JBA consulting

South Oxfordshire and Vale of White Horse Level 1 Strategic Flood Risk Assessment

Final Report

September 2024

Prepared for:

South Oxfordshire District Council

Vale of White Horse District Council

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South Oxfordshire District Council

Vale of White Horse

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Contract

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This report describes work commissioned by South Oxfordshire District Council and Vale of White Horse District Council. The Client's lead representative for the contract was Rebekah Goodwill of South Oxfordshire and Vale of White Horse District Councils. Freya Nation and Laura Thompson of JBA Consulting carried out this work.

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Acknowledgements

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Abbreviations

AEP	Annual Exceedance Probability
CFMP	Catchment Flood Management Plan
CSO	Combined Sewer Overflow
Defra	Department for Environment Food & Rural Affairs
DLUHC	Department for Levelling Up, Housing and Communities
EA	Environment Agency
FAS	Flood Alleviation Scheme
FCERM	Flood and Coastal Erosion Risk Management
FMfP	Flood Map for Planning
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FRR	Flood Risk Regulations
FRCC-PPG	Flood Risk and Coastal Change planning Practice Guidance
FRMP	Flood Risk Management Plan
FSA	Flood Storage Area
FWMA	Flood and Water Management Act
GI	Green Infrastructure
HFM	Historic Flood Map
LDP	Local Development Plan
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
mAOD	Metres above Ordnance Datum
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
OCC	Oxfordshire County Council
PFR	Property Flood Resilience
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
RBD	River Basin District
RBMP	River Basin Management Plan
RFCC	Regional Flood and Coastal Committee
RFO	Recorded Flood Outline
RMA	Risk Management Authority

RoFSW	Risk of Flooding from Surface Water
SA	Sustainability Appraisal
SAB	SuDS Approving Body
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TW	Thames Water
WFD	Water Framework Directive
WwNP	Working with Natural Processes

Executive Summary

This Level 1 Strategic Flood Risk Assessment (SFRA) is an update to the previous Level 1 SFRAs, completed in 2018 (South Oxfordshire Level 1 SFRA) and 2019 (Vale of White Horse Level 1 SFRA), using the latest flood risk information available at the time of writing and in accordance with current national planning policy and guidance set out in the National Planning Policy Framework (NPPF) (2023)[1] and Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG) (2022)[2]. The latest SFRA guidance has also been considered, including 'How to prepare a strategic flood risk assessment' guidance, May 2024[3], and the 'Strategic flood risk assessments a Good Practice Guide' guidance, December 2021[4]. The latest climate change guidance for strategic flood risk assessment and site-specific flood risk assessments has also been considered[5].

This Level 1 SFRA is focused on collecting readily available flood risk information from key stakeholders, the aim being to help identify the spatial distribution of all sources of flood risk present throughout the South Oxfordshire and Vale of White Horse authority areas to inform the application of the Sequential Test.

The Joint Local Plan (JLP) which will cover South Oxfordshire and Vale of White Horse requires this Level 1 SFRA to initiate the sequential risk-based approach to the allocation of land for development and to identify whether application of the Exception Test is likely to be necessary. This will help to inform and provide the evidence base for the emerging Joint Local Plan. This SFRA considers risk across the whole South Oxfordshire and Vale of White Horse authority areas and takes a catchment-based approach to flood risk management and the cumulative impacts of new development.

South Oxfordshire District Council and Vale of White Horse District Council as Local Planning Authorities (LPAs), provided their latest potential development site allocation information. An assessment of flood risk has been undertaken on sites with partial or no planning permission to assist South Oxfordshire and Vale of White Horse District Councils in their decision-making process for site allocations through the JLP. Sites with full planning permission have been excluded from the assessment.

The supplied potential development sites are shown to be at varying risk from fluvial and surface water flooding. Development consideration assessments for all sites are summarised through three strategic recommendations within Appendix D and the

1 National Planning Policy Framework, Department for Levelling Up, Housing and Communities, UK Government, 2023

2 Flood Risk and Coastal Change Planning Practice Guidance; Ministry of Housing, Communities & Local Government, 2022

3 How to prepare a Strategic Flood Risk Assessment, Defra and Environment Agency, 2024

4 Strategic flood risk assessments A GOOD PRACTICE GUIDE. ADEPT, 2021

5 Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)

development sites assessment spreadsheet in Appendix C. The strategic recommendations broadly entail the following:

- Strategic Recommendation A – recommend for withdrawal unless risk area can be avoided for development. A Level 2 SFRA would be required to inform this;
- Strategic Recommendation B – Level 2 SFRA required due to medium or high flood risk. Exception test required if a site is proposed for uses that are more vulnerable or essential infrastructure in Flood Zone 2; and
- Strategic Recommendation C – allocate and progress to developer-led FRA.

A total of 64 sites with partial or no planning permission were screened against the latest available flood risk information:

- Strategic Recommendation A applies to 33 sites.
- Strategic Recommendation B applies to 26 sites.
- Strategic Recommendation C applies to 5 sites.

See Appendix C for a full breakdown of the risk at each site and Appendix D which discusses the identified risks.

SFRA Recommendations

The main planning policy and flood risk recommendations to come out of this SFRA are outlined briefly below and are based on the fundamentals of the National Planning Policy Framework and the Flood Risk and Coastal Change Planning Practice Guidance (see Sections A.3.1 and A.3.2 of Appendix A).

SFRA recommendation:

- No development within the functional floodplain, unless development is water compatible and has passed the exception test;
- The sequential approach must be followed in terms of site allocation and development management;
- Ensure site-specific Flood Risk Assessments are carried out to a suitable standard, where required, with full consultation required with the Local Planning Authority, the Lead Local Flood Authority, the Environment Agency, and Thames Water as a minimum, before planning permission can be granted
- Appropriate investigation and use of SuDS;
- Natural Flood Management techniques must be considered for mitigation; and
- Phasing of development must be carried out to avoid possible cumulative impacts.

Included within this Level 1 SFRA, along with this main report, are:

- Discussion of relevant Planning Framework and Flood Risk Management Policies – Appendix A The Planning Framework and Flood Risk Management;
- A technical note on the delineation of the present day and future functional floodplain – Appendix B Functional floodplain delineation;

- Development site assessment spreadsheet detailing the risk to each site with recommendations on development – Appendix C Development site assessment spreadsheet;
- Discussion of the strategic recommendations outlined in the site assessment spreadsheet – Appendix D Strategic Recommendations of the proposed sites; and
- Assessment of the cumulative impacts of development – Appendix E Catchment-level assessment of Cumulative Impacts of Development on Flood Risk.

1 Introduction

1.1 Commission

In their role as Local Planning Authorities (LPAs), South Oxfordshire District Council and Vale of White Horse District Council commissioned JBA Consulting for the undertaking of a joint Level 1 Strategic Flood Risk Assessment (SFRA) to update the existing Level 1 SFRAs published in March 2019 for South Oxfordshire and in February 2018 for Vale of White Horse. The updated joint Level 1 SFRA will be used as part of the evidence base to support the emerging Joint Local Plan (JLP) which will cover South Oxfordshire and Vale of White Horse. Oxfordshire County Council (OCC) is the Lead Local Flood Authority (LLFA) for the South Oxfordshire and Vale of White Horse area.

Since the previous Level 1 SFRAs were published there have been updates to the National Planning Policy Framework (NPPF)[1] and the Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG)[2]. The Environment Agency (EA) have also published updated flooding and planning guidance and best practice, including climate change allowances. This SFRA update accounts for the most up to date guidance available at the time of publication.

1.2 Level 1 Strategic Flood Risk Assessment

LPAs should prepare SFRAs for their administrative area. The South Oxfordshire and Vale of White Horse Level 1 SFRA has been carried out in accordance with Government's latest development planning policy including the NPPF[1], first published March 2012 and last updated December 2023, and the accompanying flood risk and planning practice guidance, the FRCC-PPG[2] first published in 2014 and last updated August 2022. The EA's SFRA guidance has also been considered, including 'How to prepare a strategic flood risk assessment'[3], May 2024, and 'Strategic flood risk assessments a Good Practice Guide'[4], November 2021.The EA's latest climate change allowances guidance[5] has also been used.

This SFRA makes use of the most up-to-date flood risk datasets, available at the time of production, to assess the extent of risk, at a strategic level, to the whole of South Oxfordshire and Vale of White Horse and to the JLP sites. Sites with full planning permission have been excluded from the assessment.

1.3 Objectives

The key objectives of this SFRA, in line with the above-mentioned policy and guidance and South Oxfordshire District Council and Vale of White Horse District Council's project brief are to:

- Update the functional floodplain to account for the 3.3% AEP (1 in 30-year) fluvial defended flood events as advised in EA guidance[5]. The guidance also suggests assessing the potential impacts of climate change on the future extent of the

functional floodplain. Proxy events have been used where 3.3% AEP (1 in 30-year) results were not available. Details of the proxy events used for the functional floodplain are within Section 5.9.2.

- Assess potential Joint Local Plan site allocations through an updated sites screening assessment to account for sequential test changes, updated functional floodplain and climate change modelling. This should provide a sound basis for the application of the sequential test, inform the sustainability appraisal process and inform policy approaches on flood risk management and sustainable drainage.
- Update the Level 1 report and Appendix A to account for new guidance and best practice.
- Additionally, this updated Level 1 SFRA will include an updated Cumulative Impact Assessment (CIA).

Following the completion of the Level 1 SFRA, a Level 2 SFRA may be required to build on the findings of the Level 1 SFRA, focussing on identified high risk sites or communities that are considered important to local plan development. The flood information updated as part of this Level 1 SFRA should support further application of the Sequential Test and inform on whether sites can pass the Exception Test, where applicable, and allow for flood risk indicators to be produced for use in the Sustainability Appraisal of the Joint Local Plan.

1.4 Consultation

The EA's 2024 SFRA guidance recommends the LPA should consult with the following parties, external to the LPA:

- The EA;
- The LLFA;
- Emergency planners;
- Emergency services;
- Water and sewerage companies;
- Reservoir owners or undertakers, if relevant;
- Internal drainage boards, if relevant;
- Highways authorities;
- Relevant local authorities (i.e. neighbouring authorities); and
- Regional flood and coastal committees.

1.5 SFRA future proofing

This SFRA has been developed using the most up-to-date data and information available at the time of publication. The SFRA has been future proofed as far as possible though the reader should always confirm with the source organisation (South Oxfordshire District Council and Vale of White Horse District Council) that the latest information is being used when decisions concerning development and flood risk are being considered.

This SFRA uses the EA's Flood Map for Planning (FMfP) version issued in June 2024 to assess fluvial risk, and the Risk of Flooding from Surface Water (RoFSW) dataset to assess surface water flood risk, also from June 2024.

At the time of writing, the EA is planning to publish a new National Flood Risk Assessment (NaFRA2) in early 2025. NaFRA2 will provide a single picture of current and future flood risk from rivers, the sea and surface water, using both existing detailed local information and improved national data and surface water flood risk will be incorporated into the Flood Map for Planning.

The EA is therefore pausing updates to the flood zones of the Flood Map for Planning until Spring 2025. During this period, where new flood zone information becomes available in the study area, a comment will appear on the current Flood Map for Planning service stating - "Our understanding of flood risk from rivers and the sea has changed since this information was published". Any new information must be used instead of the flood zones published on the Flood Map for Planning service, when preparing or updating the SFRA, when requesting planning application flood risk assessments (FRA), and when applying the sequential and exception tests.

The NPPF is also, at the time of writing, undergoing a reform with the advent of the new Labour Government. A consultation period is ongoing with draft reforms to the NPPF due early 2025.

The FRCC-PPG, alongside the NPPF, is referred to throughout this SFRA, being the current primary development and flood risk policy and guidance available at the time of the finalisation of this SFRA.

The EA's SFRA guidance states a review of a SFRA should be carried out when there are changes to:

- The predicted impacts of climate change on flood risk,
- Detailed flood modelling - such as from the EA or LLFA,
- The spatial development strategy or relevant local development documents,
- Local flood management schemes,
- Flood risk management plans,
- Local flood risk management strategies, and
- National planning policy or guidance.

The SFRA should also be reviewed after a significant flood event. It is in any authority's interest to keep the SFRA as up to date as possible.

Ideally, the SFRA should be kept as a 'live' entity and continually updated when new information becomes available. The EA requests for reports and maps to be published online and be easily updateable, when required.

2 Study area

2.1 South Oxfordshire and Vale of White Horse

South Oxfordshire and Vale of White Horse are situated in the south-east of England within the county of Oxfordshire and combined they have an area of approximately 1,257 square kilometres. According to the Office for National Statistics 2021 Census data[6], the population of South Oxfordshire is 149,085 and the population of Vale of White Horse is 138,913. The combined population of the two authorities is 287,998.

As shown in Figure 2-1 the main river management catchments in South Oxfordshire and Vale of White Horse are the Gloucestershire and Vale catchment in the west and the Thames and South Chilterns catchment in the east. The northern boundary of Vale of White Horse lies within the Cotswolds management catchment. The northern tip of South Oxfordshire lies within the Cherwell and Ray management catchment and the south-western boundary of Vale of White Horse lies within the Kennet and Trib management catchment.

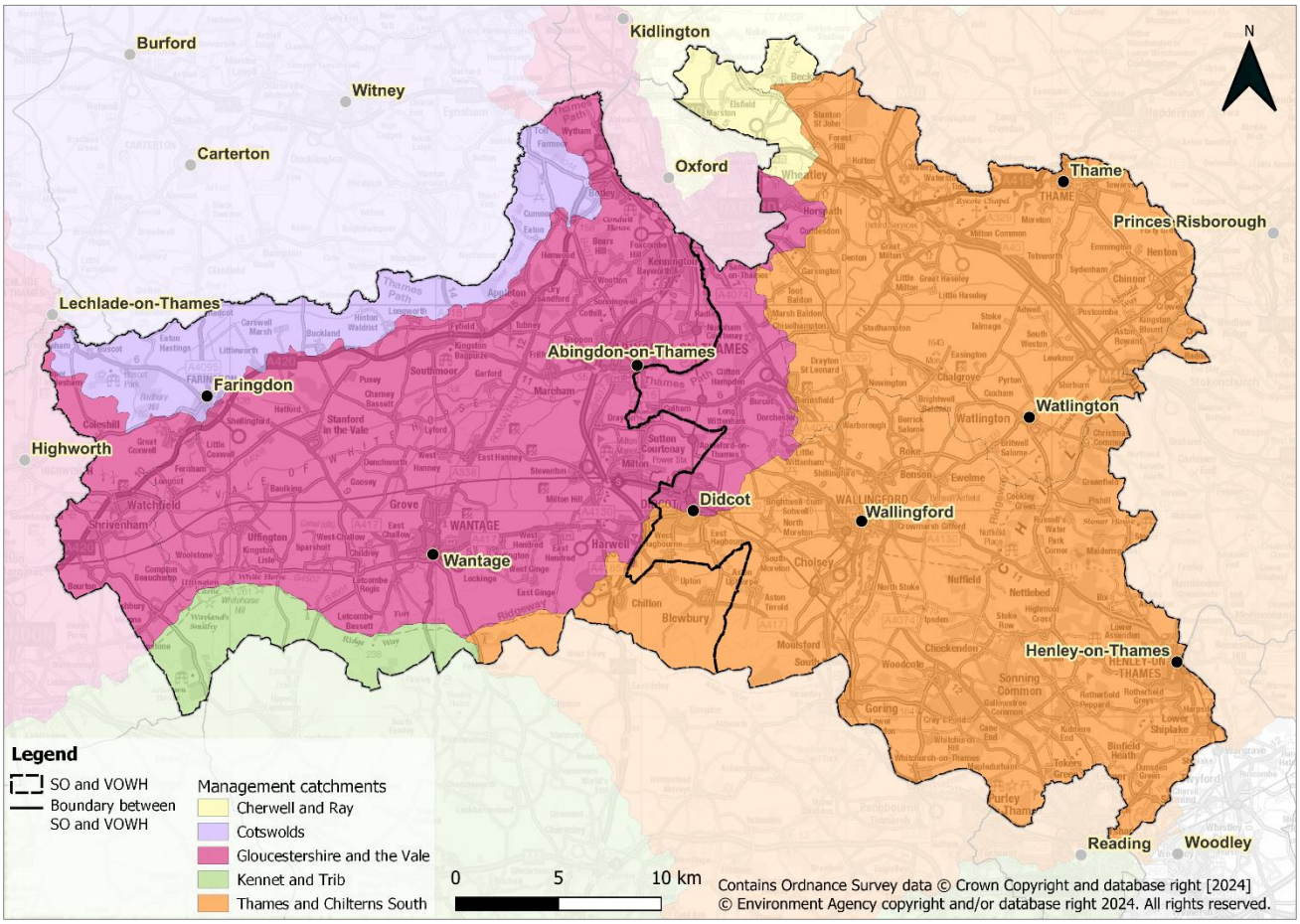


Figure 2-1: Management catchments within South Oxfordshire and Vale of White Horse

6 Office for National Statistics 2021 Census data, Area profiles

2.2 Geology and topography

Due to the size of the districts, the geology and topography are considerably varied. Table 2-1 lists the bedrock geology beneath the towns within South Oxfordshire and Vale of White Horse according to the British Geological Survey records[7]. Other deposits across South Oxfordshire and Vale of White Horse include Woolwich and Reading Beds in the south-east of South Oxfordshire.

Table 2-1: Bedrock geology of towns and their surrounding areas

Town	Bedrock formations present	Types of rock present
Abingdon-on-Thames (Vale of White Horse)	West Walton, Ampthill Clay, Kimmeridge Clay	Mudstone, siltstone, sandstone
Didcot (South Oxfordshire)	Gault, Upper Greensand	Mudstone, sandstone, limestone
Faringdon (Vale of White Horse)	Corallian, West Walton, Ampthill Clay, Kimmeridge Clay, Lower Greensand, Kellaways, Oxford Clay	Limestone, sandstone, siltstone, mudstone
Henley-on-Thames (South Oxfordshire)	Sussex White Chalk	Chalk
Thame (South Oxfordshire)	West Walton, Ampthill Clay, Kimmeridge Clay, Portland Strata	Mudstone, siltstone, sandstone, limestone, calcareous sandstone
Wallingford (South Oxfordshire)	Lower Chalk	Chalk
Wantage (Vale of White Horse)	Gault, Upper Greensand, Lower Chalk	Mudstone, sandstone, limestone, chalk

The topography of South Oxfordshire and Vale of White Horse is varied, ranging from flat low-lying ground along the along the banks of the River Thames and its tributaries, to areas of higher elevation, notably the Berkshire Downs, towards the south of Vale of White Horse and the Chiltern Hills, towards the south and west of South Oxfordshire (see Figure 2-2). Topography also rises in the north of both districts towards various hills such as Badbury Hill near Faringdon and Shotover Hill, north-east of Horspath.

7 BGS Geology - British Geological Survey

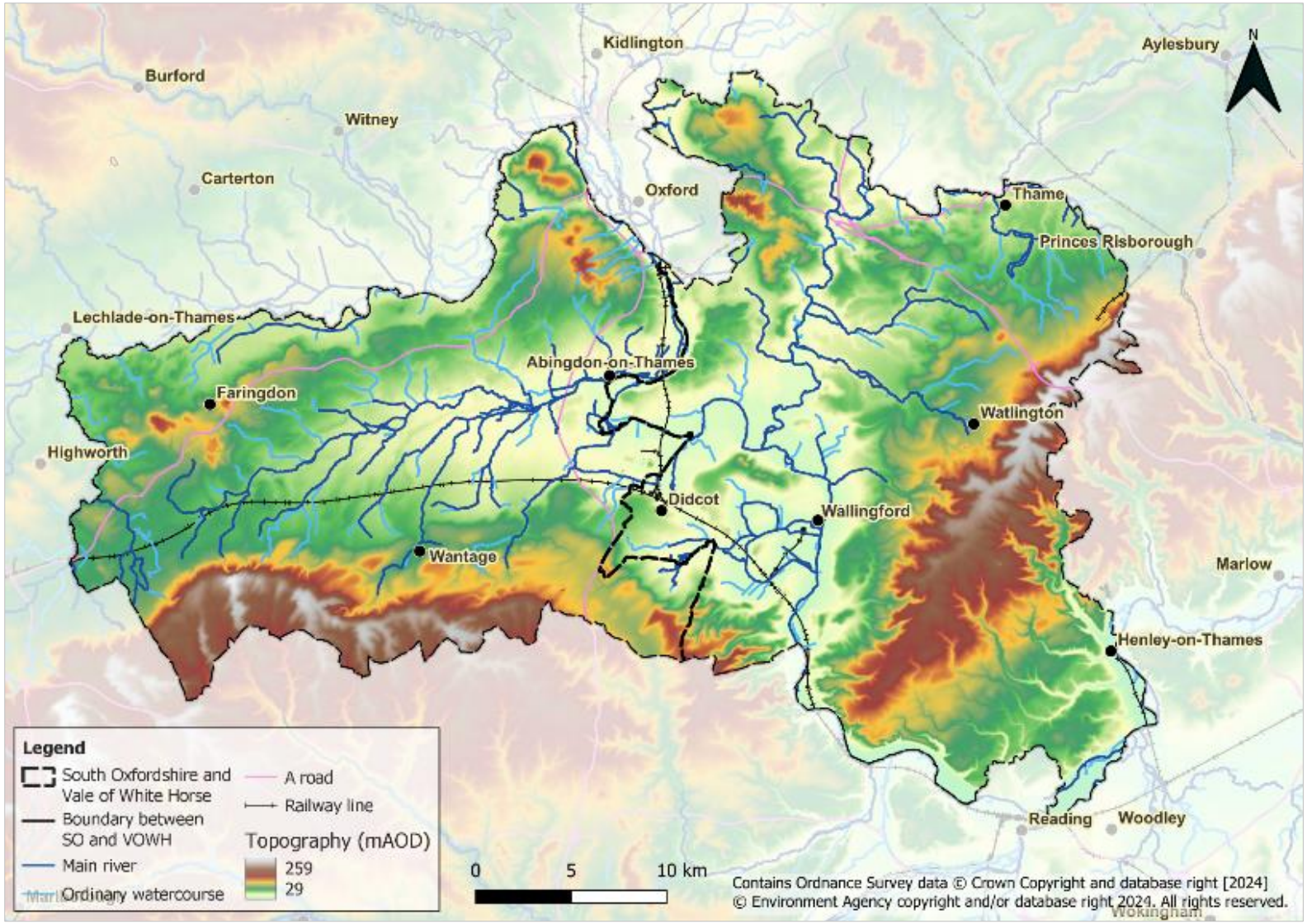


Figure 2-2: Topography, watercourses and transport in South Oxfordshire and Vale of White Horse

2.3 Main rivers

Main rivers are usually larger rivers and streams. The EA has permissive powers to carry out maintenance, improvement or construction work on main rivers to manage flood risk. The EA also regulate works next to main rivers through the Environmental Permitting Regulations 2016. The range of activities subject to regulation are listed on the GOV.UK website[8].

While the EA has permissive powers to undertake works, the maintenance of main rivers is primarily the responsibility of riparian owners. South Oxfordshire and Vale of White Horse contain the main rivers of the River Thames, River Thame, River Ock and River Cole (Figure 2-3).

2.3.1 River Thames

The River Thames is the main watercourse within the two districts, forming part of the boundary with West Oxfordshire and the City of Oxford to the north, and the boundary with West Berkshire, Reading and Wokingham to the south. The Thames also forms much of the border between the South Oxfordshire and Vale of White Horse districts themselves, between Oxford and Long Whittenham.

The River Thames rises at Thames Head in Gloucestershire and flows in a generally easterly direction through southern England (including London) before reaching the North Sea near Tilbury in Essex. The river has a length of 346km making it the longest in England. The Thames River Basin District covers an area of 16,200 km^2 and is home to 15 million people.

2.3.2 River Thame

The River Thame is a tributary of the River Thames and has itself two relatively large tributaries within South Oxfordshire district: the Cuttle Brook (20.5km long) and the Haseley Brook (14km long). The Thame gives its name to the town where it enters South Oxfordshire district from Buckinghamshire and flows in a south-westerly direction before joining the Thames, south of Dorchester-on-Thames.

2.3.3 River Ock

A main river tributary of the River Thames, the Ock originates near Little Coxwell before flowing east for around 33km before entering the River Thames at Abingdon. The entire watercourse of the River Ock falls within the Vale of White Horse, draining the valley towards the Thames.

8 Flood risk activities: environmental permits - GOV.UK (www.gov.uk)

2.3.4 River Cole

The River Cole is another main river tributary of the River Thames which rises in Swindon, Wiltshire. It flows north-easterly before heading north towards Lechlade, Gloucestershire where it meets the River Thames. The Cole forms much of the boundary between Swindon and Vale of White Horse.

2.3.5 Other main rivers

There are many other tributaries of the Rivers Thames, Thame, Ock and Cole that are also designated as main river watercourses by the EA. These include the Childrey Brook, Letcombe Brook and Ginge Brook (within Vale of White Horse) as well as the Cuttle Brook and Haseley Brook (within South Oxfordshire district). A map showing all of the main rivers in England can be viewed on the Environment Agency's website[9].

2.4 Ordinary watercourses

Ordinary watercourses are any watercourse that is not designated main river. These watercourses can vary in size considerably and can include rivers, streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 2014) and passages, through which water flows. Ordinary watercourses do not always contain flowing water all year long; there may be times where the watercourses run dry, particularly over prolonged dry spells. Such watercourses can be described as ephemeral watercourses.

Ordinary watercourses come under the regulation of the LLFA and district councils, which have permissive powers to carry out works, should this be deemed necessary, and have regulatory control over certain development activities within the watercourse channel. However, the responsibility for the maintenance of ordinary watercourses lies with the riparian owner. A riparian owner is anyone who has a watercourse within or adjacent to the boundaries of their land; they are responsible for watercourses or culverted watercourses running through, beneath or adjacent to the boundary of their land. Figure 2-3 shows some of the ordinary watercourses in South Oxfordshire and Vale of White Horse, as displayed on the OS Open Rivers 'Watercourse Link' dataset.

