Bradford Level 1 Strategic Flood Risk Assessment

Final Report

November 2023

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Revision History

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Draft v1.0 March 2022		Alex Bartle
Draft v2.0 May 2023	Update to address Environment Agency comments, including subsequent discussion. Also updated to reflect the updated PPG.	Jonathan Dicken Edward Norfolk
Draft v2.1 August 2023	Update to reflect CBMDC review comments.	Jonathan Dicken Edward Norfolk Michelle Kidd Jonathan Kenyon
Final v1.0 November 2023	Update to reflect CBMDC and Environment Agency review comments.	Jonathan Dicken Edward Norfolk

Contract

This report describes work commissioned by Alex Bartle, on behalf of City of Bradford Metropolitan District Council, by letter dated 14 May 2020. The Client's representative for the contract was Alex Bartle. Laura Thompson and Mike Williamson of JBA Consulting carried out this work.

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Purpose

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Executive Summary

This Level 1 Strategic Flood Risk Assessment (SFRA) updates the Interim Level 1 SFRA, prepared in 2020, using up-to-date flood risk information, including up to date climate change modelling, together with the most-current flood risk and planning policy available from the National Planning Policy Framework[1] (NPPF) (2023) and Flood Risk and Coastal Change Planning Practice Guidance[2] (FRCC-PPG).

The Level 1 SFRA is focused on collecting readily available flood risk information from key stakeholders, the aim being to help identify the number and spatial distribution of the flood risk sources present throughout the City of Bradford Metropolitan District Council's (CBMDC) administrative area to form the evidence base on flood risk for the Council's Local Plan.

The Council provided its potential development sites data and information. An assessment of flood risk has been undertaken on all sites provided to assist the Local Planning Authority in its decision-making process for the allocation of sites in the Local Plan.

Risk and developability of each site has been reviewed and the below strategic recommendations made:

- Strategic Recommendation A – Further investigation recommended - review and refine developable area based on flood risk;
- Strategic Recommendation B – Level 2 SFRA, Exception Test required (if applicable);
- Strategic Recommendation C – site at low flood risk (within Flood Zone 1 and at low/no risk of surface water flooding), can progress to developer-led FRA; and
- Strategic Recommendation D – site can be allocated on flood risk grounds.

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 NPPF and FRCC-PPG. Section 8 of this report provides further details, however, principally:

- No development within the functional floodplain, unless development is water compatible. Essential infrastructure must pass the Exception Test;
- Surface water flood risk should be considered with equal importance as fluvial risk;
- Climate change modelled extents should be considered;
- The sequential approach must be followed in terms of site allocation and site layout;
- Appropriate investigation and use of SuDS is required of developers;
- Natural Flood Management techniques must be considered for mitigation;

1 https://www.gov.uk/government/publications/national-planning-policy-framework--2

2 https://www.gov.uk/guidance/flood-risk-and-coastal-change

- Phasing of development must be carried out to avoid possible cumulative impacts; and
- Planning permission for at risk sites can only be granted by the LPA following an appropriate site-specific FRA.

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Abbreviations

ABD	Area Benefitting from Defences
ACDP	Area with Critical Drainage Problems
AEP	Annual Exceedance Probability
BGS	British Geological Survey
CaBA	Catchment Based Approach
CBMDC	City of Bradford Metropolitan District Council
CC	Climate change
CFMP	Catchment Flood Management Plan
DTM	Digital Terrain Model
EA	Environment Agency
FAA	Flood Alert Area
FAS	Flood Alleviation Scheme
FCERM	Flood and Coastal Erosion Risk Management
FCRMS	Flood and Coastal Risk Management Strategy
FDGiA	Flood Defence Grant in Aid
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FRCC-PPG	Flood Risk and Coastal Change Planning Practice Guidance
FRMP	Flood Risk Management Plan
FRMS	Flood Risk Management Strategy
FRR	Flood Risk Regulations
FSA	Flood Storage Area
FWA	Flood Warning Area
FWMA	Flood and Water Management Act
GI	Green Infrastructure
GIS	Geographical Information Systems
HFM	Historic Flood Map
IDB	Internal Drainage Board
LA	Local Authority
LASOO	Local Authority SuDS Officer Organisation
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
MAFRP	Multi-Agency Flood Response Plan
MHCLG	Ministry of Housing, Communities and Local Government
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
PFR	Property Flood Resilience
RBD	River Basin District
RBMP	River Basin Management Plan
RFO	Recorded Flood Outline

RFCC	Regional Flood and Coastal Committee
RoFSW	Risk of Flooding from Surface Water map
RMA	Risk Management Authority
RoFRS	Risk of Flooding from Rivers and the Sea map
SA	Sustainability Appraisal
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment
SoP	Standard of Protection
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018
WCS	Water Cycle Study
WFD	Water Framework Directive
WwNP	Working with Natural Processes
YW	Yorkshire Water

1 Introduction

1.1 Commission

The City of Bradford Metropolitan District Council (CBMDC or 'the Council') commissioned JBA Consulting in May 2020 to undertake the Level 1 Strategic Flood Risk Assessment (SFRA), updating the existing Interim Level 1 SFRA in place since 2019. CBMDC acts as the Local Planning Authority (LPA) and the Lead Local Flood Authority (LLFA) and requires the updated Level 1 SFRA to account for updated river modelling carried out by the Environment Agency (EA) and to draw on the most recent climate change allowances for peak river flows[3] (July 2021).

The modelling outputs will be used to initiate the Sequential Test and risk-based approach to the allocation of land for development and to identify whether application of the Exception Test is likely to be necessary to allocate potential development sites in the Local Plan. The SFRA will also provide the evidence to support strategic flood risk policies for the Local Plan.

1.2 Strategic Flood Risk Assessment

All local planning authorities should produce a Level 1 SFRA. A Level 2 SFRA may also be required depending on whether the local authority has plans for development in flood risk areas, identified in the Level 1 SFRA. The EA's SFRA guidance for local planning authorities[4] (updated March 2022) states:

"Your SFRA will help your planning authority make decisions about:

- *your local plan or spatial development strategy*
- *individual planning applications*
- *how to adapt to climate change*
- *future flood and coastal risk management*
- *emergency planning (the resources needed to make development safe)*
- *site masterplans and local design guidance or codes*
- *infrastructure planning*
- *community infrastructure levy and planning obligations*

You also need it to help you:

- *carry out the sequential test for the local plan or spatial development strategy, and individual planning applications*
- *do the exception test for the local plan, when you're proposing to allocate land for development in flood risk areas*
- *establish if a development can be made safe without increasing flood risk elsewhere*
- *decide when a flood risk assessment will be needed for individual planning applications*
- *identify if proposed development is in functional floodplain*
- *identify and safeguard from development, land likely to be needed for future flood risk management features and structures*

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3 https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

4 https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment#level-2-strategic-flood-risk-assessment

- *do the sustainability appraisal of the local plan or spatial development strategy."*

1.3 Bradford Level 1 SFRA

This SFRA has been carried out in accordance with Government's latest development planning guidance including the National Planning Policy Framework[5] (NPPF) (2023) and flood risk and planning guidance called the Flood Risk and Coastal Change Planning Practice Guidance[6] (FRCC-PPG) (published March 2014 and last updated August 2022).

This SFRA makes use of the most up-to-date, available flood risk datasets at the time of submission to assess the extent of risk, at a strategic level, to the longlist of potential development site allocations identified by the Council. Mapping showing the potential sites overlaid with the latest, readily available flood risk information is hosted on CBMDC's online web-GIS system and can be accessed using this link. This, along with the Development Site Assessment spreadsheet (contained in Part 2 of the report that includes site specific information), indicates the level of flood risk to each site following a strategic assessment of risk. This information allows the LPA to identify the strategic development options that may be applicable to each site and to inform the application of the Sequential Test.

