacts of flooding	Identifies opportunities to reduce the causes and impacts of flooding in the local area and land required for flood risk management purposes.
10. Recommendations of how to address flood risk in development	Provides guidance on the range of measures that could be considered as part of development in order to manage and mitigate flood risk. These measures should be considered when preparing a site-specific FRA.

1.5 Future monitoring and update

This SFRA should be reviewed when there are changes to:

- The predicted impacts of climate change on flood risk,
- Detailed flood modelling - such as from the Environment Agency or LLFA,
- Local Plans, spatial development strategies or relevant local development documents,
- Local flood management schemes,
- Flood Risk Management Plans (FRMPs),
- Shoreline Management Plans,
- Local Flood Risk Management Strategies (LFRMS), and,
- National planning policy or guidance.

The SFRA should also be reviewed after a significant flood or coastal erosion event.

2 Legislation and Policy Framework

This Section provides a high level overview of the national and regional planning context for coastal change and flood risk management in the HDC SFRA study area.

2.1 National

2.1.1 National Planning Policy Framework

The NPPF sets out the government's planning policies for England and provides a framework within which LPAs can produce Local Plans to deliver sustainable development in the face of the challenges presented by climate change, flooding, and coastal change.

The NPPF stipulates that Local Plans should be supported by SFRAs and should develop policies to manage flood risk from all sources, taking into the advice from the Environment Agency and other relevant risk management bodies such as LLFAs and Internal Drainage Boards (IDBs).

The Sequential and Exception Tests are established by the NPPF as the primary decision-making tools which LPAs should use to direct development to areas with the lowest risk of flooding wherever possible. This SFRA provides the basis for applying these tests. Further guidance on the application of these tests can be found in Section 4.

2.1.2 Planning Practice and Guidance 'Flood Risk and Coastal Change'

The PPG is a living document that supports the NPPF and is periodically updated. The 'Flood Risk and Coastal Change' PPG outlines how the risks associated with flooding and coastal change should be assessed and addressed, including clear guidance regarding the contents of SFRAs and the application of the Sequential and Exception Tests to the siting of proposed developments.

Specific PPG paragraphs are referenced throughout this document in the relevant sections.

2.1.3 Flood and Water Management Act

The Flood and Water Management Act (FWMA)[5] (2010) aims to provide sustainable and consistent management of flooding in England and Wales. It defines the roles of RMAs as the bodies with flood risk related responsibilities. RMAs include the Environment Agency, IDBs, Water and Sewerage Companies and LLFAs. The FWMA designates county councils and unitary authorities as the LLFAs. The LLFA for the HDC area is WSCC who pursuant to the FWMA have the following responsibilities:

- Carry out work to manage flooding from local sources (surface water, groundwater, and Ordinary Watercourses),
- Prepare and maintain a LFRMS,
- Investigate significant local flood incidents and publish the results of these investigations,
- Maintain a register of flood risk assets,
- Regulate work on Ordinary Watercourses,
- Share information about flood risk,
- Perform a lead role in emergency planning and recovery after a flood event, and,
- Co-operate with other RMAs.

At present, WSCC as LLFA is a statutory consultee to HDC for matters relating to surface water management in new development. Schedule 3 of the FWMA places a duty on the local authority, likely to be the LLFA, to become a SAB. Schedule 3 will remove the automatic right to connect surface water to the public sewer network and will require all new development over a prescribed threshold (to be confirmed by secondary legislation) to use SuDS to manage surface water. In addition to the normal planning application process, developers will have to submit a

[5] Flood and Water Management Act (2010): https://www.legislation.gov.uk/ukpga/2010/29/contents [Accessed May 2024].

SuDS application to the SAB, demonstrating compliance with National Standards. The SAB will approve applications and then adopt the SuDS for the lifetime of the development, with responsibility for maintenance.

At the time of writing (August 2024), Schedule 3 has not been enacted. However, the Jenkins Review published in January 2023, made recommendations that Schedule 3 be enacted by Defra. The current indication by Defra is that Schedule 3 is likely to be enacted during 2024.

2.1.4 Flood Risk Regulations

The Flood Risk Regulations (FRR)[6] (2009) transpose the requirements of the EU Floods Directive 2007 into law in England. They outline the duties of LLFAs and the Environment Agency to produce PFRAs, flood risk maps displaying the flooding extents and hazards, and Flood Risk Management Plans (see Section 2.2 for further details). These FRR requirements are completed on a six-year cycle. The FRR will be revoked once the Retained EU Law Bill (Revocation and Reform) has been passed[7].

2.1.5 Environmental Permitting (England and Wales) Regulations

The Environmental Permitting (England and Wales) Regulations (2016)[8] stipulate the regulated activities for which an environmental permit may be required when undertaken:

- in, under, over or near a Main River (including culverted sections);
- on or near a flood defence on a Main River;
- in the flood plain of a Main River; and/or
- on or near a sea defence.

Further guidance on obtaining an environmental permit is available from the Environment Agency.

2.2 Regional

2.2.1 River Basin Management Plans & Catchment Flood Management Plans

River Basin Management Plans (RBMPs) are prepared in accordance with the Water Framework Directive (WFD) and they assess the pressure facing the water environment in River Basin Districts (RBD). Each RBMP comprises a collection of documents that describes the framework by which the quality of waterbodies will be protected or enhanced in each respective RBD.

Data tables and online interactive maps with information regarding the current conditions of, and pressures on, waterbodies within each RBD, are also provided. The entirety of the HDC area is covered by the South East RBD River Basin Management Plan (2022)[9].

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 decision makers to identify and agree long-term policies for sustainable flood risk management. The HDC area encompasses the River Adur CFMP (2009)[10] and the Arun and Western Streams CFMP (2009)[11]. The policies for those sub-areas within the River Adur and Arun CFMPs that overlap with the HDC area are summarised in Table 2-1. Sub areas within the River Adur and Arun CFMPS that do not fall within the HDC area have been excluded from Table 2-1.

[6] Flood Risk Regulations (2009): https://www.legislation.gov.uk/uksi/2009/3042/contents/made [Accessed May 2024].
[7] Retained EU Law Bill (Revocation and Reform): https://bills.parliament.uk/publications/51204/documents/3436 [Accessed May 2024].
[8] Environmental Permitting Regulations (2016): https://www.legislation.gov.uk/uksi/2016/1154/contents/made [Accessed May 2024].
[9] South East RBD River Basin Management Plan: https://www.gov.uk/guidance/south-east-river-basin-district-river-basin-management-plan-updated-2022 [Accessed May 2024].
[10] River Adur Catchment Flood Management Plan (2009): https://www.gov.uk/government/publications/adur-catchment-flood-management-plan [Accessed May 2024].
[11] Arun and Western Streams Catchment Flood Management Plan (2009): https://www.gov.uk/government/publications/arun-and-western-streams-catchment-flood-management-plan [Accessed May 2024]

Table 2-1: List of relevant CFMP sub-areas

Sub Area	Preferred Policy	Relevant CFMP
Upper Adur	Policy Option 6 - areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.	River Adur
Steyning and Upper Beeding	Policy Option 3 – areas of low to moderate flood risk where we are generally managing existing flood risk effectively.	River Adur
Adur Valley	Policy Option 6 - areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.	River Adur
Horsham	Policy Option 4 – areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.	Arun and Western Streams
Pulborough	Policy Option 4 – areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.	Arun and Western Streams
Rother Valley / Middle Arun / Weald	Policy Option 6 – areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.	Arun and Western Streams

Flood Risk Management Plans (FRMPs) explain the objectives and actions needed to manage flood risk at a national and local level in England. Under the FRR (2009), FRMPs must be reviewed by the Environment Agency and LLFAs every 6 years. The current FRMPs cover the period 2021-2027[12], and are separated into a part a[13], which provides an overview of national measures that apply to all river basin districts, and part b, which is composed of ten local flood risk management plans that outline the measures that apply to specific River Basin Districts. The entirety of the HDC area is covered by the South East RBD Flood Risk Management Plan 2021 to 2027.

2.3 Local Plan

2.3.1 Horsham District Planning Framework

HDC's primary planning policy document is the Horsham District Planning Framework which was adopted in 2015 and will guide development in the HDC area up to 2031. Policy 38 (Flooding) stipulates that the impact and extent of flood risk within the HDC area will be achieved through the following measures:

1. Development proposals will follow a sequential approach to flood risk management, giving priority to development sites with the lowest risk of flooding and making required development safe without increasing flood risk elsewhere. Development proposals will;
    a. take a sequential approach to ensure most vulnerable uses are placed in the lowest risk areas.
    b. avoid the functional floodplain (Flood Zone 3b) except for water-compatible uses and essential infrastructure.
    c. only be acceptable in Flood Zone 2 and 3 following completion of a sequential test and exception test if necessary.
    d. require a site-specific Flood Risk Assessment for all developments over 1 hectare in Flood Zone 1 and all proposals in Flood Zone 2 and 3.

[12] Flood risk management plans 2021 to 2027: https://www.gov.uk/government/collections/flood-risk-management-plans-2021-to-2027 [Accessed May 2024].
[13] Flood risk management plans 2021 to 2027: national overview (part a): https://www.gov.uk/government/publications/flood-risk-management-plans-2021-to-2027-national-overview-part-a [Accessed May 2024].

2. Comply with the tests and recommendations set out in the Horsham District SFRA.
3. Where there is the potential to increase flood risk, proposals must incorporate the use of SuDS where technically feasible, or incorporate water management measures which reduce the risk of flooding and ensure flood risk is not increased elsewhere.
4. Consider the vulnerability and importance of local ecological resources such as water quality and biodiversity when determining the suitability of SuDS. New development should undertake more detailed assessments to consider the most appropriate SuDS methods for each site. Consideration should also be given to amenity value and green infrastructure.
5. Utilise drainage techniques that mimic natural drainage patterns and manage surface water as close to its source as possible will be required where technically feasible.
6. Be in accordance with the objective of the WFD, and accord with the findings of the Gatwick Sub Region Water Cycle Study in order to maintain water quality and water availability in rivers and wetlands and wastewater treatment requirements.

2.3.2 West Sussex Preliminary Flood Risk Assessment

Under the 2009 FRR all LLFAs are required to prepare a PFRA, as undertaken by WSCC in 2011. The PFRA (2011)[14] provides a high-level overview of flood risk from local flood sources such as surface water, groundwater, and Ordinary Watercourses for which WSCC are responsible. Information contained within the PFRA informed the development of the LFRMS and helped to identify areas that should be prioritised for Surface Water Management Plans (SWMPs). The Environment Agency has established a national methodology for identifying Flood Risk Areas, which refer to areas at risk with populations in excess of 30,000. PFRAs act as a screening exercise by which the Environment Agency's Flood Risk Areas can be revised and updated. The WSCC PFRA concluded that none of the Environment Agency's existing Flood Risk Areas were located in West Sussex, and that the local information did not warrant the reporting of new Flood Risk Areas to the Environment Agency.

2.3.3 West Sussex County Council Local Flood Risk Management Strategy

The WSCC LFRMS (2013)[15] sets out how WSCC carries out its flood risk responsibilities that are a statutory requirement of the FWMA 2010. It should be noted that this strategy sets out policies from 2013 to 2018, and a more recent strategy is not publicly available at the time of writing (August 2024). The key objectives to guide local focus and progress in West Sussex are as follows:

1. Understand the areas that flood.
2. Manage the flood risk in West Sussex.
3. Enable people, communities, business and public bodies to work together more effectively.
4. 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.

The LFRMS also identifies ten "Priority Wet Spots", where risk management authorities will initially prioritise work. These are all located along the southern boundary of West Sussex, with no priority areas located within HDC.

2.3.4 West Sussex LLFA Policy for the Management of Surface Water

The West Sussex LLFA Policy for the Management of Surface Water was produced in 2018 and sets out how West Sussex LLFA, as a statutory consultee, will review drainage strategies and surface water management provisions associated with applications for development.

West Sussex LLFA has adopted the policies summarised in Table 2-3 (Table 5.1 within the policy document) to conform to statutory policy and best practice. Policies 1 to 6 set out the requirements for a drainage strategy to be compliant with the NPPF and Non-Statutory Technical Standards for Sustainable Drainage. Policies 7 to 10 set out expectations to be considered within all drainage strategies.

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[14] West Sussex County Council Preliminary Flood Risk Assessment (2011): https://www.westsussex.gov.uk/media/1626/west_sussex_pfra.pdf [Accessed May 2024].
[15] West Sussex County Council Local Flood Risk Management Strategy (2014): https://www.westsussex.gov.uk/media/1595/local_flood_risk_management_strategy.pdf [Accessed May 2024]

Table 2-3: West Sussex SuDS Policies

Policy	Summary
SuDS Policy 1	Follow the drainage hierarchy
SuDS Policy 2	Manage Flood Risk through Design
SuDS Policy 3	Mimic Natural Flows and Drainage Flow Paths
SuDS Policy 4	Seek to Reduce Existing Flood Risk
SuDS Policy 5	Maximise Resilience
SuDS Policy 6	Design to be Maintainable
SuDS Policy 7	Safeguard Water Quality
SuDS Policy 8	Design for Amenity and Multi-Functionality
SuDS Policy 9	Enhance Biodiversity
SuDS Policy 10	Link to Wider Landscape Objectives

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

AECOM, in partnership with the LLFAs in South East England prepared a guidance document[16] for the integration of SuDS into the master planning of large and small developments. The guidance document intends to provide a consistent approach to the best practice design of SuDS at the master planning stage in the South East of England, and to be used as part of the initial planning and design process for all types of residential, commercial, and industrial development in the region.

[16] Water, People, Place - A guide for master planning sustainable drainage into developments: https://www.susdrain.org/files/resources/other-guidance/water_people_places_guidance_for_master_planning_sustainable_drainage_into_developments.pdf [Accessed May 2024].

3 Datasets and Methodologies

SFRAs rely on a large number of datasets and information from a range of stakeholder organisations. This section describes the datasets that have been obtained and the methods that have been applied to assess the risk from all sources of flooding across the study area.

3.1 Risk of Flooding from Rivers

Flooding from rivers occur when water levels rise higher than bank levels, causing floodwater to spill across adjacent land (floodplain). The main reasons for water levels rising in rivers are:

- Intense or prolonged rainfall causing runoff rates and flows to increase in rivers, exceeding the capacity of the channel. This can be exacerbated by wet conditions and where there is significant groundwater base flow.
- Constrictions in the river channel causing floodwater to back up.
- Constrictions preventing discharge at the outlet of the river e.g. locked flood gates or tide-locking at high tide.

To assess flooding from rivers the datasets described in Table 3-1 have been used. It should be noted that the Flood Map for Planning and the Risk of Flooding from Rivers and Sea datasets are expected to be updated in early 2025 upon completion of the Nafra2 project. This will combine local mapping with a new national model to produce improved mapped outputs and metadata. As a result of this, some of the published mapping will differ from the currently available local modelling at the time of writing (August 2024).