9 Statutory Main River Map (arcgis.com)

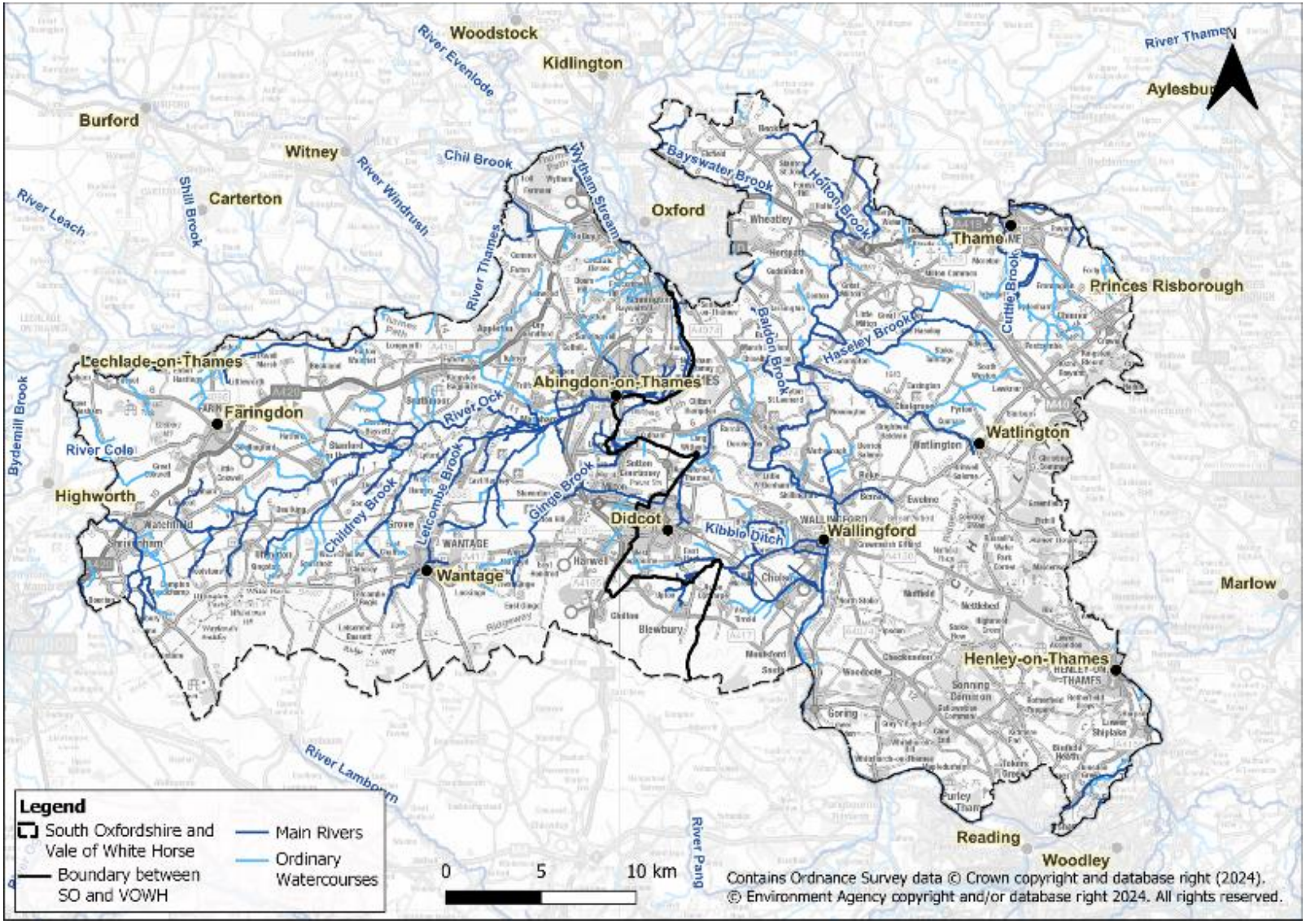


Figure 2-3: Ordinary watercourses and main rivers in South Oxfordshire and Vale of White Horse

3 Understanding flood risk

3.1 Sources of flooding

Flooding can happen at any time in a wide variety of locations. It constitutes a temporary covering of land not normally covered by water and presents a risk when human or environmental assets are present in the area that floods. Assets at risk from flooding can include housing, transport and public service infrastructure (including vulnerable services such as hospitals and schools), commercial and industrial enterprises, agricultural land and environmental and cultural heritage. Flooding in South Oxfordshire and Vale of White Horse can occur from many different and combined sources such as fluvial (from main rivers and ordinary watercourses), surface water, groundwater, sewers or indirectly from infrastructure failure (residual risk).

Different types and forms of flooding present a range of different risks and the flood hazards of speed of inundation, depth and duration of flooding can vary greatly. With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging.

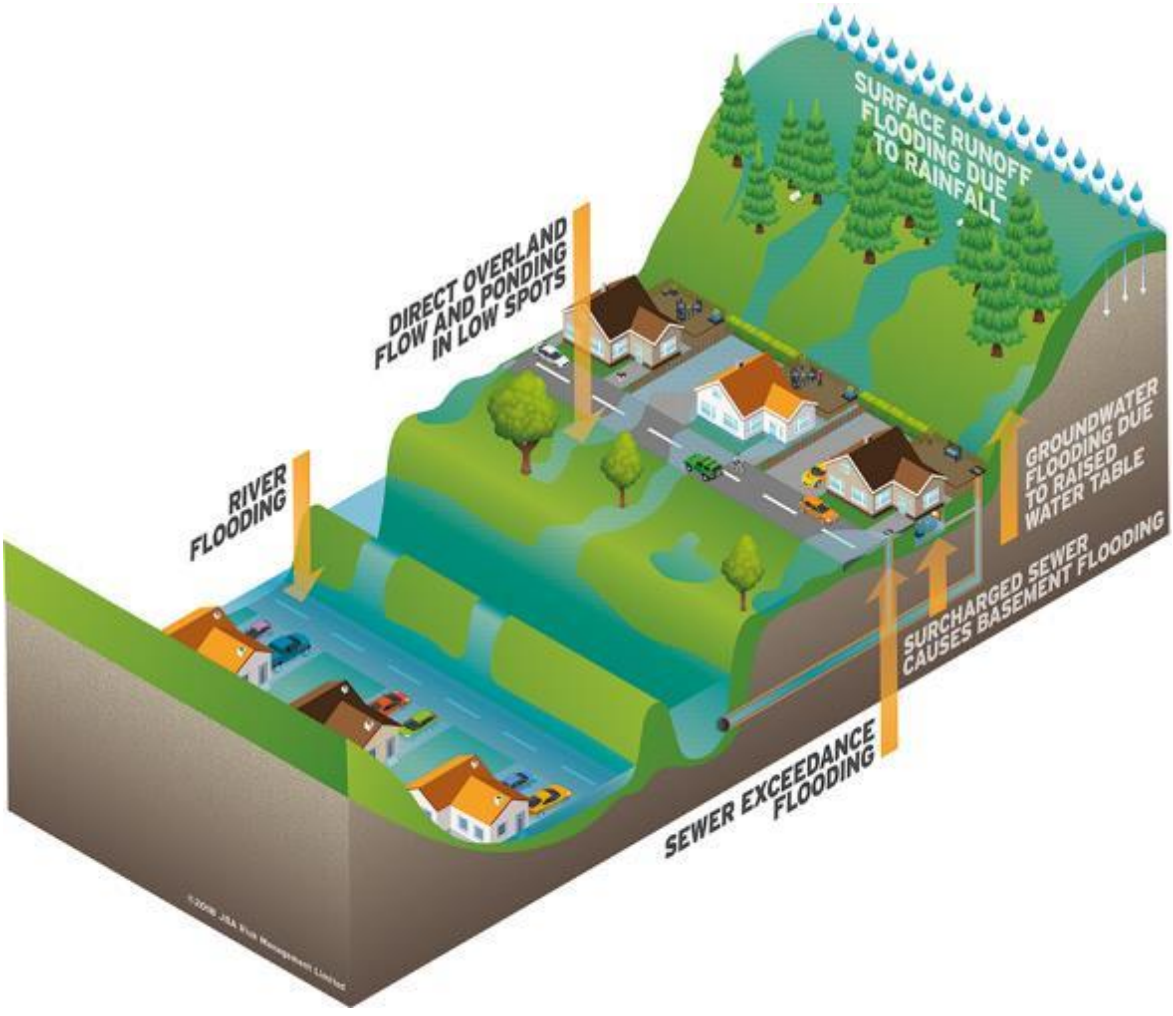


Figure 3-1: Flooding from all sources (Source: JBA Risk Management Ltd, 2018)

3.1.1 River or fluvial flooding

River flooding, also referred to as fluvial flooding, is the inundation of floodplains from rivers and watercourses; the inundation of areas outside the floodplain due to the influence of bridges, embankments and other features that artificially raise water levels; overtopping or breaching of defences; blockages of culverts or flood channels / corridors.

River flooding is associated with the exceedance of channel capacity during higher flows or as a result of blockage (residual risk). The process of flooding from a watercourse depends on a number of characteristics associated with the catchment including geographical location and variation in rainfall; steepness of the channel and surrounding floodplain; and infiltration and rate of runoff associated with urban and rural catchments.

3.1.2 Surface water

Surface water or pluvial flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. In these instances, the volume of water from rural land can exceed infiltration rates in a short amount of time, resulting in the flow of water over land. Within urban areas, this intensity can be too great for the urban drainage network resulting in excess water flowing along roads, through properties and ponding in lower areas or natural depressions. Areas at risk of pluvial flooding can, therefore, lie outside of the fluvial flood zones of the Flood Map for Planning.

Pluvial flooding within the urban areas of South Oxfordshire and Vale of White Horse will typically be associated with events equal to or greater than the 1 in 30-year (3.3% AEP) design standard of new sewer systems. Some older sewer and highway drainage networks may have a lower capacity than is required to mitigate for the 3.3% AEP event. There is also residual risk associated with these networks due to possible network failures, blockages or collapses.

There are certain locations, generally within the urban areas, where the probability and consequences of pluvial flooding are more prominent due to the complex hydraulic interactions that exist in the urban environment. Urban watercourse connectivity, surface water or combined sewer capacity and the location and condition of highway gullies all have a major role to play in surface water flood risk.

Surface water flood risk should be afforded equal standing in importance and consideration as fluvial flood risk, given the increase in rainfall intensities due to climate change and the increase in impermeable land use due to development. It should be acknowledged that once an area is flooded during a large rainfall event, it is often difficult to identify the route, cause and ultimately the source of flooding without undertaking further site-specific and detailed investigations.

The EA's Risk of Flooding from Surface Water (RoFSW) map (5.3.1) is used to assess surface water flood risk in this SFRA. Section 6.7 provides guidance on SuDS options for

developers. The RoFSW is presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

10 South and Vale web-based mapping portal

3.1.3 Groundwater

Flooding from groundwater occurs when the water table rises after prolonged rainfall to emerge above ground level remote from a watercourse. It is most likely to occur in low-lying areas underlain by permeable rock (aquifers) and groundwater recovery areas, after pumping for mining or industry has ceased. Warmer, wetter winters due to climate change may have significant impacts on groundwater levels.

The occurrence of flooding from groundwater is usually local and unlike flooding from rivers, does not generally pose a significant risk to life due to the slow rate at which the water level rises. However, groundwater flooding can cause significant damage to property, especially in urban areas and can pose further risks to the environment and ground stability.

There are several mechanisms that increase the risk of groundwater flooding including prolonged rainfall, high in-bank river levels, artificial structures, groundwater rebound and mine water rebound. Properties with basements or cellars or properties that are located within areas deemed to be susceptible to groundwater flooding are at particular risk. Development within areas that are susceptible to groundwater flooding will generally not be suited to infiltration SuDS; however, this is dependent on detailed site investigation, ground survey and risk assessment at the FRA stage.

JBA's 5m Groundwater Flood Map (Section 5.4) is used to assess potential risk from groundwater in this SFRA and is presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

The chalk aquifer which lies below much of the southern half of South Oxfordshire and Vale of White Horse (including the towns of Wantage, Didcot, Wallingford and Henley-on-Thames) is designated as a Principal Aquifer, providing a significant proportion of the water supply to the surrounding area. The bedrock geology beneath the northern half of South Oxfordshire and Vale of White Horse is designated as a Secondary A aquifer. Due to the use of aquifers for drinking water abstraction, parts of the east of South Oxfordshire is located within Groundwater Source Production Zones (SPZs), where the Environment Agency provide guidelines to protect groundwater from sources of pollution.

3.1.4 Sewers

Flooding from the sewer network can occur when flow entering the system, such as an urban storm water drainage system, exceeds its available discharge capacity, the system becomes overloaded, blocked or it cannot discharge due to a high water level in the receiving watercourse. Flooding of foul water systems can lead to sewage surcharging from the sewer system. Pinch points and failures within the drainage network may also restrict flows. Water can then back up through the sewers and surcharge through manholes, potentially flooding highways and properties, and infiltrating the groundwater and water table. It must be noted that sewer flooding in 'dry weather' resulting from blockage, collapse or pumping station mechanical failure (for example), is the sole concern of the drainage undertaker.

Combined sewers spread extensively across urban areas serving residential homes, business and highways, conveying waste and surface water to treatment works. Combined Sewer Overflows (CSOs) provide an EA consented overflow release from the drainage system into local watercourses or surface water systems during times of high flows. The implementation of Schedule 3 of the Flood and Water Management Act (FWMA) should help to reduce the pressures on sewers, reducing surface water and sewer flood risk, and discharges from storm overflows. Some areas may also be served by separate waste and surface water sewers which convey wastewater to treatment works and surface water into local watercourses or combined sewers.

Thames Water (TW) is the water and sewerage company responsible for the management of the public sewer drainage network across South Oxfordshire and Vale of White Horse.

3.1.5 Reservoirs

A reservoir can usually be described as an artificial or non-natural lake where water is stored for use. The risk of flooding associated with reservoirs is residual (Section 3.2.3.2) and is associated with failure of reservoir outfalls or dam breaching. This risk is reduced through regular inspection and maintenance by the reservoir owner / undertaker or operating authority. Reservoirs in the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

The EA's Reservoir Flood Map (RFM) shows the locations at risk from reservoir flooding (Section 5.6).

3.1.6 Canals

The risk of flooding from a canal is considered to be residual and is dependent on a number of factors. As canals are manmade systems that are heavily controlled, it is unlikely they will respond in the same way as a natural watercourse during a storm event. Flooding is more likely to be associated with residual risks, similar to those associated with river defences, such as overtopping of canal banks, breaching of embanked reaches or asset (gate) failure as highlighted in Table 3-1. Canals can also have a significant interaction with other sources, such as watercourses that feed them and minor watercourses or drains that cross underneath. Section 5.7 discusses the potential risks from canals in South Oxfordshire and Vale of White Horse.

Table 3-1: Canal flooding

Potential Mechanism	Significant Factors
Leaking causing erosion and rupture of canal lining leading to breach	Embankments Sidelong ground Culverts Aqueduct approaches
Collapse of structures carrying the canal above natural ground level	Aqueducts Large diameter culverts Structural deterioration or accidental damage
Overtopping of canal banks	Low freeboard Waste weirs
Blockage or collapse of conduits	Culverts

3.2 Likelihood and consequence

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

The principal flood sources in South Oxfordshire and Vale of White Horse include fluvial and surface water; the most common pathways are rivers, drains, sewers, overland flows; and the receptors include people, their property and the environment. All three elements must be present for flood risk to arise. Mitigation, i.e. flood defence measures have little or no effect on sources of flooding, but they can block or impede pathways or reduce risk to receptors.

3.2.1 Likelihood

The likelihood of flooding is expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1% AEP (Annual Exceedance Probability) event indicates the flood level that is expected to be reached on average once in a hundred years, i.e., it has a 1 in 100 (1%) chance of occurring in any one year, not that it will occur once every one hundred years.

Table 3-2 provides an example of the flood probabilities used to describe the flood zones as defined in the FRCC-PPG and as used by the EA in its Flood Map for Planning (Rivers and Sea).

NOTE: Paragraph 078 of the FRCC-PPG states: - *"flood zones shown on the Flood Map for Planning do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding"*.

The Flood Map for Planning can be accessed online via: Flood map for planning.

Table 3-2: NPPF flood zones[11]

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b.)
Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map.)
Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map.)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. LPAs should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the EA. (Not separately distinguished from Zone 3a on the Flood Map for Planning.)

The surface water flood zones are defined by the following events:

- High risk - 1 in 30-year event (3.3% AEP);
- Medium risk - 1 in 100-year event (1% AEP); and
- Low risk - 1 in 1000-year event (0.1% AEP).

11 Table 1: Flood Zones, Paragraph 001 of the Flood Risk and Coastal Change Planning Practice Guidance, August 2022

3.2.2 Consequence

The consequences of flooding include fatalities, property damage, disruption to lives and businesses, with severe implications for people (e.g. financial loss, emotional distress, health problems). Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, water quality) and the vulnerability of receptors (type of development, nature e.g. age-structure of the population, presence and reliability of mitigation measures etc.).

Flood risk is then expressed in terms of the following relationship:

Flood risk = probability of flooding x consequences of flooding

3.2.3 Risk

Flood risk is not static; it cannot be described simply as a fixed water level that will occur if a river overtops its banks or from a high spring tide that coincides with a storm surge. It is therefore important to consider the continuum of risk carefully. Risk varies depending on the severity of the event, the source of the water, the pathways of flooding (such as the condition of flood defences) and the vulnerability of receptors as mentioned above. It is also clear that risk will increase with climate change.

3.2.3.1 Existing risk

This is the risk 'as is' considering any flood defences that are in place for extreme flood events. Typically, these provide a minimum Standard of Protection (SoP). Hence, if a settlement lies behind a fluvial flood defence that provides a 1 in 100-year SoP then the actual risk of flooding from the river in a 1 in 100-year event is generally low. However, the residual risk may be high in that the impact of flood defence failure would likely be high.

Existing risk describes the primary, or prime, risk from a known and understood source managed to a known SoP. However, it is important to recognise that risk comes from many different sources and that the SoP provided will vary within a river catchment. For example, settlements offered protection from fluvial flooding by formal flood defences may still be at risk of surface water flooding.

3.2.3.2 Residual risk

Defended areas remain at residual risk as there is a risk of defence failure during significant flood events. Areas downstream of flood defences are at particular risk from rapid onset of fast-flowing and deep-water flooding, with little or no warning if defences are overtopped or breached.

Whilst the actual risk of flooding to a settlement that lies downstream of a fluvial flood defence that provides a 1 in 100-year SoP may be low, there will always be a residual risk from flooding if these defences overtopped or failed that must be considered. Because of this, it is never appropriate to use the term "flood free".

Developers must be able to demonstrate that development will be safe for the lifespan of the development. To that end, Paragraph 042 of the FRCC-PPG states:

"Where residual risk from flood risk management infrastructure affects large areas, the Strategic Flood Risk Assessment will need to indicate the nature, severity and variation in risk within this area, and provide guidance for residual risk issues to be covered in site-specific flood risk assessments. Where necessary, local planning authorities should use information on identified residual risk to state in strategic policies their preferred mitigation strategy for ensuring development will be safe throughout its lifetime in relation to urban form, risk management and where flood mitigation measures are likely to have wider sustainable design implications".

Residual risk also includes the risk of culvert blockages. Residual flood risk from breach or overtopping of defences, or culvert blockage must be managed for any new development. Detailed mitigation must be agreed through site-specific FRAs or through Level 2 SFRAs where it would be necessary to demonstrate site allocations would be safe for their lifetime.

3.3 Climate change

Following on from the UK Climate Projections 2009 (UKCP09), the UK Climate Projections 2018 (UKCP18) delivered a major upgrade to the range of UK climate projection tools designed to help decision-makers assess their risk exposure to our changing climate.

The UKCP18 project used cutting-edge climate science to provide updated observations and climate change projections up to the year 2100 across the UK. The project builds upon UKCP09 to provide the most up-to-date assessment of how the climate of the UK may change over the 21st century.

UKCP18 updates the projections over land and provides a set of detailed future climate projections for the UK at a 12km scale. Models of high impact events such as from localised heavy rainfall in the summer months were created. UKCP18 enables the UK to adapt to the challenges and opportunities presented by climate change.

In relation to flood risk and climate change in the planning system, the NPPF states:

"All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property." (para 167).

The Joint Local Plan should do this by safeguarding land from development that is required, or likely to be required, for current or future flood management; and to seek opportunities for the relocation of development, including housing, to more sustainable locations from areas where climate change is expected to increase flood risk.

The likely impacts of climate change are well documented and will have a significant impact on flood risk across South Oxfordshire and Vale of White Horse. Increases in duration and intensity of extreme rainfall events as a result of climate change will increase flood risk from multiple sources. Section 5.9 details the EA's climate change allowances and how these have been applied in this SFRA.

4 The planning framework and flood risk policy

Appendix A provides an overview of the documents that have shaped the current planning policy framework. There are many documents, plans and studies relevant to flood risk and development, hence why this overview has been included as an appendix to this main report. Appendix A also discusses the LLFA's and LPA's responsibilities and duties in respect to managing local flood risk including but not exclusive to the delivery of the requirements of the Flood and Water Management Act (FWMA) 2010[12].

Figure 4-1 illustrates the links between legislation, national policy, statutory documents and assessment of flood risk. The figure shows that whilst the key pieces of legislation and policy are separate, they are closely related, and their implementation should aim to provide a comprehensive and planned approach to asset record keeping and improving flood risk management within communities.

It is intended that the non-statutory Surface Water Management Plans (SWMPs) and SFRAs can provide much of the base data required to support the delivery of the LLFA's statutory flood risk management tasks as well supporting local authorities in developing capacity, effective working arrangements and informing Local Flood Risk Management Strategies (LFRMS) and Local Plans, which in turn help deliver flood risk management infrastructure and sustainable new development at a local level. This SFRA should be used to support the updating of the Local Plan and to help inform planning decisions.

12 Flood and Water Management Act 2010 (legislation.gov.uk)

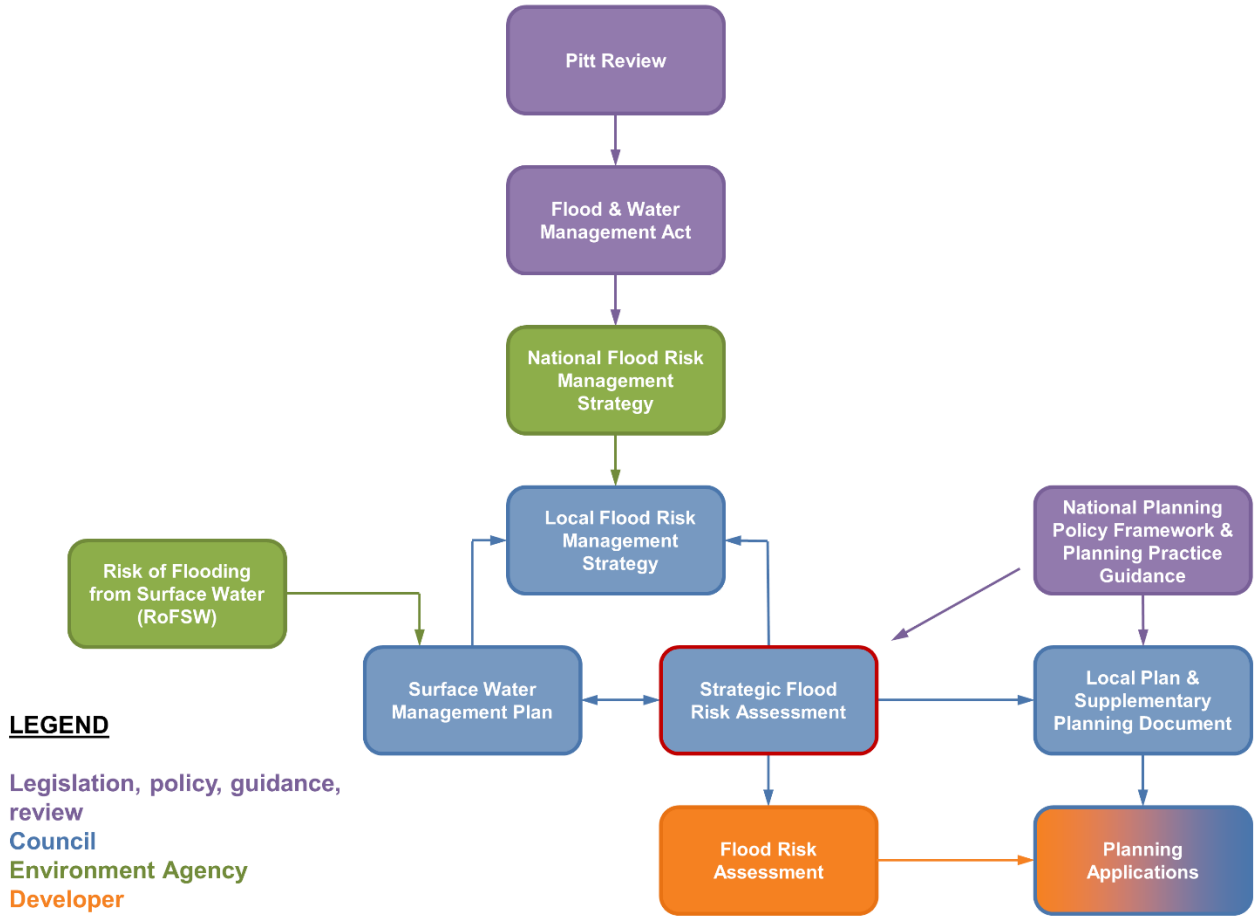


Figure 4-1: Key documents and strategic planning links with flood risk

5 Flood risk in South Oxfordshire and Vale of White Horse

5.1 Summary of flood risk

The risk across South Oxfordshire and Vale of White Horse is varied:

- The main fluvial risk comes from the River Thames that flows through Abingdon-on-Thames and along the South Oxfordshire and Vale of White Horse boundary before flowing through Wallingford and along the southern boundary of South Oxfordshire before heading north and flowing through Henley-on-Thames. The River Thame and River Ock are main river tributaries of the Thames which flow through rural South Oxfordshire and Vale of White Horse respectively affecting areas such as Thame, Drayton Saint Leonard and Dorchester on Thames (South Oxfordshire); and Caldecott, Abingdon-on-Thames (Vale of White Horse).
- Surface water risk is spread across the entirety of South Oxfordshire and Vale of White Horse with the area north of Faringdon, Shrivenham, Dean Court, Sunningwell, Wootton and parts of northern Abingdon (Vale of White Horse); Wheatley, Towersey, Stadhampton, parts of Thame, parts of Watlington and parts of Henley-on-Thames (South Oxfordshire) being identified as at high risk of surface water flooding.
- The areas with the highest levels of groundwater vulnerability are located in Abingdon-on-Thames, Stanford-in-the-Vale, Sandford-on-Thames, Grove, Stadhampton and Wallingford.
- The main reservoir risk according to the Reservoir Flood Map, affects land south of Abingdon-on-Thames and the floodplain of the River Thame and River Thames.