1.4 Aims and objectives

The aims and objectives of this Level 1 SFRA, in line with the national guidance and the Council's specific requirements are to:

- Determine the flood risk from all sources of flooding including (present day, the impacts of climate change and historic):
  - Fluvial from main rivers and ordinary watercourses,
  - Surface water (pluvial and sewer),
  - Groundwater,
  - Residual risk from reservoirs and canals
- Determine the risks to and from neighbouring authorities in the same flood catchment and possible cumulative impacts,
- Assess existing and future flood risk management, including defence infrastructure, defence types, standards of protection, condition, Areas Benefitting from Defences and associated residual risk from breaches or overtopping,
- Screen the long-list of potential development allocations against the latest available flood risk information to enable application of the Sequential Test and to determine those sites which may need to pass the Exception Test as part of a Level 2 SFRA to enable allocation. Any site shown to be at medium or high flood risk that the Council wish to allocate will be subject to a Level 2 SFRA),
- Identify the requirements for site-specific flood risk assessments in targeted locations, including those at risk from sources other than rivers,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance, storage of floodwater through appropriate Sustainable Drainage Systems (SuDS). Also, through natural flood management and the use of green infrastructure and open space for flood storage and amenity use through blue/green corridors,

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5 https://www.gov.uk/government/publications/national-planning-policy-framework--2

6 https://www.gov.uk/guidance/flood-risk-and-coastal-change

- Reference possible Property Flood Resilience (PFR) measures and flood mitigation solutions,
- Provide a reference and policy document to advise and inform the general public and private and commercial developers of their obligations under the NPPF,
- Enable the SFRA to be used as a tool to inform the Development Management process about the potential risk of flooding associated with future planning applications and the basis for requiring site-specific FRAs where necessary.

1.5 Consultation

The EA's SFRA guidance recommends consultation on the SFRA preparation 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,
- district councils,
- regional flood and coastal committees.

1.6 Report Structure

The Level 1 SFRA has been structured as follows:

- Part 1 – Main Level 1 SFRA document.
- Part 2 – Site specific information, including the methodology adopted for the site screening and the site screening spreadsheet. This information has been separated from the Main (Part 1) Report, so that it can more easily be updated in the future.

1.7 SFRA Future Proofing

This SFRA has been developed using the most up-to-date data and information available at the time of submission. The SFRA has been future proofed as far as possible though the reader should always confirm with the source organisation (CBMDC) that the latest information is being used when decisions concerning development and flood risk are being considered. The FRCC-PPG, alongside the NPPF, is referred to throughout this SFRA, as this is the current primary development and flood risk guidance information.

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 local plan, spatial development strategy or relevant local development documents,
- local flood management schemes,
- flood risk management plans,
- local flood risk management strategies,

- 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.

Where possible, the SFRA should be kept as a 'live' entity and continually updated when new information becomes available. Mapped outputs from the SFRA are hosted online and can be accessed via the CBMDC portal via this link.

This SFRA uses the EA's Flood Map for Planning (FMfP) flood zones 2 and 3, last updated nationally in August 2023 at the time of writing, to assess fluvial risk to the potential allocation sites. However, the outputs from the most recent river modelling studies have also been used to assess risk where available.

To assess surface water risk to sites, this SFRA uses the EA's Risk of Flooding from Surface Water (RoFSW) dataset, last updated nationally in May 2021. No additional surface water modelling has been carried out for this SFRA though this dataset is updated periodically when applicable local surface water modelling is carried out. Additionally, the EA is also carrying out a national update of the RoFSW as part of the National Flood Risk Assessment 2 (NaFRA2) project which is due for completion in 2024.

The CBMDC portal directly links to the Flood Map for Planning and the Flood Risk Maps for Surface water that are accessible on gov.uk ensuring that these outputs on the portal are up to date.

Going forward, the process for adopting the outputs generated from new hydraulic modelling studies is outlined below:

- Finalised outputs should be reviewed and approved by the Environment Agency.
- Once approved, appropriate outputs will be incorporated into the FMfP. This dataset is updated quarterly.
- Approved outputs can be used to justify a local revision to the outputs hosted on the CBMDC portal, for example present or future Flood Zone 1, 2, 3, 3b datasets where they differ from the datasets shown on the portal.
- The datasets used on the portal will be periodically reviewed and updated to ensure that they remain current.

2 Study area

The study area for this SFRA is defined by the administrative boundary of City of Bradford Metropolitan District Council located in West Yorkshire. Bradford is a major metropolitan authority and is the sixth largest district (in terms of population) in England covering an area of approximately 370 square kilometres stretching across the Airedale Valley, Wharfedale Valley and the Worth Valley.

Over 70% of the district is green open land and the population is estimated at approximately 546,400 (2021 Census). The main urban area within the district is the City of Bradford. Other built-up communities include the towns of Keighley, Ilkley, Bingley and Shipley with several smaller settlements such as Silsden located in the more rural areas.

The administrative area is located within the River Aire and Calder and the River Wharfe and Lower Ouse catchments. Flood processes and flood risk issues across the area are linked by the Rivers Aire, Worth and Wharfe plus their many tributaries. 24 square kilometres of the district drains to the River Calder located to the south east of Bradford.

As shown in Figure 2-1 the EA Main River the River Aire flows eastwards directly through the administrative area within a valley fed by a number of tributaries from the uplands of llkley Moor in the north and Keighley Moor in the southwest. The River Wharfe is another EA Main River north of Ilkley Moor flowing eastwards. Bradford Beck is an Ordinary Watercourse flowing northwards through the City Centre and into the River Aire. Bradford Beck is primarily culverted through the City Centre.

Flood risk across the Bradford District is varied but caused in the main by overland flow following short, high intensity, or heavy, prolonged rainfall events and/or overtopping rivers and watercourses. There is a history of land and property flooding, the most recent and severe flooding in the district in 15 years being a consequence of Storms Desmond and Eva in 2015.

Historically, flooding has significantly affected parts of Bradford with a number of large-scale damaging flood events having occurred due to a combination of high river levels, excessive surface water runoff, saturated ground, groundwater fluctuations and exceeded capacity in sewer and highway drainage systems. Due to the increasing effects of climate change, awareness of and preparedness for flooding, both at a local and national scale, is vital in reducing flood risk to local authority areas. The study area falls within the Humber River Basin District (RBD) and is served by Yorkshire Water (YW), the primary local water and sewerage operator.