Table 3-1: Datasets for river flooding

Datasets	Notes	Data source
OS Open River	GIS shapefile which provides a high level overview of watercourses. Contains over 144,000km of water bodies and watercourses. These include freshwater rivers, tidal estuaries, and canals.	Ordnance Survey free download: https://www.ordnancesurvey.co.uk/business-government/products/open-map-rivers
Catchment boundaries	GIS shapefiles obtained from the Catchment Data Explorer have been used to identify the river basin districts, management catchments in the HDC SFRA project area.	Environment Agency Catchment Data Explorer: https://environment.data.gov.uk/catchment-planning
Flood Zone 2 and Flood Zone 3a	GIS shapefiles which identify the probability of fluvial and tidal flooding, ignoring the presence of defences as mapped on the Environment Agency Flood Map for Planning (rivers and sea). Flood Zone 1: Land having a less than 0.1% annual exceedance probability (AEP) of fluvial or tidal flooding. Flood Zone 2: Land having between a 1% and 0.1% AEP of fluvial flooding, or land having between a 0.5% and 0.1% AEP of tidal flooding. Flood Zone 3a: Land having a 1% or greater AEP of fluvial flooding, or land having a 0.5% or greater AEP of tidal flooding.	Defra Data Services Platform: https://environment.data.gov.uk/dataset/86ec354f-d465-11e4-b09e-f0def148f590 https://environment.data.gov.uk/dataset/87446770-d465-11e4-b97a-f0def148f590
AIMS Spatial Flood Defences	Contains the locations of flood defences currently owned, managed or inspected by the Environment Agency, including structures, buildings, earth banks, stone and concrete walls, and sheet-piling.	Defra Data Services Platform: https://environment.data.gov.uk/dataset/8e5be50f-d465-11e4-ba9a-f0def148f590
Reduction in Risk of Flooding from Rivers and Sea due to Defences	This dataset indicates where flood defences may reduce the risk of flooding from the rivers and the sea and has replaced the Areas Benefiting from Flood Defences dataset.	Defra Data Services Platform: https://environment.data.gov.uk/dataset/7b5cf457-6853-4b50-a812-b041d9da003a
Recorded Flood Outlines	Contains all records of historic flooding from rivers, the sea, groundwater, and surface water since 1946. Takes account of the presence of defences, structures and other infrastructure that existed at the time of flooding. A companion Historic Flood Map contains a subset of these Recorded Flood Outlines which satisfy certain criteria.	Defra Data Services Platform: https://environment.data.gov.uk/dataset/8c75e700-d465-11e4-8b5b-f0def148f590

3.1.1 Hydraulic Models

On 3 April 2024, AECOM sent a data request to the Environment Agency for all hydraulic models situated within the HDC area. A high level review of the received models has been undertaken, details of which are presented in the Hydraulic Model Review Report (Appendix B). Table 3-3 summarises the models that have been received, their extents and whether they have been used in the SFRA.

3.1.2 Functional Floodplain

The SFRA should identify areas of Flood Zone 3b functional floodplain, which is defined as land where floodwater from the river or sea has to flow or be stored in times of flooding. Within the latest NPPF update, this is now defined as land that would flood during a 3.3% AEP (1 in 30 year) event or greater, with flood risk management features and structures operating effectively.

The received hydraulic models do not include results to represent Flood Zone 3b as defined above. A conservative approach has therefore been agreed with the Environment Agency to use Flood Zone 3a in place of Flood Zone 3b.

3.1.3 Impact of climate change on peak river flow

It is anticipated that climate change will increase the frequency, extent and impact of flooding, as reflected in peak river flows. For example, wetter winters and more intense rainfall may increase fluvial flooding and surface water runoff. SFRAs should consider the risk of flooding from rivers in the future as a result of the impact of climate change on rainfall patterns and peak river flows. The Environment Agency sets out the current guidance[17] on the climate change allowances that should be applied, with peak river flow allowances provided by management catchments. Management catchments are sub-catchments of RBDs. The HDC study area comprises a single river basin district (South East) and two management catchments (Adur and Ouse Management Catchment and the Arun and Western Streams Management Catchment).

The Environment Agency's peak river flow allowances are based on percentiles. A percentile describes the proportion of possible scenarios that fall below an allowance level.

- Central Allowance is based on the 50th percentile.
- Higher Central Allowance is based on the 75th percentile.
- Upper End Allowance is based on the 95th percentile.

An allowance based on the 50th percentile is exceeded by 50% of the projections in the range. At the 70th percentile it is exceeded by 30%. At the 95th percentile it is exceeded by 5%. 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 2115).

The time period that should be applied in the appraisal of a proposed development is contingent upon the expected lifetime of the development. A minimum of 100 years should be considered for a residential development, whereas the lifetime of a non-residential development should be determined on a case-by-case basis.

The Environment Agency's climate change guidance stipulates that SFRAs should assess both the Central and Higher Central allowances. The Higher Central allowance should be applied to developments classified as Essential Infrastructure in Flood Zones 2, 3a, and 3b, whereas the Central allowance should be applied for all other development categories in Flood Zones 2 and 3a. Table 3-2 provides the Central and Higher Central peak river flow allowances for the two management catchments in the HDC area – Adur and Ouse, and Arun and Western Streams.

[17] Flood Risk Assessments: climate change allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Accessed May 2024].

Table 3-2: Peak river flow allowances by management catchment (based on 1981 to 2000 baseline)[18]

Management catchment	River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Adur and Ouse	South East	Upper End	40%	57%	107%
		Higher Central	23%	28%	55%
		Central	16%	18%	37%
Arun and Western Streams	South East	Upper End	27%	36%	64%
		Higher Central	16%	19%	36%
		Central	11%	13%	25%

Table 3-3 summarises the models that have been received and how they have been used in the SFRA. The majority of models received were updated in 2017 with the latest climate change allowances at that time, however these are lower than the current allowances at the time of writing this SFRA. On the 5th June 2024, a meeting was held between the Environment Agency, AECOM and HDC, to discuss the models available and how they should be used as part of the Level 1 SFRA.

Given that the majority of the sites being taken forward by HDC are located outside of Flood Zone 2 and 3, it was agreed with the Environment Agency that a conservative approach will be applied where Flood Zone 2 will be combined with the latest climate change extent from the modelling available, to present a future fluvial and tidal flood extent. By combining the two datasets, whichever is greatest in extent will be reflected on the final figure.

It was agreed that should any sites be taken forward which are located within Flood Zone 2 and 3 (and the future flood extent as detailed above), a detailed hydraulic modelling study would be required which includes the latest climate change allowances. Results from any modelling study would then need to be used to inform the overall design of whatever development is proposed.

[18] Adur and Ouse Management Catchment Peak River Flow Allowances: https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow?mgmtcatid=3000 [Accessed May 2024].

Table 3-3: Hydraulic models for the HDC study area

Model	Coverage	Climate Change Allowances	Used within Level 1 SFRA?
Lower Tidal River Arun Strategy Model (2010)	River Arun – Pallingham Weir to Littlehampton	+20%	Yes – the 20% climate change extent combined with the Environment Agency's Flood Zone 2
Adur Eastern Branch (2011)	River Adur – Eastern branch from Burgess Hill to Henfield	+20%	No – superseded by Adur Eastern Branch Climate Change Model (2017)
Horsham ABD and Hazard Mapping (2011)	River Arun (and tribs) through Horsham	+35%, +45% and +105%	No – superseded by the Horsham ABD and Hazard Mapping study in 2017
Adur Eastern Branch Climate Change Model (2017)	River Adur – Eastern branch from Burgess Hill to Henfield	+35%, +40% and +70%	No – superseded by Upper Adur Climate Change Model (2017)
Horsham Climate Change Flood Model (2017)	River Arun (and tribs) through Horsham	+35%, +45% and +105%	No – superseded by the Upper Arun (Horsham) model
Steyning Climate Change Model (2017)	Tanyard Stream through Steyning	+35%, +45% and +70%	Yes – the +45% climate change extent combined with the Environment Agency's Flood Zone 2
Upper Adur Climate Change Model (2017)	River Adur – Eastern and Western branch down to Steyning	+35%, +45% and +70%	Yes – the +45% climate change extent combined with the Environment Agency's Flood Zone 2
Upper Arun – Arun Model (2017)	River Arun (and tribs) from Horsham to Pallingham Weir	+35%, +45% and +105%	Yes – conservative approach with the +45% extent combined the Environment Agency's Flood Zone 2
Upper Arun – Billingshurst Model (2017)	Par Book / Brockhurst Brook through Billingshurst	+35%, +45% and +105%	Yes – conservative approach with the +45% extent combined the Environment Agency's Flood Zone 2
Upper Arun – Horsham Model (2017)	River Arun (and tribs) through Horsham	+35%, +45% and +105%	Yes – conservative approach with the +45% extent combined the Environment Agency's Flood Zone 2
Upper Arun – Loxwood Model (2017)	Anstead Brook	+35%, +45% and +105%	No – outside the HDC boundary
River Adur Intertidal Model Updates (2022)	River Adur – Henfield to Shoreham	+37%, +55% and +107% Tidal uplifts for central, higher central and upper	Yes – the +55% climate change fluvial extent and the higher central tidal extent combined with the Environment Agency's Flood Zone 2

3.2 Risk of Flooding from Surface Water

Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, which is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding. It can be difficult to provide a detailed representation of such localised flooding in a strategic-scale document.

The PPG states that an SFRA should identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk published by the Environment Agency as well other available information. The Environment Agency has undertaken modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three annual probability events: 3.3% AEP (1 in 30 year), 1% AEP (1 in 100 year) and 0.1% AEP (1 in 1000 year). The extents of the latest version of the mapping have been made available for the Level 1 SFRA as GIS layers. This mapping is referred to as 'Risk of Flooding from Surface Water' (RoFSW) and is also available online on the Long Term Flood Risk Map[19].

The RoFSW mapping provides all relevant stakeholders, such as the Environment Agency, LPAs, and the public with access to information on surface water flood risk which is consistent across England and Wales. The modelling helps the Environment Agency take a strategic overview of flooding and assists LLFAs in their duties relating to management of surface water flood risk.

For the purposes of this SFRA, the mapping allows an improved understanding of areas within the study area which may have a surface water flood risk. It should be noted that this national mapping has the following limitations:

- Use of a single drainage rate for all urban areas,
- It does not show the susceptibility of individual properties to surface water flooding,
- The mapping has significant limitations for use in flat catchments,
- No explicit modelling of the interaction between the surface water network, the sewer systems, and watercourses,
- In a number of areas, modelling has not been validated due to a lack of surface water flood records, and,
- As with all models, the RoFSW mapping is affected by a lack of, or inaccuracies in, available data.

It should be noted than a new RoFSW map is expected to be published in early 2025 as part of the Nafra2 project.

3.2.1 Impact of climate change on peak rainfall intensity

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This will lead to an increased volume of water entering land and urban drainage systems, consequently resulting in surface water flooding.

LPAs are encouraged to make allowances for climate change in Local Plans to help minimise vulnerability and provide resilience to flooding. Table 3-4 shows the peak rainfall intensity allowance for all management catchments within HDC. The specific allowance to be used depends on the development, as well as its development lifetime. Current guidance on the climate change allowances that should be applied are set out by the Environment Agency[20]. The Environment Agency advises that the peak rainfall allowances should only be used for surface water flood mapping in small catchments (under 5km^2), urbanised drainage catchments, and for site-scale applications.

[19] Environment Agency Flood Risk for Surface Water Map: https://www.gov.uk/check-long-term-flood-risk [Accessed May 2024].
[20] Environment Agency Peak River Flow Allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#peak-river-flow-allowances [Accessed May 2024].

Table 3-4: Peak rainfall intensity allowance in small catchments (less than 5km^2) or urban drainage catchments (based on a 1981 to 2000 baseline)[21]

Management Catchment	River basin district	AEP	Epoch 2050s (2022-2060) or 2070s (2061-2125)	Central Allowance	Upper End Allowance
Adur and Ouse	South East	3.3%	'2050s'	20%	35%
			'2070s'	20%	40%
		1%	'2050s'	20%	45%
			'2070s'	25%	45%
Arun and Western Streams	South East	3.3%	'2050s'	20%	35%
			'2070s'	25%	40%
		1%	'2050s'	20%	45%
			'2070s'	25%	45%

The guidance advocates for the utilisation of the Upper End allowances for both the 1% (1 in 100 year) and 3.3% (1 in 30 year) AEP events when assessing the impacts of climate change on surface water flood risk within SFRAs. For site specific assessments, developers should use the 2050s epoch for development with a lifetime up to 2060 and the 2070s epoch for development with a lifetime between 2061 and 2125.

3.3 Risk of Flooding from Groundwater

Groundwater flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. Low lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground. There are many mechanisms associated with groundwater flooding which are linked to high groundwater levels and can be broadly classified as:

- Direct contribution to channel flow – where the river channel intersects the water table and groundwater enters the streambed increasing water levels and causing flooding,
- Springs erupting at the surface,
- Exceptionally large flows from perennial springs or large flows from intermittent or dormant springs, and,
- Rise of typically high groundwater levels to extreme levels in response to prolonged extreme rainfall.

The main impacts of groundwater flooding are:

- Flooding of basements of buildings below ground level – in the mildest case this may involve seepage of small volumes of water through walls, temporary loss of services etc. In more extreme cases larger volumes may lead to the catastrophic loss of stored items and failure of structural integrity.
- Overflowing of sewers and drains – surcharging of drainage networks can lead to overland flows causing significant but localised damage to property. Sewer surcharging can lead to inundation of property by polluted water. Note: it is complex to separate this flooding from other sources, notably surface water, or sewer flooding.
- Flooding of buried services or other assets below ground level – prolonged inundation of buried services can lead to interruption and disruption of supply.
- Inundation of roads, commercial, residential and amenity areas – inundation of grassed areas can be inconvenient; however, the inundation of hard-standing areas can lead to structural damage and the disruption of commercial activity. Inundation of agricultural land for long durations can have financial consequences.

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[21] Adur and Ouse Management Catchment peak rainfall allowances: https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall?mgmtcatid=3000 [Accessed May 2024].

- Flooding of ground floors of buildings above ground level – can be disruptive and may result in structural damage. In addition, typically a groundwater flood event will have a long duration (when compared to other flood sources) which adds to the disruptive nature of the flood event.

It should be noted that the BGS Groundwater Flooding dataset was not available for this study. In the absence of this data, GeoSmart's 2019 national groundwater flood risk dataset has been used to provide groundwater flood risk data. According to the GeoSmart User Guide[22], the dataset provides a preliminary indication of groundwater flood risk on a 5m grid. Like other current groundwater flood maps used in the UK, the GeoSmart map shows areas of potential groundwater emergence.

Areas are split into risk classes based on a combination of likelihood, model and data uncertainty and possible severity. Overall risk is presented on the map within the following classes:

- Class 1 – High Risk: There is a high risk of groundwater flooding in this area with a chance of greater than 1% annual probability of occurrence or more frequent.
- Class 2 – Moderate Risk: There is a moderate risk of groundwater flooding in this area with a chance of greater than 1% annual probability of occurrence.
- Class 3 – Low Risk: There is a low risk of groundwater flooding in this area with a chance of greater than 1% annual probability of occurrence.
- Class 4 - Negligible Risk: There is a negligible risk of groundwater flooding in this area and any groundwater flooding incidence has a chance of less than 1% annual probability of occurrence.

The map is a general purpose indicative screening tool, and is intended to provide a useful initial view for a variety of applications. However, it does not provide an alternative to a proper site-specific assessment, and a detailed risk assessment should be used for any site where the impact of groundwater flooding would have significant adverse consequences.

3.3.1 Impact of climate change on groundwater flooding

Groundwater flooding occurs primarily as a response to extended periods of rain during late autumn and early winter. With climate change bringing wetter winters, an increased risk of groundwater flooding may be seen. However, the complex relationship between rainfall, recharge, groundwater storage and flow make the response to climate change uncertain.

3.4 Risk of Flooding from Sewers

During heavy rainfall, flooding from the sewer system may occur if:

- The rainfall event exceeds the capacity of the sewer system/drainage system: New sewer systems are typically designed and constructed to accommodate 3.3% AEP (1 in 30 year) rainfall events, or greater. Older sewer systems have a variable design standard. Therefore, rainfall events with an annual probability less than 3.3% would be expected to result in surcharging of some of the sewer system. While sewerage undertakers recognise the impact that more extreme rainfall events may have, it is not cost beneficial to construct sewers that could accommodate every extreme rainfall event.
- The system becomes blocked by debris or sediment: Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris without sufficient maintenance (e.g. litter).
- The system surcharges due to high water levels in receiving waterbodies: There is potential for surface water outlets to become submerged due to high river or tide levels. Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses.

Within urban areas, rainwater is frequently drained into sewers conveying both surface and foul water known as 'combined sewers'. As a result, sewer flooding events where 'combined sewers' are particularly prevalent may be more frequent and associated with the potential contamination of floodwater by foul effluent.