5.2 Flood risk from rivers

Figure 5-1 shows the EA's Flood Map for Planning (Rivers and Sea), which identifies areas across South Oxfordshire and Vale of White Horse that are at risk of flooding from rivers. There is no risk from the sea to South Oxfordshire and Vale of White Horse. Several of these fluvial risk areas are located within Flood Zone 3 and therefore identified as being at high risk of fluvial flooding.

An extensive area of Flood Zone 3 is located along the River Thames, which flows along the northern boundary of Vale of White Horse before changing course and flowing along the boundary of South Oxfordshire and Vale of White Horse, passing through Abingdon-on-Thames, Wallingford and eventually Henley-on-Thames where it exits South Oxfordshire. Other key areas include Thame, in the north-eastern corner of South Oxfordshire, Stadhampton, in the north of South Oxfordshire, Dorchester-on-Thames, in the west of South Oxfordshire; and rural villages in Vale of White Horse including Stanford-in-the-Vale, Charney Bassett, Lyford and Marcham, as well as Caldecott, on the western side of

Abingdon. The flooding within these areas is likely to be attributable to the River Thame and the River Ock respectively.

Other areas identified as being at high risk include parts of Wantage and Steventon in Vale of White Horse, which are at risk from the Letcombe Brook and Ginge Brook respectively. Didcot is at risk of flooding from the Moor Ditch and its tributaries. Moor Ditch is a tributary of the River Thames. Chalgrove and Watlington in South Oxfordshire, are each at risk of flooding from Chalgrove Brook, a tributary of the River Thame.

5.2.1.1 Inconsistencies in the Flood Map for Planning

South Oxfordshire and Vale of White Horse District Councils are aware of anomalies in the Flood Map for Planning and national surface water mapping (RoFSW) which have caused issues with planning in the past. An area north of the M40 near Tetsworth (South Oxfordshire) is shown to be at high risk of flooding from surface water in the RoFSW mapping due to a restriction from the culvert on an unnamed tributary of the Haseley Brook. However, this location is within Flood Zone 1 of the Flood Map for Planning.

Due to the importance of considering all sources of flooding, sites at risk of flooding from surface water will be flagged during the site screening process, described further in Appendix C and Appendix D.

Where 'unmodelled' watercourses exist (generally includes ordinary watercourses), this SFRA has used the 1% AEP Risk of Flooding from Surface Water mapping as well as an 8m buffer of the watercourse to delineate Flood Zone 3b (the functional floodplain). Further information on how Flood Zone 3b has been delineated can be found within Appendix B.

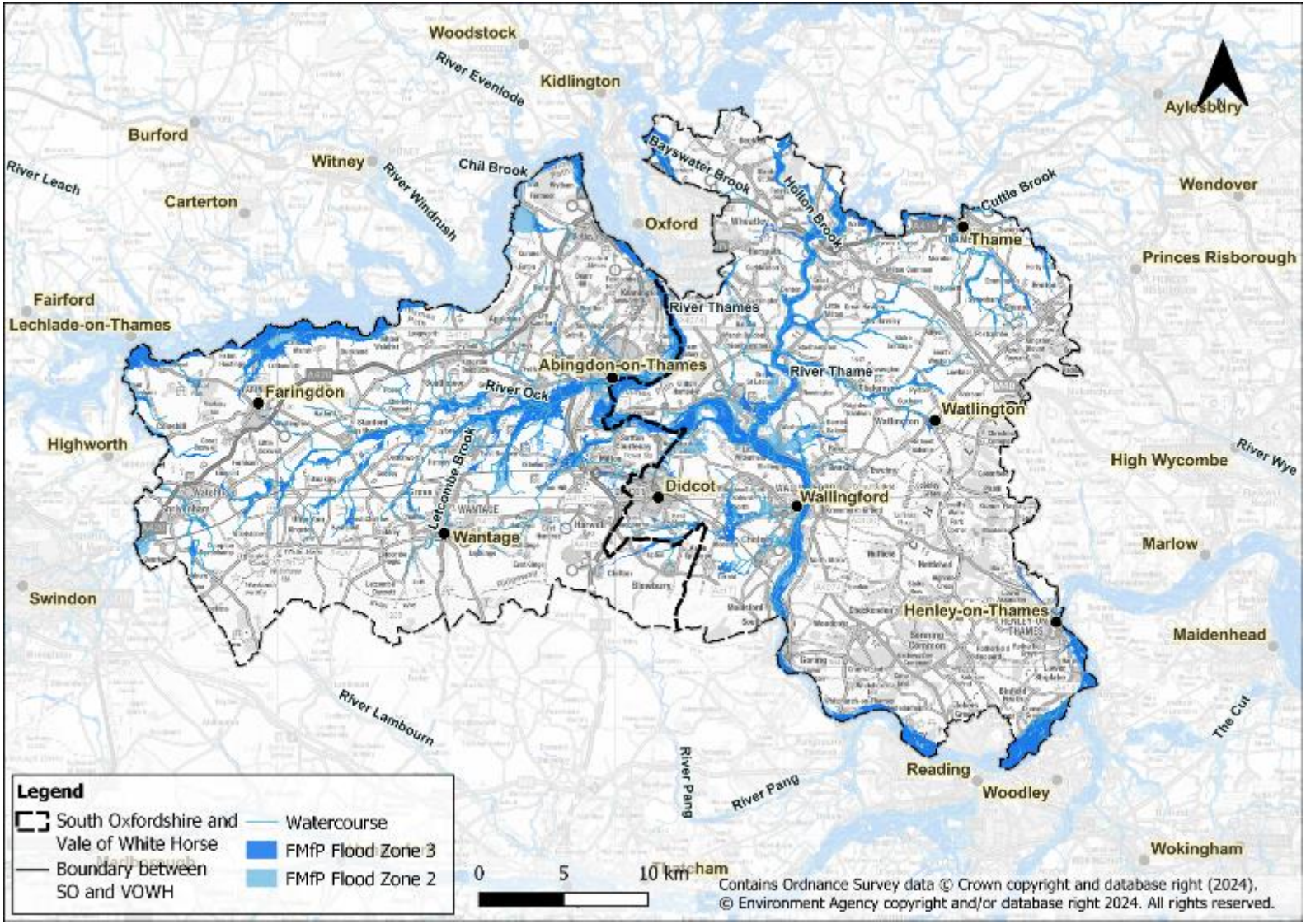


Figure 5-1: Flood Map for Planning showing the risk of flooding from rivers within South Oxfordshire and Vale of White Horse

5.2.2 EA Flood Map for Planning (Rivers and Sea)

South Oxfordshire and Vale of White Horse web-based mapping portal[10] presents the EA's Flood Map for Planning, which shows the fluvial coverage of Flood Zones 2 and 3 across the study area at a more detailed scale.

The Flood Map for Planning is the main dataset used by planners for predicting the location and extent of flooding from rivers. This is supported by the Catchment Flood Management Plans (CFMPs) and River Basin Management Plans (RBMPs)along with several detailed hydraulic river modelling reports that provide further detail on flooding mechanisms and climate change. The Thames CFMP and RBMP are discussed further in Appendix A.

The Flood Map for Planning illustrates the modelled flood extents for rivers for the 1 in 100-year (1% AEP) flood event (Flood Zone 3) and the 1 in 1000-year (0.1% AEP) flood event (Flood Zone 2). Flood Zone 3 is considered to be high risk and Flood Zone 2 medium risk.

Flood zones were originally prepared by the EA using a methodology based on the national digital terrain model (NextMap), derived river flows from the Flood Estimation Handbook (FEH) and two-dimensional flood routing. Since their initial release, the EA has regularly updated its flood zones with detailed hydraulic model outputs as part of its national flood risk mapping programme.

The Flood Map for Planning is precautionary in that it does not take account of flood defence infrastructure (which can be breached, overtopped or may not be in existence for the lifetime of the development) and therefore, represents a worst-case scenario of present-day flood risk. The flood zones do not consider sources of flooding other than from rivers or the sea and do not take account of climate change. As directed by the FRCC-PPG, this SFRA subdivides Flood Zone 3 into Flood Zone 3a and Flood Zone 3b, also known as the functional floodplain.

This SFRA uses the Flood Map for Planning issued in June 2024 to assess the risk from river flooding across the study area. At the time of writing, the EA is planning to publish a new National Flood Risk Assessment (NaFRA2) in early 2025. NaFRA2 will provide a single picture of current and future flood risk from rivers, the sea and surface water, using both existing detailed local information and improved national data and surface water flood risk will be incorporated into the Flood Map for Planning.

The EA is therefore pausing updates to the flood zones of the Flood Map for Planning until Spring 2025. During this period, where new flood zone information becomes available in the Lancaster authority area, a comment will appear on the current Flood Map for Planning service stating - "Our understanding of flood risk from rivers and the sea has changed since this information was published". Any new information must be used instead of the flood zones published on the Flood Map for Planning service, when preparing or updating the SFRA, when requesting planning application flood risk assessments (FRA), and when applying the sequential and exception tests.

The EA also provides a 'Risk of Flooding from Rivers and Sea Map'. This map shows the EA's assessment of the likelihood of flooding from rivers and the sea, at any location and is based on the presence and effect of all flood defences, predicted flood levels and ground levels. This dataset is not used in the assessment of flood risk for planning applications but is a useful source of information to show the presence and effects of flood risk management infrastructure. This dataset is discussed further in Section 5.2.4 and presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

5.2.3 Functional floodplain (Flood Zone 3b)

The functional floodplain forms a very important planning tool in making space for flood waters when flooding occurs. Development should be directed away from these areas.

Table 1, Paragraph 078 of the FRCC-PPG defines Flood Zone 3b as:

"*…land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:*

- *land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or*
- *land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding)".*

Paragraph 078 also explains that:

"Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency."

The extent of the functional floodplain is assessed and agreed upon by the LPA, the LLFA and the EA, based on their local knowledge.

A technical note is provided in Appendix B that explains the methodology and datasets used in creating the functional floodplain outline. In summary, the hierarchy of methods used to define Flood Zone 3b are:

1. Use of detailed model outputs where they are available. Only final and EA approved model outputs have been used to delineate Flood Zone 3b.
2. Use of a proxy approach in areas subject to detailed modelling, where approximate outputs are available (e.g. in areas where outputs for the 3.3% AEP event are not available, but where alternative AEP events are available and can be used as a proxy).
3. Use of the latest Flood Zone 3 (June 2024) outline in areas where no detailed modelling outputs are available.
4. Use of the 1% AEP Risk of Flooding from Surface Water outline along ordinary watercourses in the absence of detailed modelling and Flood Zone 3.

5. Use of the buffered watercourse (8 metres either side of the channel) and EA Flood Storage Area dataset.

5.2.4 EA Risk of Flooding from Rivers and Sea map

The Risk of Flooding from Rivers and Sea map (RoFRS) is a high level, coarse scale national dataset showing the likelihood of flooding from rivers and the sea based on the presence and effect of all flood defences, predicted flood levels and ground levels, and is shown on South Oxfordshire and Vale of White Horse's web-based mapping portal[10]. The RoFRS map splits the likelihood of flooding into four risk categories:

- High – greater than or equal to 1 in 30-year event (3.3% AEP) chance in any given year;
- Medium – less than 1 in 30-year event (3.3% AEP) but greater than or equal to 1 in 100-year event (1% AEP) chance in any given year;
- Low – less than 1 in 100-year event (1% AEP) but greater than or equal to 1 in 1000-year flood event (0.1% AEP) chance in any given year; and
- Very Low – less than 1000-year event (0.1% AEP) chance in any given year.

The RoFRS map is presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

This dataset is not suitable for use with any planning application, nor should it be used for the sequential testing of site allocations. The EA's Flood Map for Planning should be used for all planning purposes, as per the FRCC-PPG.

The Thames River Basin District Flood Risk Management Plan (2022)[13] identified the Oxford Rivers and Sea Flood Risk Area (RS FRA) which slightly crosses into South Oxfordshire District and Vale of White Horse District. The EA's flood warning and alert service is available in most parts of the RS FRA. The service aims to provide advance warning to people of the risk of flooding from rivers, the sea and groundwater. There are four flood risk management measures within this flood risk area[14]. The EA are the authority responsible for carrying out the following measures:

- Seek and support early engagement with local planning authorities in Oxford
- Support deployment of temporary flood barriers in Oxford
- Work in partnership to finalise the approvals needed and begin construction on a flood alleviation scheme in Oxford
- Work with the Earth Trust to plan future land management practices in Oxford Flood Alleviation Scheme area.

13 Thames River Basin District Flood Risk Management Plan 2021 to 2027 (publishing.service.gov.uk)
14 Oxford, Thames (RoFRS) Flood Risk Area – Flood Plan Explorer (data.gov.uk)

5.3 Surface water flood risk

The risk of flooding from surface water is shown in Figure 5-2 and illustrates that there are numerous areas of surface water flood risk across South Oxfordshire and Vale of White Horse. Surface water risk largely follows the topography, like that of fluvial watercourses and dry valleys. Several areas are identified as being at high risk including the area north of Faringdon, Shrivenham, Dean Court, Sunningwell, Wootton and parts of northern Abingdon-on-Thames (Vale of White Horse); Wheatley, Towersey, Stadhampton, parts of Thame, parts of Watlington and parts of Henley-on-Thames (South Oxfordshire).

The Thames River Basin District Flood Risk Management Plan (2022)[15] also identified the Reading Surface Water Flood Risk Area (SW FRA) which slightly crosses into South Oxfordshire District.

There are 11 flood risk management measures within this flood risk area[16]. Reading Borough Council are the authority responsible for carrying out the following measures:

- Carry out a flood investigation
- Carry out a strategic flood study
- Consider production of a Supplementary Planning Document on the use of Sustainable Drainage Systems (SuDS) within new developments in Reading
- Consider retrofitting Sustainable Drainage Systems in any highway scheme
- Investigate a Flood Alleviation Scheme in Byworth Close
- Investigate a Flood Alleviation Scheme in North Street
- Investigate a Flood Alleviation Scheme in Princes Street
- Promote understanding of critical flood risk assets through engagement with local communities
- Raise awareness of flood risk by engaging with the community
- Undertake a holistic annual review of progress of flood alleviation schemes, strategies and measures
- Work in partnership with Thames Water Limited and the Environment Agency to progress a Flood Alleviation Scheme

15 Thames River Basin District Flood Risk Management Plan 2021 to 2027 (publishing.service.gov.uk)

16 Reading, Thames (RoFSW) Flood Risk Area – Flood Plan Explorer (data.gov.uk)

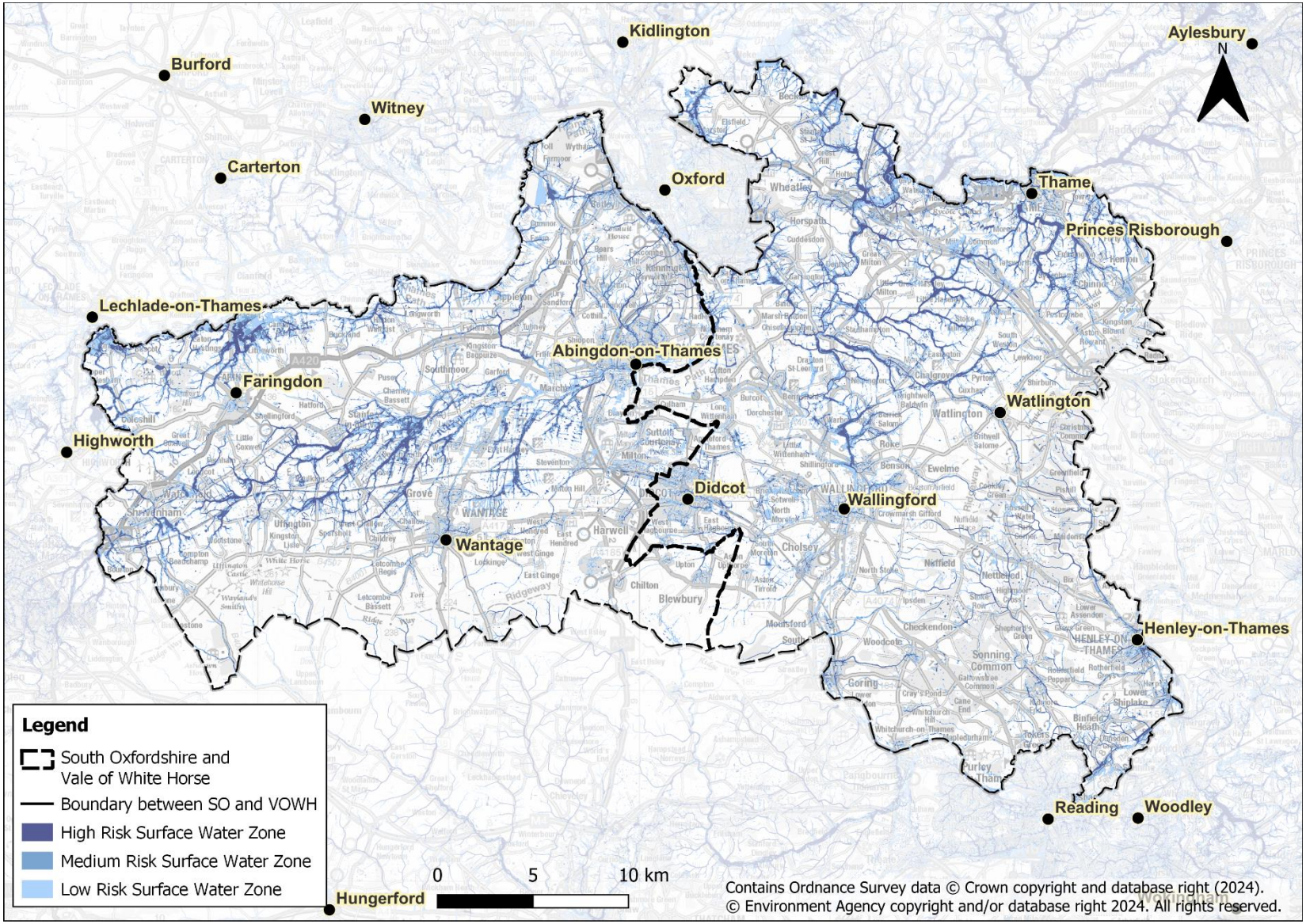


Figure 5-2: Risk of Flooding from Surface Water in South Oxfordshire and Vale of White Horse

5.3.1 Risk of Flooding from Surface Water dataset

The Risk of Flooding from Surface Water (RoFSW) map is the third-generation national surface water flood map, produced by the EA, aimed at helping to identify areas where localised, flash flooding can cause problems even if the main rivers are not overflowing. The RoFSW, used in this SFRA to assess risk from surface water, has proved extremely useful in supplementing the EA Flood Map for Planning by identifying areas in Flood Zone 1, which may have critical drainage problems, and therefore should inform the sequential test.

NOTE: EA guidance on the use of the RoFSW states:

"This dataset is not suitable for identifying whether an individual property will flood. It should not be used with basemapping more detailed than 1:10,000 as the data is open to misinterpretation if used as a more detailed scale. Because of the way the map has been produced and the fact that it is indicative, the map is not appropriate to act as the sole evidence for any specific planning or regulatory decision or assessment of risk in relation to flooding at any scale without further supporting studies or evidence."

More detailed surface water modelling would be required at the FRA stage to robustly inform on surface water flood risk to a site and surrounding areas.

The RoFSW includes surface water flood outlines, depths, velocities, and hazards for the following events:

- 1 in 30-year event (3.3% AEP) – high risk;
- 1 in 100-year event (1% AEP) – medium risk; and
- 1 in 1000-year event (0.1% AEP) – low risk.

The outlines of the RoFSW are presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

The EA produced a guidance document, updated in April 2019[17], explaining the methodology applied in producing the map.

Note: The national map of surface water flood risk is, at the time of writing, undergoing a significant update. However, the updated map is unlikely to made available until late 2024.

5.3.1.1 Locally agreed surface water information

LLFAs have determined "locally agreed surface water information" as part of the Preliminary Flood Risk Assessments (PFRA) process, which sets out the national and local surface water datasets that best represent local conditions.

At the time of writing, locally agreed surface water information for South Oxfordshire and Vale of White Horse either consists of:

- The RoFSW map; or

17 What is the Risk of Flooding from Surface Water map? Environment Agency, 2019

- Compatible local mapping if it exists i.e., from a SWMP; or
- A combination of both these datasets for defined locations in the LLFA area.

5.4 Groundwater flood risk

This SFRA assesses groundwater flood risk through JBA's 5m Groundwater Flood Risk Map, which provides a general broadscale assessment of the groundwater flood hazard. The good practice guide to producing SFRAs[18], developed in part by the EA and published in December 2021, recommends the use of this dataset in SFRAs.

Figure 5-3 shows the groundwater flood risk within South Oxfordshire and Vale of White Horse and is categorised by grid code where each code is explained in Table 5-1

There are a large number of settlements which have grid code 4 groundwater flood risk. Some of the main areas include Abingdon-on-Thames, Stanford-in-the-Vale, Sandford-on-Thames, Grove, Stadhampton and Wallingford. In these areas, groundwater levels are either at, or very near the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.

Areas categorised as grid code 3 are located throughout South Oxfordshire and Vale of White Horse with notable locations within this risk category being Faringdon, Chinnor and Thame. Here, groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. There is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.

Despite being within grid code 2 of JBA's Groundwater Flood Risk Map, it is known that the Assendon Spring[19] emerges when groundwater levels are particularly high. This water rises south of Stonor and flows downwards towards Henley-on-Thames before discharging into the Thames.

It is important to make sure that future development is not placed at unnecessary risk from any flood source. Therefore, groundwater flood risk should be considered on a site-by-site basis in development planning, e.g. assessing the groundwater flood risk at site allocations through a Level 2 SFRA.

Groundwater flood risk should be considered particularly when determining the acceptability of SuDS schemes as a way of managing surface water drainage. Developers should consult with the LPA, the LLFA and the EA at an early stage of any site-specific groundwater assessment.

18 Strategic flood risk assessments A GOOD PRACTICE GUIDE, Report produced using Environment Agency research on 'using flood risk information in spatial planning' (2019-2020), 2021

19 Emergence of an ephemeral chalk stream at Assendon, Oxfordshire | 2016

JBA's 5m Groundwater Flood Risk Map is presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

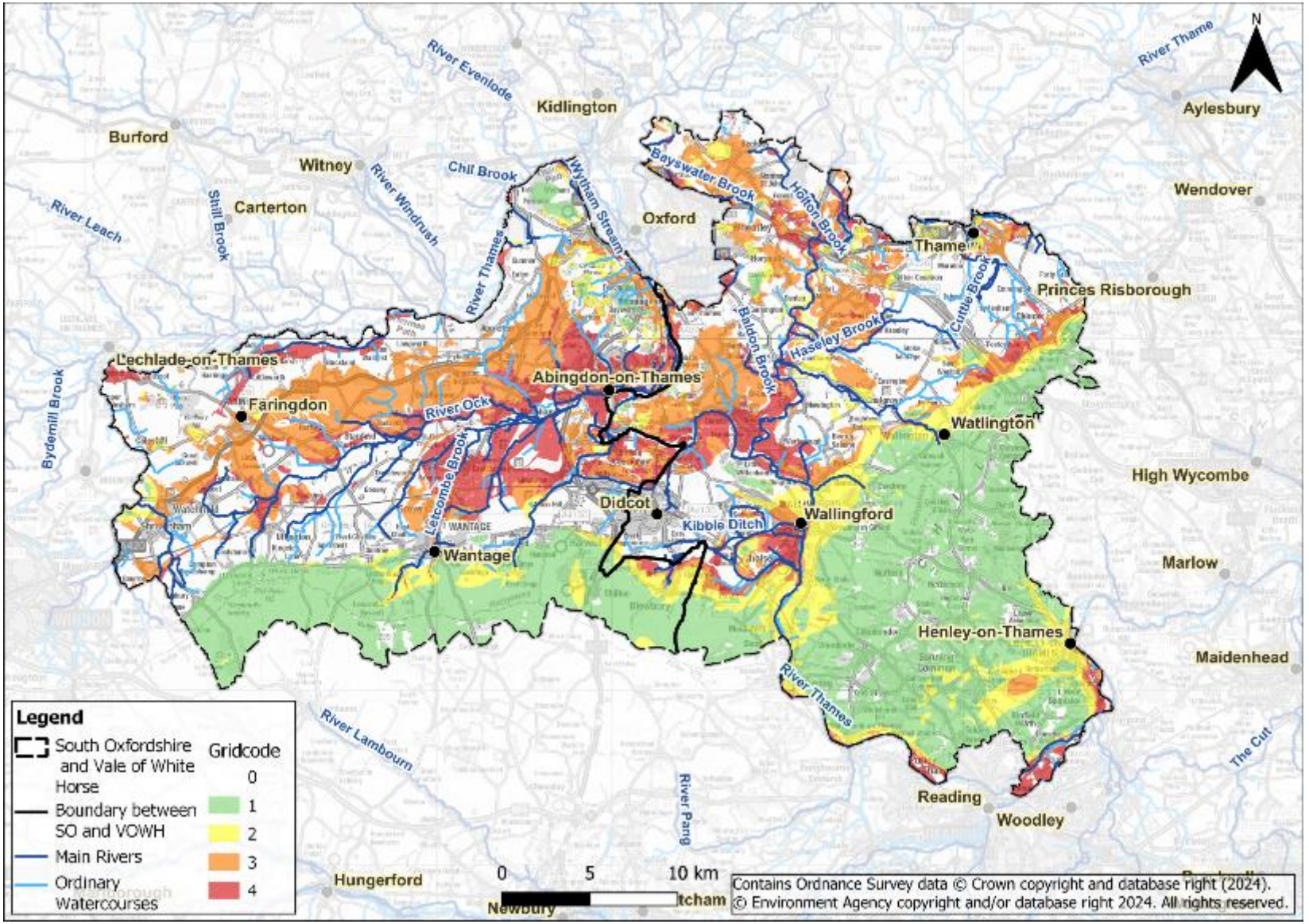


Figure 5-3: Risk of Groundwater emergence within South Oxfordshire and Vale of White Horse

Table 5-1: Groundwater flood hazard classification of JBA groundwater map

Groundwater head difference (m)*	Grid Code	Class label
0 to 0.025	4	Groundwater levels are either at, or very near (within 0.025m of), the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	3	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	2	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event. There is a risk of flooding to subsurface assets, but surface manifestation of groundwater is unlikely.
>5	1	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	0	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.		