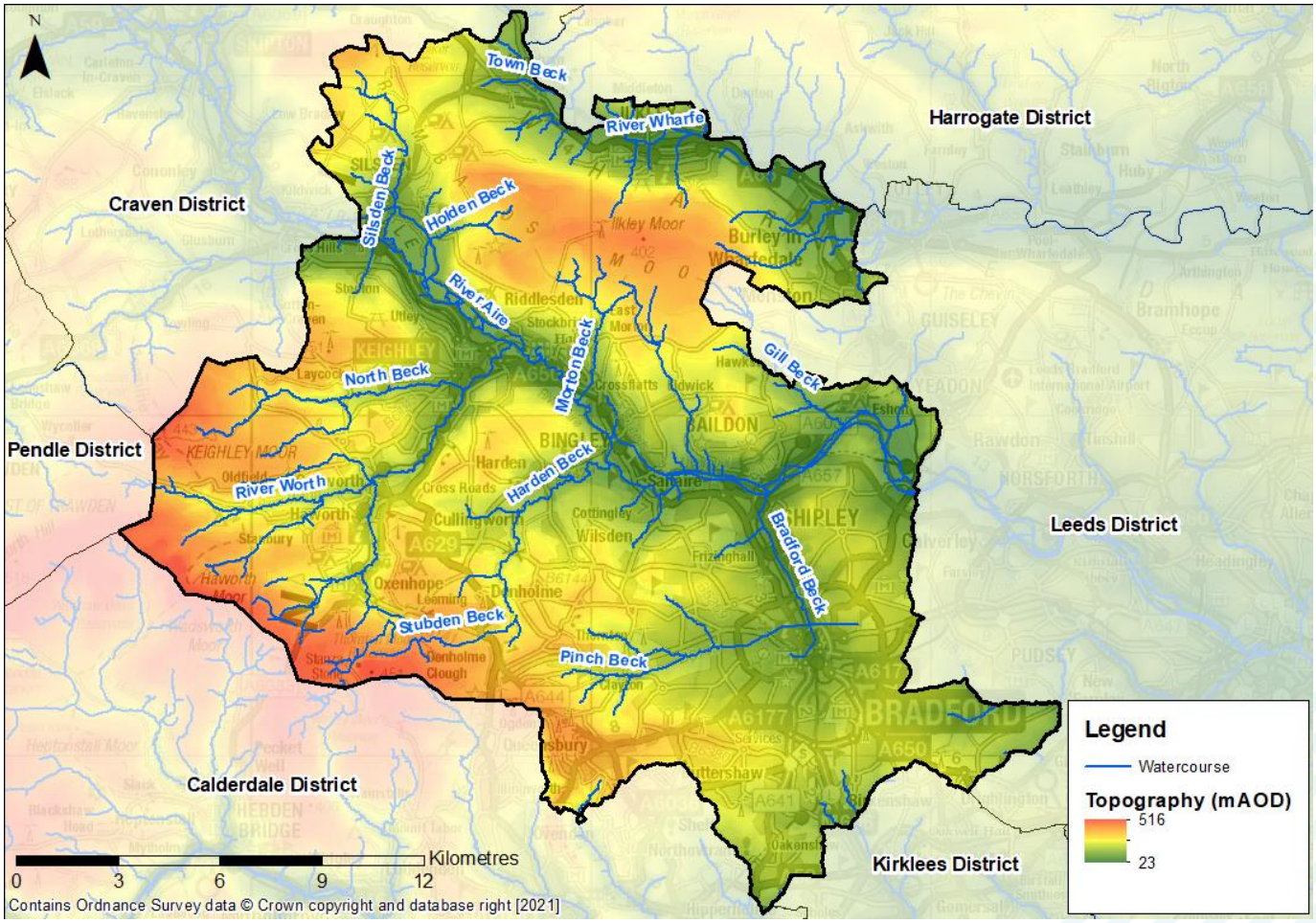

Figure 2-1: SFRA study area (CBMDC administrative area)

3 Understanding flood risk

3.1 Sources of flooding

Flooding is a natural process and can happen at any time in a wide variety of locations, as discussed below. 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, commercial and industrial enterprises, agricultural land and environmental and cultural heritage. Flooding can occur from many different and combined sources and in many different ways. Major sources of flooding (shown in Figure 3-1) include:

- Fluvial (main rivers and ordinary watercourses) – inundation of floodplains from rivers and watercourses; 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; blockages of flood channels/corridors.
- Surface water – surface water flooding covers two main sources including direct run-off from adjacent land (pluvial) and surcharging of piped drainage systems (public sewers, highways drains, etc.)
- Groundwater – water table rising after prolonged rainfall to emerge above ground level remote from a watercourse; most likely to occur in low-lying areas underlain by permeable rock (aquifers); groundwater recovery after pumping for mining or industry has ceased.
- Infrastructure failure – reservoirs; canals; industrial processes; burst water mains; blocked sewers or failed pumping stations.

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.

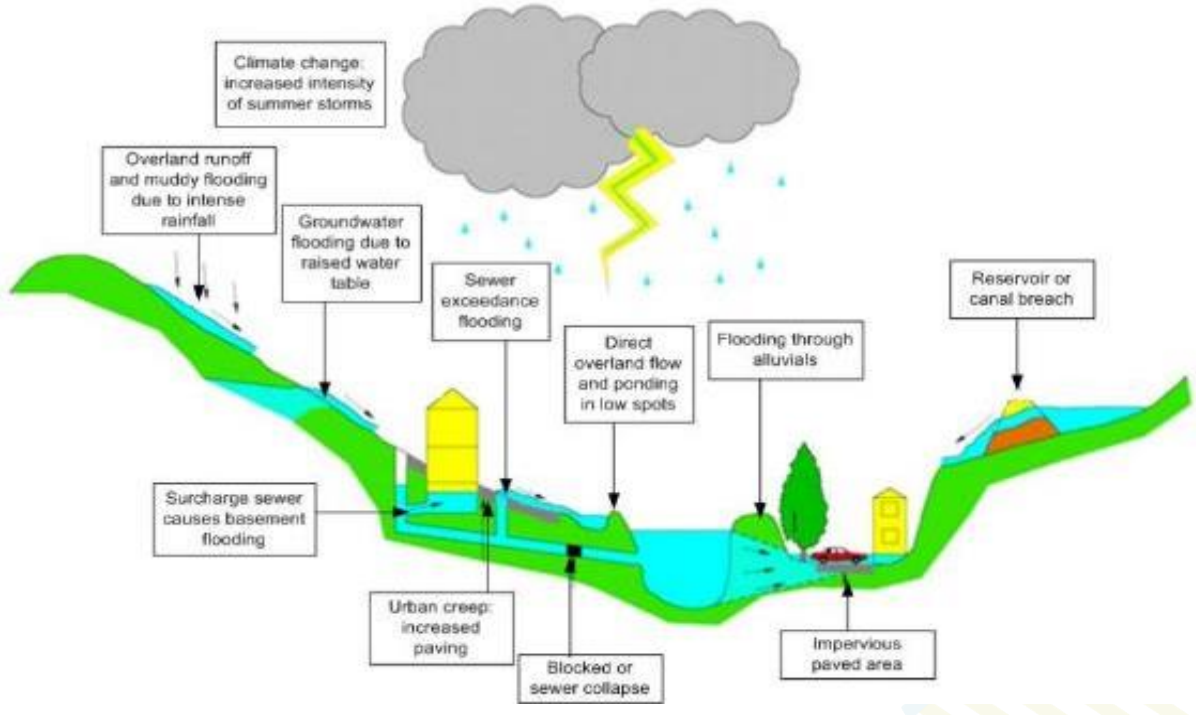

Figure 3-1: Flooding from all sources

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 in Figure 3-2 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.

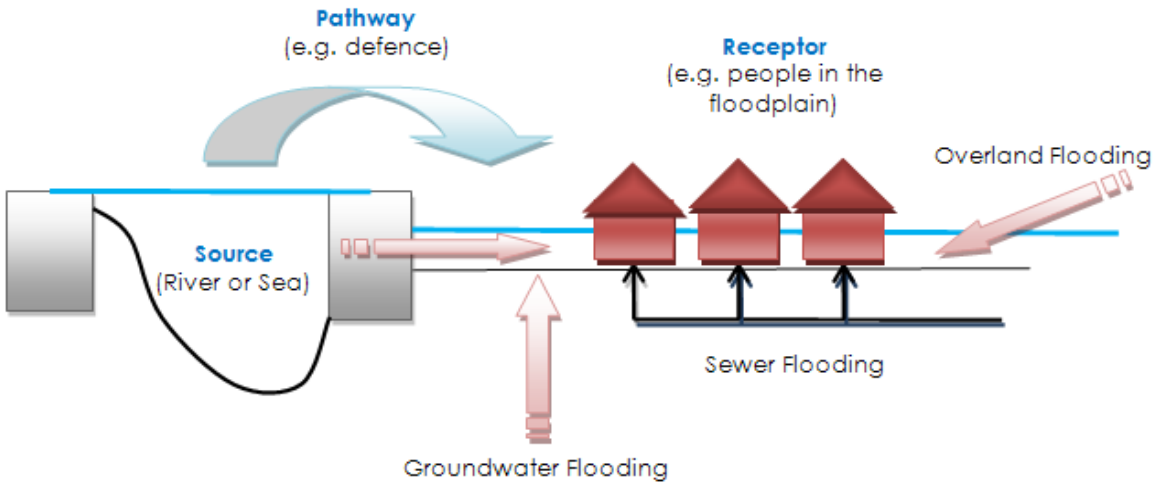

Figure 3-2: Source-Pathway-Receptor Model

In the CBMDC administrative area, the principal flood sources are 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 remove receptors.