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[22] GeoSmart Groundwater Flood Risk Map User Guides: https://geosmartinfo.co.uk/user-guides/ [Accessed July 2024]

3.4.1 Impact of climate change on sewer flooding

Climate change is anticipated to increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination is likely to increase the pressure on the existing efficiency of sewer systems, thereby reducing their design standard and leading to more frequent localised flooding incidents. Any sewer flooding that may occur could be exacerbated as a result of surface water runoff during extreme rainfall events.

Water companies continue to monitor the risk of sewer flooding and put plans in place to manage the risk, as required, based on their business plan and priorities. The LPAs can work with Southern Water to identify flooding hotspots and locations of known sewer capacity issues where risk could be exacerbated. Water companies prioritise investment for potential flood alleviation schemes depending on the severity and frequency of flooding, but this can only be identified where affected property owners report the incident to the water company.

3.5 Risk of Flooding from Reservoirs

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The PPG encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding. Areas at risk of reservoir flooding are presented on the Environment Agency's Long Term Flood Risk Map[23]. Datasets showing the flood extents for all large, raised reservoirs in the event of their failure are available. Two flood extents are provided for each reservoir denoting the "dry day" scenario[24] during which river levels are normal, and the "wet day" scenario[25] during which local rivers have already overflowed their banks.

The dataset represents the prediction of a credible worst case scenario, although its improbable that any actual flood would be this large. The dataset gives no indication of the likelihood or probability of reservoir flooding. Flood extents are not provided for smaller reservoirs (i.e. those with a volume below the threshold of 25,000m^3) or for reservoirs registered following the onset of the modelling programme beginning in October 2016.

Although the impacts emanating from the breach of a large, raised reservoir could be severe, large-raised reservoirs are carefully monitored and maintained across England in line with the provisions of the Reservoirs Act 1975[26], and consequently, the risk of reservoir failure is very low.

[23] Environment Agency Risk of Reservoir Flooding: https://www.gov.uk/check-long-term-flood-risk [Accessed May 2024].
[24] Reservoir Flood Extents Dry Day National: https://environment.data.gov.uk/dataset/c66ee97f-49d2-454e-9a19-d48a47bd22ad [Accessed May 2024].
[25] Reservoir Flood Extents Wet Day National: https://environment.data.gov.uk/dataset/d81646cf-37e5-4e71-bbcf-b7d5b9ca3a1c [Accessed May 2024].
[26] Reservoirs Act 1975: https://www.legislation.gov.uk/ukpga/1975/23 [Accessed May 2024].

4 Applying the Sequential and Exception Tests

4.1 Sequential Test

The Sequential Test is a decision-making tool designed to ensure that development is steered away from areas at risk of flooding, and that areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk. When preparing a Local Plan, the LPA should demonstrate that a range of site allocations have been considered, using the SFRA to apply the Sequential and Exception Tests where necessary. The Sequential Test should be applied to the whole LPA area to increase the likelihood of allocating development in areas not at risk of flooding. The sequential approach can be applied at all levels and scales of the planning process, both between and within Flood Zones. All opportunities to locate new developments (except Water Compatible developments) in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk. Figure 4-1 illustrates the approach for applying the Sequential Test that HDC should adopt in the allocation of sites as part of the preparation of the Local Plan. This has been reproduced from Diagram 2 of the PPG.

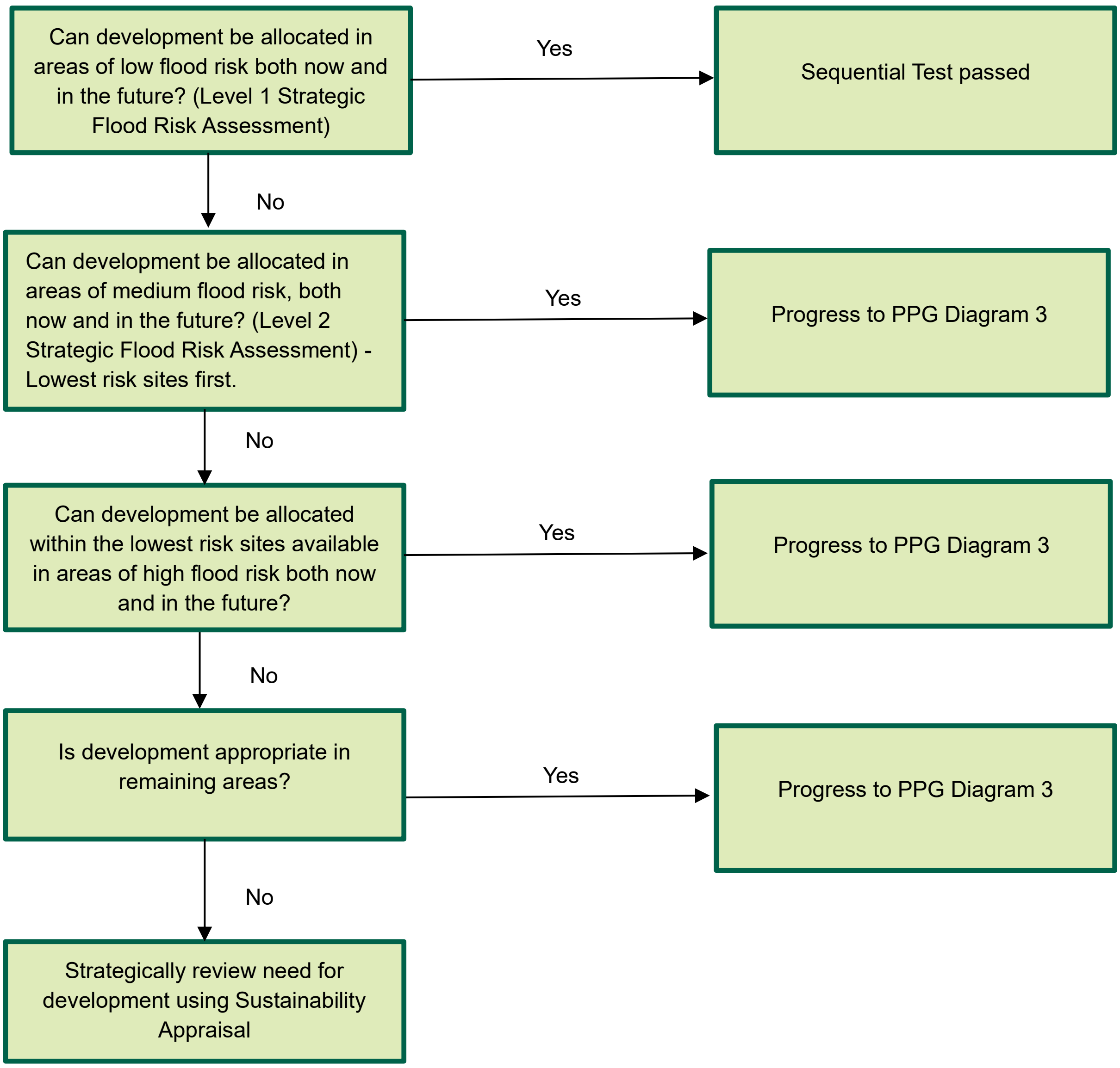

Figure 4-1: Applying the Sequential Test in the preparation of a Local Plan (PPG Diagram 2)

The NPPF acknowledges that some areas may also be at risk of flooding from sources other than fluvial. All sources must be considered when planning for new development including flooding from land or surface water runoff, groundwater, sewers, and artificial sources. If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test.

4.1.1 Recommended Stages for LPA Application of the Sequential Test

As the LPA, HDC must demonstrate that throughout the site allocation process a range of possible sites have been considered in conjunction with the flood risk and vulnerability information from the SFRA, and that the Sequential Test, and where necessary the Exception Test, has been applied.

When preparing a Local Plan, a Site Assessment Database of the potential allocation sites across Horsham can be generated and populated using flood risk information from all sources contained within this SFRA and used by HDC when applying the steps below.

1. Assign potential developments with a vulnerability classification. Where development is mixed, the development should be assigned the highest vulnerability class of the developments proposed.
2. The location and identification of potential development should be recorded.
3. The Flood Zone classification of potential development sites should be determined based on a review of the Flood Map for Planning (Rivers and Sea). Where these cover more than one Flood Zone, all zones should be noted, preferably using percentages.
4. The design life of the development should be considered with respect to climate change:
    - 100 years – up to 2125 for residential developments; and
    - 75 years – up to 2100 for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.
5. Identify existing flood defences serving the potential development sites. However, it should be noted that for the purposes of the Sequential Test, flood zones ignoring defences should be used (i.e. the flood zones presented on the Environment Agency's Flood Map for Planning).
6. Highly Vulnerable developments to be accommodated within the District should be located on those sites identified as being within Flood Zone 1 and at low risk of flooding from other sources. If these cannot be located in areas of low risk, because the identified sites are unsuitable or there are insufficient sites in areas of low risk, sites in Flood Zone 2 can then be considered. Highly Vulnerable sites entirely within Flood Zone 2 will require application of the Exception Test (as detailed in Table 4-1). If sites in Flood Zone 2 are inadequate, then the LPA may have to identify additional sites in Flood Zones 1 or 2 to accommodate development or seek opportunities to locate the development outside their administrative area. Within each flood zone, Highly Vulnerable development should be directed, where possible, to the areas at lowest risk from all sources of flooding. It should be noted that Highly Vulnerable development is not appropriate in Flood Zones 3a and 3b.
7. Once all Highly Vulnerable developments have been allocated to a development site, consideration can be given to those development types defined as More Vulnerable. In the first instance More Vulnerable development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments entirely within Flood Zone 3a will require application of the Exception Test. As with Highly Vulnerable development, within each flood zone, More Vulnerable development should be directed to areas at lowest risk from all sources of flooding. It should be noted that More Vulnerable development is not appropriate in Flood Zone 3b.
8. Once all More Vulnerable developments have been allocated to a development site, consideration can be given to those development types defined as Less Vulnerable. In the first instance Less Vulnerable development should be located on sites in Flood Zone 1, continuing sequentially with Flood Zone 2, then 3a. Less Vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.
9. Essential Infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is satisfied.
10. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed

in the selection of sites; however, it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies.

11. On completion of the Sequential Test, consideration may need to be given to the risks posed to a site within an area at risk of flooding in more detail in a Level 2 SFRA (as explained below). By undertaking the Exception Test, this more detailed study should consider the detailed nature of the risk posed by all sources of flooding, and potential flood hazard to allow a sequential approach to site allocation. Consideration of flood hazard within a flood zone would include:
    - Flood risk management measures,
    - The rate of flooding,
    - Flood water depth,
    - Flood water velocity.
12. Where the development is Highly Vulnerable, More Vulnerable, Less Vulnerable or Essential Infrastructure and a site is found to be impacted by a recurrent flood source (other than fluvial), the site and flood sources should be investigated further regardless of any requirement of the Exception Test. It is noted that for any development at risk of flooding, a site-specific FRA will be required.

If following the application of the Sequential Test, it is not possible to locate all of the sites within areas of low flood risk it may be necessary for a Level 2 SFRA to be prepared to provide additional information to support the application of the Exception Test.

The Level 2 SFRA should consider further detail on the nature of the flood risk to each site from all sources, based on available datasets. Flood depth and hazard rating should also be considered where detailed modelling outputs are available, as well as the condition and location of flood defences where appropriate. A Level 2 SFRA should use this information to further apply the sequential approach and sequential test to identify sites with the lowest risk of flooding.

4.1.2 Applying the Sequential Test for Planning Applications

The Environment Agency publication 'Demonstrating the flood risk Sequential Test for Planning Applications'[27] sets out the procedure for applying the Sequential Test to individual applications as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the District area, or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area).
- Identify the source of 'reasonably available' alternative sites; this is usually drawn from evidence base /background documents produced to inform the Local Plan.
- State the method used for comparing flood risk between sites; for example the Environment Agency's Flood Map for Planning, the SFRA mapping, site-specific FRAs if appropriate, other mapping of flood sources.
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk from all sources is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding from all sources that would be appropriate to the type of development or land use proposed.
- Where necessary, apply the Exception Test.
- Apply the sequential approach to locating development within the site.

Ultimately, after applying the Sequential Test, HDC needs to be satisfied in all cases that the proposed development would be safe and not lead to increased flood risk elsewhere. This needs to be demonstrated within a FRA and is necessary regardless of whether the Exception Test is required.

[27] Demonstrating the flood risk Sequential Test for Planning Applications: http://www.gwfoe.org.uk/wp-content/uploads/2014/01/EA-Sequential-Test-Process-v3.1-April-2012.pdf [Accessed May 2024].

4.1.3 Sequential Test Exemptions

According to the PPG and paragraph 174 of the NPPF, the Sequential Test does not need to be applied in the following circumstances:

- Individual developments proposed on sites which have already been allocated in development plans through the Sequential Test (on the assumption that the proposed development is consistent with the use for which the site was allocated, and that there have been no changes to the known level of flood risk, now and in the future).
- Change of use applications, unless it is for a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site.
- The site is in an area at low risk from all sources of flooding unless the SFRA, or other more recent information, indicates there may be flooding issues now or in the future (for example, through the impact of climate change).
- Some minor developments including householder development and non-residential extensions with a footprint less than 250m^2.

4.2 Exception Test

Following the application of the Sequential Test it may be concluded that there are no reasonable available alternative sites in areas of lower risk, and in some cases the Exception Test may be required.

Table 4-1 (reproduced from PPG Table 2) identifies when the Exception Test is required, based on the Flood Zone and the vulnerability classification of the proposed development, as defined in Table 2 of the PPG.

Table 4-1: Flood risk vulnerability and Flood Zone 'incompatibility'[28]

Flood Zone	Flood risk vulnerability classification				
	Essential Infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required†	✗	Exception Test required	✓	✓
Zone 3b*	Exception Test required*	✗	✗	✗	✓*

Notes:
✓ = Exception Test not required
✗ = Development should not be permitted
†In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.
**In Flood Zone 3b (functional floodplain) essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to:*

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

[28] Planning Practice Guidance Table 2 Flood Risk Vulnerability and Flood Zone incompatibility: https://www.gov.uk/guidance/flood-risk-and-coastal-change#table2 [Accessed May 2024].

As set out in paragraph 170 of the NPPF, of the exception test should be informed by a strategic or site-specific FRA, depending on whether it is being applied during plan production or at the application stage. To pass the exception test it should be demonstrated that:

> (a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and
>
> (b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Both elements of the Exception Test should be satisfied for development to be allocated or permitted.

In order to fulfil Part 1 of the Exception Test, the sustainability framework set out in HDC's Sustainability Appraisal (SA) report[29] should be used to assess each potential development site. The sustainability framework includes a list of objectives and indicators which can be employed to appraise the sustainability of a proposed development.

In order to address Part 2, a site-specific FRA should be prepared for the proposed development that demonstrates how the site will be safe. Consideration should be made of the following as appropriate:

- Applying a sequential approach within the site layout.
- Development design to manage and reduce flooding.
- Safe access and egress.
- Design of flood defence infrastructure.
- Operation and maintenance.
- Flood warning and evacuation procedures.
- Funding or maintenance arrangements for implementing measures.

Figure 4-2 (reproduced from PPG Diagram 3) sets out how the Exception Test should be applied in the preparation of a Local Plan.

[29] Horsham District Council Sustainability Appraisal and Strategic Environmental Assessment Report: https://www.horsham.gov.uk/planning/neighbourhood-planning/sustainability-appraisal-and-strategic-environmental-assessment [Accessed May 2024].