5.5 Flood risk from sewers

The previous SFRAs for the districts discussed historic sewer flooding incidents taking place in Chinnor, Brightwell-cum-Sotwell and Henley-on-Thames in SO. In Vale of White Horse, sewer flooding has occurred in South Hinksey, Botley and Wantage.

In 2012 Thames Water completed a scheme to address sewer flooding in South Hinksey and Botley. However, in 2020 a combination of heavy rainfall and the Littlemore Pumping Station being unable to cope with the high volume of water resulted in sewer flooding to properties within this area[20].

At the time of writing, South Oxfordshire and Vale of White Horse District Councils are preparing a Water Cycle Study to support their Joint Local Plan. This study will consider sewage treatment works capacity in further detail.

In January 2024, heavy rainfall from Storm Henk caused sewer flooding in Radley, Vale of White Horse. Following these flood events, Thames Water released the following statement: "*we have published plans to upgrade over 250 of our sewage treatment works and sewers, including Oxford and Abingdon our sewage treatment works." … "This will improve the sites' ability to treat the high volumes of incoming sewage and reduce the need for overflows during wet weather."*[21]

5.6 Flood risk from reservoirs

The EA is the enforcement authority for the Reservoirs Act 1975 in England and Wales, with the FWMA amending this Act. All large reservoirs must be regularly inspected and supervised by reservoir panel engineers. Local authorities are responsible for coordinating emergency plans for reservoir flooding and ensuring communities are well prepared. The LPA should work with other members of the Thames Valley Local Resilience Forum to develop these plans. See Section 6.9.1.1 for more information on the Thames Valley Local Resilience Forum.

Paragraph 046 of the FRCC-PPG states that, in relation to development planning and reservoir dam failure:

“The local planning authority will need to evaluate the potential damage to buildings or loss of life in the event of dam failure, compared to other risks, when considering development downstream of a reservoir. Local planning authorities are also advised to consult with the owners/operators of raised reservoirs, to establish constraints upon safe development."

Updated How to Prepare a Strategic Flood Risk Assessment guidance (May 2024)[5], advises that LPAs assess:

- *"the potential loss of life and damage to buildings in the event of dam failure*
- *How any impounding reservoirs will affect existing flood risk*

20 Sewer flooding in South Hinksey | Oxford Flood Alliance

21 Oxfordshire flooding: Homes and cars submerged after heavy rain - BBC News

- *whether emergency drawdown of the reservoir (reducing the water level) will add to flooding*

Local authorities, as category 1 responders, can access more detailed information about reservoir risk using the Resilience Direct[22] system".

Land is currently safeguarded in the Vale of White Horse Local Plan 2031 for the possible future provision of a new reservoir between the villages of Drayton, East Hanney and Steventon. The purpose of the safeguarding is to discourage development from taking place within the identified area, to keep it available for the reservoir development should it come forward. The Joint Local Plan proposes to continue this safeguarding. However, Vale of White Horse District Council has stated its opposition to this proposal[23].

5.6.1 Reservoir Flood Map (RFM)

The EA has produced Reservoir Flood Maps (RFM) for all large reservoirs that they regulated under the Reservoirs Act 1975 (reservoirs that hold over 25,000 cubic metres of water). The FWMA updated the Reservoirs Act and targeted a reduction in the capacity at which reservoirs should be regulated from 25,000m^3 to 10,000m^3. This reduction is, in place under the FWMA section 33.

In November 2021, the EA published the RFM guidance 'Reservoir flood maps: when and how to use them[24]', which provides information on how the maps were produced and what they contain. To view the RFM, the Defra Data Services Platform can be used to search for specific reservoirs[25].

The RFM shows that there are 19 large-raised reservoirs that have the potential to impact South Oxfordshire and Vale of White Horse in the event of a breach during a dry-day scenario. Figure 5-4 highlights the risk of flooding from reservoirs extents across South Oxfordshire and Vale of White Horse for a dry-day scenario. In Vale of White Horse, Faringdon Park, Eaton Hastings, Farmoor, Filchampstead, Wytham, Kennington Meadows and South Hinksey and within SO, Long Whittenham and rural land north of Chalgrove is located within the dry-day reservoir flood extent. A dry-day, as opposed to a wet-day scenario, assumes the water level in a reservoir is lower than the spillway level and the upstream and downstream watercourses are at normal levels.

The RFM extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. It is worth considering that reservoirs within the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

22 Resilience Direct Hub Dashboard

23 Chapter 13. Infrastructure, transport, connectivity and... | Joint Local Plan Preferred Options (southandvale.gov.uk)

24 Reservoir flood maps: when and how to use them – Environment Agency, 2021.

25 Reservoir Flood Maps, Environment Agency

If development is proposed downstream of a reservoir, there will need to be an assessment of whether work is needed to improve the design or maintenance of the reservoir. Together with the reservoir undertakers, the LPA should look to avoid an intensification of development within the risk areas and/or make sure that reservoir undertakers can assess the cost implications of any reservoir safety improvements required due to changes in land use downstream of these assets.

The LPA will need to evaluate:

- The potential damage to buildings or loss of life in the event of dam failure compared to other risks;
- How an impounding reservoir will modify existing flood risk in the event of a flood in the catchment;
- Whether emergency draw-down of the reservoir will add to the extent of flooding; and
- Emergency planning requirements with appropriate officers to ensure safe sustainable development.

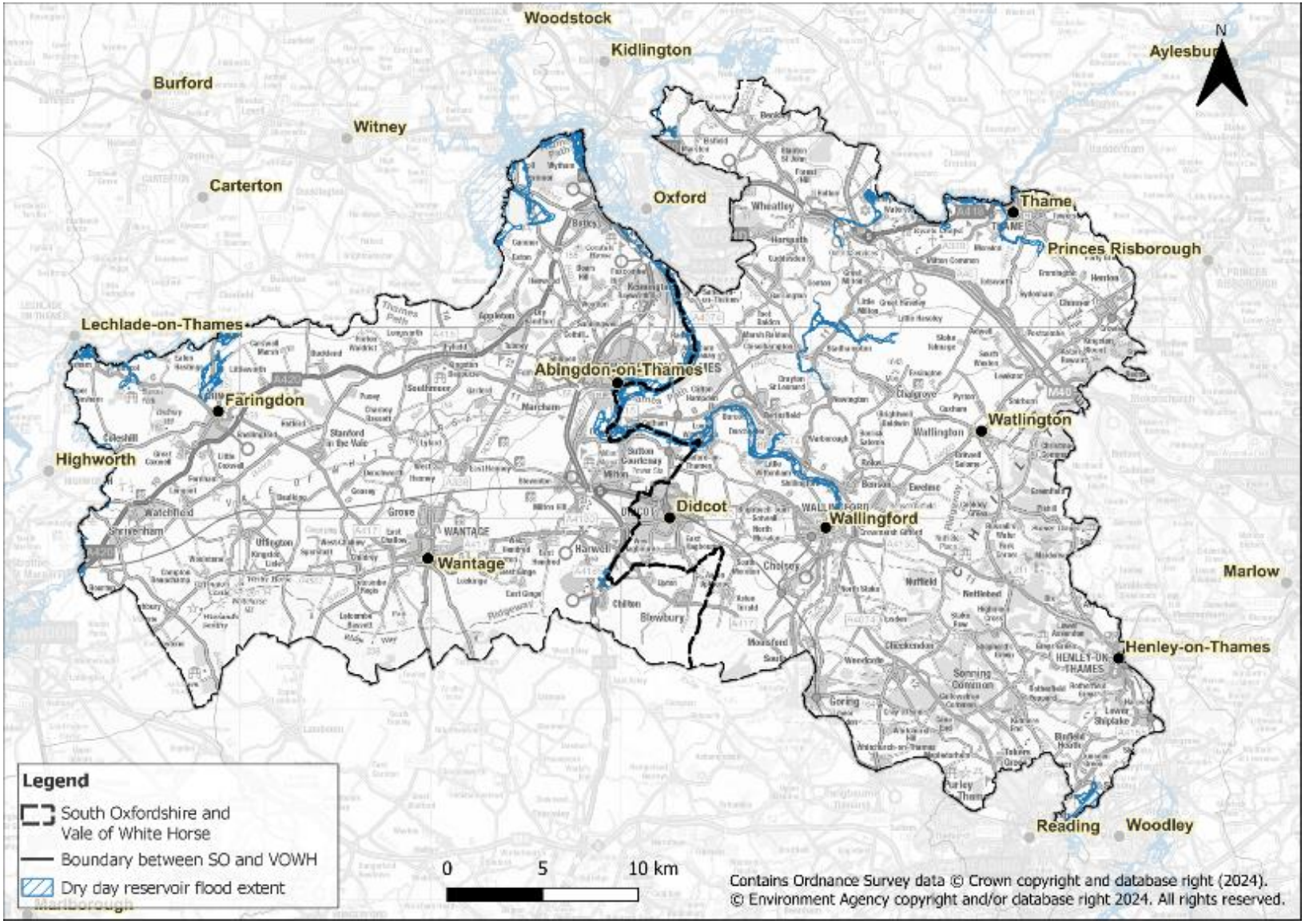


Figure 5-4: Risk of flooding from reservoirs within South Oxfordshire and Vale of White Horse during a dry-day scenario

5.7 Flood risk from canals

The residual risks associated with flooding from canals are dependent on the potential failure location with the consequence of flooding higher where floodwater could cause the greatest harm due to the presence of local highways and adjacent property.

Much of the River Thames in South Oxfordshire and Vale of White Horse is navigable and has 'canalised' reaches controlled by various weirs, sluices and locks. During times of normal flow, the Thames acts like a series of ponds that are fed via upstream locks, with water levels controlled by downstream structures. At times of high flow, the Thames floods its large rural floodplain[26]. The navigation authority for the Thames is the EA. The Thames links into the Oxford Canal at Oxford.

The Wilts and Berks Canal is the only other canal within South Oxfordshire and Vale of White Horse. The canal is currently derelict. It originally linked the Thames at Abingdon with the Kennet & Avon Canal near Melksham, Wiltshire. Policy IN4[27] of the draft JLP contains the council's support for the restoration of the Wilts and Berks Canal.

Although derelict, the canal still receives surface water from drains and runoff from the surrounding land, so there is a risk of overtopping if the outlet is overwhelmed or not operating correctly. For example two properties were threatened by flooding at East Challow in the winter of 2012/13 when the outlet from the canal was blocked and surface water drainage filled the canal to capacity.

At present, canals do not have a level of service for flood recurrence (i.e., there is no requirement for canals to be used in flood mitigation), although the Environment Agency, as part of its function, will endeavour to maintain water levels to control the risk of flooding from the River Thames to adjacent properties.

In response to the JLP preferred options consultation the Wilts and Berks Canal Trust have stated:

"The Wilts & Berks Canal runs for a considerable length along the lower edge of upland downs and intersects many of the run-off watercourses. The canal needs a water supply to offset evaporation and leakage and maintain a stable operational water level. These aims can be achieved by capturing excessive or surplus flows in the watercourses and holding it to top up canal water levels. This strategy corresponds exactly with government policy to hold water upstream of settlements to reduce flood risk. Additionally, surface water from development, suitably cleaned, can be accepted into the canal as a form of final stage SuDS treatment before it eventually reaches the natural watercourse or aquifer. The canal therefore offers an additional method of managing flood flows."

26 Thames River Basin District Flood Risk Management Plan 2021 to 2027 (publishing.service.gov.uk)

27 Chapter 13. Infrastructure, transport, connectivity and... | Joint Local Plan Preferred Options (southandvale.gov.uk)

It is important, however, that any development proposed adjacent to a canal be investigated on an individual basis regarding flooding issues and should be considered as part of any FRA.

5.7.1 Historical flooding from canals

The CRT has no recorded canal breach or overtopping within South Oxfordshire and Vale of White Horse.

5.8 Cumulative impacts assessment

The NPPF states that strategic policies…

"…*should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards*" (para 166).

Previous policies have relied on the assumption that if each individual development does not increase the risk of flooding, the cumulative impact will also be minimal. However, if there is a lot of development occurring within one catchment, particularly where there is flood risk to existing properties or where there are few opportunities for mitigation, or proposed developments of less than 10 dwellings, that are not referred to the LLFA for consultation under the Town and Country Planning (Development Management Procedure) Order (DMPO) 2015, the cumulative impact may be to change the flood response of the catchment.

In plan making and development planning, consideration should be given to the following:

- The importance of the phasing of development;
- Cross boundary impacts i.e., there should be dialogue between the South Oxfordshire and Vale of White Horse and neighbouring authorities (West Oxfordshire, Cherwell, Oxford, Buckinghamshire, Wokingham, Reading, West Berkshire, Wiltshire, Swindon and Cotswold) upstream and downstream of South Oxfordshire and Vale of White Horse on flood risk management practices and plans for development;
- Leaving space for floodwater by safeguarding land through the Joint Local Plan and utilising greenspace for flood storage and slowing the flow (see Sections 5.8.2 and 5.11.6);
- Ensuring floodplain connectivity;
- Use of appropriate SuDS and the containment of surface water onsite as opposed to directing elsewhere (see Section 6.7); and
- The loss of floodplain storage volume, as well as the impact of increased flows on flood risk downstream. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe.

All development plans are required to comply with the NPPF and FRCC-PPG and demonstrate they will not increase flood risk elsewhere. Therefore, providing all new development complies with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory there should not be any increase in flood risk downstream.

Strategic solutions may include upstream flood storage, integrated major infrastructure / Flood Risk Management schemes, new defences, and watercourse improvements as part of regeneration and enhancing green infrastructure, with opportunities for Working with Natural Processes and retrofitting of SuDS to existing development.

Through the Joint Local Plan, South Oxfordshire District Council and Vale of White Horse District Council should consider the following strategic solutions:

- Use of sustainable flood storage and mitigation schemes to store water and manage surface water runoff in locations that provide overall flood risk reduction as well as environmental benefits;
- In areas where flood risk is being managed effectively, there will be a need in the future to keep pace with increasing flood risk as a result of climate change;
- Assessment of long-term opportunities to move development away from the floodplain and to create blue/green river corridors throughout South Oxfordshire and Vale of White Horse;
- Identification of opportunities to use areas of floodplain to store water during high flows, to reduce long-term dependence on engineered flood defences located both within and outside South Oxfordshire and Vale of White Horse;
- Safeguarding the natural floodplain from inappropriate development;
- Where possible, changes in land management should look to reduce runoff rates from development whilst maintaining or enhancing the capacity of the natural floodplain to retain water. Land management and uses that reduce runoff rates in upland areas should be supported;
- Development should maintain conveyance of watercourses through hamlets and villages to help reduce the impact of more frequent flood events and to improve the natural environment and WFD targets;
- Use of this SFRA to help inform future development and minimise flood risk from all sources;
- Implementation of upstream catchment management i.e., slow the flow and flood storage schemes could be implemented in upper catchments to reduce risk downstream and across neighbouring authority boundaries; and
- Promotion and consideration of SuDS at the earliest stage of development planning through Schedule 3 of the FWMA, when implemented.

According to the NPPF, LPAs should work with neighbouring authorities to consider strategic cross-boundary issues and infrastructure requirements. Local authorities also have a duty to cooperate whereby councils work together on strategic matters and produce effective and deliverable policies on strategic cross boundary matters. The FWMA also requires that all Risk Management Authorities (RMAs) cooperate with relevant authorities regarding exercising flood and coastal risk management.

Additionally, South Oxfordshire District Council and Vale of White Horse District Council are represented by the Thames Regional Flood and Coastal Committee (RFCC) where cross-boundary resources, projects and data are shared between neighbouring authorities.

5.8.1 Hydrological linkages and cross boundary issues

There are a large number of tributaries of the River Thames within neighbouring authority areas. Although these tributaries do not enter South Oxfordshire and Vale of White Horse, land use changes within the catchment of these watercourses could impact flood risk from the River Thames further downstream.

Other watercourses such as the River Thame and River Cole, enter South Oxfordshire and Vale of White Horse from the neighbouring authorities of Swindon and Buckinghamshire respectively, before joining the River Thames. Main rivers that originate from within South Oxfordshire and Vale of White Horse also eventually flow into the River Thames.

Therefore, development control and responsible land management across upstream authorities and within South Oxfordshire and Vale of White Horse is crucial to ensuring sustainable development within the downstream authorities.

Figure 5-5 illustrates fluvial hydraulic linkages for the catchments in and around South Oxfordshire and Vale of White Horse. Close partnerships between South Oxfordshire and Vale of White Horse and neighbouring authorities i.e. Swindon, Cotswold, West Oxfordshire, Cherwell, Oxford City, Buckinghamshire, Wokingham, Reading, West Berkshire and Wiltshire should be maintained.

Were the above strategic solutions not considered in upstream development planning, the following issues may occur:

- Reduction in upstream floodplain storage capacity; and
- Increase in impermeable areas leading to a reduction in rainfall infiltration and subsequent increased runoff to the detriment of downstream communities.

The need for consistent regional development policies controlling runoff or development in floodplains within contributing districts is therefore crucial as this would have wider benefits for neighbouring local authorities as well as South Oxfordshire and Vale of White Horse. This should be carried out by the successful implementation of the sequential test.

The authorities of influence upstream and downstream of South Oxfordshire and Vale of White Horse are:

- Oxford City
- Cherwell
- West Oxfordshire
- Cotswold
- Swindon
- Wiltshire
- West Berkshire
- Reading

- Wokingham
- Buckinghamshire

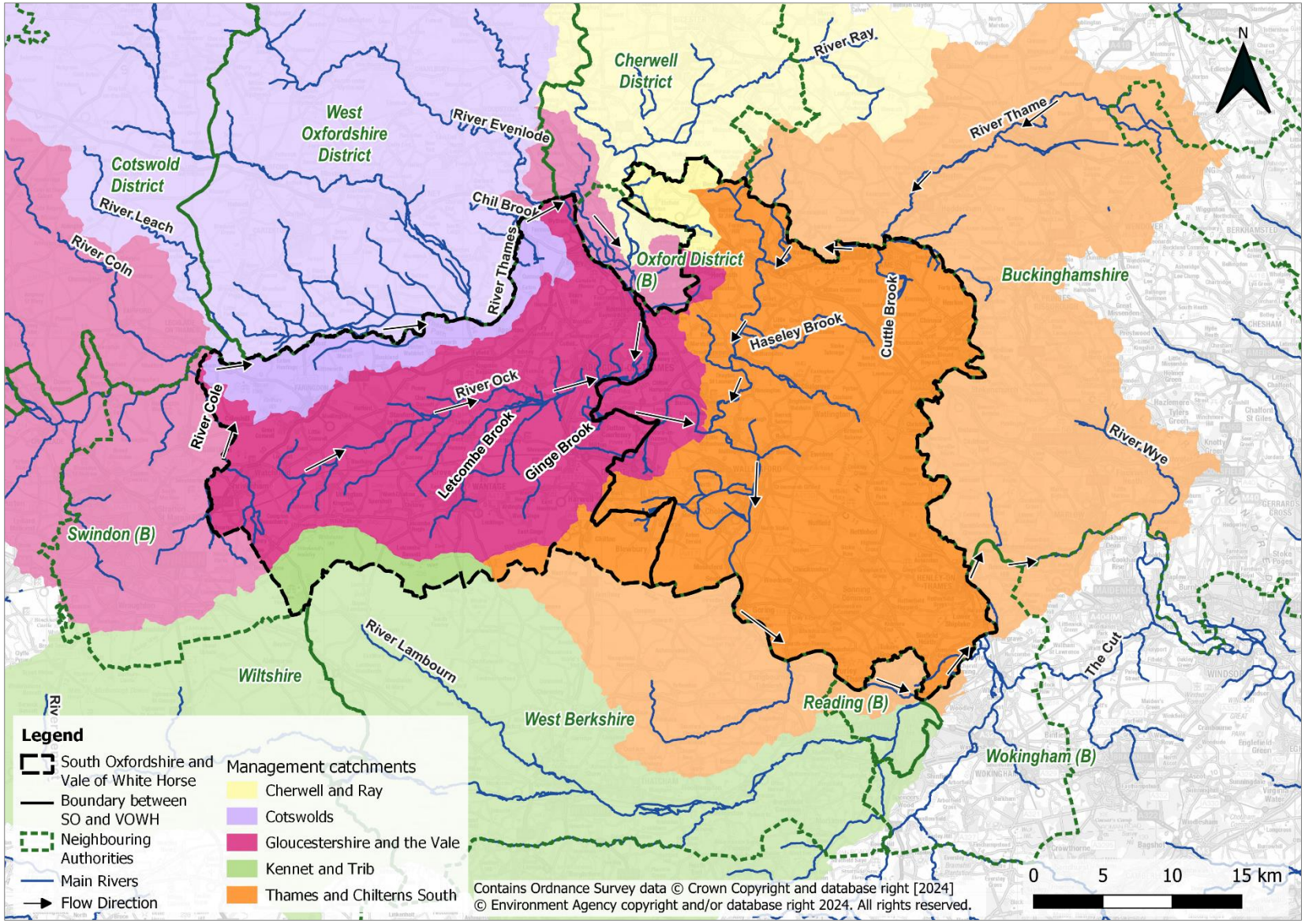


Figure 5-5: Hydrological linkages for catchments in and around South Oxfordshire and Vale of White Horse

5.8.2 Safeguarding land for flood storage

South Oxfordshire District Council and Vale of White Horse District Council will look to allocate land designed for flood storage functions through the Joint Local Plan. Such land can be explored by using this SFRA to assess the flood risk within areas of open space and to ascertain what benefit could be gained by leaving at risk areas undeveloped.

Paragraph 167 of the NPPF states *"to avoid where possible, flood risk to people and property, the LPAs should manage any residual risk by safeguarding land from development that is required, or likely to be required, for current or future flood management".*

Applicable locations may include any current greenfield sites:

- Considered to be large enough to store floodwater to achieve effective mitigation (modelling would be required to establish required storage volumes);
- With large areas of their footprint at high or medium surface water flood risk (based on the RoFSW) outside of the fluvial flood zones;
- Within the functional floodplain (Flood Zone 3b);
- With large areas of their footprint at risk from Flood Zone 3a or Flood Zone 2; and
- That are large enough and within a suitable distance to receive floodwater from a nearby development site using appropriate SuDS techniques which may involve pumping, piping or swales/drains.

Brownfield sites could also be considered, though this would entail clearance of existing buildings, conversion to greenspace and contaminated land assessments.

5.8.3 Catchment-level assessment of cumulative impacts of development on flood risk

Cumulative impacts are defined as the effects of past, current and future activities on the environment. These cumulative impacts may be negative, i.e. development leading to an increase in the existing level of flood risk within the catchment, or positive i.e. surface water management within a development helping to alleviate existing flooding issues within a catchment. A catchment-level assessment has been completed as part of this SFRA to understand the impact of future development on flood risk in South Oxfordshire and Vale of White Horse. Refer to Appendix E which details the methodology and results of the assessment.

5.9 Climate change

NPPF para 8 states that mitigating and adapting to climate change is an important objective that is key to delivering sustainable development that should be delivered through local plans.

In relation to flood risk and climate change in the planning system, the NPPF states:

"*New development should be planned for in ways that:*

a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure". (Para 159).

The Level 1 SFRA should be the starting point for any LPA to assess the effects of climate change on flood risk across the local plan area. Section 5.9.2 details the climate change mapping carried out as part of this SFRA.

Along with the NPPF, FRCC-PPG and EA guidance, South Oxfordshire and Vale of White Horse should refer to the Royal Town Planning Institute and Town & Country Planning Association's new edition of their joint guidance: 'The Climate Crisis – a guide for local authorities on planning for climate change'[28] when preparing the Joint Local Plan.

5.9.1 EA climate change allowances

The EA previously revised the climate change allowances for peak river flows in July 2021, and peak rainfall intensities in May 2022, for use in FRAs and SFRAs and will, at the time of writing, use these revised allowances when providing advice. These updates are based on the science behind UKCP18.

Climate change guidance is continually evolving therefore developers should refer to the climate change allowances on the Government's website[29] to ensure those outlined below are the most up-to-date available.

5.9.1.1 Peak river flow allowances

Peak river flow allowances include for the anticipated changes to peak flow by EA management catchment. Management catchments are sub-catchments of river basin districts. Figure 5-5 shows the Cherwell and Ray, Cotswolds, Gloucestershire and the Vale, Kennet and Trib, and Thames and South Chilterns management catchments which cover South Oxfordshire and Vale of White Horse.

The central and higher central allowances for the 2080s epoch are required to be assessed for SFRAs. Where it is appropriate to apply a credible maximum scenario, the upper end allowance should also be applied. Instances where this may be appropriate include nationally significant infrastructure projects, new settlements or significant urban extensions, none of which are considered within the JLP. Table 5-2 lists the allowances for each relevant management catchment.