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

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 many years. A 1 in 100 year 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% AEP (Annual Exceedance Probability)) chance of occurring in any one year, not that it will occur once every one hundred years. Table 3-1provides an example of the flood probabilities used to describe the fluvial flood zones as defined in the FRCC-PPG and as used by the EA in its Flood Map for Planning (Rivers and Sea).

Note that the 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.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 (0.1%) annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of river flooding; (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 (1%) or greater annual probability of river flooding; (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. Functional floodplain will normally comprise: - Land having a 1 in 30 (3.3%) or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or - Land that is designated to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 1 in 1000 (0.1%) probability of flooding). 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)

Table 3-1: NPPF flood zones[7]

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

3.3 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.

3.3.1 Defended risk

This is the existing risk accounting for any flood defences that are in place for frequent 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 have a major impact.

7 Table 1: Flood Zones, Paragraph 078 of the Flood Risk and Coastal Change Planning Practice Guidance

Defended 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. Hence, the actual risk of flooding from the river may be low to a settlement behind the defence but moderate from surface water, which may pond behind the defence in low spots and is unable to discharge into the river during high water levels. Defence SoP will also vary over time due to climate change and deterioration. A defence SoP is a designed level of defence at a certain point in time for a certain duration. As time passes a SoP will naturally reduce without intervention as climate change impacts are realised.

3.3.2 Residual risk

Paragraph 041 of the FRCC-PPG defines residual risk as risk that remains after the effects of flood risk infrastructure have been taken into account.

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

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. It may also be appropriate for this information to inform a sequential approach to the location of development within these areas, where the initial application of the Sequential Test is unable to steer development to lower risk areas. 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".

Whilst the actual risk of flooding to a settlement that lies behind 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 are overtopped or fail that must be considered. Because of this, it is never appropriate to use the term "flood free". As a high level indicator of residual risk, areas protected by known flood defences that are within the 1% AEP flood map extent (Flood Zone 3) should be considered as being at residual risk. Residual risk will be assessed as part of the Level 2 assessment through detailed hydraulic modelling. This will be used to determine the areas at residual flood risk and associated flood depths and velocities.

4 The planning framework and flood risk policy

Appendix A of the SFRA provides an overview of the key planning and flood risk policy documents that have shaped the current planning 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 Risk Regulations (FRR) 2009 and the Flood and Water Management Act (FWMA) 2010[8]. 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 LPA's emerging Local Plan and to help inform planning decisions.

8 https://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

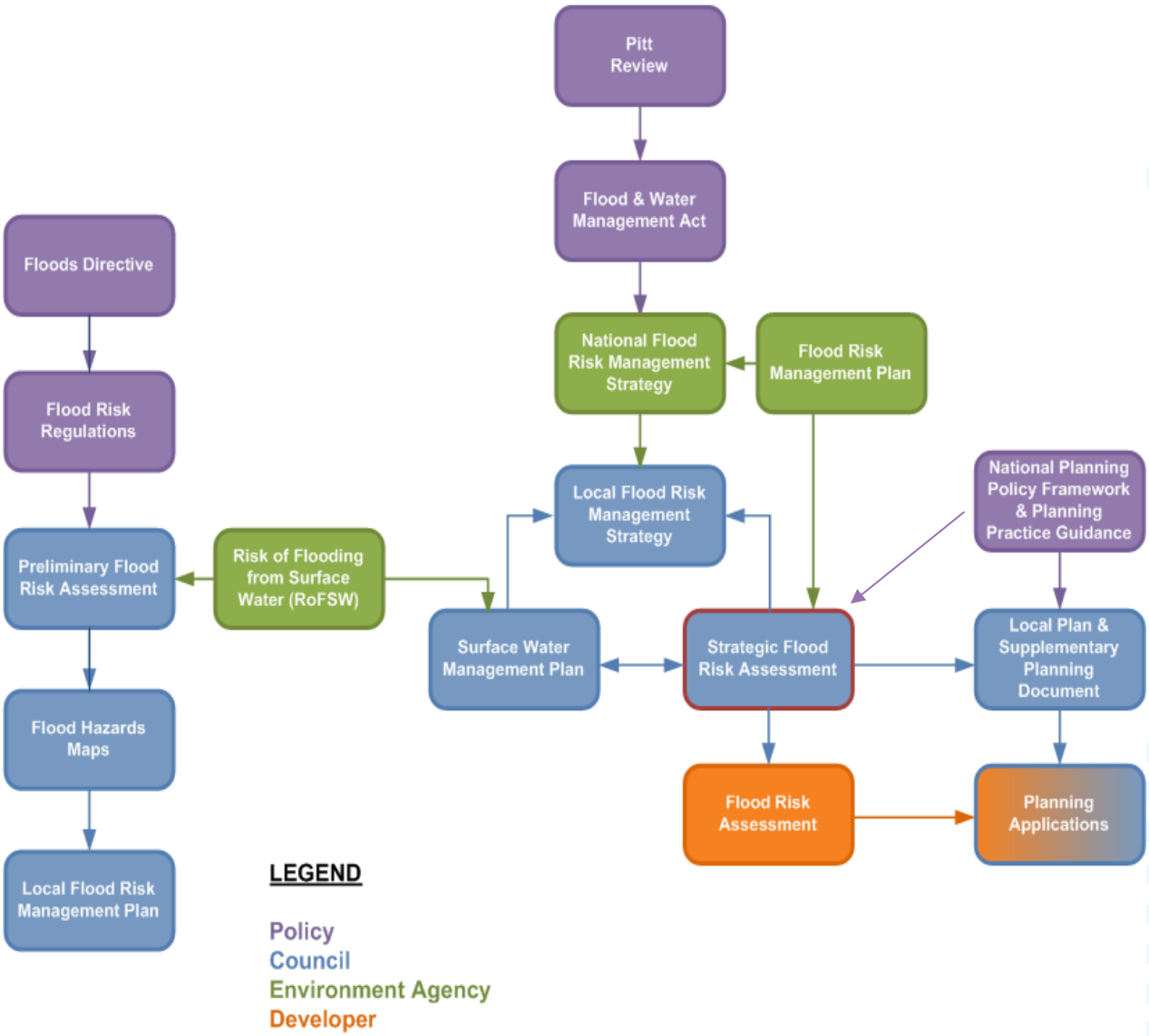

Figure 4-1: Key documents and strategic planning links with flood risk

5 Understanding flood risk in the City of Bradford District

5.1 Flood risk datasets

This section of the SFRA provides a strategic overview of flood risk from all sources within the CBMDC area. The information contained is the best available at the time of publication and is intended to provide an overview of risk. Table 5-1 provides a summary of the key datasets used in this SFRA according to the source of flooding.

Flood Source	Datasets/Studies
Fluvial	EA Flood Map for Planning (Rivers and Sea) (downloaded August 2023)
	EA Risk of Flooding from Rivers and Sea map
	Finalised Modelled Flood Outlines (MFO) from latest available EA Flood Risk Mapping Studies (as outlined in Appendix B)
	EA Historic Flood Map (HFM) (downloaded February 2022)
	EA Recorded Flood Outlines (RFO) (downloaded February 2022)
	EA Flood Warning Areas (FWA) (downloaded February 2022)
Pluvial (surface water runoff)	EA Risk of Flooding from Surface Water (RoFSW) (downloaded February 2022)
	Preliminary Flood Risk Assessment (2017)
Groundwater	JBA 5m Resolution Groundwater Flood Map (2020)
Reservoir	EA Reservoir Flood Maps (available online)
All sources	Humber Flood Risk Management Plan 2015 to 2021
	Humber River Basin Management Plan (June 2018)
	Aire Catchment Flood Management Plan (2009)
	Bradford District Local Flood Risk Management Strategy (2016)
	CBMDC Flooded Property Database (2022)
Flood risk management infrastructure	EA Spatial Flood Defence data (downloaded February 2022)

Table 5-1: Flood source and key datasets

5.2 Fluvial flooding

Fluvial flooding is associated with the exceedance of channel capacity during higher flows or as a result of blockage. The process of flooding from watercourses 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.