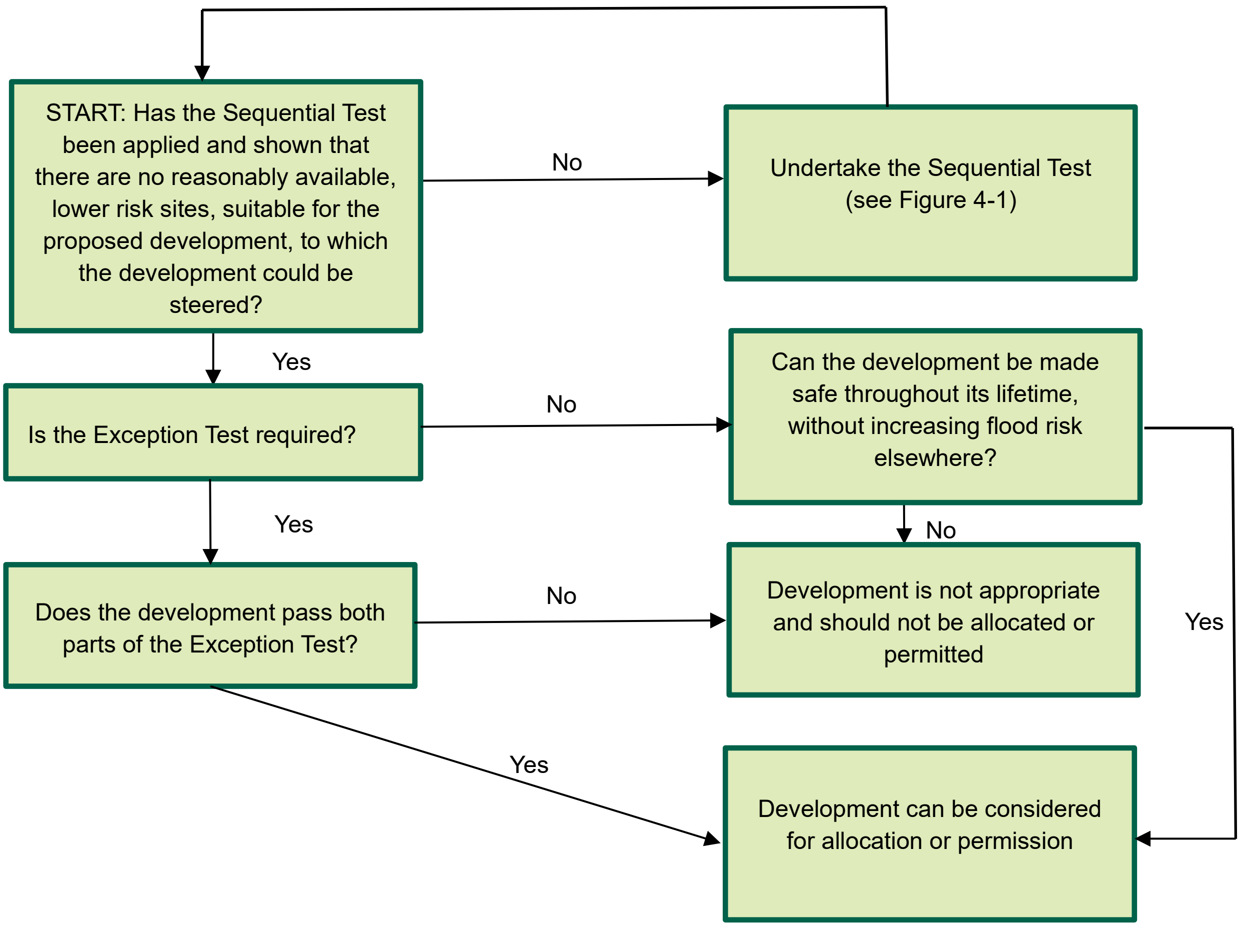

Figure 4-2: Applying the Exception Test in the preparation of a Local Plan (PPG Diagram 3)

4.3 Impact of development on flood risk elsewhere

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

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

While the increase in runoff, or loss in floodplain storage, from individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe without appropriate mitigation measures. This must be considered at the planning application and development design stages and the appropriate mitigation measures undertaken, within an appropriate FRA, to ensure flood risk is not exacerbated, and in many cases the development should provide betterment when flood risk is considered. Maintenance and upkeep for mitigation measures, such as SuDS, must be set out as part of a site-specific drainage strategy and management funding for the lifetime of the development must be agreed.

Where the Sequential and the Exception Tests have been applied as necessary and not met, development should not be allowed.

5 Preparing Flood Risk Assessments

5.1 What is a FRA?

A site-specific FRA is a report conducted by, or on behalf of, a developer to assess the flood risk from all sources to and from a development, and to demonstrate how the proposed development will be designed so that it remains safe over its lifetime, and not increase flood risk elsewhere. A FRA must be prepared by a suitably qualified and experienced person and must contain all the information needed to allow HDC to satisfy itself that the requirements have been met.

According to paragraph 173 of the NPPF, development should only be allowed in areas at risk of flooding where, in the light of a FRA, it can be demonstrated that:

- Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;
- It incorporates SuDS, unless there is clear evidence that this would be inappropriate;
- Any residual risk can be safely managed; and
- Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

5.2 When is a FRA required?

According to footnote 59 of the NPPF a site-specific FRA is required in the following circumstances:

- Proposals for all developments in Flood Zones 2 and 3.
- Proposals of 1 hectare or greater in Flood Zone 1.
- Proposals for development in an area within which has critical drainage problems (as identified by the Environment Agency).
- Proposals in Flood Zone 1 where land is identified in an SFRA as being at increased flood risk in the future.
- Proposals for the change of use to a more vulnerable class on land that may be subject to other sources of flooding.

5.3 What needs to be addressed in a FRA?

The PPG states that the objectives of a site specific FRA are to establish:

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

5.4 How detailed should a FRA be?

The PPG stipulates that site-specific FRAs should be proportionate to the scale and nature of the development, to the severity of flood risk, to the development's vulnerability classification, and to the status of the site in relation to the Sequential and Exception Test.

The report should employ readily available information such as the mapping presented within the LPA's SFRA and on the Environment Agency's website. In some cases, additional hydraulic modelling or detailed calculations may need to be undertaken. For example, an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people in an area of flood risk, would typically need a less detailed assessment than a new development comprising a greater number of houses, such as an apartment block. Likewise, HDC may require a more detailed assessment at a location where the flood risk is greater, such as the execution of site-specific hydraulic modelling to precisely determine the level of flood risk to and from the site both pre and post-development, and to appraise the effectiveness of any proposed mitigation measures.

The Environment Agency provides standing advice for FRAs[30] which should be followed for all development classed as[31]:

- a minor extension (household extensions or non-domestic extensions less than 250m^2) in Flood Zone 2 or 3.
- 'more vulnerable' development in Flood Zone 2 (except for landfill or waste facility sites, caravan or camping sites).
- 'less vulnerable' development in Flood Zone 2 (except for agriculture and forestry, waste treatment, mineral processing, and water and sewage treatment).
- 'water compatible' development in Flood Zone 2.
- a change of use into one of these vulnerable categories or into the water compatible category.

The Environment Agency's standing advice stipulates that the following information should be included in a FRA:

- site address.
- a description of the development.
- an assessment of the flood risk from all sources of flooding for the development, plus an allowance for climate change.
- the estimated flood level for the development, taking into account the impacts of climate change over its lifetime.
- details of the finished floor levels.
- details of the flood resistance and resilience plans.
- any supporting plans and drawings.

The estimated flood level is the maximum anticipated depth of flooding on a development site in a 1% AEP (1 in 100 year) fluvial event (plus an allowance for climate change) or in a 0.5% AEP (1 in 200 year) tidal event (plus an allowance for climate change).

For all developments involving surface water drainage in flood risk areas and major developments involving surface water drainage, SuDS must be provided unless clear evidence detailing their unsuitability is provided to the LPA. The management of surface water, including the provision of SuDS, should be outlined in a FRA, or in a separate surface water drainage strategy.

Environment Agency Data Requests

The Environment Agency offers a series of 'products' for obtaining flood risk information suitable for informing the preparation of site-specific FRAs as described on their website: https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications.

- Product 1: contains a flood map, including Flood Zones, defences and storage areas and areas benefitting from defences.
- Product 3: contains a basic FRA map, including Flood Zones, defences and storage areas, areas benefiting from defences, statutory Main River designations and some key modelled flood levels.
- Product 4: contains a detailed FRA map, including Flood Zones, defences and storage areas, areas benefiting from defences, statutory Main River designations, historic flood event outlines and more

[30] Preparing a flood risk assessment standing advice: https://www.gov.uk/guidance/flood-risk-assessment-standing-advice#standing-advice-for-vulnerable-developments [Accessed May 2024].
[31] Flood risk assessments if you're applying for planning permission: https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications [Accessed May 2024].

detailed information from our computer river models (including model extent, information on one or more specific points, flood levels, flood flows)

- Product 5: contains the flood modelling and hydrology reports for the specific hydraulic model.
- Product 6: contains the model output data so the applicant can interrogate the data to inform the FRA.
- Product 7: comprises the hydraulic model.
- Product 8: contains flood defences breach data including maximum flood depth, velocity and hazard maps. This allows the residual risk associated with defence breach to be assessed and is important for the consideration of mitigation if the site benefits from flood defences.

Modelling of Ordinary Watercourses

It should be noted that the scope of hydraulic modelling studies undertaken by the Environment Agency typically covers flooding associated with Main Rivers, and therefore Ordinary Watercourses that form tributaries to the Main Rivers may not always be included in the model.

Where a proposed development site is in close proximity to an Ordinary Watercourse the LLFA and/or local authority should be contacted to see whether any modelling data exists (on the assumption that this has not been considered by the Environment Agency). If either no hydraulic modelling exists, or the available modelling is considered to provide very conservative estimates of flood extents (due to the use of national generalised modelling such as JFLOW), applicants may need to prepare a hydraulic model to enable more accurate assessment of the probability of flooding associated with the watercourse and to inform the site-specific FRA. The requirements of this should first be discussed with the LLFA. If required, modelling should be carried out in line with industry standards and in agreement with the Environment Agency and WSCC (as the LLFA).

Where a watercourse exists on, under, or adjacent to a property, the owner of that property is classified as a riparian owner. A ‘watercourse’ here is defined as any natural or artificial channel above or below ground through which water flows, such as a river, brook, ditch, gill or stream (which may be piped or culverted in sections). The responsibilities of riparian owners include:

- The clearance of silt and debris, including rubbish, from a watercourse
- The management of vegetation within the channel
- Ensuring the flow of water within the watercourse is not obstructed

Riparian owners have the right to protect their property from flooding or their land from erosion. However, riparian owners must not:

- Dispose of waste such as grass cuttings into the watercourse
- Fill in, obstruct, bridge, or pipe the watercourse without obtaining consent

Further information in relation to riparian ownership can be viewed on the WSCC website[32].

5.5 Pre-application advice

At all stages, HDC, and where necessary the Environment Agency, WSCC and/or the statutory water undertaker, may need to be consulted to ensure the FRA provides the necessary information to fulfil the requirements for planning applications.

The Environment Agency, WSCC and HDC each offer pre-application advice services which should be utilised to discuss particular requirements for specific applications.

- HDC: https://www.horsham.gov.uk/planning/planning-applications/pre-application-planning-advice
- WSCC: https://www.westsussex.gov.uk/planning/planning-applications/county-planning-pre-application-advice/

[32] West Sussex County Council Riparian Ownership: https://www.westsussex.gov.uk/fire-emergencies-and-crime/dealing-with-extreme-weather/flooding/flood-risk-management/managing-flood-risk/ [Accessed April 2024].

- Environment Agency: https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion.

The following government guidance sets out when LPAs should consult with the Environment Agency on planning applications: https://www.gov.uk/flood-risk-assessment-local-planning-authorities.

6 Sources of flood risk and expected effects of climate change

This Section provides a description of the local topography, geology and hydrology in the study area, and an assessment of the risk of flooding from all sources based on available datasets.

6.1 Topography

Appendix A, Figure A1 displays the topography throughout the HDC area. This figure shows the Light Detection and Radar (LiDAR) dataset for HDC, which has a spatial resolution of 1m and contains digital elevation data derived from surveys carried out between 2000 and 2020.

In general, higher ground elevations are seen to the north of the area, with lower elevations situated around the channels of Main Rivers throughout the area. Topographic low points are seen surrounding the River Adur, particularly through Upper Beeding to Henfield where ground levels reach approximately 5m Above Ordnance Datum (AOD).

6.2 Geology

The bedrock geology of the HDC area is presented in Appendix A, Figure A2. The majority of the study area consists of the Wealden Group, which is split into the High Weald and the Low Weald. The High Weald, covering the majority of the study area, consists of sandstones and mudstones including the Horsham Stone Member and the Upper Tunbridge Wells Sand. These units are overlain by the Weald Clay Formation. The High Weald then drops down to the Low Weald to the south where the geology is comprised predominantly of chalk and softer sandstones and mudstones. The north of the HDC area is also intersected by the western ridge of the Wealden anticline, which gently dips to the south-southwest, such that the rocks get progressively younger in this direction.

Along the southern boundary of the HDC area, bedrock geology primarily consists of the Lower Greensand Group, with a number of other units also intersecting the HDC area near Upper Beeding.

6.3 Hydrology

The principal watercourses and associated catchments are shown in Appendix A, Figure A3 and described in Table 6-1. The primary river systems in the HDC area are the River Adur and the River Arun, with their mainstem channels and tributaries covering the majority of the district.

The catchment of the River Arun covers the north and western sections of the study area, with its source located at St Leonard's Forest near Horsham. The Upper Arun collects water from the High and Low Weald, which mainly comprises of low permeability Weald Clay, and transfers it downstream to the confluence with the River Rother at Pulborough, which is also the tidal limit. The Upper and Eastern Arun is the reach of the river that covers the majority of the study area. The watercourse continues to flow south beyond the HDC boundary and outfalls to the sea at Littlehampton.

The River Adur and its tributaries are situated in the High Weald, Low Weald and South Downs natural conservation areas. The entire catchment of the River Adur is in excess of 600km^2 and extends from the south coast at Littlehampton in the west, Brighton and Hove in the east, and northwards to Horsham and Haywards Heath. The upper and western branch of the Adur catchment spans most of Horsham District. The River Adur begins as two separate branches. The source of the Western Adur is located at Slinfold, whereas the source of the Eastern Adur is Ditchling Common in East Sussex. The two branches meet near Henfield, before flowing south through Upper Beeding and outfalling into the sea at Shoreham-by-Sea.

Table 6-1: Watercourses in the HDC area

Watercourse	Classification	Tidal (Y/N)	Description
River Arun	Main River	Y	60km long Main River that rises at St Leonard’s Forest in the Weald (TQ 21819 30177), and has a mouth at Littlehampton (TQ 02881 01047). The River Arun flows westwards through Horsham, before flowing south along the western border of the HDC study area. The tidal limit is Pulborough, in the south of the HDC area. This river has the largest catchment out of all rivers in HDC, spanning Rudgwick, Billinghurst and North Heath.

River Adur	Main River	N	32km long Main River that begins as two separate branches, the western Adur and the eastern Adur, which meet 2km west of Henfield (TQ 19452 16683). The western Adur rises at Slinfold (TQ 11468 29299), and the eastern Adur rises at Ditchling Common, in East Sussex. The mouth of the River Adur is located at Shoreham-by-Sea (TQ 23513 04578).
Baldhorns Brook	Ordinary Watercourse	N	12km long tributary of the River Mole that flows through Rusper, in the north east of the HDC area. Its catchment is primarily rural.
Boldings Brook	Main River	N	10km long Main River that rises near Kingsfold (TQ 17765 36593), and outfalls into the River Adur near Highwood (TQ 15392 30199). The entirety of this watercourse is located within the HDC area, and its catchment spans Littlehaven and west Horsham.
Honeybridge Stream	Ordinary Watercourse	N	Tributary of the River Adur, which rises from springs to the west of Ashington. The streams flows north easterly for approximately 6km, before joining the River Adur near Partridge Green (TQ 18023 17851).
North River	Main River	N	Source located near Standon Lane in Dorking (TQ 13270 38612), and its confluence with the River Arun located north of Slinfold (TQ 11852 32330). The river’s catchment area is primarily rural and is located along the northern border of HDC,
River Stor	Main River	N	Rises adjacent to Chantry Lane, along the southern boundary of the HDC area, then flows north west through Storrington, before reaching its confluence with the River Arun, located outside of the HDC study area.