28 The Climate Crisis – a guide for local authorities on planning for climate change | The Royal Town Planning Institute and Town & Country Planning Association | January 2023
29 Flood risk assessments: climate change allowances | Environment Agency | May 2022

Table 5-2: Recommended peak river flow allowances for the Cherwell and Ray, Cotswolds, Gloucestershire and the Vale, Kennet and Trib, and Thames and South Chilterns management catchments

Management catchment	Allowance category	Total potential change anticipated for peak river flows (based on a 1981 to 2000 baseline)		
		2020s (2015-2039)	2050s (2040-2069)	2080s (2070-2125)
Cherwell and Ray	Upper end	24%	27%	49%
	Higher central	11%	10%	25%
	Central	6%	4%	15%
Cotswolds	Upper end	31%	43%	82%
	Higher central	17%	21%	43%
	Central	11%	13%	30%
Gloucestershire and the Vale	Upper end	33%	43%	84%
	Higher central	17%	19%	41%
	Central	11%	11%	26%
Kennet and Trib	Upper end	32%	39%	76%
	Higher central	16%	16%	35%
	Central	10%	8%	21%
Thames and South Chilterns	Upper end	30%	42%	76%
	Higher central	17%	22%	43%
	Central	12%	14%	31%

5.9.1.2 Peak rainfall intensity allowances

To gauge the impacts of climate change on surface water and for small scale drainage design, the EA has produced allowances for peak rainfall intensities based on EA management catchments, provided in

Table 5-3, which should be used for small (less than 5km^2) and urbanised drainage catchments. However, the peak flow allowances (Table 5-2) should be used for any large rural drainage catchments.

The EA advises that SFRAs and FRAs should assess the upper end allowances for the 2070s epoch for both the 3.3% and 1% AEP events to gauge the range of impacts.

Table 5-3: Peak rainfall intensity allowances in small and urban catchments for England

Management catchment	Allowance category	Total potential change anticipated for peak rainfall intensities (based on a 1961 to 1990 baseline)			
		3.3% annual exceedance rainfall event		1% annual exceedance rainfall event	
		2050s (up to 2060)	2070s (2061-2125)	2050s (up to 2060)	2070s (2061-2125)
Cherwell and Ray	Upper end	35%	35%	40%	40%
	Central	20%	25%	20%	25%
Cotswolds	Upper end	35%	35%	40%	40%
	Central	20%	25%	20%	25%
Gloucestershire and the Vale	Upper end	35%	35%	40%	40%
	Central	20%	25%	20%	25%
Kennet and Trib	Upper end	35%	35%	40%	40%
	Central	20%	25%	20%	25%
Thames and South Chilterns	Upper end	35%	35%	40%	40%
	Central	20%	25%	20%	25%

5.9.2 Fluvial climate change approach for 3.3% AEP event (future functional floodplain)

As part of the Level 1 SFRA, it has been agreed between South Oxfordshire District Council, Vale of White Horse District Council and the EA to use proxy results where modelling of up-to-date climate change allowances is not available, due to the large number of models within the study area. This approach is summarised below.

- In instances where the 3.3% AEP event plus climate change is not available in a model, a 'best available' event proxy has been used. The best available event proxy was determined through coarsely upscaling the peak flows by the climate change allowance (i.e. +31% central allowance for 2080s epoch for a watercourse in the Thames and South Chilterns management catchment) to check whether this peak flow best aligns with a modelled 2%, 1.3% or 1% AEP event using the model hydrology reports. Each best available event proxy modelled flood outline was then collated to form a composite future functional floodplain proxy outline.

- In instances where there is no available present day 3.3% AEP event within a model, the 1% AEP event has been used as the best available proxy for the 3.3% AEP event. In these instances, Flood Zone 2 has been used as an extreme precautionary future functional floodplain extent.
- In instances where there is no modelling present at all, the proxy defaults to Flood Zone 3 of the Flood Map for Planning. For ordinary watercourses where there is no national mapping available, the 1% AEP event of the RoFSW dataset is used as a proxy to infer fluvial risk.

This functional floodplain delineation methodology is explained in detail in Appendix B.

It should be noted that at site-specific flood risk assessment stage, detailed hydraulic modelling may be needed to confirm the effects of climate change on the functional floodplain, but this is deemed a pragmatic approach for the strategic assessment of sites.

The events used within this SFRA are listed in Table 5-4.

Table 5-4: Future functional floodplain proxies

EA flood model	Present day functional floodplain representation	Central 2080s allowance	Future functional floodplain proxy
Assendon Stream (Middle Assendon to Thames confluence) 2014	3.3% AEP	+31%	1% AEP
Bradfords Brook (Wallingford) 2009	Use 1 % AEP as proxy (only 5% or 1% available)	+31%	Flood Zone 2
Chalgrove Brook (Chalgrove) 2022	2% AEP	+31%	0.5% AEP
Chalgrove Brook (Watlington) 2016	3.3% AEP	+31%	1% AEP
Cherwell (Thrupps Bridge to Thames Confluence) 2006	Use 1 % AEP as proxy (only 5% or 1% available)	+15%	Flood Zone 2
Cole EDA (A419 to South Marston Brook) 2011	Use 1 % AEP as proxy (only 5% or 1% available)	+26%	Flood Zone 2
Didcot Valley Park 2019	Use 1 % AEP as proxy (only 5% or 1% available)	+26%	Flood Zone 2
Ewelme Stream (Benson) 2019	3.3% AEP	+31%	1% AEP
Ginge Brook 2018	3.3% AEP	+26%	1.3% AEP
Letcombe Brook 2009	Use 1 % AEP as proxy (only 5% or 1% available)	+26%	Flood Zone 2

EA flood model	Present day functional floodplain representation	Central 2080s allowance	Future functional floodplain proxy
Moor Ditch (Didcot to Thames Confluence) 2007	Use 1 % AEP as proxy (only 5% or 1% available)	+26%	Flood Zone 2
North East Didcot FRA 2014	Use 1 % AEP as proxy (only 5% or 1% available)	+26%	Flood Zone 2
Northfield & Littlemore Brooks 2011	Use 1 % AEP as proxy (only 5% or 1% available)	+26%	Flood Zone 2
Ock (East Hanney to Thames Confluence) 2017	3.3% AEP	+26%	2% AEP
Pang & Sulham Brook (M4 to Thames Confluence) 2016	Use 1 % AEP as proxy (only 5% or 1% available)	+31%	Flood Zone 2
South Moreton (Flood Map Challenge) 2019	Use 1 % AEP as proxy (only 5% or 1% available)	+31%	Flood Zone 2
Stert (A34 to Thames Confluence) 2012	Use 1% AEP as proxy (only 5% or 1% available)	+26%	Flood Zone 2
Thames (Eynsham to Sandford) 2018 + 2022 (CC data only)	3.3% AEP	+26%	0.5% AEP
Thames (MRL to St Johns) 2014	2% AEP	+26%	2% AEP + 43% CC
Thames (Pangbourne to Sonning) 2019	3.3% AEP	+31%	2% AEP + 25% CC
Thames (Sandford to Pangbourne) 2018	3.3% AEP	+26%	1% AEP
Thames (Sonning to Hurley) 2019	3.3% AEP	+31%	1% AEP
Thames (St Johns to Shifford) 2011	Use 1 % AEP as proxy (only 5% or 1% available)	+30%	Flood Zone 2

5.9.3 Surface water climate change approach

The impact of climate change on surface water has not been modelled as part of this SFRA. The RoFSW dataset is presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10]. The 0.1% AEP event (1000-year) outline can be used as a

conservative representation of the future extent of surface water flooding in South Oxfordshire and Vale of White Horse.

5.10 Historic risk

Records of past flood events can help to build a picture of areas and locations that may be prone to flooding and to help back up or confirm flood modelling outputs. Historic flood events can also help Risk Management Authorities to target where flood risk management or resilience works may be required based on tangible evidence.

5.10.1 LLFA historic flood records

LLFAs have a statutory responsibility, under the FWMA, to maintain and update a historic flood incidents database as and when it considers a 'locally significant flood incident' to have occurred. Details of these events are also documented in Section 19 reports which can be found on Oxfordshire County Council's Flood Toolkit website.[30] Most recently, these include:

- Bridge Close, Edinburgh Drive, Didcot 2016 (South Oxfordshire)
- Didcot Rail Station 2016 (South Oxfordshire)
- Didcot Rail Station 2019 (South Oxfordshire)
- Manor School, Lydalls Close, Didcot 2016 (South Oxfordshire)
- Sunningwell 2023 (Vale of White Horse)
- Clifton Hampden 2024 (South Oxfordshire)
- Henley-on-Thames and Goring 2024 (South Oxfordshire)
- Nuneham Courtenay 2024 (South Oxfordshire)
- Nash Drive, Abingdon 2024 (Vale of White Horse)
- Milton 2024 (Vale of White Horse)
- Larkmead School, Abingdon (Vale of White Horse)

The main source of flooding indicated in these Section 19 reports is surface water flooding, often due to the capacity of drainage networks being unable to cope with large amounts of rainfall. The Thames FRMP[31] states that 2.3 million people are at risk of flooding from surface water in the Thames River Basin District. The Oxfordshire County Council Preliminary Flood Risk Assessment (PFRA)[32] explains that the majority of recorded flood incidents by local sources in Oxfordshire are due to surface water flooding (often interacting with ordinary watercourses) after intense rainfall.

After intense rainfall and flooding in January 2024, Oxfordshire County Council have identified the following areas where the threshold for carrying out a Section 19 investigation has been met:

30 Oxfordshire County Council Section 19 Flood Investigation Reports
31 Thames River Basin District Flood Risk Management Plan 2021 to 2027 (publishing.service.gov.uk)
32 Oxfordshire PFRA Main Report 2011 (oxfordshirefloodtoolkit.com)

- Chinor (South Oxfordshire)
- Didcot (South Oxfordshire)
- East Hagbourne (South Oxfordshire)
- Whitchurch-on-Thames (South Oxfordshire)
- Challow (Vale of White Horse)
- Steventon (Vale of White Horse)
- Sunningwell (Vale of White Horse)
- Wooton - including Whitecross (Vale of White Horse)

The Oxfordshire Preliminary Flood Risk Assessment[33], published in 2011 details severe flooding across the Thames catchment in July 2007. Didcot was affected by the flooding. Rail infrastructure was particularly impacted with the railway lines between Didcot and Bristol, Oxford and Reading being closed.

5.10.2 EA Historic Flood Map and Recorded Flood Outlines

The Historic Flood Map (HFM) is a spatial dataset showing the maximum extent of all recorded historic flood outlines from river, sea and groundwater and shows areas of land that have previously been flooded across England. Records began in 1946 when predecessor bodies to the EA started collecting information about flooding incidents. The HFM accounts for the presence of defences, structures, and other infrastructure where such existed at the time of flooding. It includes flood extents that may have been affected by overtopping, breaches or blockages. It is also possible that historic flood extents may have changed and that some areas would not flood at present i.e., if a flood defence has been built.

The HFM does not contain any information regarding the specific flood source, return period or date of flooding, nor does the absence of the HFM in an area mean that the area has never flooded, only that records of historic flooding do not exist. The Recorded Flood Outlines (RFO) dataset however does include details of flood events. The difference between the two datasets is that the HFM only contains flood outlines that are ‘considered and accepted’ by the EA following adequate verification of the RFO dataset using certain criteria.

The HFM and RFO datasets are presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

5.10.3 Historic fluvial flooding

Significant fluvial flooding has been documented by OCC as the LLFA through various Storm Henk Section 19 reports. In January 2024, fluvial flooding occurred in Clifton Hampden and Henley-on-Thames (South Oxfordshire), as well as in Abingdon-on-Thames, Milton and at Larkmead School (Vale of White Horse). This flooding was attributed to heavy rainfall causing high river levels and out of bank flow. Flooding from main rivers included

33 Oxfordshire PFRA (oxfordshirefloodtoolkit.com)

the River Thames (in Clifton Hampden and Henley-on-Thames), the River Ock and Sandford Brook (in Abingdon-on-Thames) and Moor Ditch (in Milton). The ordinary watercourse Wildmere Brook flooded Larkmead School in Abingdon-on-Thames. Clifton Hampden was also flooded by unnamed ordinary watercourses.

Additionally, fluvial flooding is described in the Sunningwell Section 19 report. In summary, from late March 2023 to early April 2023, heavy rainfall led to surface water runoff overwhelming the ordinary watercourse which runs through Sunningwell village. As a result, water flowed through gardens, garages and properties towards the watercourse from upstream/uphill. Surface water also overloaded foul sewers leading to foul sewer flooding in the village.

The HFM and RFO datasets show areas of historic flooding mainly from the River Thames at locations including South Hinksey, Abingdon-on-Thames (Vale of White Horse), Sandford-on-Thames, Clifton Hampden, Shillingford, Wallingford, North Stoke, South Stoke, Goring-on-Thames, Whitchurch-on-Thames, Playhatch, Lower Shiplake and Henley-on-Thames (South Oxfordshire). Thame, Stadhampton, Drayton Saint Leonard and Dorchester-on-Thames (South Oxfordshire) along the River Thame are also shown to be in the HFM. Lyford and Caldecott along the River Ock; Steventon along the Ginge Brook; and Grove and East Henney along the Letcombe Brook are also shown to have previously flooded (all Vale of White Horse).

5.10.4 Historic sewer flooding

A number of Section 19 reports published by OCC have noted the role of Thames Water, Network Rail and Highways sewers / drainage networks in surface water flooding incidents in Didcot, South Oxfordshire in 2016 and 2019. A Section 19 report was also produced following flooding in Sunningwell, Vale of White Horse in 2023 where heavy rainfall resulted in foul sewer flooding.

5.10.5 Historic surface water flooding

Surface water has been recorded to have previously contributed to flood events across South Oxfordshire and Vale of White Horse:

16 September 2016

On the 16th of September 2016 heavy rain (70mm in 12 hours) resulted in the surcharging of various sewers in Didcot, South Oxfordshire. Three Section 19 reports have been produced for surface water flood events which occurred in Didcot on this day. The flooding at Didcot Rail Station, Bridge Close/Edinburgh Drive and The Manor School met the threshold for Oxfordshire County Council to carry out a Section 19 investigation.

31 May 2018

Didcot Rail Station once again flooded in May 2018. Heavy rain exceeded sewer capacity and was exacerbated by various blockages and defects within the drainage network in the vicinity of the station.

31 March - 1 April 2023

Heavy rainfall in March and April saturated the ground creating the conditions for a surface water flooding event in Sunningwell, Vale of White Horse between the 31st of March and 1st of April 2023. Surface Water runoff flowed through gardens, garages and properties in Sunningwell and also overwhelmed the unnamed ordinary watercourse which runs through the centre of the village. Surface water also overloaded foul sewers which lead to foul sewer flooding in the village.

3 January - 04 January 2024

Storm Henk brought exceptionally heavy rainfall to southern and central parts of England in January 2024. Heavy rainfall in December 2023 had already saturated soils and likely increased baseflow. In Nuneham Courtenay, South Oxfordshire, surface water runoff from farmland overwhelmed the surface water drainage system in the village which surcharged in various locations. 10 properties flooded internally and two further flooded externally Foul sewers in the village were also overloaded and foul water flooding was reported. In Milton, Vale of White Horse, three businesses were flooded when high water levels in Moor Ditch prevented the surface water drainage system from discharging to the watercourse resulting in the backing up of surface water at multiple units.

5.10.6 Historic groundwater flooding

It is difficult to attribute a groundwater flooding event as occurring solely due to groundwater as its source. It may be the case that groundwater flood events have occurred but have not been recorded. The 2011 PFRA for Oxfordshire[34] states that there was a prolonged groundwater flooding event in 2000/1 which affected areas in South Oxfordshire causing flooding in watercourses including Assendon Spring, Harpsden Court Drain (Henley-on-Thames), Stert Brook (Thame) and Ewelme Brook (Ewelme/Benson). Cumnor and Botley were also affected in this event according to the South Oxfordshire and Vale of White Horse Level 1 SFRA (2009).

Watlington has historically suffered from groundwater flooding. In 2014, a combination of high groundwater levels and heavy rainfall in resulted in flooding to properties. However, this event did not meet the threshold for a formal Section 19 investigation. The same flooding mechanism of combined high groundwater levels and heavy rainfall was observed during an event in 2024, however did not result in flooding to property.

5.11 Flood risk management

The aim of this section of the SFRA is to identify existing Flood Risk Management (FRM) assets and proposed FRM schemes. The location, condition and design standard of existing assets will have a significant impact on actual flood risk mechanisms. Whilst future

34 Oxfordshire Preliminary Flood Risk Assessment Main Report 2011 (oxfordshirefloodtoolkit.com)

schemes in high flood risk areas carry the possibility of reducing the probability of flood events and reducing the overall level of risk. Both existing assets and future schemes will have a further impact on the type, form and location of new development or regeneration.

5.11.1 Culverts

Culverts may frequently increase flood risk, both due to blockages, either of the culvert itself or trash screens, or where they are hydraulically inadequate due to under-capacity or condition. In general South Oxfordshire and Vale of White Horse have a low proportion of culverted watercourses, but where they do exist, they can be problematic. Responsibility for maintenance of culverts can be difficult to determine between riparian owners, district councils, county councils and the EA.

All culverts recorded on the EA AIMS database are shown in Figure 5-6. The AIMS database only includes culverts on main rivers. OCC as LLFA hold an asset register with information on drainage infrastructure within Oxfordshire. The LLFA should also have records of culverts within their asset database. South Oxfordshire and Vale of White Horse Drainage teams may also hold further information on culvert locations.

Notable culverts in the districts include:

- River Stert, Abingdon-on-Thames (Vale of White Horse) - Culverted through Abingdon town centre.
- Radley Park Ditch, Abingdon-on-Thames (Vale of White Horse) - Culverted from the south end of Chilton Close to Radley Road.
- Ladygrove Brook, Didcot (South Oxfordshire) - Culverted under the Ladygrove Estate.
- Mill Brook, Wallingford (South Oxfordshire) - Flows into the head of this culvert were reversed in the 1970s, directing all natural flows into the Bradford's Brook. Only local surface water sewers and highway drainage connect into this culvert.
- Assendon Stream, Henley-on-Thames (South Oxfordshire) - The course of Assendon Stream enters a culvert along Fair Mile but is not recorded on AIMS. A crude route plan was obtained from Oxfordshire County Council. This culvert was found to be in poor condition during the last flood in 2000/1.
- Wheatley Brook, Wheatley (South Oxfordshire) - Culverted from west to east under the High Street to Crown Square. Takes high natural flows from surrounding land.
- Town Ditch, Henley-on-Thames (South Oxfordshire) - Runs from upper Henley through the town centre between Hart Street and Friday Street. Takes highway drainage and spring flows.

This is by no means an exhaustive list, and risk from culverts should be assessed on a local basis, particularly on ordinary watercourses.

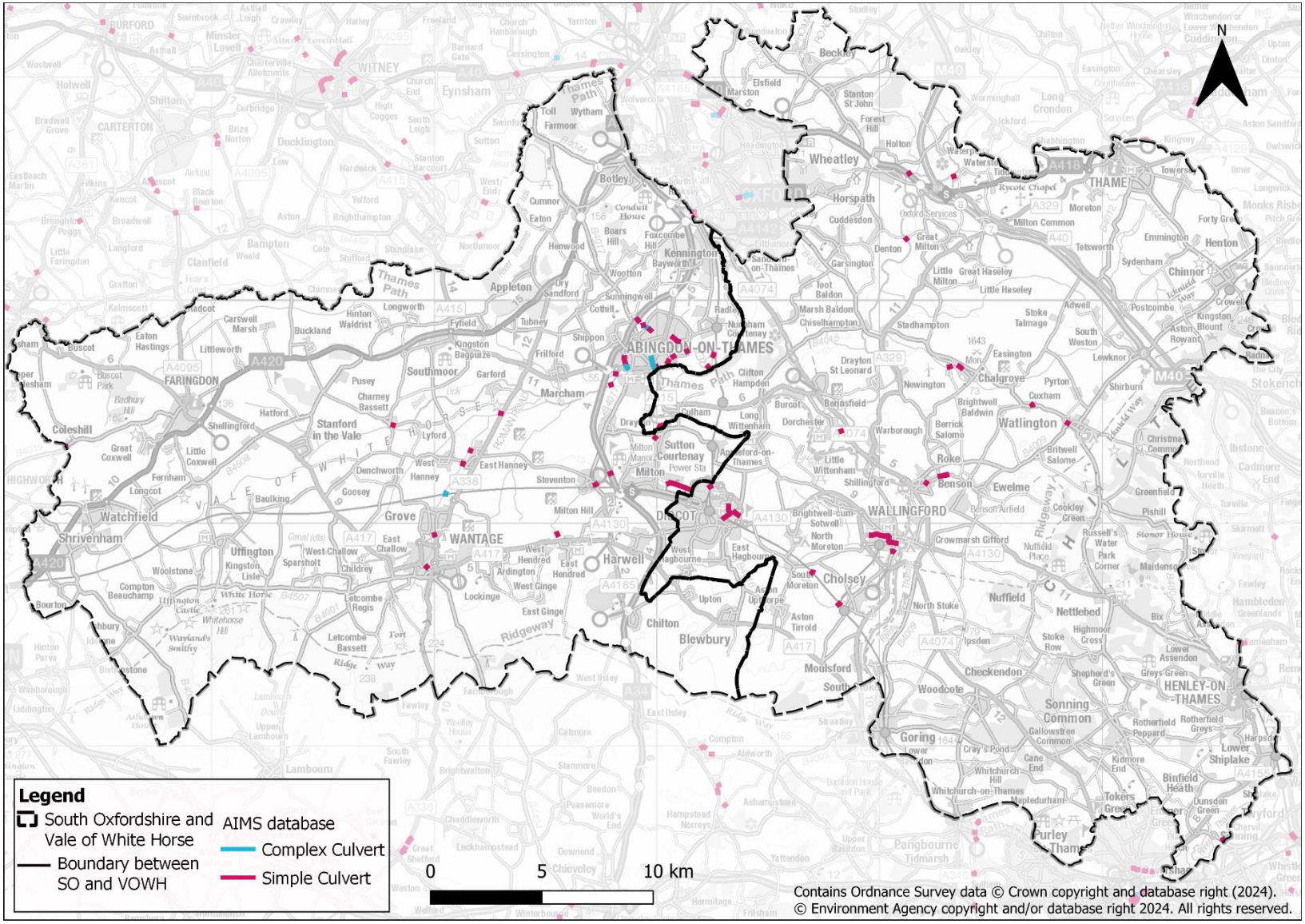


Figure 5-6: AIMS database culverts in South Oxfordshire and Vale of White Horse

5.11.2 EA Assets

The EA maintains a spatial dataset called the Spatial Flood Defences dataset. This national dataset contains such information as:

- Asset type (flood wall, embankment, high ground, demountable defence, bridge abutment);
- Flood source;
- Design Standard of Protection (SoP);
- Asset length;
- Asset age;
- Asset location; and
- Asset condition.

This dataset does not include flood defence assets on non-main rivers. See Figure 5-7 for condition assessment grades using the EA's Condition Assessment Manual[35] (CAM).

The design standard of protection (SoP) for a flood defence is a measure of how much protection a flood defence gives. If the SoP is 100, the defence is designed to protect against a flood with the probability of occurring once in 100 years (1% AEP event).

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

Figure 5-7: EA flood defence condition assessment grades

35 Environment Agency. (2012). Visual Inspection Condition Grades. In: EA Condition Assessment Manual. Bristol: Environment Agency. P9.

Table 5-5: Major flood defences within South Oxfordshire and Vale of White Horse

Defence Location	Asset Type	Flood Source	Watercourse	Design Standard	Condition Grade
South Oxford-shire	Embankment (7)	Fluvial	Moor Ditch (1), Cuttle Brook (2), River Thames (1), unnamed watercourse (3)	5 years (2), 3 years (2), unknown (3)	3 (1), unknown (6)
Vale of White Horse	Embankment (10)	Fluvial	River Ock (3), River Stert (1), River Thames (1), Farmoor Reservoir (1), Radley Park Ditch (1), Hinksey Drain (1), unnamed watercourse (2)	5 years (5), 50 years (2), 25 years (1), unknown (2)	4 (1), 3 (1), unknown (8)
	Wall (3)	Fluvial	Hinksey Drain (1), River Ock (1), Radley Park Ditch (1)	Unknown (2), 5 years (1)	Unknown (3)
	Demountable Defence (1)	Fluvial	Hinksey Drain (1)	Unknown (1)	4 (1)
*The number in brackets refers to the number of features with that attribute.					

The full Spatial Flood Defences dataset, which displays the defences by asset type, is shown on South Oxfordshire and Vale of White Horse web-based mapping portal[10].

As well as the ownership and maintenance of a network of formal defence structures, the EA carries out several other flood risk management activities that help to reduce the probability of flooding, whilst also addressing the consequences of flooding. These include:

- Maintaining and improving the existing flood defences, structures and watercourses;
- Enforcement and maintenance where riparian owners unknowingly carry out work that may be detrimental to flood risk;
- Identifying and promoting new flood alleviation schemes (FAS), where appropriate;
- Working with local authorities to influence the location, layout and design of new and redeveloped property and ensuring that only appropriate development is permitted relative to the scale of flood risk;
- Operation of Floodline Warnings Direct and flood warning services for areas within designated Flood Warning Areas (FWA) or Flood Alert Areas (FAA). EA FWAs and FAAs are presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10];

- Promoting awareness of flooding so that organisations, communities, and individuals are aware of the risk and are therefore sufficiently prepared in the event of flooding; and
- Promoting resilience measures for existing properties that are currently at flood risk or may be in the future as a result of climate change (Property Flood Resilience - see Section 6.8.5).

5.11.3 OCC assets

OCC (as the LLFA), under the provisions of the FWMA, has a duty to maintain a register of structures or features that have a significant effect on flood risk, including details of ownership and condition as a minimum. The asset register should include those features relevant to flood risk management function including feature type, description of principal materials, location, measurements (height, length, width, diameter) and condition grade. The FWMA places no duty on the LLFA to maintain any third-party features, only those for which the authority has responsibility as land/asset owner. The LLFA may carry out a strategic assessment of structures and features within the asset register to inform partners' capital programmes and prioritise maintenance programmes.