The interactive mapping hosted on CBMDC's online web-GIS portal presents the EA's Flood Map for Planning which shows the fluvial coverage of flood zones 2 and 3 across the study area. The portal can be accessed using this link.

5.2.1 EA Flood Map for Planning (Rivers and Sea)

The EA's Flood Map for Planning is the main dataset used by planners for predicting the location and extent of fluvial flooding. This is supported by the CFMPs and FRMPs along with a number of detailed hydraulic river modelling reports which provide further detail on flooding mechanisms.

The Flood Map for Planning provides flood extents for the 1 in 100 year (1% AEP) fluvial event (Flood Zone 3) and the 1 in 1000 year (0.1% AEP) fluvial event (Flood Zone 2). 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 their 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 conservative scenario of flooding. The flood zones 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 (functional floodplain).

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 further discussed in Section 5.2.3.

This SFRA uses the Flood Map for Planning issued in August 2023 to assess fluvial risk to potential development sites. The Flood Map for Planning is updated at quarterly intervals by the EA, as and when new modelling data becomes available. It can be accessed via the link:

https://flood-map-for-planning.service.gov.uk/

5.2.2 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 the functional floodplain as: "*…land where water from rivers or the sea has to flow or be stored in times of flood.*

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

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

Although the definition of functional floodplain described above states that functional floodplain comprises of land where water has to flow or be stored in times of flood, it was agreed between CBMDC and the EA that the spatial delineation of the functional floodplain should not account for existing solid buildings or infrastructure. This is due to the complexity associated with the evidencing of existing infrastructure being solid and therefore not considered as functional floodplain. The functional floodplain for the administrative area of Bradford therefore includes existing buildings and infrastructure.

In accordance with FRCC-PPG only water compatible development or essential infrastructure would be permitted within the functional floodplain. Water compatible development and essential infrastructure must 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.

Where an existing building is within the functional floodplain extent, which is demonstrated to be a solid building, is demolished and/or redeveloped, the new development must not exceed the current development footprint and where possible should reduce the development footprint or be fully converted to open greenspace. The number of receptors within the new development footprint should not be increased (i.e. a property cannot be split into multiple properties) and the development must be the same, or lower, vulnerability classification (see Annex 3 of the NPPF). Areas of higher land shown as 'dry islands' within the functional floodplain should also be considered undevelopable, the only exception to this is for water compatible or essential infrastructure uses.

Flood Storage Areas (FSA) are included in the functional floodplain, based on the definition in the FRCC-PPG.

Existing flood outlines from detailed models have been used to define the extent of Flood Zone 3b and how this might change in the future. Flood Zone 3 has been used to define Flood Zone 3b in areas not subject to detailed modelling, allowing the incorporation of national generalised modelling that is embedded within the Flood Zone 3 dataset. This approach has been agreed with CBMDC and the Environment Agency.

A technical note is provided in Appendix B which explains the methodology used in creating the functional floodplain outline.

5.2.3 EA Risk of Flooding from Rivers and the Sea map

The Risk of Flooding from Rivers and Sea map (RoFRS) shows 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 the interactive mapping hosted on CBMDC's online web-GIS system, that can be accessed via this link. The RoFRS map splits the likelihood of flooding into four risk categories:

- High – chance of flooding of greater than 3.3% each year;
- Medium – chance of flooding of between 1% and 3.3% each year;
- Low – chance of flooding of between 0.1% and 1% each year; and
- Very Low – chance of flooding of less than 0.1% each year.

The RoFRS map is included on the SFRA maps to act as a supplementary piece of information to assist the LPA in the decision-making process for site allocation.

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.

5.3 Surface water flooding

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.

Surface water flooding, in the context of this SFRA, includes:

- Surface water runoff (also known as pluvial flooding); and
- Sewer flooding.

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

The EA's Risk of Flooding from Surface Water (RoFSW) map along with information within the LFRMS (see Section A.6.1 of Appendix A) should assist with this and various mitigative

measures, i.e. SuDS, should be identified. Section 6.8 provides guidance on mitigation options and SuDS for developers.

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.

5.3.1 Pluvial flooding

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 natural depressions. Areas at risk of pluvial flooding can, therefore, lie outside of the fluvial flood zones.

Pluvial flooding within urban areas across the country will typically be associated with events greater than the 1 in 30 year (3.3% AEP) design standard of new sewer systems. Some older sewer and highway drainage networks will 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.

EA Risk of Flooding from Surface Water dataset

The Risk of Flooding from Surface Water (RoFSW) aims to identify areas where localised, flash flooding can cause problems even if 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.

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.*"

The RoFSW also presents a conservative scenario, therefore, any sites identified to be at risk from surface water flooding according to the RoFSW should be assessed in more detail, following this Level 1 SFRA, either as part of a Level 2 SFRA or at the FRA stage which should include an appropriately detailed drainage strategy.

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

- High risk - chance of flooding of greater than 3.3% each year;
- Medium risk - chance of flooding of between 1% and 3.3% each year;
- Low risk - chance of flooding of between 0.1% and 1% each year; and
- Very low risk - chance of flooding of less than 0.1% each year.

The outlines of the RoFSW are presented on the interactive mapping hosted on CBMDC's online web-GIS system, that can be accessed via this link. The EA is carrying out a national update of the RoFSW as part of the National Flood Risk Assessment 2 (NaFRA2) project which is due for completion in 2024.

5.3.2 Sewer flooding

Combined sewers spread extensively across urban areas serving residential homes, businesses 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. 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.

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 blocked, or it cannot discharge due to a high water level in the receiving watercourse. Pinch points and failures within the drainage network may also restrict flows. Water then begins to back up through the sewers and surcharge through manholes, potentially flooding highways and properties. 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.

Yorkshire Water (YW) is the water company responsible for the management of the public sewer drainage network across the district.

5.3.3 Areas with Critical Drainage Problems

The EA can designate Areas with Critical Drainage Problems (ACDPs). ACDPs may be designated where the EA is aware that development within a certain catchment/drainage area could have detrimental impacts on fluvial flood risk downstream, and/or where the EA has identified existing fluvial flood risk issues that could be exacerbated by upstream activities. In these instances, the EA would work with the LLFA and LPA to ensure that adequate surface water management measures are incorporated into new development to help mitigate fluvial flood risk.

EA guidance on carrying out Flood Risk Assessments[9] states that an FRA should be carried out for sites in Flood Zone 1 that are…

"…in an area with critical drainage problems as notified by the Environment Agency."

At the time of writing there are no ACDPs in the CBMDC area.

5.3.4 Locally agreed surface water information

EA guidance, from within the FWMA[10], on using surface water flood risk information recommends that CBMDC, as LLFA, should:

"…review, discuss, agree and record, with the Environment Agency, Water Companies, Internal Drainage Boards and other interested parties, what surface water flood data best represents their local conditions. This will then be known as locally agreed surface water information".

Locally agreed surface water information either consists of:

- The RoFSW map; or
- 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.

CBMDC have not developed SWMP's that cover the Bradford District. CBMDC should therefore consider the RoFSW to be its locally agreed surface water flood information as this is the latest, most robust surface water flood map available for the administrative area, at the time of writing.

5.4 Groundwater flooding

Groundwater flooding is caused by the emergence of water from beneath the ground, either at point or diffuse locations. The occurrence of groundwater flooding is usually local and unlike flooding from rivers, does not generally pose a significant risk to life due to the slow

9 https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zone-1-and-critical-drainage-areas

10 https://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

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. See Section A.5.2 in Appendix A for further details on basement vulnerability. Development within areas that are susceptible to groundwater flooding will generally not be suited to SuDS; however, this is dependent on detailed site investigation and risk assessment at the FRA stage.

This SFRA uses groundwater data in the form of JBA's 5m groundwater map, which provides a general broadscale assessment of the groundwater flood hazard. The good practice guide to producing SFRAs, developed by the EA and published December 2021, recommends the use of this dataset in SFRAs. The map is categorised by grid code where each code is explained in *Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.

Table 5-2.