6.4 Historical Flooding

Information on previously recorded flood events is provided in this section. This information has been taken from data provided by WSCC and the Environment Agency’s Recorded Flood Outlines.

6.4.1 Fluvial flooding

A number of relatively widespread fluvial flooding events have occurred within the study area. The Environment Agency’s Recorded Flood Outlines dataset documents the following events, as seen in Appendix A, Figure A4:

- September 1968 – The channel capacity of the River Arun was exceeded, causing multiple isolated areas of flooding throughout Horsham.
- November 1974 – Overtopping of defences along both the River Adur and the River Arun, causing widespread floodplain inundation in numerous locations along the reach.
- June 1981 – Channel capacity of the River Stor exceeded, causing flooding through the centre of Storrington.
- December 2013 – Overtopping of defences along the River Arun, leading to flooding along the whole stretch of river from Loxwood to Pulborough.

WSCC’s 2011 PFRA provides detail on the September 1968 floods within Horsham, stating: “main road flooded and adjacent properties internally flooded to 0.6m”, however no further information on the source of flooding is available.

6.4.2 Surface Water Flooding

WSCC provided a register detailing all recorded historic flooding events within HDC in the past 10 years. The most common source of historic flooding within this dataset is shown to be surface water. Appendix A, Figure A4 shows this dataset, with the areas that have experienced surface water flooding highlighted. It should be noted that records only appear where they have been reported to WSCC, and as such they may not include all instances of surface water flooding.

A high majority of recorded incidents are shown to have occurred within Billinghurst, however these areas have likely been targeted for maintenance and improvements, and as such areas that experienced flooding in the past may no longer be at greatest risk of flooding in the future.

6.4.3 Sewer Flooding

Water companies are required to maintain a register of locations which are at risk of flooding due to hydraulic overloading of sewers (sewer pipe is too small or positioned at too shallow a gradient). The identification of these locations of previous flooding can inform LPAs of areas where additional development may have a significant impact on the capacity of the sewer system, and where water companies may need to prioritise investment in measures to improve the system's capacity to support proposed developments. However, it should be noted that historic incidents may have been addressed through water companies' asset management programmes and may no longer reflect an area where sewer incapacity is a problem or where flooding is probable.

Southern Water has provided an extract from their DG5 Flood Register for the study area, which records historic internal and external sewer flooding events. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within four digit postcode areas that have experienced flooding either internally or externally within the last 10 years (2014-2024). It should be noted that records only appear on the DG5 register where they have been reported to Southern Water, and as such they may not include all instances of sewer flooding. Furthermore, given that Southern Water target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding in the future.

Appendix A, Figure A5 shows the number of sewer flooding incidents reported by Southern Water over the last 10 years in each four-digit postcode in the HDC study area. However, it should be noted that Southern Water focus their efforts on removing properties from the DG5 register and therefore this information may not accurately represent those properties currently at risk. The figure shows that there is a high frequency of sewer flooding incidents in the HDC study area. Each of the 6 postcodes within HDC have experienced upwards of 21 sewer flooding incidents, with the postcodes occupying most of the district boundary (RH12, RH13 and RH20) having experienced between 41 and 120 sewer flooding incidents.

6.5 Flood Mapping

6.5.1 Fluvial and Tidal Flooding

Appendix A, Figure A6 shows Flood Zones 2 and 3 for the principal watercourses within the study area (see Table 3-1 for more information on Flood Zones). Areas of Flood Zones 2 and 3 are primarily confined to the channels and immediate floodplain surrounding the Main Rivers and ordinary watercourses throughout the catchment. An extensive area of Flood Zone 3 is concentrated around the floodplain to the north of Upper Beeding.

Future flood risk

Climate change is expected to increase the frequency, extent, and impact of flooding, as reflected in higher 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 sea levels may also increase flood risk within areas of HDC that are tidally influenced. Fluvial flood risk may also be increased due to rising tidal levels which can cause tide locking.

Appendix A, Figure A7 provides the modelled extent of the combined fluvial and tidal climate change extent (higher central, 2080s). As described within Section 3.1, a conservative approach has been taken where future flood risk has been represented by a merged maximum extent between Flood Zone 2 (0.1% AEP) and the available modelled climate change allowances as detailed in Table 3-2.

Within Appendix A, Figure A7, small increases are seen throughout the flood extents when compared to present day (Appendix A, Figure A6). Areas of flood risk which were previously confined to the channels of watercourses are now seen to encroach onto their surrounding floodplains. A large area of floodplain concentrated around the River Adur is shown to be located within the modelled flood extents, from Upper Beeding to Henfield.

6.5.2 Functional Floodplain

Flood Zone 3b functional floodplain is defined as land where water has to flow or be stored in times of flooding. This is identified by the normal form of the river channel and land that would flood during a 3.33% AEP (1 in 30 year) event or greater in any year, with flood risk management features and structures operating effectively.

As described in Section 3.1, a conservative approach was agreed with the Environment Agency regarding Flood Zone 3b. It was agreed that Flood Zone 3a would be used to represent Flood Zone 3b throughout this Level 1 SFRA as modelling results for the 3.33% AEP (1 in 30 year) were not available.

The Environment Agency guidance 'How to prepare a Strategic Flood Risk Assessment'[4] encourages the use of site specific FRAs to determine whether a site is classified as functional floodplain. If sites are proposed for development in such areas in any of the LPA's Local Plans, it may be necessary to undertake additional assessment (which may include hydraulic modelling) to map the location of the functional floodplain as part of a Level 2 SFRA.

Future Flood Risk

In line with the future flood risk of river flooding, the area of functional floodplain is expected to increase as a result of climate change. Flood Zone 3a, and subsequently Flood Zone 3b is expected to have a greater extent in the future, potentially impacting the floodplain around the River Adur from Upper Beeding to Henfield.

6.5.3 Groundwater Flooding

The 2019 GeoSmart Groundwater Flood Risk dataset has been mapped in Appendix A, Figure A8. This map does not show the risk of groundwater flooding, rather it identifies areas where geological conditions could enable groundwater flooding to occur.

The dataset shows the majority of the HDC area to be situated within Class 4 (Negligible Risk). This means that there is a less than 1% annual probability of groundwater flooding within each 5m grid square. Areas of Class 3 (Low Risk) and Class 2 (Moderate Risk) are shown to align with the River Arun and River Adur, however these areas of higher risk are primarily confined to the channels and their immediate floodplains.

There are some areas of Class 1 (High Risk) situated along the southern border of HDC, primarily located in Upper Beeding and to the east of Pulborough. Class 1 is defined as having a greater than 1% annual probability of groundwater flooding within each 5m grid square.

Future Flood Risk

Most climate change models indicate an increased likelihood of drier summers, albeit with more intense rainfall when it occurs, and wetter winters. As groundwater flooding occurs primarily as a response to extended periods of rain during late autumn and early winter, there may be an increased risk of groundwater flooding arising from these changing rainfall patterns. However, the complex relationship between rainfall, recharge, groundwater storage and flow make the response to climate change uncertain. It is recommended that this figure should be updated once the groundwater dataset is updated.

6.5.4 Surface Water

The Environment Agency's RoFSW dataset is presented in Appendix A, Figure A9. This map shows that the risk of surface water flooding is concentrated around watercourses in the district, most notably the River Arun and the River Adur. The risk of surface water flooding also increases markedly in urbanised areas, with this being most pronounced in Horsham and Billinghurst.

Future flood risk

Section 3.2 describes the impact of climate change on surface water flood risk and summarises the peak rainfall intensity climate change allowances for the study area which range from 20% - 45% depending on the specific location and epoch under consideration.

Climate change must be considered in evaluating the flood risk from all sources, including surface water. The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding and it is not within the scope of this SFRA to undertake widespread surface water modelling to apply all the allowances within the guidance. However, a range of three annual probability events have been modelled within the RoFSW, 3.3%, 1% and 0.1%, and therefore it is possible to use with caution the 0.1% outline as a proxy dataset to provide an indication of the implications of climate change.

6.5.5 Reservoir Flooding

In total there are 17 Reservoir Act registered impoundments with the potential to cause flooding within the HDC area have been identified, which are presented in Table 6-2.

Table 6-2: List of Reservoir Act registered impoundments with the potential to cause flooding within HDC

Name	Location	Grid Reference	Flood Risk in HDC?
Douster Pond	Ifield (Outside of HDC)	TQ2444934329	Flooding is restricted to the valley of the Douster Brook and only marginally crosses into the HDC area near Ifield Wood and near Buchan Country Park. There are a few isolated vulnerable receptors within the affected area.
Furnace Pond	Crabtree	TQ2295925205	Flooding is restricted in both the 'dry day' and 'wet day' scenarios to the floodplain immediately adjacent to the Cowfold Stream between Furnace Pond and London Road. There are only isolated buildings in the affected area.
Hammer Pond	Mannings Heath	TQ2224329188	Flooding is restricted in both the 'dry day' and 'wet day' scenarios to the floodplain immediately adjacent to Golding's Stream, and subsequently the River Arun. There are no vulnerable receptors within the affected area.
Hawkins Pond	Mannings Heath	TQ2160029200	Flooding is restricted in both the 'dry day' and 'wet day' scenarios to the floodplain immediately adjacent to Golding's Stream, and subsequently the River Arun. There are no vulnerable receptors within the affected area.
Hardham Reservoir	Hardham (Outside of HDC)	TQ0414216753	Flooding is predominantly restricted to the reach of the River Arun located in the South Downs National Park and only marginally crosses into the HDC area near Pulborough. A number of vulnerable receptors are impacted within the HDC area.
Kneppmill Pond	West Grinstead	TQ1571421243	Flooding is restricted in both the 'dry day' and 'wet day' scenarios to the floodplain immediately adjacent to the River Adur between Shipley and Upper Beeding.
Park Mill Pond	Northchapel (Outside of HDC)	SU9710030800	Flooding is predominantly restricted to the reach of the River Arun located in the South Downs National Park and only marginally crosses into the HDC area near Pulborough and near Adversane. A number of vulnerable receptors are impacted within the HDC area.
Burton Mill Pond	Duncton, Chichester (Outside of HDC)	SU9790018000	Flooding is predominantly restricted to the reach of the River Arun located in the South Downs National Park and only marginally crosses into the HDC area near Pulborough and near Adversane. A number of vulnerable receptors are impacted within the HDC area.
Chingford Pond	Duncton, Chichester (Outside of HDC)	SU9725017350	Flooding is predominantly restricted to the River Rother and the reach of the River Arun located in the South Downs National Park, and only marginally crosses into the HDC area near Pulborough. A number of vulnerable receptors are impacted within the HDC area.
Ridgehanger	Ellen's Green	TQ1126034900	Flooding is restricted in both the 'dry day' and 'wet day' scenarios to the floodplain immediately adjacent to the middle reaches of the River Arun, from Stane Street to Drungewick Lane. There are some vulnerable receptors positioned within the affected area.
Roosthole Pond	Horsham	TQ2047029580	Flooding is restricted in both the 'dry day' and 'wet day' scenarios to the floodplain immediately adjacent to the upper reaches of the River Arun, from Mannings Heath to Broadbridge Heath. A number of vulnerable receptors are impacted through the centre of Horsham.

Vann Lake	Ockley	TQ1560039500	Flooding is primarily restricted in both the 'dry day' and 'wet day' scenarios to the floodplain immediately adjacent to North River, from Ockley to Slinfold. Only a very few isolated receptors are impacted during a 'wet day' event.
Warnham Mill Pond	Horsham	TQ1700032500	Flooding is restricted to the entire length of Boldings Brook, and subsequently the reach of the River Arun between Horsham and Bignor Wood. A number of isolated buildings are impacted during a 'wet day' event.
Whitevane Pond	Horsham	TQ2112431488	Flooding follows the route of the River Arun from St Leonards Forest, near the source of the river, to Stane Street in Slinfold. In the 'wet day' event, many vulnerable receptors through the centre of Horsham are impacted.
Ifield Mill Pond	Ifield (Outside of HDC)	TQ2450036400	Flooding is predominantly restricted to the River Mole and only marginally crosses into the HDC area near Ifield. A number of vulnerable receptors are impacted within the HDC area dueing both the 'wet day' and 'dry day' events.
Pond Lye	Goddards Green (Outside of HDC)	TQ2900021400	Flood extents follow the lower reach of the River Adur, from Goddards Green to Shoreham-by-Sea. The flood extent for the 'wet day' event extends far into the floodplain, particularly within the south-east region of HDC, resulting in a number of vulnerable receptors being impacted.
Burton Mill Reservoir	Duncton, Chichester	SU9790018000	Small area (approx 0.13km^2) within HDC area. There are no vulnerable receptors within the affected area.

Appendix A, Figure A10 shows the potential extent of flooding in the unlikely event of a failure of these reservoirs when river levels are normal ('dry' day scenario) and when rivers have already overtopped their banks ('wet' day scenario). The mapping shows that the area at risk follows the floodplains and valleys of the River Adur and the River Arun, with the majority of flooding occurring regardless of the river levels. Reservoir flood risk only extends to the wider floodplain surrounding the River Adur from Ashurst to Upper Beeding when rivers are in flood (i.e. the 'wet' day scenario).

7 Cumulative impact of development and land use change

7.1 Cumulative impact assessment

The NPPF states that strategic policies should be informed by a SFRA and 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. The 'How to prepare a Strategic Flood Risk Assessment' guidance[4] also states that an SFRA should include as assessment of the cumulative impacts of development and land-use change which should include any impact expected from:

- Strategically planned development;
- Windfall development;
- Permitted development; and
- Significant changes in land use, such as paving over domestic gardens or reforestation of uplands.

Development, or the cumulative impacts of development, may result in an increase in flood risk elsewhere as a result of impacts such as the loss of floodplain storage, deflection or constriction of flood flow routes and/or through inadequate management of surface water.

Where flood storage from any source of flooding is to be lost as a result of development, on-site level for level, volume for volume compensatory storage for the 1% AEP flood event accounting for the predicted impacts of climate change over the lifetime of the development, should be provided. Where it is not possible to provide compensatory storage on site, it may be acceptable to provide off-site if it is hydraulically and hydrologically linked. More information is provided in Section 9.3.1.

Identification of those areas where changes in land use could potentially increase surface water runoff rates and volumes can strategically aid spatial planning in avoiding areas where significant mitigation of surface water runoff following development may be required. The provision of multifunctional sustainable drainage systems, natural flood management and green infrastructure can also make a valuable contribution to mitigating the cumulative impacts of development on 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 effects of multiple development may be more severe at downstream locations in the catchment. Locations where there are existing flood risk issues 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.

From a review of all future development sites provided by HDC, it is unlikely that any development sites will have a cumulative impact. Development sites are generally spread across HDC and are located in areas which are not significantly impacted by flood sources.

7.2 Cross boundary considerations

Many of the catchments within the HDC area cross borders between LPA administrative areas, such that future development in another LPA could impact flood risk in the HDC area, and vice versa. It is important that LPAs work together and take a catchment-wide approach when considering the wider impacts of any proposed development.

The source of the western Adur rises at Slinfold within HDC, and the eastern Adur rises at Ditchling Common, in Lewes District Council. Both arms join near Henfield and flow south to their mouth at Shoreham-by-Sea. Developments upstream of the eastern Adur, in Lewes District Council, could have an impact downstream on flood risk in the HDC area, whilst development in HDC could impact flood risk to other districts positioned further downstream in the River Adur catchment.

The River Arun rises at St Leonard's Forest within HDC, flows westwards through Horsham before flowing south to its mouth at Littlehampton. Therefore, any development within HDC has the potential to impact flood risk downstream of the district.

As a result, any new development will need to produce a site specific assessment inclusive of a Surface Water Drainage Strategy which ensures that flood risk will not increase to third parties as a result of the proposed development.