5.11.4 Future flood risk management schemes

Ongoing flood risk management schemes within the area include:

Oxford Flood Alleviation Scheme[36]

Led by the EA and nine other organisations (including Oxfordshire County Council and Vale of White Horse District Council), the Oxford Flood Alleviation Scheme aims to create a new stream with a wetland wildlife corridor to the west of Oxford. This major project aims to reduce flood risk in the city and surrounding areas. At the time of writing, the EA had made a Compulsory Purchase Order (CPO) to acquire the land/access rights for the scheme and the public inquiry for the CPO concluded in January 2024. At the time of writing, the CPO has yet to be confirmed. A planning application for the scheme has also been submitted to Oxfordshire County Council for review.

Thames Valley Flood Scheme[37]

The Thames Valley Flood Scheme is an EA led project investigating ways to manage flood risk on a large scale across the Thames Valley catchment (which covers the districts of South Oxfordshire and Vale of White Horse). So far, the scheme has found that creating new flood storage sites, supported by natural flood management (NFM), could work at a large scale to reduce flood risk and 17 locations have been identified as suitable. One location in Vale of White Horse and three locations within South Oxfordshire have been identified as suitable. The next phase of work will refine the precise extent of these locations.

36 Oxford Flood Alleviation Scheme Citizen Space (environment-agency.gov.uk)
37 Thames Valley | Engage Environment Agency (engagementhq.com)

5.11.5 Water company assets

The sewerage infrastructure within South Oxfordshire and Vale of White Horse area may have a risk of localised flooding associated with the existing drainage capacity and sewer system. Thames Water (TW) is responsible for the management of the adopted sewerage system. This includes surface water and foul sewerage. There may however be some private surface water sewers in the area as only those connected to the public sewer network that were transferred to the water companies under the Private Sewer Transfer in 2011 are likely to have been constructed since this transfer date. Surface water sewers discharging to watercourses were not part of this transfer and would therefore not be under the ownership of TW, unless adopted under a Section 104 adoption agreement.

Water company assets include Wastewater Treatment Works, Combined Sewer Overflows, pumping stations, detention tanks, sewer networks and manholes.

5.11.6 Natural Flood Management / Working with Natural Processes

Natural flood management (NFM) or Working with Natural Processes (WwNP) is a type of nature-based flood risk management solution used to protect, restore and re-naturalise the function of catchments and rivers to reduce flood and coastal erosion risk. WwNP has the potential to provide environmentally sensitive approaches to minimising flood risk, to reduce flood risk in areas where hard flood defences are not feasible and to increase the lifespan of existing flood defences.

A wide range of techniques can be used that aim to reduce flooding by working with natural features and processes in order to store or slow down floodwaters before they can damage flood risk receptors (e.g. people, property, infrastructure, etc.). WwNP involves taking action to manage flood and coastal erosion risk by protecting, restoring and emulating the natural regulating functions of catchments, rivers, floodplains and coasts.

The EA is actively encouraging the implementation of WwNP measures within catchments and coastal areas in order to assist in the delivery of environmental protection and national policies. The implementation of WwNP will continue to become a fundamental component of the flood risk management tool kit due to climate change.

The Thames Region Flood and Coastal Committee (RFCC) carried out a local assessment of NFM opportunities in the Thames region. The Thames NFM opportunity and priority mapper is discussed further in this blog post[38].

5.11.6.1 Evidence base for WwNP to reduce flood risk

The EA has produced a WwNP evidence base[39], which includes three interlinked projects:

- Evidence directory;
- Mapping the potential for WwNP; and

38 Thames Regional Flood and Coastal Committee (RFCC) - GOV.UK (www.gov.uk)
39 Working with natural processes to reduce flood risk, GOV.UK, February 2021

- Research gaps.

The evidence base can be used by those planning projects that include WwNP measures to help understand:

- Their potential FCRM benefits and multiple benefits;
- Any gaps in knowledge;
- Where it has been done before and any lessons learnt; and
- Where in a catchment they might be most effective.

A guidance document sits alongside the evidence directory and the WwNP maps that explains how to use them to help make the case for implementing WwNP when developing business cases.

5.11.6.2 Mapping the potential for WwNP

National maps for England make use of different mapping datasets and highlight the potential areas for tree-planting (for three different types of planting), runoff attenuation storage, gully blocking and floodplain reconnection. The maps can be used to signpost potential areas for WwNP and do not consider issues such as land ownership and drainage infrastructure, but they may well help start the conversation and give indicative estimates of, for example, additional distributed storage in upstream catchments.

These maps are intended to be used alongside the evidence directory to help practitioners think about the types of measure that may work in a catchment and the best places in which to locate them. There are limitations with the maps, however it is a useful tool to help start dialogue with key partners. The maps are provided as spatial data for use in GIS and interactive GeoPDF format, supported by a user guide and a detailed technical guide.

The WwNP types are listed in Figure 5-8.

WWNP Type	Open data licence details
Floodplain reconnection	• Risk of Flooding from Rivers and Seas (April 2017). • Data derived from the Detailed River Network, which is not displayed, rescinding the licence requirements for displaying the dataset (to be superseded by OS Water Network but not available for project in time). • Constraints data.
Run-off attenuation features	• Data derived from Risk of Flooding from Surface Water (Depth 1% AEP and Depth 3.3% AEP) (October 2013). The original data is not displayed due to licensing restrictions. • Constraints data. • Gully blocking potential (a subset of run-off attenuation features on steeper ground). • Data derived from OS Terrain 50 (2016) to classify each run-off attenuation feature based on median slope.
Tree planting (3 categories)	• Floodplain: Flood Zone 2 from Flood Map for Planning (April 2016) and new constraints layer. • Riparian: 50m buffer OS water features with constraints layer • Wider catchment woodland: o Based on slowly permeable soils. o BGS Geology 50,000 Superficial and Bedrock layers (both V8, 2017). Used with new science to derive new 100m gridded open data. This new layer can be used to signpost areas of SLOWLY PERMEABLE SOILS and can be checked in more detail on the BGS portal. o To the north of the line of Anglian glaciation, the presence of till-diamicton has been shown to be a strong predictor of slowly permeable soils. o To the south of this line, particular bedrock geologies have shown a similarly strong spatial relationship to the presence of slowly permeable soils.

Figure 5-8: WwNP measures and data

The WwNP datasets are presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10] and should be used to highlight any sites or areas where the potential for WwNP should be investigated further as a means of flood mitigation:

- Floodplain Reconnection:
  - Floodplain Reconnection Potential – areas of low or very low probability based on the EA's Risk of Flooding from Rivers and Sea dataset that are near a watercourse and that do not contain properties, are possible locations for floodplain reconnection. It may be that higher risk areas can be merged, depending on the local circumstances.
- Runoff Attenuation Features (Run-off attenuation features are based on the premise that areas of high flow accumulation in the RoFSW) maps are areas where the runoff hydrograph may be influenced by temporary storage if designed correctly):
  - Runoff Attenuation Features 1% AEP
  - Runoff Attenuation Features 3.3% AEP
- Tree Planting
  - Floodplain Woodland Potential and Riparian Woodland Potential – woodland provides enhanced floodplain roughness that can dissipate the energy and momentum of a flood wave if planted to obstruct significant flow pathways. Riparian and floodplain tree planting are likely to be most effective if close to the watercourse in the floodplain, which is taken to be the 0.1% AEP flood extent (Flood Zone 2) and within a buffer of 50 metres of smaller watercourses where there is no flood mapping available. There is a constraints dataset that includes existing woodland; and
  - Wider Catchment Woodland Potential – slowly permeable soils have a higher probability of generating 'infiltration-excess overland flow' and 'saturation overland flow'. These are best characterised by gleyed soils, so tree planting can open up the soil and lead to higher infiltration and reduction of overland flow production.

Limitations

The effectiveness of WwNP measures is site-specific and depends on many factors, including the location and scale at which they are used. It may not always be possible to guarantee that these measures alone will deliver a specified standard of defence. Consequently, flood risk management measures should be chosen from several options ranging from traditional forms of engineering through to more natural systems. The research gaps that need to be addressed to move WwNP into the mainstream are identified in the evidence directory.

5.11.6.3 NFM in South Oxfordshire and Vale of White Horse

The key locations within South Oxfordshire and Vale of White Horse that are considered to have significant potential for WwNP schemes include:

- Potential for floodplain reconnection along Wadley Stream, the River Thame, Mill Brook and the River Ock and its tributaries;
- Potential for floodplain woodland planting along the majority of watercourses in South Oxfordshire and Vale of White Horse; and
- Wider catchment woodland potential along the northern boundary of Vale of White Horse, within much of the northern half of South Oxfordshire and across the centre of Vale of White Horse.

An interactive map of nature-based flood risk management projects and potential projects can be found at JBA Trust Mapping[40].

5.11.7 EA flood risk management activities and Flood and Coastal Erosion Risk Management (FCERM) Research and Development

The FCERM Research and Development Programme is run by the EA and Defra and aims to serve the needs of all flood and coastal operating authorities in England. The strategic objectives for research include:

- better understand future flood and coastal erosion risk
- prepare for the scale and frequency of future incidents
- optimise the management of FCERM infrastructure
- improve responsibility and funding for flood and coastal risk
- understand the potential of new technology and innovation
- increase resilience to flood and coastal erosion risk

Completed and ongoing research can be found online.[41]

Much of the research carried out through the FCERM Research and Development Programme could be relevant to South Oxfordshire and Vale of White Horse. This includes:

- The Natural Flood Management (NFM) manual[42]
- Using flood risk information in spatial planning[43]
- Review of groundwater flood risk management in England[44]
- Communicating impacts in flood warnings and forecasting[45]

40 Working with Natural Processes Mapping, JBA Trust
41 FCERM research and development projects, GOV.UK, March 2021
42 The Natural Flood Management (NFM) manual - GOV.UK (www.gov.uk)
43 Using flood risk information in spatial planning - GOV.UK (www.gov.uk)
44 Review of groundwater flood risk management in England - GOV.UK (www.gov.uk)
45 Communicating impacts in flood warnings and forecasting - GOV.UK (www.gov.uk)

6 Development and flood risk

6.1 Introduction

The information and guidance provided in this chapter summarises the online national planning policy and guidance provided in the NPPF and FRCC-PPG and other government guidance on development and flood risk. Specifically, the basis from which to apply the sequential approach in plan-making and development management processes.

6.2 Sequential test

The FRCC-PPG provides the basis for the application of the sequential test. It is this approach, integrated into all stages of development planning processes, which provides the opportunities to reduce flood risk to people, property, infrastructure, and the environment to acceptable levels. Land at the lowest risk of flooding from all sources should be considered for development, following the requirements of the sequential test.

The test is based around the FRM hierarchy, in which actions to avoid, substitute, control and mitigate flood risk is central. For example, it is important to assess the level of risk to an appropriate scale during the decision-making process, (starting with this Level 1 SFRA). Once this evidence has been provided, positive planning decisions can be made and effective FRM opportunities identified.

Figure 6-1 illustrates the FRM hierarchy with an example of how this may translate into the LPA's site allocation and developer's development proposal decisions and actions.

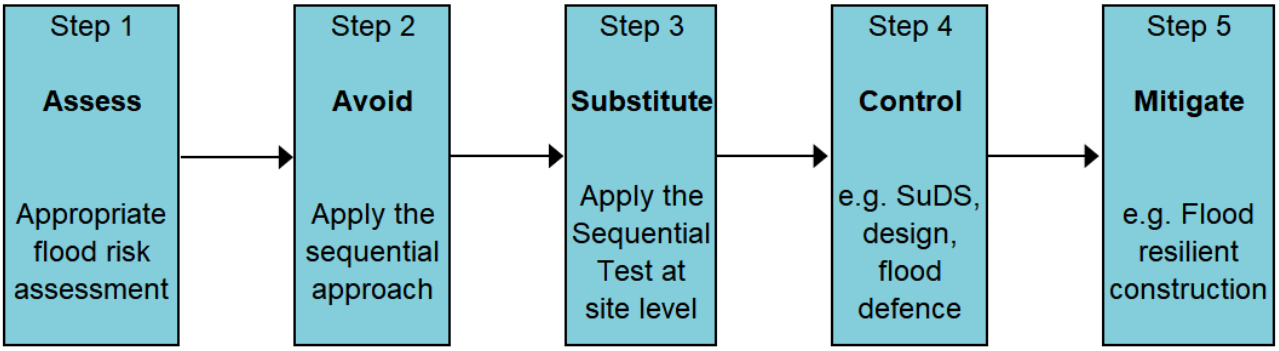


Figure 6-1: Flood risk management hierarchy

There are two different aims in carrying out the sequential test depending on what stage of the planning process is being carried out, i.e., South Oxfordshire and Vale of White Horse District Councils allocating land in the Joint Local Plan or when determining specific planning applications for development from developers. South Oxfordshire and Vale of White Horse will apply the sequential test to potential allocations for inclusion in the Joint Local Plan using the whole local planning authority area to increase the possibilities of accommodating development that is not exposed to flood risk, both now and in the future. For other developments, such as windfall developments, developers must supply evidence

to South Oxfordshire and Vale of White Horse, with a suitable planning application, that the development has passed the test.

This Level 1 SFRA provides the basis for applying the sequential test. South Oxfordshire and Vale of White Horse should perform the test as part of the process by which the suitability of sites is tested for plan-making purposes. This can be demonstrated through a free-standing document, or as part of a Housing and Economic Land Availability Assessment or other site assessment report.

Whether any further work is needed to decide if the land is suitable for allocation will depend on both the vulnerability of the development and the flood zone it is proposed for. Table 2 of the FRCC-PPG[46] defines the flood risk vulnerability and flood zone 'incompatibility' of different development types to fluvial flooding, as shown in Figure 6-2.

Flood Zones	**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 †	X	Exception Test required	✔	✔
Zone 3b *	Exception Test required *	X	X	X	✔ *

Key:

✔ Exception test is not required

X Development should not be permitted

Figure 6-2: Table 2 of the FRCC-PPG: Flood risk vulnerability and flood zone 'incompatibility'

46 Flood risk and coastal change - GOV.UK, 2022

Notes to Figure 6-2:

- *This table does not show the application of the Sequential Test which should be applied first to guide development to the lowest flood risk areas; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;*
- *The Sequential and Exception Tests do not need to be applied to those developments set out in National Planning Policy Framework footnote 59. The Sequential and Exception Tests should be applied to 'major' and 'non major' development; and*
- *Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.*

"†" 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.*

6.3 The sequential test for local plan preparation

The FRCC-PPG, para 024, states the aim of the sequential test is:

"*…to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account."*

South Oxfordshire District Council and Vale of White Horse District Council should seek to avoid inappropriate development in areas at risk from all sources of flooding, where applicable, by directing development away from areas at highest risk and ensuring that all development does not increase risk and where possible can help reduce risk from flooding to existing communities and development.

At a strategic level, this should be carried out through the JLP using this Level 1 SFRA by:

1. Applying the sequential test and if the sequential test is passed, applying and passing the exception test, if required, through a Level 2 SFRA;
2. Safeguarding land from development that is required for current and future flood management (i.e. using the EA's potential for WwNP datasets as a starting point, increasing existing areas of fluvial floodplain to provide additional storage);
3. Using opportunities offered by new development to reduce the causes and impacts of flooding through effective mitigation i.e., SuDS;
4. Identifying where flood risk is expected to increase with climate change so that existing development may be made sustainable in the long term through Property Flood Resilience measures; and
5. Seeking opportunities to facilitate the relocation of at risk development including housing to more sustainable locations, where feasible.

Figure 6-3 presents Diagram 2 of the FRCC-PPG (para 026), which illustrates the sequential test process for plan preparation. The test can be applied using the information provided in this Level 1 SFRA.

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

This can be done using the development site assessment spreadsheet in Appendix C. This spreadsheet will help show that South Oxfordshire and Vale of White Horse, through the SFRA, have applied the sequential test for sites at fluvial and / or surface water risk and thus considered development options for each site.

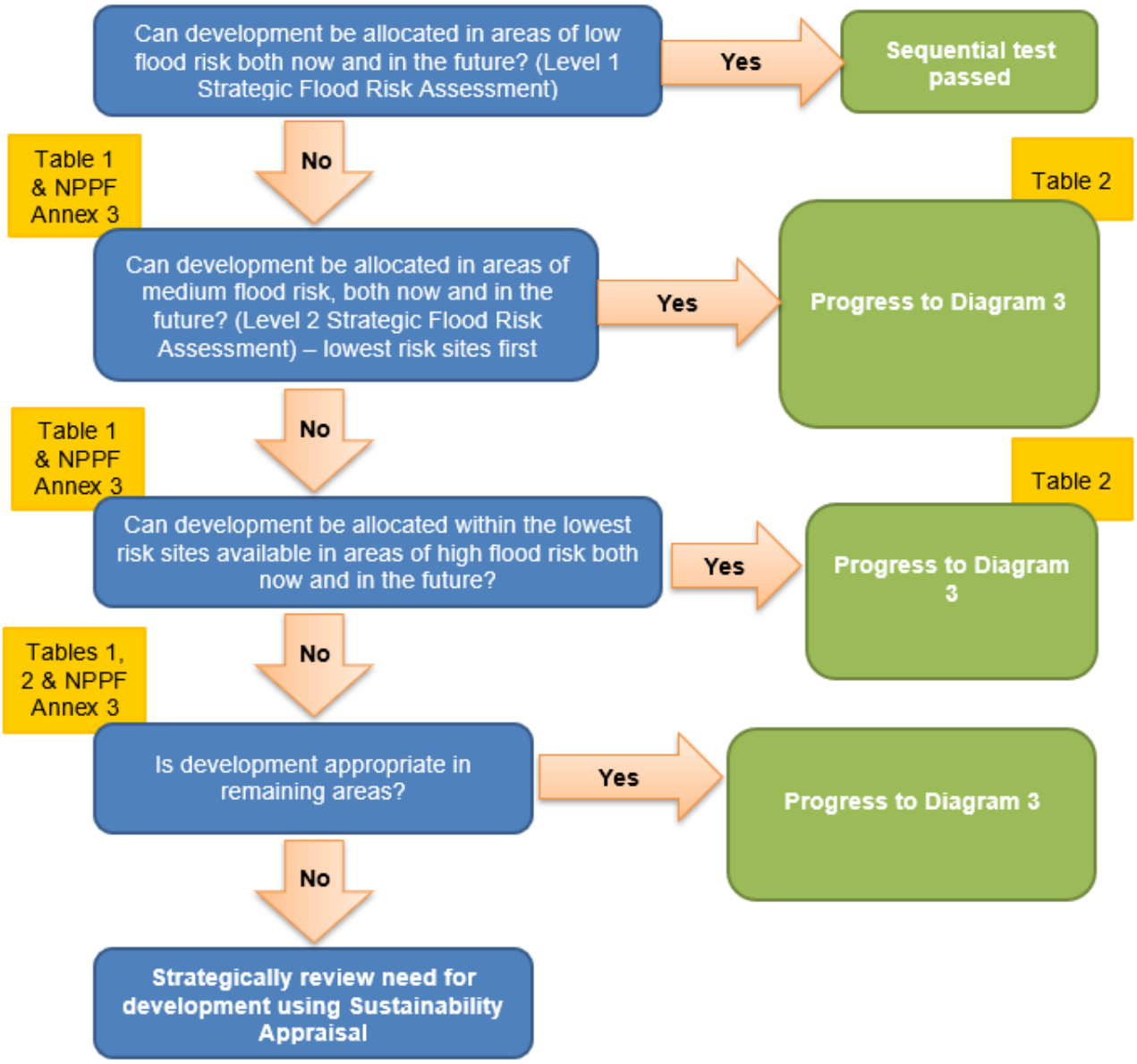


Figure 6-3: Diagram 2: Application of the sequential test for plan preparation[47]

Notes on Diagram 2:

- 'Tables 1 and 2' refer to the flood zone and flood risk tables of the FRCC-PPG Paragraphs 078-079
- 'Areas of low flood risk' include:
  - Areas within Flood Zone 1 (rivers and sea),
  - Areas within the low risk surface water flood event extent of the Risk of Flooding from Surface Water map,
  - Areas not at additional risk from climate change.
- 'Areas of medium flood risk' include:
  - Areas within Flood Zone 2 (rivers and sea),

47 Flood risk and coastal change: paragraph 25, GOV.UK, 2022

  - Areas within the medium risk surface water flood event extent of the Risk of Flooding from Surface Water map,
  - Areas at risk from Flood Zone 2 plus climate change,
- 'Areas of high flood risk' include:
  - Areas within Flood Zone 3a and Flood Zone 3b (rivers and sea),
  - Areas within the high risk surface water flood event extent of the Risk of Flooding from Surface Water map
  - Areas at risk from Flood Zone 3a plus climate change and future functional floodplain.

All sources of flooding additional to fluvial and surface water also need to be considered in the sequential test. However, the datasets available for other risk sources are not of a level of detail consistent with those for fluvial and surface water, including for risk from groundwater (Section 5.4), sewers (Section 5.5) and reservoirs (Section 5.6). These flood sources have therefore been considered separately in the sites assessment (Appendix C and D). At the strategic plan making level, these datasets should only be used to flag that there is risk from these sources that should be investigated in more detail at the site-specific FRA stage.

The approach shown in Figure 6-3 provides an open demonstration of the sequential test being applied in line with the NPPF and the FRCC-PPG. South Oxfordshire and Vale of White Horse should agree a locally specific approach to application of the sequential test, based on the available evidence and circumstances. The EA would not be required to approve the locally specific approach taken by South Oxfordshire and Vale of White Horse, though they can consult the EA regarding potential sites and any local information or consultations with the LLFA and any wider stakeholders should also be taken into account.

This Level 1 SFRA provides the main evidence required to carry out this process, including for windfall sites that do not form part of the Joint Local Plan allocation process. The process also enables those sites that have passed the sequential test and may require the exception test or additional more detailed investigation through a Level 2 SFRA, to be identified.

"The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3 of the NPPF" (NPPF para 169).

6.4 The exception test for local plan preparation

The NPPF, para 170, states:

"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."

Applicable sites must satisfy both elements of the test to enable allocation in the Joint Local Plan. A Level 2 SFRA would normally inform on whether the second part of the exception test can be passed, notwithstanding the requirement for a site-specific FRA at the planning application stage. However, as stated in para 172 of the NPPF, the test may need to be reapplied if relevant aspects of the planning proposal had not been considered when the test was first applied to allocate the site in the Joint Local Plan, or if more recent information about existing or potential flood risk is available and should be accounted for.

Figure 6-4 presents Diagram 3 of the FRCC-PPG (para 033), which illustrates the application of the exception test for allocating sites in the local plan. This process should be informed by a Level 2 SFRA.

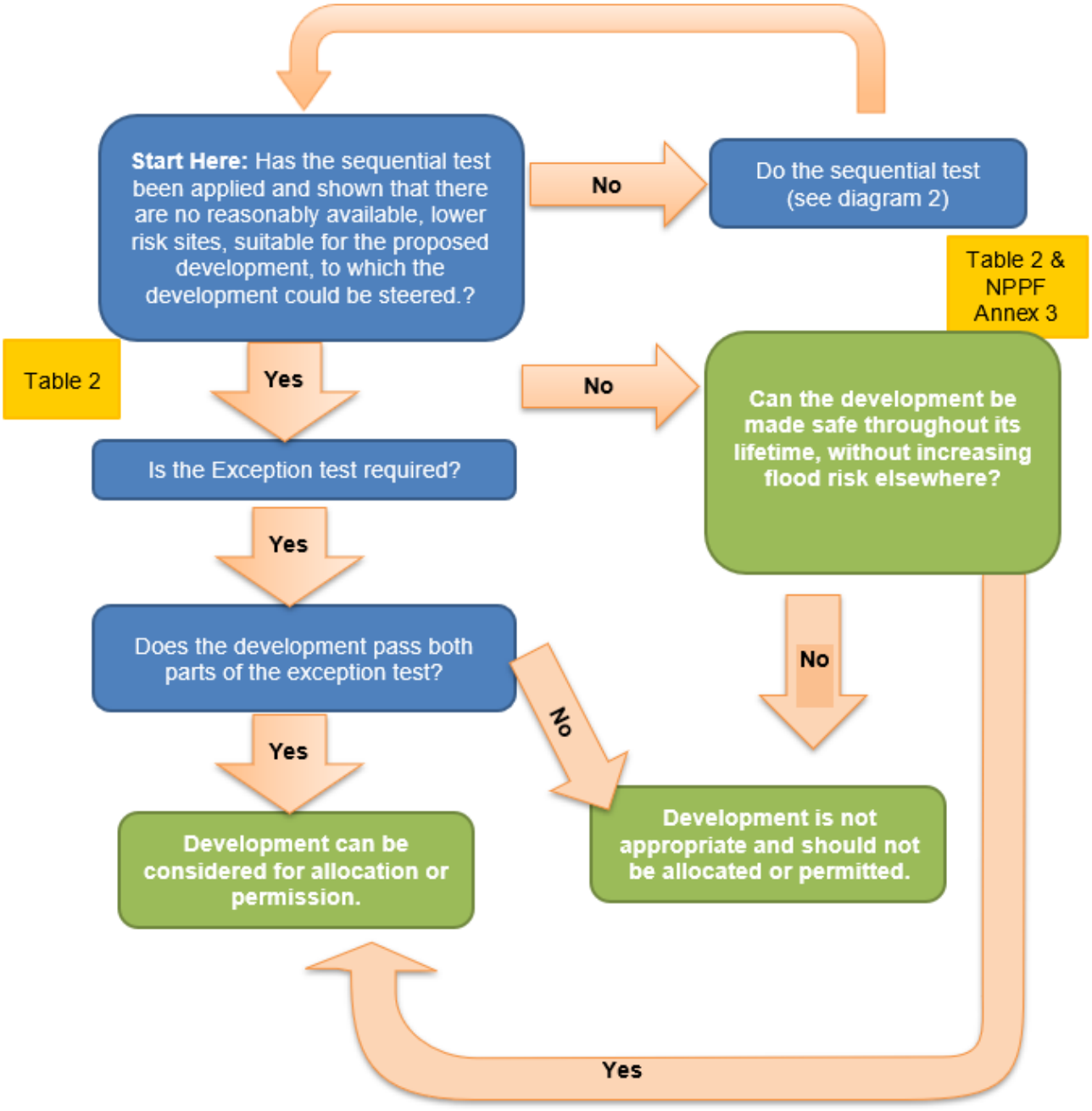


Figure 6-4: Diagram 3: Application of the exception test to plan preparation

Where it is found to be unlikely that the exception test can be passed due to few wider sustainability benefits (part a), the risk of flooding being too great (part b), or the viability of the site being compromised by the level of flood risk management work required, then South Oxfordshire and Vale of White Horse should consider avoiding the site altogether.