Groundwater head difference (m)*	Grid Code	Class label
0 to 0.025	4	Groundwater levels are either at 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.**

Table 5-2: Groundwater flood hazard classification of JBA groundwater map

The areas of the highest groundwater flood risk (grid codes 3 and 4) are focussed to the west of Bradford city centre, Oxenhope, Keighley, Menston and Addingham. Much of the district is categorised as low or no risk (grid codes 1 and 0).

It is important to ensure that future development is not placed at unnecessary risk therefore groundwater flood risk should be considered on a site-by-site basis in development planning.

Where potential development sites are shown to lie within areas that are susceptible to groundwater flooding, detailed hydrogeological investigation and risk assessment should be carried out at the Flood Risk Assessment stage to fully understand the risk from this source. 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.

The groundwater vulnerability dataset is shown on the interactive mapping hosted on CBMDC's online web-GIS system, that can be accessed via this link.

5.5 Canal and reservoir flood risk

5.5.1 Canals

Non-natural or artificial sources of flooding can include canals where water is retained above natural ground level. The risk of flooding along a canal is 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 events such as overtopping of canal banks, breaching of embanked reaches or asset (gate) failure as highlighted in Table 5-3. Canals can also have a significant interaction with other sources, such as watercourses that feed them and minor watercourses or drains that cross underneath.

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

Table 5-3: Canal flooding

The risks associated with these events are also dependent on their 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.

There is one canal located within the District. The Leeds and Liverpool Canal flows from the north west to south east of the District and runs parallel to the River Aire for much of its length. There are no records of breach or overtopping of this canal within the District. The Canal & River Trust has indicated that there are some raised sections of canal within Bradford, notably at the Dowley Gap Seven Arches aqueduct (412213, 438246), the Bradford Beck aqueduct (415185, 437762) and the Thackley Beck aqueduct (416849,

438868). These sections have an increased risk of failure and due to their elevated nature, any failure would result in larger flood risk consequences.

At the time of writing, 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 Canal & River Trust, as part of its function, will endeavour to maintain water levels to control the risk of flooding from canals to adjacent properties. 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.

5.5.2 Reservoirs

A reservoir can usually be described as an artificial body of water where water is stored for use. Some reservoirs supply water for household and industrial use, others serve other purposes, for example, as fishing lakes or leisure facilities. Like canals, the risk of flooding associated with reservoirs is residual and is associated with failure of reservoir outfalls or breaching. This risk is reduced through regular maintenance by the 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 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. LAs are responsible for coordinating emergency plans for reservoir flooding and ensuring communities are well prepared. The LPAs should work with other members of the West Yorkshire Local Resilience Forum to develop these plans. See Section 7.1.1 for more information on the West Yorkshire 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 a dam failure, compared to other risks, when considering development downstream of a reservoir. Local planning authorities should also consider any implications for reservoir safety and reservoir owners and operators caused by new development located downstream of a reservoir, such as the cost of measures to improve the design of the dam to reduce flood risk, the operation of the reservoir, and general maintenance costs, by consulting with reservoir owners and operators on plan and development proposals".

5.5.3 Reservoir Flood Map (RFM)

The EA has produced Reservoir Flood Maps (RFM) for all large reservoirs that they regulate 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, at the time of writing, yet to be confirmed meaning the requirements of the Reservoirs Act 1975 should still be adhered to.

In November 2021, the EA produced the RFM guidance 'Reservoir flood maps: when and how to use them', which provides information on how the maps were produced and what they contain.

The RFM can be viewed nationally at:

https://environment.data.gov.uk/reservoir-flood-maps

The RFM shows that there are 22 large, raised reservoirs within the CBMDC boundary. Figure 5-1 highlights the Risk of Flooding from Reservoirs extents across the CBMDC area. There are 36 large, raised reservoirs which have the potential to impact Bradford in the event of a breach.

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.

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 ensure 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 it is located within and/or 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.

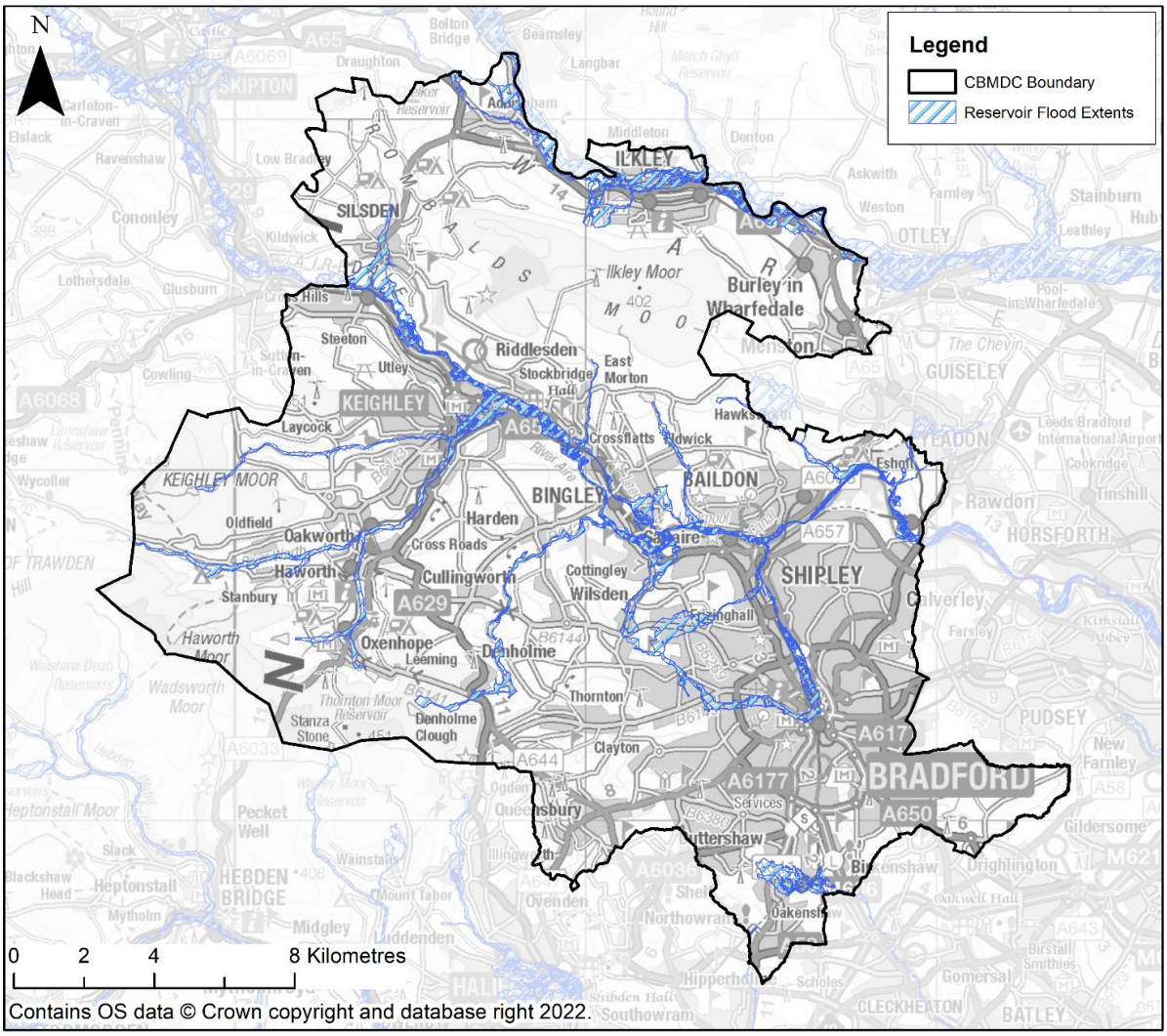

Figure 5-1: Reservoir flood extents within CBMDC

5.6 Historic flooding

CBMDC, as LLFA, has a responsibility, under the FWMA, to maintain and update its historic flood incidents database as and when any locally significant flood incidents occur. As many of these incidents are at the property level and considered as sensitive information, they will

only be shown at the smaller scale of the whole authority. Figure 5-2 shows the recorded historic flood incidents within CBMDC, which includes multiple sources of flooding. The dataset provided by the LLFA includes flooding of property, gardens to property, highways and footpaths.