8 Flood Management and Defences

8.1 Defences

The following details regarding flood management and defences within the HDC area were extracted from the Environment Agency's Asset Information Management System (AIMS) dataset:

- Natural high ground is located along the majority of the length of the River Arun, located along both banks. This starts at Horsham and covers all Main River downstream of Horsham within the HDC area;
- Natural high ground surrounds the entire length of Boldings Brook on both banks;
- Engineered high ground surrounds Warnham Mill Pond. This is bordered to the south by a series of walls, embankments and Warnham Mill Road Flood Gate;
- A series of embankments spans the River Arun on both banks which starts near Bines Green and covers all Main River downstream; and
- Natural high ground covering the entirety of Cowfold Stream.

A series of smaller lengths of natural high ground are also located within the HDC area, however these are isolated areas and short in length.

8.2 Flood Warning Service

The Environment Agency operates a Flood Warning Service[33] in respect to Main River (and tidal) flooding across England. Three different codes are issued depending on the type of flooding forecasted:

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

The Environment Agency's website offers up-to-date flood information, monitoring information of river and sea levels and latest flood risk forecast, as well as a page to sign up to warnings by phone, text, email, or fax.

There are 9 Flood Warning Areas in the HDC area which are shown in Appendix A, Figure A11 including:

- Broadbridge Heath to Pallingham Quay on the River Arun;
- Coolham and Shipley on the River Adur;
- Horsham on the River Arun;
- Horsham on the Boldings Brook;
- Ifield Brook and the River Mole at Ifield and the River Mole at Lowfield Heath;
- Loxwood, Brewhurst and Drungewick on the River Lox;
- Mock Bridge, near Shermanbury on the River Adur;
- Pulborough on the River Arun; and
- Upper Beeding and Bramber on the River Adur.

The Environment Agency publishes 'Water situation: area monthly reports for England'[34] for each of its areas. These reports identify monthly rainfall, soil moisture deficit, river flows, groundwater levels and reservoir levels. The Environment Agency also publishes 'Groundwater situation'[35] reports which provide the latest update on monitored groundwater levels and whether there are any groundwater alerts or warnings in force. These reports will give an indication as to when groundwater levels may be high and groundwater flooding may be imminent.

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[33] Environment Agency Flood Warning Service: https://check-for-flooding.service.gov.uk/ [Accessed May 2024].
[34] Water situation: area monthly reports for England 2022: https://www.gov.uk/government/publications/water-situation-local-area-reports [Accessed May 2024].
[35] Groundwater situation reports: https://www.gov.uk/government/collections/groundwater-current-status-and-flood-risk [Accessed May 2024].

The Environment Agency also provide a targeted groundwater flood warning service through issue of groundwater "Flood Alerts" for specific locations and communities. According to the Environment Agency's 'Hydrometric Monitoring Points' dataset[36], there is currently one groundwater monitoring station within the HDC area, named 'Ashington Jinkes Farm' which is located at Longbury Hill.

8.3 Residual Risk

The risk of flooding from rivers can never be fully mitigated, and there will always be a residual risk of flooding that will remain after measures have been implemented to protect an area or a particular site from flooding. This residual risk is associated with a number of potential risk factors including (but not limited to):

- a flooding event that exceeds that for which the flood risk management measures have been designed e.g. flood levels above the designed defence crest level,
- the structural deterioration of flood defence structures (including informal structures acting as a flood defence) over time resulting in a defence breach,
- blockage of key defence/conveyance structures,
- the occurrence of large, unpredictable cliff falls, and/or
- general uncertainties inherent in the prediction of flooding.

The modelling of flood flows and flood levels is not an exact science, therefore there are inherent uncertainties in the prediction of flood levels used in the assessment of flood risk. While Flood Zones provide a relatively robust depiction of flood risk for specific conditions, all modelling requires the making of core assumptions and the use of empirical estimations relating to (for example) rainfall distribution and catchment response. No residual modelling (breach or overtopping of defences or structural blockages) has been undertaken as part of this SFRA. This should be included as part of a site-specific FRA, or a Level 2 SFRA, should development be located in an area where residual flood risk is considered to be an issue.

Steps should be taken to manage these residual risks through the use of flood warning and evacuation procedures, as described in Section 10.

[36] Environment Agency Hydrometric Monitoring Points: https://www.data.gov.uk/dataset/0bac3947-c632-47eb-83d5-fff7f1911537/hydrometric-monitoring-points

9 Opportunities to reduce the causes and impacts of flooding

This Section identifies opportunities to reduce the causes and impacts of flooding in the local area and land required for flood risk management purposes.

9.1 Maintenance of watercourses

9.1.1 Main Rivers

The Environment Agency is likely to seek an 8m wide undeveloped easement alongside Main Rivers for maintenance purposes and is likely to also ask developers to explore opportunities for riverside restoration as part of any development.

Under Section 109 of the Water Resources Act 1991 and/or Environment Agency Byelaws, any works within 8m of any statutory Main River, flood defence or culvert (16m if it is a tidal Main River or defence structure) requires Environment Agency consent in the form of a Flood Risk Activity Permit. Under the Environmental Permitting (England and Wales) Regulations (2016), an environmental permit is required if works are to be carried out:

- on or near a Main River,
- on or near a flood defence structure,
- in a floodplain,
- on or near a sea defence.

Since requirements of the consenting process in relation to flood risk, biodiversity and pollution may result in changes to development proposals or construction methods, the Environment Agency aims to advise on such issues as part of its statutory consultee role in the planning process. Should proposed works not require planning permission the Environment Agency can be consulted regarding permission to do work on or near a river, or a flood or sea defence by contacting enquiries@environment-agency.gov.uk.

Recommendation: Where practical, retain an 8m wide undeveloped easement alongside Main Rivers or flood defence structure (16m if it is a tidal Main River or defence structure) and explore opportunities for riverside restoration. Undeveloped easements greater than 8m/16m will be encouraged where possible to provide biodiversity, flood risk and water quality benefits.

9.1.2 Ordinary Watercourses

Ordinary Watercourses are watercourses that are not part of a Main River and include streams, ditches, drains, cuts, culverts, dykes, sluices, sewers (other than public sewers) and passages, through which water flows.

Responsibility for the consenting of works by third parties on Ordinary Watercourses under Section 23 of the Land Drainage Act 1991 (as amended by the Flood and Water Management Act 2010) lies with the LLFA. As the LLFA, WSCC is responsible for the consenting of works to Ordinary Watercourses it has powers to enforce un-consented and non-compliant works. This includes any works (including temporary) that place or alter a structure within an Ordinary Watercourse or affect the flow or storage of water within an Ordinary Watercourse. WSCC will seek an undeveloped easement to be retained alongside Ordinary Watercourses. Further information can be found on the WSCC's website[37].

WSCC intends to work with riparian owners[32] (those living adjacent to an Ordinary Watercourse) who are responsible for maintaining Ordinary Watercourses to ensure that the effectiveness of the existing ditches is improved and ensure that future maintenance is undertaken at appropriate intervals. The Environment Agency have prepared a guidance document which provides information on the rights and responsibilities of riparian owners relating to flood risk management[38].

[37] WSCC Ordinary Watercourse Land Drainage Consent: https://www.westsussex.gov.uk/fire-emergencies-and-crime/dealing-with-extreme-weather/flooding/flood-risk-management/ordinary-watercourse-land-drainage-consent/ [Accessed May 2024].
[38] Managing Flood Risk: https://www.westsussex.gov.uk/fire-emergencies-and-crime/dealing-with-extreme-weather/flooding/flood-risk-management/managing-flood-risk/ [Accessed May 2024].

Recommendation: Where practical, an undeveloped easement should be retained alongside Ordinary Watercourses for maintenance purposes. This should be discussed and agreed with the LLFA. Developers should explore opportunities for riverside restoration as part of any development adjacent to Ordinary Watercourses.

9.2 River Restoration and Flood Storage

During the last century, many rivers were modified using hard engineering techniques to often straighten or canalise them. The disadvantages of these techniques have now become apparent which include the damage to the environment and ecosystems, and in some cases an increase in flooding.

River restoration contributes to flood risk management by supporting the natural capacity of rivers to retain water. By re-connecting brooks, streams and rivers to floodplains, former meanders, and other natural storage areas, and enhancing the quality and capacity of wetlands, river restoration increases natural storage capacity and can reduce flood risk. Excess water is stored in a timely and natural manner in areas where values such as attractive landscape and biodiversity are improved and opportunities for recreation can be enhanced.

Returning rivers to a more natural state can often include the removal of structures such as weirs or culverts which can have multiple benefits for biodiversity in addition to improving the flow regime[39]. Further guidance on river restoration is available from the Environment Agency[40]. The Adur River Recovery is an ongoing land manager-led project aiming to revitalise and restore the River Adur[41]. The project aims to revive floodplains, increase biodiversity and improve water quality along the Main River.

Flood Storage Areas (FSAs) are natural or man-made areas that temporarily fill with water during periods of high river level, retaining a volume of water which is released back into the watercourse after the peak river flows have passed. There are two main reasons for providing temporary detention of floodwater:

- To compensate for the effects of catchment urbanisation, and
- To reduce flows passed downriver and mitigate downstream flooding.

Providing flood storage within a development area or further upstream of a development can manage and control the risk of flooding. In some cases, it can provide sufficient flood protection on its own; in other cases, it may be chosen in conjunction with other measures. The advantage of flood storage is that the flood alleviation benefit generally extends further downstream, whereas other methods tend to benefit only the local area and may increase the flood risk downstream.

Further guidance on Flood Storage is provided within Chapter 10 of the Environment Agency's Fluvial Design Guide[42].

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

9.2.1 Floodplain Compensation

According to guidance provided in the PPG (notes to Table 2), all new development within Flood Zone 3 must not 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, land raising or other structures such as bunds, the developer must ensure that it does not impact upon the ability of the floodplain to store water and should seek opportunities to provide betterment with respect to floodplain storage. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain

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[39] European Centre for River Restoration: https://www.ecrr.org/River-Restoration/Flood-risk-management/Healthy-Catchments-managing-for-flood-risk-WFD/Environmental-improvements-case-studies/Remove-culverts [Accessed May 2024].
[40] Environment Agency, Fluvial Design Guidance Chapter 8: https://assets.publishing.service.gov.uk/media/60549ae1e90e0724c0df4619/FDG_chapter_8_-_Works_in_the_river_channel.pdf [Accessed May 2024].
[41] Adur River Recovery: https://www.adur-river-recovery.org/ [Accessed June 2024]
[42] Environment Agency's Fluvial Design Guide: https://assets.publishing.service.gov.uk/media/60549b7a8fa8f545cf209a29/FDG_chapter_10_-_Flood_storage_works.pdf [Accessed May 2024].

storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.

As depicted in Figure 9-1, floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it must be in the immediate vicinity, in the applicant's ownership and linked to the site. Floodplain compensation must be considered in the context of the 1% AEP (1 in 100 year) flood level including an allowance for climate change. According to the Environment Agency's climate change allowances guidance[43], the appropriate allowance to assess off-site impacts and calculate floodplain storage compensation depends on land uses in affected areas. The allowances used should be:

- The Central allowance for most cases.
- The Higher Central allowance when the affected area contains essential infrastructure.

Likely future land uses should also be considered, shown by local plan allocations or unimplemented extant planning permissions.

When designing a scheme, floodwater must be able to flow in and out and must not pond. A FRA must demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624[44].

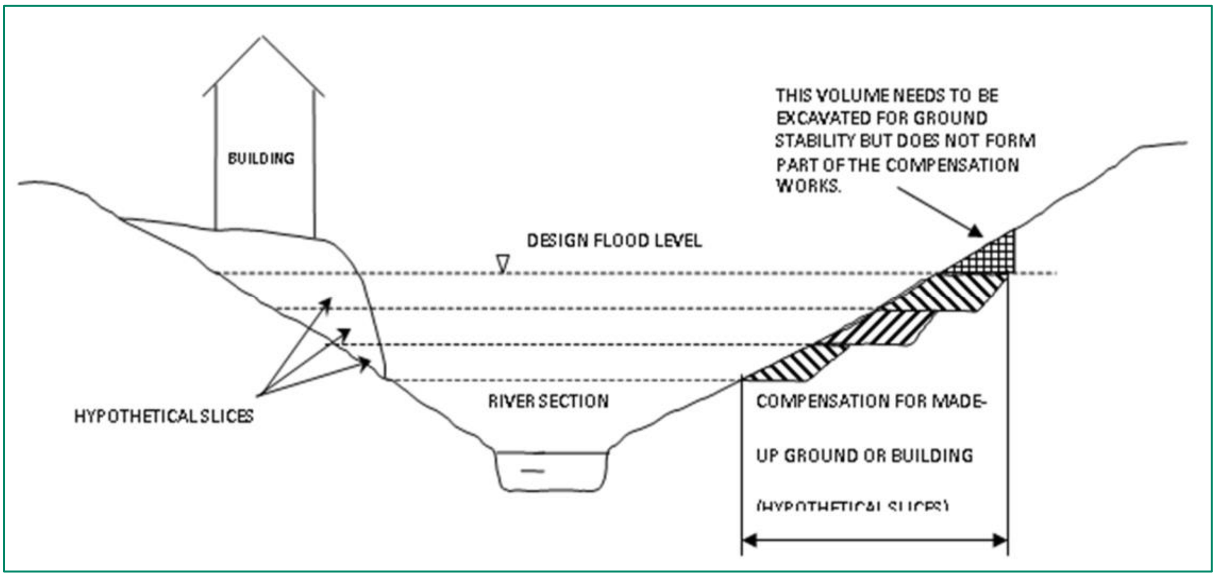

Figure 9-1: Example of Floodplain Compensation Storage (Environment Agency 2009)

The requirement for no loss of floodplain storage means that it is not possible to modify ground levels on sites which lie completely within the floodplain (when viewed in isolation), as there is no land available for lowering to bring it into the floodplain.

It is possible to provide off-site compensation within the local area e.g. on a neighbouring or adjacent site, or indirect compensation, by lowering land already within the floodplain, however, this would be subject to detailed investigations and agreement with the Environment Agency to demonstrate (using an appropriate flood model where necessary) that the proposals would improve and not worsen the existing flooding situation or could be used in combination with other measures to limit the impact on floodplain storage.

Should it not be possible to achieve all the level for level compensation required, the Environment Agency should be consulted to explore and discuss alternatives.

[43] Flood Risk Assessments: Climate Change Allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Accessed May 2024].
[44] CIRIA (2004) CIRIA Report 624: Development and Flood Risk - Guidance for the Construction Industry.

While the use of stilts and voids below buildings may be an appropriate approach to mitigating flood risk to the buildings themselves, such techniques should not normally be relied upon for compensating for any loss of floodplain storage. This is because voids do not allow the free flow of water, trash screens get blocked, voids get silted up, they have limited capacity, and it is difficult to stop them being used for storing belongings or other materials. In line with the latest planning guidance, it is recommended that voids are not used as a form of mitigation i.e. compensatory storage.

Recommendation: As referenced within this section, all new development within Flood Zone 3 must not result in a net loss of flood storage capacity. Where proposed development results in a change in building footprint, land raising or other structures such as bunds, the developer must ensure that it does not impact upon the ability of the floodplain to store water and should seek opportunities to provide betterment with respect to floodplain storage. Floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it must be in the immediate vicinity, in the applicant's ownership and linked to the site. Floodplain compensation must be considered in the context of the 1% AEP (1 in 100 year) flood level including an allowance for climate change. This should be discussed and agreed with the Environment Agency.

9.3 Groundwater

The majority of the HDC area has a negligible groundwater flood risk, however there are areas around the River Adur and Arun where risk is greater, primarily surrounding Upper Beeding and to the east of Pulborough.

Recommendation: For all proposed developments in groundwater risk areas, groundwater monitoring during periods of high groundwater (winter/spring) should be included in all FRAs, unless adequate justification can be provided by the applicant to exempt the proposed development from this requirement.

Additionally, slope stabilisation and reprofiling measures should be avoided wherever possible, to minimise/prevent disruption to groundwater flows, and the aggravation of groundwater flood risk elsewhere.