Once this process has been completed, South Oxfordshire and Vale of White Horse should then be able to allocate appropriate development sites through the local plan as well as prepare flood risk policy, including the requirement to prepare site-specific FRAs for all allocated sites that remain at risk of flooding or that are greater than one hectare in area.

6.5 Development management sequential and exception testing

6.5.1 Sequential testing for developers

South Oxfordshire District Council and Vale of White Horse District Council, with advice from the EA, are responsible for considering the extent to which sequential testing considerations have been satisfied for a site. The sequential test must be applied to the whole site area. For sites where only a small proportion of the site is identified as being at high or medium risk of flooding, it may be possible for the sequential test to be satisfied if all proposed development can be placed in areas of low flood risk. This can be sequentially preferable to site locations where high or medium flood risk areas cannot be avoided. Developers are also required to apply the sequential test to all available potential development sites, unless a site is:

- A strategic allocation and the test has already been carried out by South Oxfordshire and Vale of White Horse through the local plan process, or
- Subject to a change of use (except to a higher vulnerability classification), or
- A minor development (householder development, small non-residential extensions with a footprint of less than 250m^2), or
- Wholly located in Flood Zone 1 unless there are other flooding issues in the area of the development (i.e. surface water, groundwater, sewer flooding, residual risk).

This Level 1 SFRA contains information on all sources of flooding, to the extent that information was available. This should be the first consideration for a developer when undertaking the sequential test, including the consideration of reasonably available alternative sites at lower flood risk which the LPA should advise on. The impacts of climate change on all sources of flood risk, where feasible, should be robustly accounted for, i.e., through appropriate modelling.

Where newer, more detailed and robust information is available (such as more detailed surface water modelling not included in the SFRA), this data should be used to inform the sequential test for developers. Any new or updated data should have been reviewed and accepted by the LLFA (for surface water, groundwater, ordinary watercourse risk) or the EA (for risk from main rivers). The LPA should always be consulted before performing the sequential test.

Local circumstances must be used to define the area of application of the sequential test (within which it is appropriate to identify reasonably available alternative sites).

Para 028 of the FRCC-PPG defines reasonably available sites as:

"*those in a suitable location for the type of development with a reasonable prospect that the site is available to be developed at the point in time envisaged for the development. These could include a series of smaller sites and/or part of a larger site if these would be capable of accommodating the proposed development. Such lower-risk sites do not need to be owned by the applicant to be considered 'reasonably available'*".

The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear e.g., school catchments, in other cases it may be identified by other local plan policies. For some sites e.g., regional distribution sites, it may be suitable to widen the search area beyond the South Oxfordshire and Vale of White Horse administrative boundaries. The relevant LPA should be consulted by the developer to ascertain the appropriate search area.

The sources of information on reasonably available sites may include:

- Site allocations in the local plan
- Sites with planning permission but not yet built
- Housing and Economic Land Availability Assessments (HELAAs)/ five-year land supply/ authority monitoring reports
- Locally listed sites for sale

It may be that several smaller sites or part of a larger site at lower flood risk form a suitable alternative to a development site at high flood risk. Ownership or landowner agreement is not acceptable as a reason not to consider alternatives.

6.5.2 Exception testing for developers

If, following application of the sequential test it has been agreed with the LPA that it is not possible for the development to be in areas with a lower probability of flooding, the exception test must then be applied if required (as set out in Diagram 3 of the FRCC-PPG). Developers are required to apply the exception test to all applicable sites (including strategic allocations).

The applicant will need to provide information that the application can pass both parts of the exception test by:

- Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk (part a).
- Referring to wider sustainability objectives in the Sustainability Appraisal. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.
- Detailing the suitability issues the development will address and how doing it will outweigh the flood risk concerns for the site e.g., by facilitating wider regeneration

of an area, contributing to the local economy, providing community facilities, infrastructure that benefits the wider area, etc.

- Demonstrating that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall (part b).
- Demonstrating that the site will be safe, and the site users will not be exposed to hazardous flooding from any source. The FRA should consider existing and residual risk and how this will be managed over the lifetime of the development, including:
  - The design of any flood defence infrastructure improvements, including operation and maintenance and continuing funding,
  - Availability of dry access and escape routes during the extreme flood event, accounting for climate change impacts,
  - Design of the development to manage and reduce flood risk wherever possible i.e., through SuDS, including for designated ownership and maintenance procedures, through raising finished floor levels to appropriate levels, by preventing increases in flood risk through level for level compensation etc.
  - Resident awareness through appropriate emergency plans and signposting / signage,
  - Emergency planning and flood warning and evacuation procedures, including whether the development would increase the pressure on emergency services to rescue people during a flood event, and
  - Any funding arrangements required for implementing mitigation measures, maintenance procedures.

6.6 Site-specific flood risk assessment

The principal aims of a flood risk assessment (FRA) are to determine the level of flood risk to a site and to confirm that suitable flood management measures can be developed to control flooding, and safeguard life and property, without increasing risk to the surrounding area.

Once the site has been sequentially tested and, if required, has passed the exception test through a Level 2 SFRA, a site-specific FRA should be undertaken. The LPA, LLFA and EA should be consulted as a minimum to determine the content and scope of the FRA. For sites in Flood Zone 1 and not shown to be at risk from climate change, a FRA should accompany all proposals involving sites of one hectare or more.

The production of a site-specific FRA can be seen as an iterative process by subdividing the FRA into three stages:

- Stage 1 is a screening study used to identify whether there are any flood risk issues that need to be considered further i.e., reviewing the SFRA outcomes;
- Stage 2 is a scoping study that should be undertaken if the Stage 1 FRA indicates that there are flood risk issues that need further consideration; and

- Stage 3 is a detailed study where further quantitative analysis is required to fully assess flooding issues and confirm that effective mitigation measures can be implemented to control flood risk and that the second part of the exception test can be passed.

It is appropriate to review the level of risk present and assess whether development is appropriate and achievable at each stage of the assessment.

The SFRA is an assessment of flood risk at a strategic level. This information can be used to provide evidence for Stages 1 and 2 of the FRA. Where a more detailed FRA is required (Stage 3), then a developer should undertake a detailed assessment of the flood risk at the site, which would likely include appropriate flood modelling. A suitable drainage strategy would also normally be required for new developments to ensure surface water is controlled in a suitable way, often to a rate set by the LLFA.

Significant consultation with the LPA and key consultees and stakeholders that are relevant to the site will be required for complex development proposals. Complex developments may need to include flood mitigation measures and compensatory storage.

Together with appropriate consultation, accepted FRA guidance should be followed by developers including:

- Find out when you need to do an FRA as part of a planning application, how to complete one and how it's processed:
  - Flood risk assessments if you're applying for planning permission[48]
  - Flood risk assessment in flood zones 2 and 3[49]
  - Flood risk assessment in flood zone 1 and critical drainage areas[50]
- EA standing advice:
  - Preparing a flood risk assessment: standing advice[51]

In summary, the FRA should address the following:

1. Development description and location
   - What is the type of development and where will it be located?
   - What is the vulnerability classification (Table 2 of FRCC-PPG (Figure 6-2)) of the current and future building use?
   - Has the development site been assessed in the SFRA? If so, has the sequential test been carried out? Has the exception test (if applicable) been applied and passed previously?
2. Definition of flood hazard
   - What are the sources of flooding at the site?

48 Flood risk assessments if you're applying for planning permission, GOV.UK, 2017
49 Flood risk assessment in flood zones 2 and 3, GOV.UK, 2017
50 Flood risk assessment in flood zone 1 and critical drainage areas, GOV.UK, 2017
51 Preparing a flood risk assessment: standing advice, GOV.UK, February 2022

- For each source how would flooding occur? Referencing any historical records
- What existing surface water drainage infrastructure is present on the site? Consultation required with LPA, LLFA, EA and water companies)

3. Probability
   - Confirm the flood zone designation for the site (refer to the Flood Map for Planning: Flood Map for planning)
   - Determine the actual and residual risks at the site
   - What are the discharge rates and volumes generated by the existing site and proposed development? How should these be attenuated and to what rates?
4. Climate change
   - How is flood risk at the site likely to be affected by climate change?
   - Check appropriate allowances (see Section 5.9.1). [52]
5. Flood Risk Management measures
   - How will the site be protected from flooding, including from the potential impacts of climate change, over the lifetime of the development?
6. Residual risks
   - What are the consequences to the site of flood defence failure? Breach / overtopping scenarios should be modelled.
   - What are the consequences to the site of asset blockage? Culvert, bridge blockage scenarios should be modelled.
   - Is there residual risk from reservoirs? If so, how can this be mitigated and does the emergency plan for the site address such risk? Reference the EA's Reservoir Flood Map[25].
   - Is there residual risk of flooding from canals? If so, how can this be mitigated and does the emergency plan for the site address such risk? Consultation required with the EA, county council and Canal & River Trust, or private owner. Breach / overtopping scenarios should be modelled if applicable.
   - What flood-related risks will remain after mitigation measures have been implemented?
   - How, and by whom, will these risks be managed over the lifetime of the development?
7. Access and escape routes
   - Can safe access and escape routes be achieved during the extreme flood event whilst accounting for climate change?
   - Safe access and escape routes should be explicitly identified as part of an agreed emergency plan tailored specifically to the site.

8. Offsite impacts

52 Flood risk assessments: climate change allowances, GOV.UK, May 2022

- How will the proposed development design make sure there are no impacts to other development offsite now and in the future?
- What measures will be implemented to control surface water runoff? SuDS? What arrangements are in place for SuDS ownership, maintenance?

9. Groundwater
   - This mechanism of flooding should be considered particularly when determining the acceptability of SuDS schemes as a way of managing surface water drainage. Developers should consult with the LPA, LLFA and EA at an early stage of the assessment to establish any requirements for ground investigation.
10. Sewer systems
    - Where the SFRA has identified a risk of surface water flooding, any water that escapes from the sewer system would tend to follow similar flow paths and pond in similar locations.
    - Where required, liaison with the relevant water company should be undertaken at an early stage in the assessment process to confirm localised sewer flooding problems that could affect the site.
    - Future development should be designed so that it does not exacerbate existing sewer capacity problems. Developers should check with the LPA whether a Water Cycle Study has been developed.

6.7 Surface water management and Sustainable Drainage Systems

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and consequently a potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts, and other drainage infrastructure. Managing surface water discharges from new development is therefore crucial in managing and reducing flood risk to new and existing development downstream and nearby. Carefully planned development can also play a role in reducing the number of properties that are directly at risk from surface water flooding.

The planning system has a key role to play in setting standards for sustainable drainage from new developments and ensuring that developments are designed to take account of the risk from surface water flooding. Sustainable drainage plays an important part in reducing flows in the sewer network and in meeting environmental targets, alongside investment in maintenance by the water companies on their assets. Water companies plan their investment on a five-year rolling cycle, in consultation with key partners, including the EA and local authorities.

The Department for Levelling Up, Housing and Communities (DLUHC) (formally the Department for Communities and Local Government (DCLG)) announced, in December 2014, that the local planning authority, in consultation with the LLFA, should be responsible for delivering SuDS[53] through the planning system. Changes to planning legislation gave

53 Sustainable drainage systems, UK Parliament, 2014

provisions for major applications of ten or more residential units or equivalent commercial development to require sustainable drainage within the development proposals in accordance with the 'non-statutory technical standards for sustainable drainage systems'[54], published in March 2015. A Practice Guidance[55] document has also been developed by the Local Authority SuDS Officer Organisation (LASOO) to assist in the application of the non-statutory technical standards.

Developers should be aware of Schedule 3 of the Flood and Management Act (see Appendix A). The Act, which incorporates recommendations from the 2008 review includes the implementation of required SuDS standards and the removal of the automatic rights for developers to connect to public sewers. Schedule 3, when enacted, will provide a framework for the approval and adoption of drainage systems, a SuDS Approval Body (SAB), and national statutory standards on the design, construction, operation, and maintenance of SuDS.

The Design and Construction Guidance (DCG[56]) for sewers became the regulated sewerage guidance on 1 April 2020. This allows water and sewerage companies to adopt SuDS components that meet the criteria of the DCG. Details on the sewerage sector guidance can be found online.[57]

South Oxfordshire District Council and Vale of White Horse District Council may wish to encourage the use of SuDS through their Joint Local Plan policies.

6.7.1 OCC local standards for sustainable drainage

To manage flood risk, all development, regardless of development type, flood zone and development size, must give priority use to SuDS. Particularly for major developments, there is a requirement to assess and include SuDS for managing surface water at the development unless it is demonstrated during the assessment that it is inappropriate for the site, i.e. due to high groundwater levels not allowing for infiltration SuDS.

At the time of writing, OCC does not adopt any specific SuDS schemes, though this may change with the forthcoming enaction of Schedule 3. OCC have published local guidance[58] to support LPAs in reviewing drainage strategies and aid developers in the design of surface water drainage systems. The guidance describes the standards applied by OCC as LLFA for new development proposals and reflects the National Non-Statutory Technical Standards for SuDS[59].

54 Sustainable drainage systems: non-statutory technical standards, Defra, 2015
55 Non-Statutory Technical Standards for sustainable drainage, LASOO, 2016
56 Sewerage Sector Guidance - approved documents | Water UK
57 Sewerage Sector Guidance, Water UK
58 Local Standards for publication v1.2 December 2021 (oxfordshirefloodtoolkit.com)
59 Sustainable drainage systems: non-statutory technical standards - GOV.UK (www.gov.uk)

Under Schedule 3 of the FWMA, once it is enacted, OCC will likely take on the role of the SAB. This will make OCC responsible for the approval of SuDS. OCC as the SAB will also decide who is responsible for the adoption and maintenance of SuDS features following construction.

6.7.2 SuDS and the NPPF

The NPPF, para 175, states:

"*Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:*

a. Take account of advice from the lead local flood authority;

b. Have appropriate proposed minimum operational standards;

c. Have maintenance arrangements, in place to ensure an acceptable standard of operation for the lifetime of the development; and

d. Where possible, provide multifunctional benefits".

All developments, both major and minor, should include SuDS that is proportionate to the type and scale of the development, providing multiple benefits that contribute to many other NPPF policies, including climate change, biodiversity net gain, amenity, and water quality improvements. Where site conditions may be more challenging, the SuDS components used will need to accommodate the site's opportunities and constraints. For large scale developments, developers should be identifying opportunities for a variety of SuDS components according to geology, soil type, topography, groundwater/mine water conditions, their potential impact on site development, and setting out local SuDS guidance and opportunities for in perpetuity adoption and maintenance.

At the planning application stage, maintenance options must clearly identify who will be responsible for maintaining SuDS and funding for maintenance should be fair for householders and premises occupiers and set out a minimum standard to which the SuDS must be maintained. This is set out in the local standards for major development on the Oxfordshire County Council online Flood Toolkit. At the outline planning application stage, a summary of how maintenance of the SuDS features will be secured should be documented. Detailed maintenance regimes and maintenance undertakers are secured via condition. The preference is for all drainage schemes to be adopted where possible and not passed on to management companies.

Sustainable drainage should form part of an integrated design methodology secured by detailed planning conditions to make sure that the SuDS to be constructed is maintained to a minimum level of effectiveness.

6.7.3 SuDS hierarchy

The runoff destination should always be the first consideration when considering design criteria for SuDS including the following possible destinations in order of preference:

1. To ground;
2. To surface waterbody;
3. To surface water sewer; or
4. To combined sewer.

Effects on water quality should be investigated when considering runoff destination in terms of the potential hazards arising from development and the sensitivity of the runoff destination.

The EA may also look at the potential impact of an outfall structure through the planning consultation and Environmental Permitting Regulation[60] process. It should be noted that detailed modelling will not be available for all outfalls therefore developers should carry out their own investigations whilst referring to the non-statutory technical standards for sustainable drainage systems (March 2015)[61].

The non-statutory technical standards for sustainable drainage systems sets out appropriate design criteria based on the following:

1. Flood risk outside the development;
2. Peak flow control;
3. Volume control;
4. Flood risk within the development;
5. Structural integrity;
6. Designing for maintenance considerations; and
7. Construction.

Many different SuDS techniques can be implemented. As a result, there is no one standard correct drainage solution for a site. In most cases, using the Management Train principle (see Figure 6-5), will be required, where source control is the primary aim. Source control includes interception of the first 5mm of rainfall and water quality treatment should be as near to source as possible.

In February 2021, Defra published its research project to review and provide recommendations to update the current non-statutory technical standards for sustainable drainage systems[62]. Based on the research findings, recommendations have been made to replace the current standards with a new suite of standards to cover the following:

1. Runoff destinations
2. Everyday rainfall
3. Extreme rainfall
4. Water quality
5. Amenity
6. Biodiversity

60 Environmental permits: detailed information | Environment Agency
61 Sustainable drainage systems: non-statutory technical standards, GOV.UK, 2015
62 Defra (2021) Recommendations to Update Non-Statutory Technical Standards for Sustainable Drainage Systems (SuDS) - WT15122

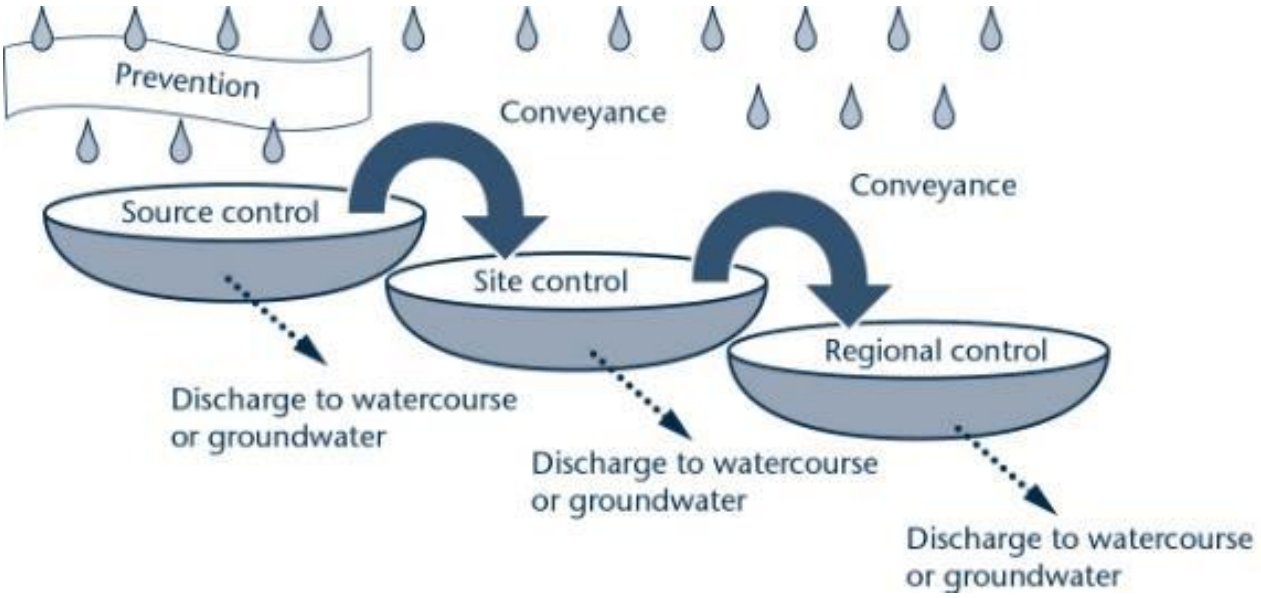


Figure 6-5 SuDS management train principle[63]

The effectiveness of a flow management scheme within a single site is heavily limited by land use and site characteristics including (but not limited to) topography, geology, and soil (permeability) and available area. Potential ground contamination associated with urban and former industrial sites should be investigated with concern being placed on the depth of the local water table and potential contamination risks that will affect water quality. The design, construction and ongoing maintenance regime of any SuDS scheme must be carefully defined as part of a site-specific FRA. A clear and comprehensive understanding of the catchment hydrological processes (i.e., nature and capacity of the existing drainage system) is essential for successful SuDS implementation.

In addition to the national standards, the LLFA and / or LPA may set local requirements for planning permission that include more rigorous obligations than the non-statutory technical standards. Currently, the local standards for sustainable drainage in Oxfordshire (as described in Section 6.7.1) reflect the non-statutory technical guidance). More stringent requirements should be considered where current greenfield sites lie upstream of high-risk areas. This could include improvements on greenfield runoff rates. The LLFA and LPA should always be contacted with regards to any local requirements at the earliest opportunity in development planning.

The CIRIA SuDS Manual[64] 2015 should also be consulted by developers. The SuDS manual (C753) is highly regarded and incorporates the latest research, industry practice, technical advice, and adaptable processes to assist in the planning, design, construction, management, and maintenance of good SuDS. The SuDS Manual complements the non-

63 CIRIA (2008) Sustainable Drainage Systems: promoting good practice – a CIRIA initiative
64 CIRIA (2008), CIRIA SuDS Manual

statutory technical standards and goes further to support the cost-effective delivery of multiple benefits.

6.7.4 Overland flow paths

Underground drainage systems have a finite capacity and regard should always be given to larger events when the capacity of the network will be exceeded. Hence there is a need to design new developments with exceedance in mind. This should be considered alongside any surface water flows likely to enter a development site from the surrounding area.

Masterplanning should make sure that existing overland flow paths are retained within the development and not obstructed. As a minimum, the developer should investigate, as part of a site-specific FRA, the likely extents, depths, and associated hazards of surface water flooding on a development site. This is considered to be an appropriate approach to reduce the risk of flooding to new developments. Green/blue infrastructure should be used wherever possible to accommodate such flow paths.

6.8 Mitigation measures

Whilst the sequential approach to development and flood risk should always be followed, there are certain instances where development must occur in areas of flood risk. This section details the generic mitigation measures that are available for new development and for existing developments at flood risk.

6.8.1 Site layout and design

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

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land uses away from areas of flood risk for example to higher ground, while development that is in a lower vulnerability category (such as vehicular parking, recreational space) may be suitable in higher risk areas that may be on lower ground. Please note car parking is 'less vulnerable' development and so is not appropriate in Flood Zone 3b.

Waterside areas, or areas along known flow routes, could be designed and maintained as blue / green infrastructure, used for recreation, amenity, and environmental purposes, allowing the preservation of flow routes and flood storage, whilst at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas and avoid the creation of isolated islands as water levels rise during a flood event.

6.8.2 Sustainable Drainage Systems

SuDS provide a means of dealing with the quantity and quality of surface water and can also provide amenity and biodiversity benefits. SuDS also provide wider environmental benefits such as helping address the causes and effects of climate change through carbon

sequestration and by moderating the temperature of buildings through SuDS features such as green roofs. Given the flexible nature of SuDS they can be used in most situations within new developments as well as being retrofitted into existing developments. SuDS can also be designed to fit into most spaces. For example, permeable paving could be used in parking spaces or rainwater gardens as part of traffic calming measures.

The developer is responsible for ensuring the design, construction and future/ongoing maintenance of any SuDS scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and current drainage arrangements is essential.

Refer to Section 6.7 for full details on SuDS.

6.8.3 Modification of ground levels

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

Modifying ground levels to raise land above the design flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for floodwaters. However, care must be taken as raising land in the floodplain could reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land. Raising ground levels can also deflect flood flows, so analysis through flood modelling should be performed to demonstrate that there are no adverse effects on third party land or property.

Compensatory flood storage should be provided and should be on a level-for-level, volume-for-volume basis on land that does not currently flood but is adjacent to the floodplain (for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary (unless the site is strategically allocated in a local plan). Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624[65].

Where proposed development results in a change in building footprint, the developer should make sure that it does not impact upon the ability of the floodplain to store or convey water and seek opportunities to provide floodplain betterment.

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

65 CIRIA January 2004, CIRIA Report 624: Development and Flood Risk - Guidance for the Construction Industry

6.8.4 Raised floor levels

If raised floor levels are proposed, these should be agreed with the LPA and the EA. The minimum Finished Floor Level (FFL) may change dependent upon the vulnerability and flood risk to the development.

The EA advises[66] that minimum FFLs should be set to a minimum of whichever is higher of 600mm above the average ground level of the site, the adjacent road level to the building, or the 100-year plus climate change peak flood level, where the latest climate change allowances have been used (see Section 5.9.1 for the climate change allowances). An additional allowance may be required due to residual risks relating to blockages to the channel, culvert or bridge structures and should be considered as part of an FRA.

It is also advised that: "*flood resistant materials should also be used up to 600mm above the estimated flood level. Where there is a high level of certainty about the estimated flood level, it may be appropriate to reduce this to 300mm. If there is a particularly high level of uncertainty it may need to be increased. If you cannot raise the floor levels in this way, you will also need to include extra flood resistance and resilience measures. These measures should protect the property to at least 600mm above the estimated flood level".*

Designating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels. Single storey buildings such as ground floor flats or bungalows are especially vulnerable to the rapid rise of floodwater (such as that experienced during a defence breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route from the development to safe and dry locations.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 and areas at high or medium risk of surface water flooding should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the exception test. Access should be situated above the design flood level and waterproof construction techniques used.

6.8.5 Property flood resilience

Para 173 of the NPPF explains that development must only be allowed in areas at flood risk where, following the sequential and exception tests and supported by an FRA, the development is appropriately flood resistant and resilient.

Flood resilience and resistance measures are mainly designed to mitigate flood risk and reduce damage and adverse consequences to existing property. Such measures may aim to help residents and businesses recover more quickly following a flood event. Developers are responsible for the provision of PFR where appropriate.