The LFRMS (2016) identified that the district has experienced significant historic flooding. Flooding has been caused by a combination of high river levels, excessive surface water runoff, saturated ground, groundwater fluctuations and exceeded capacity in sewer and highway drainage systems. Notable flood events occurred in November 2000, Summer 2002 and Winter 2015 due to periods of prolonged rainfall causing both fluvial and surface water flooding. More recently, Storm Ciara brought persistent heavy rain. Over a month's rain fell across parts of West Yorkshire in around 18 hours with several hundred properties affected by flooding.

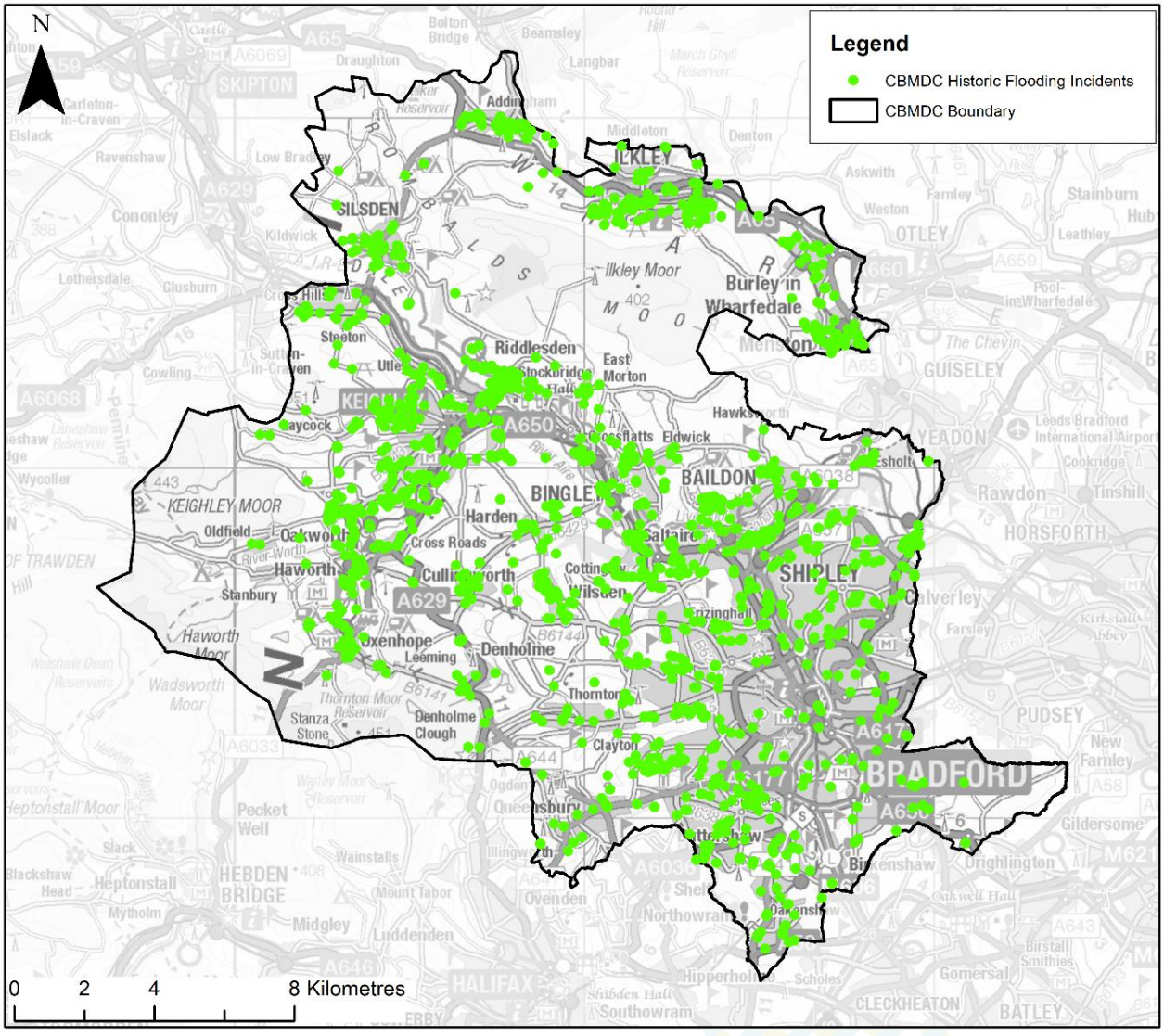

Figure 5-2: Historic flooding incidents within CBMDC

5.6.1 Historic surface water flooding

The LFRMS states that the Summer 2002 flooding was caused in part from fluvial sources, however also as a result heavy rainfall contributing to surface water flooding. Several locations experienced the equivalent of two months average rainfall in two days. The main

impact of this event was felt along roads and railways, of which many had to close for several days.

5.6.2 Historic groundwater flooding

Bradford receives between 550 and 725 calls per year regarding flooding to cellars, with groundwater being a potential source. However, between 2005 and 2010, only 130 cellar flooding incidents have been confirmed as occurring as a result of groundwater. Therefore, the LFRMS indicates that groundwater flooding has not historically been identified as a major problem within the district. This is due to the underlying geology and the lack of records of confirmed cases.

5.6.3 EA Historic Flood Map (HFM)

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 using certain criteria.

In relation to CBMDC, the HFM and RFO show areas of historic flooding mainly following the path of the River Aire through the centre of the district and the River Wharfe along the northern boundary, with some localised areas of flooding throughout the district.

The HFM and RFO datasets are shown on the interactive mapping hosted on CBMDC's online web-GIS system, that can be accessed via this link.

5.7 Flood Risk Management

The aim of this section of the SFRA is to identify existing Flood Risk Management (FRM) assets and previous/proposed FRM schemes. The location, condition and design standard of existing assets will have a significant impact on flood risk mechanisms, whilst future 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. Note that flood alleviation schemes are designed to help to defend existing development and not for proposed development.

5.7.1 EA inspected assets (Spatial Flood Defences)

The EA maintains a national spatial dataset called the Spatial Flood Defences dataset. In the context of Bradford, this dataset contains such information as:

- Asset type (flood wall, embankment, high ground, demountable defence, bridge abutment);
- Flood source (fluvial);

- Design Standard of Protection (SoP) – the SoP for a flood defence is a measure of how much of the level of defence a flood defence is designed to provide. If the SoP is 100, the defence is designed to defend against a flood with the probability of occurring once in any 100 years;
- Asset length;
- Asset age;
- Asset location; and
- Asset condition - see Table 5-4 for condition assessment grades using the EA's Condition Assessment Manual[11] (CAM).

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.

Table 5-4: EA flood defence condition assessment grades

Defence Location	Asset Type	Flood Source	Watercourse	Design Standard	Condition Grade
Keighley	5 embankments 36 walls 2 flood gates	Fluvial	River Aire	80 (7) 50 (6) N/A (30)	2 (14) 3 (20) 4 (4) N/A (5)
Steeton	8 embankments	Fluvial	River Aire	80 (3) 50 (2) N/A (3)	3 (6) 4 (2)
Ilkley	5 walls	Fluvial	River Wharfe	N/A (5)	2 (2) 4 (3)
Burley-in-Wharfedale	1 embankment	Fluvial	River Wharfe	N/A (1)	4 (1)
Bingley	1 wall	Fluvial	River Aire	50 (1)	3 (1)
Shipley	2 walls	Fluvial	River Aire	50 (2)	2 (1) 3 (1)

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

Defence Location	Asset Type	Flood Source	Watercourse	Design Standard	Condition Grade
Oxenhope	4 walls	Fluvial	Leeming Water	50 (4)	2 (2) 3 (2)

Table 5-5: Major EA flood defences within the CBMDC boundary

Table 5-5 highlights the main locations within the district that have significant EA FRM assets, namely Keighley, Steeton, Ilkley, Burley-in-Wharfedale, Bingley, Shipley and Oxenhope.