Where the installation of foundations and associated excavation works is required for proposed developments, these should either take place above the maximum height of the groundwater table (as confirmed by on-site groundwater monitoring), or shall implement appropriate pumping and SuDS to dewater the excavated area and to mitigate against the loss of groundwater storage.

9.4 Working with Natural Processes

Natural flood management involves techniques that aim to work with natural hydrological and morphological processes, features, and characteristics to manage the sources and pathways of flood waters. Techniques include the restoration, enhancement and alteration of natural features and characteristics, but exclude traditional flood defence engineering that works against or disrupts these natural processes.

There are a number of opportunities available to reduce the causes and impacts of flooding through Working with Natural Processes (WWNP). This involves implementing measures that help to protect, restore, and emulate the natural functions of catchments, floodplains, rivers, and the coast. WWNP takes many forms and can be applied in urban and rural areas, and on rivers, estuaries, and coasts. Potential natural processes are detailed in Table 9-1.

As part of a research project undertaken by the Flood and Coastal risk Management Research and Development Programme and the Environment Agency[45], a series of spatial datasets have been generated for these natural processes, identifying their best estimate of locations in the country where the methods can be applied (Table 9-1). As well as reducing the causes and impacts of flooding, WWNP has a number of environmental, social, and cultural benefits, including water quality, habitat, climate regulation, health access, air quality, and aesthetic quality. Although WWNP methods have very promising benefits, they are relatively new concepts, and more research is required to gain a greater understanding of their impacts in different conditions and representation in models. The WWNP data does not provide information on design, which may need to consider issues such as drain-down between flood events. It is important to note that land ownership and change to flood risk have not been considered. Locations identified may have more recent building or land use than available data indicates.

[45] Working with natural processes to reduce flood risk: https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk [Accessed May 2024].

Appendix A, Figure A12 provides information from the Environment Agency's 'Working with Natural Processes' spatial datasets and displays where these measures could be applied within the HDC area.

Recommendation: Where possible, all new developments should explore the opportunity to implement natural processes to alleviate flooding. This should be discussed and agreed with HDC.

Table 9-1: Description of WWNP datasets

Natural Process	Benefits	Most Effective Conditions	Notes
Floodplain Woodland Planting Potential	Slows floodwaters and increases water depth on the floodplain. Reduces flood peaks, delays flood peak timing and desynchronises flood peaks. Enhances sediment deposition on the floodplain.	Middle and lower reaches of medium-sized and large catchments.	Based upon Flood Zone 2. Information is largely based on modelled data and open access constraints data. It is indicative rather than specific. Locations may have more recent building or land use than the available data indicates.
Riparian Woodland Planting Potential (woodlands on land immediately adjoining a watercourse)	Slows flood flows. Reduces sediment delivery to the watercourse. Reduces bankside erosion. Creates below ground storage.	At the reach scale in middle and upper catchments.	Based upon a 50m buffer of available OS Open Data river networks. Information is largely based on open data and is indicative rather than specific. Locations may have more recent building or land use than the available data indicates.
Wider Catchment Woodland	Intercepts, slows, stores and filters water. Reduced flood peaks, flood flows and frequency.	Small events on small catchments – extent of reduction decreases as flood magnitude increases.	Based upon the 1:50k BGS geology survey and relies upon identifying drift and bedrock geologies that are characteristic of slowly permeable soils. Information is largely based on the 100m gridded version of BGS data and open constraints data and is indicative rather than specific.
Floodplain Reconnection Potential (reconnecting watercourses and floodplains)	Encourages more regular floodplain inundation and floodwater storage. Decreases the magnitude and delays the onset of flood peaks. Reduces downstream floodplain depths.	High frequency, low return period floods.	Designed to support signposting of areas where there is currently poor connectivity such that flood waters are constrained to the channel and flood waves may therefore propagate downstream rapidly. Based upon the Risk of Flooding from Rivers and Sea probability maps and identifies areas of low and very low probability that are close to a watercourse, but do not contain residential properties or key services (may contain non-residential properties).
Runoff Attenuation Features (3.33% and 1% AEP) (includes swales, ponds, and sediments traps)	Delays and flattens the hydrograph and reduces peak flow locally for small flood events.	A cluster of features working as a network throughout the landscape.	Based upon the Risk of Flooding from Surface Water datasets and identifies areas of high flow accumulations for the 1% and 3.33% AEP surface water maps. The areas of ponding or accumulation are between 100 and 5000 metres squared and have been tagged where they fall on an area of slope steeper than 6% as gully blocking opportunities.

9.5 Surface Water Management

Development should be designed so that there is no increase in flood risk elsewhere and the development will be safe from surface water flooding.

Drainage systems must be designed such that flooding does not occur in any part of a site for the 3.33% (1 in 30 year) rainfall event (including the relevant allowance for climate change), and so that flooding does not occur in any part of a building, or in any utility plant susceptible to water within the development for the 1% AEP (1 in 100 year) rainfall event (including the relevant allowance for climate change). Exceedance flows resulting from rainfall in excess of the 1% AEP (1 in 100 year) rainfall event must be managed in such a way that minimises the risks to people and property[46].

With respect to peak runoff rates discharged from developments, these should never exceed the greenfield runoff rates for the annual (1 in 1 year) and 1% AEP (1 in 100 year) rainfall events (including relevant allowances for climate change) for greenfield developments. For developments on brownfield sites, the peak runoff rates must be as close to the greenfield runoff rates for the annual (1 in 1 year) and 1% AEP (1 in 100 year) rainfall events (including relevant allowances for climate change) as reasonably practicable and should not exceed the runoff rates from the site prior to redevelopment for these two events.

Proposed drainage systems should be able to accommodate multiple consecutive rainfall events by ensuring that they can empty within 48 hours. As it is not possible to design for every rainfall event, it is important that excess flows can be managed safely during rainfall events exceeding that for which the proposed drainage system has been designed for.

The 'Water. People. Places. A guide for master planning sustainable drainage into developments' document outlines the design requirements for SuDS, and the delivery stages for SuDS that should be followed by developers within the WSCC area[47].

The relevant allowances for climate change (described in Table 3-4) should be identified through reference to the lifetime of the development:

- For development with a lifetime beyond 2100, use the upper end allowances for the 2070s epoch.
- For development with a lifetime of between 2061 and 2100 use the central allowance for the 2070s epoch.
- For a development with a lifetime up to 2060 use the central allowances for the 2050s epoch.

Recommendation: All new developments should incorporate a range of SuDS to target the required water quantity, quality, amenity and biodiversity benefits, unless it can be demonstrated that SuDS are not technically appropriate. Proposed SuDS should be designed such that surface water runoff rates from greenfield developments should not exceed greenfield runoff rates for the annual and 1% AEP rainfall events, and so that surface water runoff rates for brownfield developments should not exceed existing runoff rates and should be as close to greenfield runoff rates as reasonably practicable.

For each new development, SuDS guidance should be developed to inform future management. A maintenance schedule must be prepared for all proposed SuDS, which will identify the body responsible for the maintenance and continuing funding of these. Developers should adhere to the guidance within the 'Water. People. Places.' Document from the LLFAs of the South East of England.

9.6 Sustainable Drainage Systems

Suitable surface water management measures should be incorporated into new development designs in order to reduce and manage surface water flood risk to, and posed by, a development. This should ideally be achieved by incorporating SuDS.

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[46] DEFRA Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems (March 2015): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf [Accessed May 2024].
[47] Water, People, Place - A guide for master planning sustainable drainage into developments: https://www.susdrain.org/files/resources/other-guidance/water_people_places_guidance_for_master_planning_sustainable_drainage_into_developments.pdf [Accessed May 2024].

SuDS are typically softer engineering solutions inspired by natural drainage processes such as ponds and swales which manage water as close to its source as possible. However, harder engineering solutions such as oversized pipes and tanks are often relied upon to provide adequate surface water storage to meet design requirements. It is recommended that preference be given to above ground SuDS in line with best practice.

Wherever possible, a SuDS technique should seek to contribute to each of the three following goals:

- To control the quantity and rate of surface water runoff from a development,
- To improve the quality of the surface water runoff,
- To provide wider landscape, amenity, and wildlife benefits to the development site and its surroundings.

According to the PPG, the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

- Into the ground (infiltration),
- To a surface water body,
- To a surface water sewer, highway drain, or another drainage system, and,
- To a combined sewer.

SuDS techniques can be used to reduce the rate and volume, and to improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc). The SuDS manual[48] identifies several processes that can be used to manage and control runoff from developed areas. Each option can provide opportunities for storm water control, flood risk management, water conservation and groundwater recharge. Reference should be made to the non-statutory technical standards[49] for guidance on the design, maintenance, and operation of SuDS.

- Infiltration: The soaking of water into the ground. This is the most desirable solution as it mimics the natural hydrological process. The rate of infiltration will vary with soil type and condition, the antecedent conditions and with time. The process can be used to recharge groundwater sources and feed baseflows of local watercourses, but where groundwater sources are vulnerable or there is risk of contamination, infiltration techniques are not suitable. Where infiltration is proposed, the findings of a detailed ground investigation undertaken at the same location and depth as the proposed infiltration system, should underpin the SuDS design.
- Detention/Attenuation: The slowing down of surface flows before their transfer downstream, usually achieved by creating a storage volume and a constrained outlet. In general, though the storage will enable a reduction in the peak rate of runoff, the total volume will remain the same, just occurring over a longer duration.
- Conveyance: The transfer of surface runoff from one place to another e.g. through open channels, pipes and trenches.
- Water Harvesting: The direct capture and use of runoff on site e.g. for domestic use (flushing toilets) or irrigation of urban landscapes. The ability of these systems to perform a flood risk management function will be dependent on their scale, and whether there will be a suitable amount of storage always available in the event of a flood.

As part of any SuDS scheme, consideration should be given to the whole life management and maintenance of the SuDS to ensure that it remains functional for the lifetime of the development. All parts of the drainage system should be designed to be accessible at all times and location in private property should be avoided, wherever possible. It is advisable that a maintenance plan be submitted with the drainage application, including details of access arrangements, the safety of operatives, and the frequency of maintenance. The adopting organisation may require

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[48] CIRIA C697 SuDS Manual
[49] Sustainable drainage systems non-statutory technical standards: https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards [Accessed May 2024].

the developer to maintain the drainage system for a minimum period of one year, so that problems can be identified and addressed.

As per Policy 38 in the Horsham District Planning Framework, all new developments that have potential to increase flood risk are required to incorporate SuDS, where technically feasible, to ensure there is no increase in surface water runoff from new developments. It is recommended that Policy 38 of the Horsham District Planning Framework be reviewed once the legislation regarding SABs is released.

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

SuDS should be considered and integrated into the site layout at the early stages of planning to reduce the risk of abortive work associated with needing to modify the site layout to include SuDS at a later stage, and so that the principles of a surface water drainage strategy can be agreed through consultation with the LLFA and HDC. The existing and proposed drainage outfall points for the site must be agreed with relevant stakeholders before fixing the site layout.

Georeferenced as built drawings of proposed SuDS must be supplied to WSCC as the LLFA, together with CCTV or any other surveys used to support the drainage design, for inclusion in their Asset Register. Table 9-2 details typical SuDS components, as well as their common uses.

Table 9-2*: Typical SuDS Components (Y = primary process, * = some opportunities subject to design)*

Technique	Description	Conveyance	Detention	Infiltration	Harvesting
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.		Y	Y	*
Filter Drains	Linear drains/trenches filled with a permeable material, often with a perforated pipe in the base of the trench. Surface water from the edge of paved areas flows into the trenches, is filtered, and conveyed to other parts of the site.	Y	Y		
Filter Strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and particulates.	*	*	*	
Swales	Shallow vegetated channels that conduct and/or retain water and can permit infiltration when unlined.	Y	Y	*	
Ponds	Depressions used for storing and treating water.		Y	*	Y
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds. Based on geology these measures can also incorporate some degree of infiltration.	*	Y	*	Y
Detention Basin	Dry depressions designed to store water for a specific retention time.		Y		
Soakaways	Sub-surface structures that store and dispose of water via infiltration.			Y	
Infiltration Trenches	As filter drains but allowing infiltration through trench base and sides.	*	Y	Y	
Infiltration Basins	Depressions that store and dispose of water via infiltration.		Y	Y	
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water. This is because the hydraulic performance during extreme events is similar to a standard roof.		Y		
Rainwater Harvesting	Storage and use of rainwater for non-potable uses within a building e.g. toilet flushing. It is noted that storage in these types of systems is not usually considered to count towards the provision of on-site storage for surface water balancing, given the sporadic nature of the use of harvested water, it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event.	*	*	*	Y

9.7 Flow routing

Redevelopment in areas at risk of flooding from surface water, river flooding or groundwater flooding has the potential to affect flood routing and increase flood risk elsewhere. For example, redevelopment may give rise to backwater effects or divert floodwaters on to other properties.

Consideration should be given to configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties. Consideration should be given to the use of fences and landscaping walls so as to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

Opportunities should be sought within site design to make space for water, such as:

- Identification of existing surface water or fluvial flow routes across the site, so that road and building layouts can be safely designed around them.
- Removing boundary walls or replacing with other boundary treatments such as hedges and fences (with gaps).
- Considering alternatives to solid wooden gates or ensuring that there is a gap beneath the gates to allow the passage of floodwater.
- On uneven or sloping sites, consider lowering ground levels to extend the floodplain without creating ponds. The area of lowered ground must remain connected to the floodplain to allow water to flow back to river when levels recede.
- Create under-croft car parks or consider reducing ground floor footprint and creating an open area under the building to allow flood water storage.
- Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.

Recommendation: All new development should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities shall be sought within the site design to make space for water.

10 Recommendations of how to address flood risk in development

A Site Assessment Database (as per Section 4.1.1) has been provided to HDC to help inform their Sequential Test. This offers a high-level overview of the sources of flood risk and provides a ranking system to determine the overall flood risk to each of the potential development sites that have been provided. The Site Assessment Database is designed to help inform the site allocation choices in conjunction with other planning considerations summarised within a separate Site Assessment Report and Sustainability Appraisal[50].

It may not always be possible to avoid locating development in areas at risk of flooding. This section builds on the findings of the SFRA to provide guidance on the range of measures that could be considered on site in order to manage and mitigate flood risk. These measures should be considered when preparing a site-specific FRA. The section outlines the approach that HDC should consider in relation to flood risk planning policy and development management decisions.

10.1 Sequential Approach

Flood risk should be considered at an early stage in deciding the layout and design of a site so that development in current and future medium and high flood risk areas can be avoided so far as possible. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas (considering all sources of flooding) e.g. residential elements should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas may be placed on lower ground with a higher probability of flooding. Adopting a sequential approach is the most effective measure for addressing flood risk as it is not reliant on measures such as flood defences, property level resilience, and flood warnings.

As per the NPPF, development should only be allowed in areas at risk of flooding where it can be demonstrated that: within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location; the development is appropriately flood resistant and resilient; it incorporates SuDS; any residual risk can be safely managed; and safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Recommendation: A sequential approach to site planning should be applied within new development sites.

10.2 Appropriate types of development

Table 2 in the PPG provides a compatibility matrix and determines which types of development are appropriate in areas of flood risk.

Recommendation: Location of development shall take into account the vulnerability of users.

10.3 Previously developed sites

It is possible that some areas of previously developed land could come forward as part of the site allocation process which are now considered to be at risk from fluvial/tidal flooding.

Recommendation: Where buildings have been demolished within the functional floodplain (Flood Zone 3b) for a significant length of time (i.e. over a year), the land should be reverted back to functional floodplain and consequently, development should be avoided within these areas. Where a building(s) is already located in the functional floodplain, any proposals to regenerate/replace such building(s) will not increase the footprint any greater than the existing footprint.

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[50] Horsham District Council Sustainability Appraisal Update 2023: https://www.horsham.gov.uk/__data/assets/pdf_file/0006/132378/Sustainability-Appraisal-Dec-23.pdf [Accessed August 2024]

10.4 Access / egress

Where development may be proposed in areas at risk of flooding, safe access and egress are required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood, and enable flood defence authorities to carry out any necessary duties during periods of flood.