The 'Code of practice for property flood resilience', published by CIRIA in 2021[67], defines active PFR measures as *"…measures which are not permanently installed into the property*

66 Preparing a flood risk assessment: standing advice - GOV.UK (www.gov.uk)
67 CIRIA (2021) Code of practice for property flood resilience (C790F)

and will require deployment before a flood event (e.g. a door guard)'. Passive PFR measures are defined as '…*measures which are installed into the property and do not require further deployment or activation before a flood event (e.g. a flood door or automatic airbrick cover)*".

Research[68] carried out by the then DCLG (now DLUHC) and the EA recommended that the use of PFR measures should generally be limited to a nominal protection height of 600 mm above ground level, the lowest point of ground abutting the external property walls. This is because the structural integrity of the property may be compromised if flooded above this level. The EA recommends that advice from a structural engineer should be sought for any measures to resist a depth of 600 mm or more.

It should be noted that it is not possible to completely prevent flooding to all communities and businesses. Also, PFR measures would not be expected to cause an increase in flood risk to other properties or other parts of the local community. They will help mitigate against flood risk but, as with any flood alleviation scheme, flood risk cannot be removed completely. Emergency plans should, therefore, be in place that describe the installation of measures and residual risks.

As the flood risk posed to a property cannot be removed completely, it is recommended that PFR products are deployed by the developer in conjunction with pumps of a sufficient capacity. Pumps help manage residual flood risks not addressed by PFR measures alone such as rising groundwater.

6.8.5.1 Definitions

Flood resilience measures aim to reduce the damage caused by floodwater entering a property. Flood resilience measures are based on an understanding that internal flooding may occur again and when considering this eventuality, homes and businesses are encouraged to plan for flooding with an aim of rapid recovery and the return of the property to a habitable state.

For example, tiled floors are easier to clean than carpets, raised electricity sockets and high-level wall fixings for TVs/computers may mean that that power supply remains unaffected. Raising kitchen or storage units may also prevent damage that may not require replacement after a flood. There is a lot of information available about what items get damaged by floodwater and features that are considered to provide effective resilience measures that can be installed at a property.

Flood resistance measures aim to reduce the amount of floodwater entering the property. Obvious inflow routes, such as through doors and airbricks may be managed, for example, by installing bespoke flood doors, door flood barriers and automatic closing airbricks. However, the property's condition and construction are also key to understanding how floodwater may enter and move between buildings. For example, floodwater can also flow

68 DCLG & EA (2007) Improving the Flood Performance of New Buildings - Flood Resilient Construction

between properties through connecting cavity walls, cellars, beneath suspended floors and through internal walls. Flood resistance measure alone may not keep floodwater out. Building condition is a critical component of any flood mitigation study.

6.8.5.2 Property mitigation surveys

To define the scale and type of resistance or resilience measures required, a survey will need to be undertaken to pick up property threshold levels, air brick levels, doorways, historic flood levels and several ground spot levels required to better understand the flood mechanisms for floodwater arriving at the property (e.g., along roads and pavements). The depth of flooding recorded at a property will help guide the selection of the most appropriate PFR measures. Surveys will need to include:

- Detailed property information i.e., structure, presence of air bricks, cellars, outlet pipes, floor levels, door and window levels, manhole and grid locations;
- An assessment of flood risk, including property (cross) threshold levels;
- Routes of water ingress (fluvial, ground and surface water flooding);
- An assessment of the impact of floodwaters;
- A schedule of recommended measures to help to reduce risk;
- Details of recommendations (including indicative costs);
- Advice on future maintenance of measures; and
- Advice on flood preparedness and emergency planning.

All sources of flooding will need to be considered, including a comprehensive survey of openings (doors, windows, and air bricks), as well as potential seepage routes through walls and floors, ingress through service cables, pipes, drains and identification of possible weaknesses in any deteriorating brickwork or mortar.

6.9 Emergency planning

The provisions for emergency planning for local authorities as Category 1 responders are set out by the Civil Contingencies Act, 2004[69] and the National Flood Emergency Framework for England, December 2014[70]. This framework is a resource for all involved in emergency planning and response to flooding from rivers, surface water, groundwater, and reservoirs. The framework sets out Government's strategic approach to:

- Ensuring all delivery bodies understand their respective roles and responsibilities when planning for and responding to flood related emergencies;
- Giving all those involved in an emergency flooding situation a common point of reference, which includes key information, guidance and key policies;
- Establishing clear thresholds for emergency response arrangements;
- Placing proper emphasis on the multi-agency approach to managing flooding events;

69 Civil Contingencies Act, GOV.UK, 2004
70 The national flood emergency framework for England, GOV.UK, 2014

- Providing clarity on the means of improving resilience and minimising the impact of flood events;
- Providing a basis for individual responders to develop and review their own plans; and
- Being a long-term asset that will provide the basis for continuous improvement in flood emergency management.

Along with the EA flood warning systems, there are a range of flood plans at a local level, outlining the major risks from flooding and the strategic and tactical response framework for key responders. The EA and the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) have produced guidance on flood risk emergency plans for new development (September 2019)[71]. It would however be for the LPA to review and approve flood risk emergency plans with emergency planners or through the Local Resilience Forum (see Section 6.9.1.1).

This SFRA contains useful data and information to allow emergency planning processes to be tailored to the needs of the area and be specific to the flood risks faced. The information presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10] and the accompanying GIS files should be made available to emergency planners to help prepare for any flood event and throughout the planning process.

6.9.1 Civil Contingencies Act

Under the Civil Contingencies Act (CCA, 2004)[72], OCC and South Oxfordshire and Vale of White Horse District Councils are classified as Category 1 responders and thus have duties to assess the risk of emergencies occurring, and use this to:

- Inform contingency planning;
- Put in place emergency plans;
- Put in place business continuity management arrangements;
- Put in place arrangements to make information available to the public about civil protection matters;
- Maintain arrangements to warn, inform and advise the public in the event of an emergency;
- Share information with other local responders to enhance coordination; and
- Cooperate with other local responders to enhance coordination and efficiency and to provide advice and assistance to businesses and voluntary organisations about business continuity management.

During an emergency, such as a flood event, the local authorities must co-operate with other Category 1 responders (such as the emergency services and the EA) to provide the core response.

71 Flood Risk Emergency Plans for New Development, ADEPT/EA, September 2019
72 The Civil Contingencies Act, GOV.UK, 2013

6.9.1.1 Thames Valley Local Resilience Forum (TVLRF)[73]

The aim of the TVLRF is to legally deliver the duties stated in the Civil Contingencies Act 2004 within a multi-agency environment. The TVLRF is a group of multi-agency organisations that work together to prepare and respond to emergencies in the Thames Valley. The TVLRF consists of local authorities, emergency services, health agencies, EA and local businesses.

The TVLRF's main aims are to:

- Co-operate with other local responders
- Share information with other local responders
- Assess the risk of emergencies in the area
- Put in place business continuity management arrangements.
- Put in place arrangements to warn, inform and advise the public in the event of an emergency
- Provide advice and assistance to businesses and voluntary organisations about business continuity

6.9.1.2 Community Risk Register

The TVLRF produces the Community Risk Register (CRR)[74] which lists the possible risks, the probability of an emergency event occurring and the potential impact. The CRR provides information on the biggest emergencies that may happen the Thames Valley, together with an assessment of how likely they are to happen and the potential impacts to people, houses, the environment and local businesses. Each identified risk is then analysed and given a rating according to how likely the risk is to lead to an emergency and their potential impact on safety and security, health, economy, environment and society.

6.9.1.3 Community Emergency Plan

Communities may need to rely on their own resources to minimise the impact of an emergency, including a flood, before the emergency services arrive. Many communities already help each other in times of need, but experience shows that those who are prepared cope better during an emergency. Communities with local knowledge, enthusiasm and information are a great asset and a Community Emergency Plan can help. Details on how to produce a community emergency plan, including a toolkit and template, are available from the Government's website[75].

73 Thames Valley Local Resilience Forum
74 Thames Valley Community Risk Register
75 Resilience in society: infrastructure, communities and business, GOV.UK, December 2014

6.9.1.4 Local Flood Plans

This SFRA provides several flood risk data sources that should be used when producing or updating flood plans. South Oxfordshire and Vale of White Horse will be unable to write their own specific flood plans for new developments at flood risk. Developers should write their own. Generally, owners with individual properties at risk should write their own individual flood plans, however larger developments or regeneration areas, such as retail parks, hotels and leisure complexes, should consider writing one collective plan for the assets within an area.

This SFRA can help to:

- Update these flood plans if appropriate;
- Inform emergency planners in understanding the possibility, likelihood and spatial distribution of all sources of flooding;
- Identify safe evacuation routes and access routes for emergency services;
- Identify key strategic locations to be protected in flooding emergencies, and the locations of refuge areas that are capable of remaining operational during flood events;
- Provide information on risks in relation to key infrastructure, and any risk management activities, plans or business continuity arrangements;
- Raise awareness and engage local communities;
- Support emergency responders in planning for and delivering a proportionate, scalable and flexible response to the level of risk; and
- Provide flood risk evidence for further studies.
- The guidance written by the EA and ADEPT[76] is aimed at LPAs to help assist in setting up their own guidelines on what should be included in flood risk emergency plans.

As the LLFA, OCC have produced a Local Flood Risk Management Strategy which explains how local flood risk is managed in Oxfordshire. The current strategy was published in 2021 and is discussed further in Appendix A. The strategy is also available online[77]. At the time of writing, a new Local Flood Risk Management Strategy for Oxfordshire is out for consultation.

6.10 Flood warning and evacuation plans

Developments that include areas that are designed to flood (e.g., amenity greenspace areas) or have a residual risk associated with them (e.g., located behind a flood defence), will need to contain appropriate flood warning and instructions so users and residents are safe in the event of a flood. This may include both physical warning signs and written flood

76 Flood Risk Emergency Plans for New Development, ADEPT/Environment Agency, September 2019
77 Local Flood Risk Management Strategy. Oxfordshire County Council. 2021

warning and evacuation plans. Those using any new development should be made aware of any evacuation plans.

In relation to a new development, it is up to the LPA to determine whether the flood warning and evacuation plans, or equivalent procedures, are sufficient or not. If the LPA is not satisfied, considering all relevant considerations, that a development can be considered safe without the provision of safe access and escape routes, then planning permission should be refused.

Whilst there is no statutory requirement on the EA or the emergency services to approve evacuation plans, LPAs are accountable under their Civil Contingencies duties, via planning condition or agreement, to make sure that plans are suitable. This should be done in consultation with development management officers and emergency planners. Given the cross-cutting nature of flooding, it is recommended that further discussions are held internally by the LPA between emergency planners and policy planners/development management officers, drainage engineers and external stakeholders such as the emergency services, the EA, TW, Canal & River Trust and Internal Drainage Boards (if applicable).

The LPA may consider whether, as a condition of planning approval, flood evacuation plans should be provided by the developer that aim to safely evacuate people out of flood risk areas, using as few emergency service resources as possible. It may also be useful to consider how key parts of agreed flood evacuation plans could be incorporated within local development documents, including in terms of protecting evacuation routes and assembly areas from inappropriate development.

Once the development receives planning permission, it will be the requirement of the plan owner (developer) to make sure the plan is put in place, and to liaise with the LPA regarding maintenance and updating of the plan.

People that live within flood risk areas can also develop their own personal flood plans. Personal flood plans should include a list of things that should be done to prepare for a flood. The EA offer advice on preparing a personal flood plan[78].

6.10.1 What should a flood warning and evacuation plan include?

Flood warning and evacuation plans should include the information stated in Table 6-1. Advice and guidance on plans are accessible from the EA website and plan templates are available for businesses and local communities.

Table 6-1: Flood warning and evacuation plans

Consideration	Purpose
Availability of existing flood warning system	The EA offers a flood warning service that covers designated Flood Warning Areas in England. In these areas, they can provide a full flood warning service.

78 Personal flood plan. Environment Agency. 2023

Consideration	Purpose
Rate of onset of flooding	The rate of onset is how quickly the water arrives and the speed at which it rises, which, in turn, will govern the opportunity for people to effectively prepare for and respond to a flood. This is an important factor within Emergency Planning in assessing the response time available to the emergency services.
How flood warning is given and the occupant's awareness of the likely frequency and duration of flood events	Everyone eligible to receive flood warning should be signed up to the EA flood warning service. Where applicable, the display of flood warning signs should be considered. Particularly sites that will be visited by members of the public daily, such as sports complexes, car parks, retail stores. It is envisaged that the responsibility should fall upon the developers and should be a condition of the planning permission. Information should be provided to new occupants of houses concerning the level of risk and subsequent procedures if a flood occurs.
The availability of site staff, occupants, or users to respond to a flood warning and the time taken to respond to a flood warning	The plan should identify roles and responsibilities of all responders. The use of community flood wardens should also be considered.
Designing and locating safe access routes, preparing evacuation routes and the identification of safe locations for evacuees	Dry routes will be critical for people to evacuate as well as emergency services entering the site. The source, extent, depth, and flood hazard rating, including allowance for climate change, should be considered when identifying these routes.
Vulnerability of occupants	Vulnerability classifications associated with development as outlined in the FRCC-PPG. This is closely linked to its occupiers i.e., elderly, less able, children are more vulnerable.
How easily damaged items will be relocated, and the expected time taken to re-establish normal use following an event	The impact of flooding can be long lasting well after the event has taken place affecting both the property which has been flooded and the lives that have been disrupted. The resilience of the community to get back to normal will be important including time taken to repair/replace damages.

Consideration	Purpose
Mental health	Exposure to a flood event i.e., having your home flooded can have severe effects on the mental health of those affected. There should be guidance on how to get help with mental issues.

6.10.2 EA Flood Warning Areas (FWA) and flood awareness

The EA monitors river levels within the main rivers affecting South Oxfordshire and Vale of White Horse and based upon weather predictions provided by The Met Office, assesses the anticipated maximum water level that is likely to be reached within the proceeding hours (and/or days). Where these predicted water levels are expected to result in inundation of a populated area, the EA will issue a series of flood warnings within defined FWAs, encouraging residents to take action to avoid damage to property in the first instance.

At the time of writing, there are 38 EA Flood Warning Areas within South Oxfordshire and Vale of White Horse, which are located primarily along main rivers including the River Thame, River Thames, River Ock, River Cole, Mill Brook, Letcombe Brook and Ginge Brook. These Flood Warning Areas are presented on the South Oxfordshire and Vale of White Horse web-based mapping portal[10].

More information on flood warnings is provided by the EA[79].

Live information on flood warning and flood alerts is available[80].

Emergency planners may also use the outputs from this SFRA to raise awareness within local communities. This should include raising awareness of flood risk, roles, responsibilities and measures that people can take to make their homes more resilient to flooding from all sources whilst also encouraging all those at fluvial flood risk to sign up to the EA's Flood Warning Service.[81]

It is also recommended that Category 1 responders are provided with appropriate flood response training to help prepare them for the possibility of a major flood with an increased number of people living within flood risk areas, to make sure that adequate pre-planning response and recovery arrangements are in place.

79 Flood alerts and warnings: what they are and what they do, Environment Agency, November 2010

80 Flood warning and alert service, Met Office and Environment Agency

81 Flood warning service sign up, GOV.UK

7 Conclusions and recommendations

7.1 Conclusions

This Level 1 SFRA provides a single repository planning tool relating to flood risk and development in South Oxfordshire and Vale of White Horse. Key flood risk stakeholders namely the EA, LLFA and TW were consulted to collate all available and relevant flood risk information on all sources into one comprehensive high-level assessment. Together with this report, this Level 1 SFRA also provides a suite of SFRA GIS datasets illustrating the level of risk to the districts. These SFRA datasets can be viewed on the South Oxfordshire and Vale of White Horse web-based mapping portal[10]. Appendices C and D present a flood risk screening assessment of all potential local plan site allocations to enable South Oxfordshire and Vale of White Horse to perform the sequential test.

Whilst the aim of the sequential approach is the avoidance of development in areas of high and / or medium flood risk areas, where South Oxfordshire and Vale of White Horse are looking for continued growth and/or regeneration, this may not always be possible. This SFRA therefore provides the necessary links between spatial development, wider flood risk management policies, local strategies, and plans and on the ground works by combining all available flood risk information together into one single repository. However, as this is a strategic study, detailed local information on flood risk is not fully accounted for.

The data and information used throughout the SFRA process is the most up-to-date data available at the time of writing. Once new, updated, or further information becomes available, South Oxfordshire and Vale of White Horse should look to update this SFRA. The Level 1 SFRA should be maintained as a 'live' entity that is updated as and when required (when new modelling or flood risk information becomes available or when there are changes in national policy). South Oxfordshire and Vale of White Horse can decide to update the SFRA and the EA and LLFA as statutory consultees on local plans can also advise on when an update is required to inform the local plan evidence base.

Gaps in the data received to inform this SFRA are noted within Section 7.2. Recommendations for further work are provided in Section 7.3.

7.2 Data gaps

Gaps in data and information have become apparent throughout the preparation of this SFRA. It may be the case that this information does not exist or has not been made available for the SFRA for unknown reasons. Such gaps in information includes:

- Up-to-date fluvial and surface water 3.3% AEP, 1% and 0.1% AEP plus climate change modelled flood outlines
- Thames Water sewer flood records
- GIS file of OCC flood incident records
- Tetsworth modelling.

7.3 Recommendations for further work

The SFRA process has developed into more than just a planning tool. Sitting alongside the Sustainability Appraisal and Local Flood Risk Management Strategy, it can be used to provide a much broader and inclusive vehicle for integrated, strategic and local flood risk management and delivery.

There are several studies listed in Table 7-1 that may be of benefit to the LPAs, in developing the flood risk evidence base to support the delivery of the Joint Local Plan, or to the LLFA to help fill critical gaps in flood risk information that have become apparent through the preparation of this Level 1 SFRA.

Table 7-1: Potential further works and assessments

Type	Study	Reason	Timeframe
Understanding of local flood risk	Level 1 SFRA update	When there are changes to: the predicted impacts of climate change on flood risk; detailed flood modelling - such as from the EA or LLFA; the local plan, spatial development strategy or relevant local development documents; local flood management schemes; flood risk management plans; local flood risk management strategies; and national planning policy or guidance. Or after a significant flood event.	As required Oxfordshire County Council are, at the time of writing, updating their Local Flood Risk Management Strategy. SODC and VOWHDC may wish to update their SFRA when this document is published.
	Level 2 SFRA	Reviewing of EA flood zones in those areas not covered by existing detailed hydraulic models i.e., the Flood Map for Planning does not cover every watercourse such as those <3km^2 in catchment area or ordinary watercourses. If a watercourse or drain is present on OS mapping but is not covered by the Flood Map for Planning, this does not mean there is no potential flood risk. A model may therefore be required to ascertain the flood risk, if any, to any nearby sites.	Short term
	Level 2 SFRA	Further, more detailed assessment of flood risk to high and medium risk	Short term

Type	Study	Reason	Timeframe
		sites as notified by this Level 1 SFRA. Climate change should be modelled as appropriate for fluvial and surface water flood risk.	
	SWMP/ detailed surface water modelling	It may be useful in high surface water risk areas to gain a better understanding of surface water flood risk both now and in the future. However, the LLFA has confirmed they will not be preparing any Surface Water Management Plans within South Oxfordshire or Vale of White Horse authority areas.	-
	Climate change assessment for Level 1 update / part of Level 2 SFRA	Modelling of climate change, using EA's allowances where these are updated, across all watercourses within South Oxfordshire and Vale of White Horse. Also, for surface water flood risk.	Short term
Flood storage and attenuation	Working with Natural Processes	Further assess WwNP options in upper catchments to gauge possible areas for Natural Flood Management. Promote creation of floodplain and riparian woodland, floodplain reconnection and runoff attenuation features where the research indicates that it would be beneficial within the districts.	Short term
Water resources	Water Cycle Study	To ensure sufficient provision of infrastructure for water supply and wastewater for new development across both districts. A Water Cycle Study is required for the Joint Local Plan.	Short term
Data collection	Flood Incident data	LLFA should continue to record flood events including such information as date, location, weather, flood source (if apparent without an investigation), impacts (properties flooded or number of people affected) and response by any Risk Management Authority. This should be made available in GIS format. However, the LLFA has confirmed they are not able to share such information due to data protection issues.	Ongoing

Type	Study	Reason	Timeframe
	FRM Asset Register	The LLFA should continue to update and maintain its asset register as per FWMA requirements.	Ongoing
Risk assessment	Asset inspection	The LLFA may arrange with the EA to carry out inspections of critical assets (see Section 5.11.1) and those defences with condition grades of 4 (see Section 5.11.2).	Short term
Capacity	SuDS review / guidance	If a timeline is confirmed for the enactment of Schedule 3 of the FWMA the LLFA will need to clearly identify its requirements for the design and construction of SuDS in new developments. Internal capacity, within South Oxfordshire and Vale of White Horse and / or the LLFA, should be in place to deal with SuDS applications, set local specification and set policy for adoption and future maintenance of SuDS.	Short term
Partnership	Thames Water	South Oxfordshire and Vale of White Horse and LLFA should continue to collaborate with TW on sewer and surface water projects to ensure their assets can remain operational and resilient at all times across the catchment and that capacity for new development is appropriate.	Ongoing
	EA	South Oxfordshire and Vale of White Horse should continue to work with the EA on fluvial flood risk management projects. Potential opportunities for joint schemes to tackle flooding from all sources should be identified.	Ongoing
	Community	Continued involvement with the community through existing flood risk partnerships.	Ongoing

A Appendix A - The Planning Framework and Flood Risk Management

This section contains information relating to the planning framework and provides a background to the flood risk policy documents that are relevant to South Oxfordshire and Vale of White Horse.

B Appendix B - Functional floodplain delineation

Technical note explaining the methodology behind the delineation of the functional floodplain (Flood Zone 3b) for this SFRA.

C Appendix C - Site assessment spreadsheet

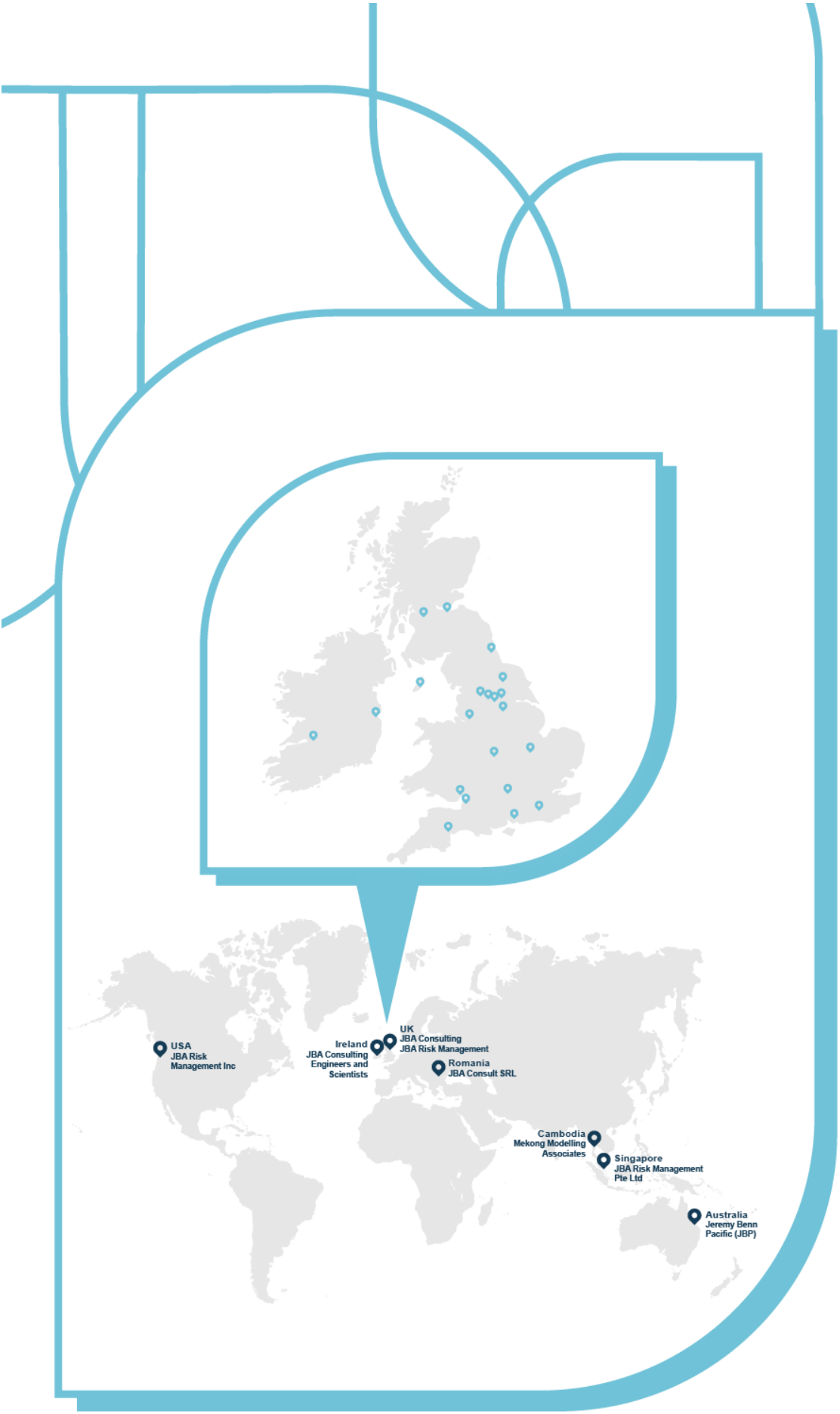
Excel spreadsheet containing an assessment of flood risk to the potential development sites based on Flood Zones 2, 3a and 3b, as delineated through this SFRA and accounting for climate change, and the Risk of Flooding from Surface Water (RoFSW), also accounting for climate change. Each site is assigned a strategic recommendation based on risk and developability.

D Appendix D - Strategic Recommendations of the proposed sites

Summarises the outcomes of the Sites Assessment process recorded in Appendix C.

E Appendix E - Catchment-level assessment of Cumulative Impacts of Development on Flood Risk

Outlines the methodology and results of the detailed cumulative impact assessment.



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