A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area (e.g. within Flood Zone 1 or an area of low surface water flood risk) using public rights of way without the intervention of emergency services or others during design flood conditions, including climate change allowances. Where a dry route is not possible the FRA should provide an assessment of the flood hazard rating along the route and demonstrate that the route is a low hazard (as defined in the FD2320 Flood risk to people calculator[51]).

The guidance document 'Flood Risk Emergency Plans for New Development' published by the Environment Agency and ADEPT[52] provides more detail on safe access and escape.

Recommendation: Safe access / egress must be provided for new development in areas which are at risk of flooding and must reflect the type of flooding (source of flooding, scale of flooding, floodwater depth, and floodwater velocity) that the location is vulnerable to.

10.5 Flood warning and evacuation

The Environment Agency operates an effective flood warning service with respect to Main River and tidal flooding across England. Three different codes are issued depending on the type of flooding forecasted including Flood Alerts, Flood Warnings and Severe Flood Warnings (Section 8.4).

Information on these warnings can be issued via a number of methods[53]. The Environment Agency's website offers up-to-date flood information, monitoring information of river and sea levels and latest flood risk forecast, as well as a page to sign up to warnings by phone, text, email, or fax[54].

Evacuation is where flood alerts and warnings provided by the Environment Agency enable timely actions by residents or occupants to allow them to get to safety unaided, i.e. without the deployment of trained personnel to help people from their homes, businesses, and other premises. Rescue by the emergency services is likely to be required where flooding has occurred, and prior evacuation has not been possible.

For all developments proposed in Flood Zone 2 or 3, or in areas of medium to very high surface water flood risk, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety. The plan should also demonstrate that their development will not impact on the ability of the local authority and the emergency services to safeguard the current population.

For sites in Flood Zone 1 that are located on 'dry islands', it may also be necessary to prepare a Flood Warning and Evacuation Plan to determine potential egress routes away from the site through areas that may be at risk of flooding during the 1% AEP (1 in 100 year) fluvial flood event including an allowance for climate change, or a 0.5% AEP (1 in 200 year) tidal flood event including an allowance for climate change if tidal is the dominant source.

The Environment Agency has a tool on their website to create a Personal Flood Plan[55]. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.

[51] Defra Environment Agency Flood and Coastal Defence R&D Programme, 2004: https://assets.publishing.service.gov.uk/media/602a9348e90e070559970f9d/Operations_and_Maintenance_Concerted_Action_Report_pdf.pdf [Accessed May 2024].
[52] ADEPT, Environment Agency, September 2019, Flood Risk Emergency Plans for New Development: https://www.adeptnet.org.uk/floodriskemergencyplan [Accessed May 2024].
[53] Environment Agency Flood Warnings: Flood Guidance Statement: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/services/government/hazard-manager-flood-guidance.pdf [Accessed May 2024].
[54] Environment Agency, 2022, Check for Flooding in England: https://check-for-flooding.service.gov.uk/ [Accessed May 2024].
[55] Environment Agency Tool 'Make a Flood Plan'. Available from: https://www.gov.uk/government/publications/personal-flood-plan [Accessed May 2024].

Flood Warning and Evacuation Plans should include:

- How flood warning is to be provided, such as:
  - Availability of existing flood warning systems,
  - Where available, rate of onset of flooding and available flood warning time, and,
  - How flood warning is given.
- What will be done to protect the development and contents, such as:
  - How easily damaged items (including parked cars) or valuable items (important documents) will be relocated,
  - How services can be switched off (gas, electricity, water supplies),
  - The use of flood protection products (e.g. flood boards, airbrick covers),
  - The availability of staff/occupants/users to respond to a flood warning, including preparing for evacuation, deploying flood barriers across doors etc., and,
  - The time taken to respond to a flood warning.
- Ensuring safe occupancy and access to and from the development, such as:
  - Occupant awareness of the likely frequency and duration of flood events, and the potential need to evacuate,
  - Safe access route to and from the development,
  - If necessary, the ability to maintain key services during an event,
  - Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible, and,
  - Expected time taken to re-establish normal use following a flood event (clean-up times, time to re-establish services etc.).

There is no statutory requirement for the Environment Agency or the emergency services to approve evacuation plans. WSCC is accountable as the LLFA via planning condition or agreement to ensure that plans are suitable. This should be done in consultation with emergency planning staff.

Recommendation: A Flood Warning and Evacuation Plan, including safe access/egress routes and emergency planning measures, should be prepared as part of a FRA for all developments sited within areas at risk of flooding and that have potentially vulnerable users.

10.6 Finished Floor Levels

Where developing in Flood Zone 2 and 3 is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) and Highly Vulnerable development types (as outlined in Annex 3 of the NPPF), is to ensure internal floor levels are raised to a freeboard level above the design flood level including an appropriate allowance for climate change.

For fluvial flooding, the design flood is the 1% AEP (1 in 100 year) event plus an appropriate allowance for climate change, whilst for tidal flooding, the design flood is the 0.5% AEP (1 in 200 year) event plus an appropriate allowance for climate change. Less vulnerable development should also aim to raise the floor levels. Where this is not achievable, flood resilience measures should be incorporated. These measures should be detailed within the FRA.

With reference to the 'Flood risk assessment: standing advice for flood risk[56]', finished floor levels for vulnerable developments in Flood Zone 2 and 3, or within areas of medium to very high surface water or groundwater flood risk, should be a minimum of 600mm above the estimated flood level, unless there is a high level of certainty about the estimated flood level, in which case it can be reduced to 300mm. If there is a particularly high level of uncertainty this level may need to be increased. The guidance document "Accounting for residual uncertainty: an update to the

[56] Preparing a flood risk assessment standing advice: https://www.gov.uk/guidance/flood-risk-assessment-standing-advice [Accessed May 2024].

fluvial freeboard guide – technical report"[57] explains how to determine the appropriate residual uncertainty allowances. The process involves identifying sources of uncertainty in the datasets upon which the assessment is based, estimating the magnitude of residual uncertainties, and determining the appropriate response. The resulting residual uncertainty allowances range from 300mm to 900mm.

In certain situations (e.g. for proposed extensions to buildings with a lower floor level or conversion of existing historical structures with limited existing ceiling levels), it could prove impractical to raise the internal ground floor levels to the required height. The FRA standing advice for flood risk stipulates that in these cases the design should be made sufficiently flood resilient and resistant by:

- using flood resistant materials that have low permeability to at least 600mm above the estimated flood level.
- making sure any doors, windows or other openings are flood resistant to at least 600mm above the estimated flood level.
- using flood resilient materials (for example lime plaster) to at least 600mm above the estimated flood level.
- by raising all sensitive electrical equipment, wiring and sockets to at least 600mm above the estimated flood level.
- making it easy for water to drain away after flooding such as installing a sump and a pump.
- making sure there is access to all spaces to enable drying and cleaning.
- ensuring that soil pipes are protected from back-flow such as by using non-return valves.

The FRA standing advice for flood risk also states that the details of emergency escape plans for any parts of a building below the estimated flood level should also be provided as part of a FRA.

In addition to the measures outlined in the FRA standing advice for flood risk, it is also recommended that the following steps be taken to ensure that the design of a building is flood resilient and resistant:

- ensuring that all waste pipes are protected from back-flow by using non-return valves.
- ensuring that all doors are flood-resistant doors and have not been tampered with, for example through the installation of a cat flap.
- all utilities servicing the building must be watertight.
- voids should have smart air bricks which utilise in-built sensors to regulate air flow in response to changes in humidity and temperature.

Recommendation: For More Vulnerable and Highly Vulnerable developments within Flood Zones 2 and 3a the finished floor levels for the lowest room of a building should be set above the minimum ground level of the site, above the adjacent road to the building, or above the estimated flood level for the design flood, depending on which of these three values is highest. For minor extensions, the finished floor levels of the lowest room of a building should be no lower than existing floor levels or above the estimated flood level for the design flood. The design flood here pertains to either the 1% AEP (1 in 100 year) fluvial event with an appropriate allowance for climate change, or the 0.5% AEP (1 in 200 year) tidal event with an appropriate allowance for climate change. The required freeboard value for the finished floor levels of developments is defined within the Environment Agency's online standing advice for flood risk assessments[58].

10.7 Flood resistance and resilience strategies

There is a range of flood resistance and resilience construction techniques that can be implemented in new developments to mitigate potential flood damage. The Department for Levelling Up, Housing and Communities (DLUHC) have published a document 'Improving the Flood Performance of New Buildings, Flood Resilient

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[57] Accounting for residual uncertainty an update to the fluvial freeboard guide: https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/accounting-for-residual-uncertainty-an-update-to-the-fluvial-freeboard-guide?web=1&wdLOR=c7DCE6B52-35F0-469F-843D-3238FA827B79 [Accessed May 2024].

[58] Environment Agency 'Preparing a Flood Risk Assessment: Standing Advice': https://www.gov.uk/guidance/flood-risk-assessment-standing-advice [Accessed May 2024].

Construction'[59], the aim of which is to provide guidance to developers and designers on how to improve the resistance and resilience of new properties to flooding through the use of suitable materials and construction details. Figure 10-1 provides a summary of the Water Exclusion Strategy (flood resistance measures) and Water Entry Strategy (flood resilience measures) which can be adopted depending on the depth of floodwater that could be experienced.

Recommendation: Where proposing development or redevelopment in areas at risk of flooding, flood resilience and resistance strategies should be implemented to reduce damage in a flood and increase the speed of recovery. These measures should be designed to accommodate the 1% AEP event plus climate change flood level and should not be normally relied on for new development as an appropriate mitigation method. Where resilience and resistance measures are required, proposals must include details of their construction, removal, the party responsible for their maintenance, and the cost of replacement when they deteriorate.

10.7.1 Flood resistance design strategies

Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy): they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will only be effective for short duration, low depth flooding i.e. less than 300mm, although these measures should be adopted where depths are between 300mm and 600mm and there are no structural concerns.

In areas at risk of flooding of low depths (<300mm), implement flood resistance measures such as:

- Using materials and construction with low permeability,
- Land raising,
- Landscaping e.g. creation of low earth bunds (subject to this not increasing flood risk to neighbouring properties),
- Raising thresholds and finished floor levels e.g. porches with higher thresholds than main entrance,
- Flood gates with waterproof seats, and,
- Sump and pump for floodwater to remove water faster than it enters.
- Properties (residential and commercial) to have smart water butts installed

There are a range of property flood protection devices available on the market, designed specifically to resist the passage of floodwater. These include removable flood barriers and gates designed to fit openings, vent covers and stoppers designed to fit WCs. These measures can be appropriate for preventing water entry associated with fluvial flooding as well as surface water and sewer flooding. The efficacy of such devices relies on them being deployed before a flood event occurs. It should also be considered that devices such as air vent covers, if left in place by occupants as a precautionary measure, may compromise safe ventilation of the building in accordance with Building Regulations.

[59] CLG (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf [Accessed May 2024].

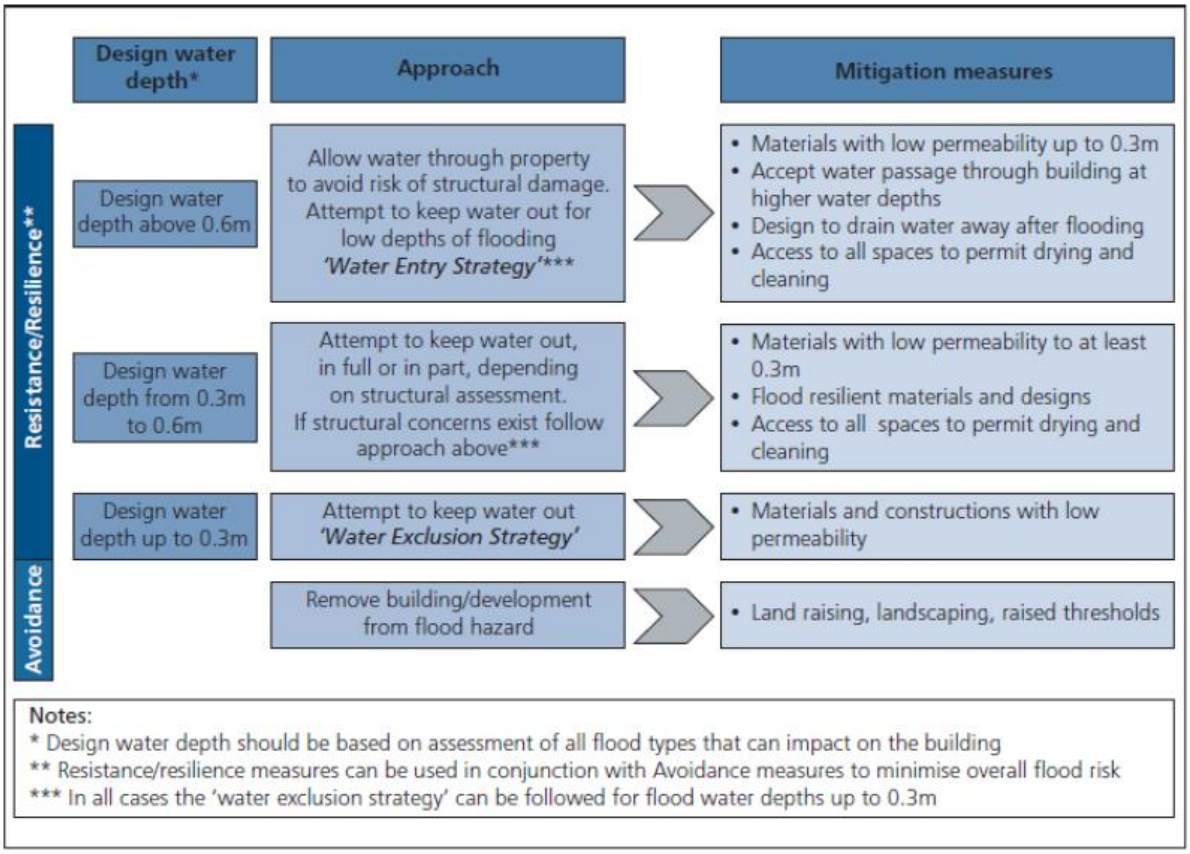

***Figure 10-1*: Flood Resistant/Resilient Design Strategies, Improving Flood Performance (DHLUC 2007)**

10.7.2 Flood resilience design strategies

For flood depths greater than 600mm, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, but to implement careful design in order to minimise damage and allow rapid re-occupancy. This is referred to as the Water Entry Strategy. These measures are appropriate for uses where temporary disruption is acceptable and suitable flood warning is received.

Materials should be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example, the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 100mm above the design flood level. Resilience measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

In areas at risk of frequent or prolonged flooding, implement flood resilience measures such as:

- Use of materials with either, good drying and cleaning properties, or sacrificial materials that can easily be replaced post-flood.
- Design for water to drain away after flooding.
- Design access to all spaces to permit drying and cleaning.
- Raise the level of electrical wiring, appliances, and utility meters.
- Coat walls with internal cement-based renders; apply tanking on the inside of all internal walls.
- Ground supported floors with concrete slabs coated with impermeable membrane.
- Tank basements, cellars, or ground floors with water resistant membranes.
- Use plastic water resistant internal doors.

Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction[59].

Structures such as bus, bike shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground and designed in such a way as to prevent entrainment of debris which in turn could increase flood risk and/or breakaway posing a danger to life during high flows.

Appendix A - Figures

Figure A1: Topography

Figure A2: Bedrock Geology

Figure A3: Watercourses and River Catchments

Figure A4: Environment Agency Recorded Flood Outlines

Figure A5: Sewer Flooding Incidents

Figure A6: Environment Agency Flood Zones

Figure A7: Future Fluvial and Tidal Flood Extent

Figure A8: Groundwater Flooding

Figure A9: Surface Water Extents

Figure A10: Reservoir Flood Extents

Figure A11: Flood Warning Areas

Figure A12: Opportunities to Reduce the Causes and Impacts of Flooding

Appendix B – Hydraulic Model Review

Appendix C – Sequential Test Database