There are 14 embankments with varying design standards, that have been assessed at condition grades 3 or 4 meaning the condition is rated as 'Fair' or 'Poor' according to the EA's Condition Assessment Manual (as discussed in Table 5-4) meaning that there are some assets where defects could reduce or significantly reduce performance of the structure.

Along the majority of the Main Rivers within CBMDC's authority area, there are only areas of high ground offering protection from fluvial flooding, with no formal defences. The condition grade of the majority of these defences is stated as 2/3, which means 'Good/Fair', as per the EA's Condition Assessment Manual meaning there could be defects that could reduce the performance of the asset or the defects are only minor and would not compromise performance.

The Spatial Flood Defences dataset is shown on the interactive mapping hosted on CBMDC's online web-GIS system, that can be accessed via this link.

As well as the ownership and maintenance of a network of formal defence structures, the EA carries out a number of 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 warning services for areas within designated Flood Warning Areas (FWA) or Flood Alert Areas (FAA). EA FWAs are shown on the interactive mapping hosted on CBMDC's online web-GIS system (that can be accessed via this link);
- Promoting awareness of flooding so that organisations, communities and individuals are aware of the risk and therefore sufficiently prepared in the event of flooding; and
- Promoting resilience and resistance measures for existing properties that are currently at flood risk or may be in the future as a result of climate change.

Note that the EA is not responsible for all formal defence structures, only those which fall within their remit. The Local Authority and private owners will also have responsibility in some areas.

5.7.2 CBMDC assets and future Flood Risk Management schemes

CBMDC (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 Act 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 should carry out a strategic assessment of structures and features on the FRM Asset Register to inform capital programmes and prioritise maintenance programmes. Critical assets (i.e. culverts in poor condition) should be prioritised for designated works.

Since the major floods in 2015 the Council has recognised the need for a long term strategic approach to managing flood risk across the district. The Council has worked with the Environment Agency and Yorkshire Water to scope and develop a Bradford Flood Programme Board ('the Board'). The Board's objectives alongside ongoing scheme development, is to prioritise the identification and delivery of cost-beneficial solutions for communities at risk of flooding within the district. The Board was established in January 2017 and has progressed and supported the emergence of a capital flood risk management programme of works for the district. The work conducted by the Council in recent years has provided the tools and knowledge to develop a healthy and progressive capital flood risk management programme. Not only have projects advanced within areas initially impacted by Storm Eva in 2015, but largely due to the many partnerships and relationships formed in creating the programme, this has provided a springboard towards unearthing a multitude of multi organisation flood risk management schemes in the district.

It is essential that the schemes in the Council's programme continue to be progressed collaboratively to ensure high risk communities are resilient to future climate changes and an increased risk of flooding. The Council's Local Flood Risk Management Strategy includes information about the projects within the capital programme and provides details of the forecasted benefits, costs and progress of each scheme.

5.7.3 Water company assets

The sewerage infrastructure within CBMDC's administrative area is primarily managed by Yorkshire Water (YW). This includes adopted sewerage systems of 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 YW, 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.

5.7.4 Natural Flood Management/Working with Natural Processes

Natural flood management (NFM) also referred to as Working with Natural Processes (WwNP) is a type of flood risk management 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. NFM and WwNP are used interchangeably in the UK though the term WwNP will be used throughout this report.

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 flood waters 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 UK Government 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. It is expected that the implementation of WwNP across the UK will continue to become a fundamental component of the flood risk management tool kit due to climate change.

See Appendix A for further information on green-blue infrastructure and CBMDC's Green Infrastructure strategy.

Mapping the potential for WwNP

The JBA Trust has worked with Lancaster Environment Centre (LEC) to produce an interactive catalogue of nature-based flood risk management projects in the UK. This map includes a catalogue of projects where WwNP is being applied on the ground or is being considered as an option to reduce flood risk. Additionally, the map includes a set of layers that indicate the potential areas where WwNP would be beneficial based on EA research. These are not areas secured for WwNP but are indicative of the areas where there is potential for NFM.

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 areas of potential and do not take into account issues such as landownership 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[12] 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 platforms and also interactive GeoPDF format, supported by a user guide and a detailed technical guide.

The WwNP types are listed in Table 5-6.

12 https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/working-with-natural-processes-to-reduce-flood-risk

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 percent annual chance and Depth 3.3 percent annual chance) (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 planning (3 categories)	• Flood plain: Flood Zone 2 from Flood Map for Planning (April 2016) and new constraints layer
	• Riparian: 50m buffer OS water features from Section 2.2.3 with constraints layer
	• Wider catchment woodland:
	  ○ Based on slowly permeable soils
	  ○ 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.
	  ○ 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.
	  ○ To the south of this line, particular bedrock geologies have shown a similarly strong spatial relationship to the presence of slowly permeable soils.

Table 5-6: WwNP measures and data

The WwNP datasets are included on the interactive mapping hosted on CBMDC's online web-GIS system (that can be accessed via this link) 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 Risk of Flooding from Rivers and Sea dataset (see Section 5.2.3), which are in close proximity to 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 - 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 level of defence. Consequently, flood risk management measures should be chosen from a number of 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.

The key areas with significant areas of potential for WwNP schemes are:

- Along the channel and floodplains of the River Aire and River Wharfe
- To the north of the district around Silsden, Addingham and Ilkley
- Oxenhope
- Keighley

An interactive map of current nature-based flood risk management projects and potential projects can be found at:

https://naturalprocesses.jbahosting.com/Map

5.7.5 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 programme provides the key evidence, information, tools and techniques to:

- Inform the development of FCERM policy and strategy;
- Understand and assess coastal and flood risk and the processes by which these risks arise;

- Manage flood and coastal erosion assets in a sustainable way; and
- Prepare for and manage flood events effectively.

See below link for the latest information on the flood and coastal erosion risk management investment program:

https://www.gov.uk/government/publications/programme-of-flood-and-coastal-erosion-risk-management-schemes

6 Development and flood risk

6.1 Introduction

The information and guidance provided in this chapter summarises the online guidance provided in the FRCC-PPG and other government guidance on development and flood risk. This chapter is supported by the interactive mapping hosted on CBMDC's online web-GIS system (that can be accessed via this link) and the site specific screening that is contained in Part 2 of the report. Each can be used by the LPA to inform its Local Plan and provide the basis from which to apply the Sequential Approach in the development allocation and development management process.

6.2 The Sequential Approach

The FRCC-PPG provides the basis for the Sequential Approach. It is this approach, integrated into all stages of the development planning process, 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 approach is based around the FRM hierarchy, in which actions to avoid, substitute, control and mitigate flood risk are 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 development management decisions and actions.

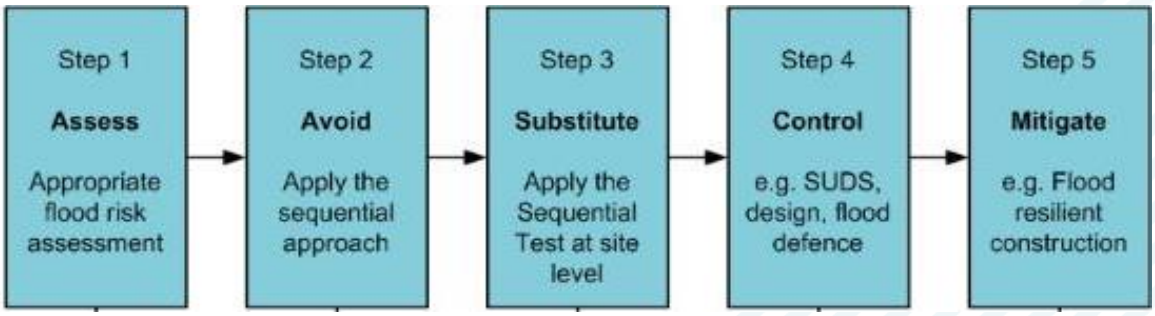

Figure 6-1: Flood risk management hierarchy

There are two different aims in carrying out the Sequential Test depending on what stage of the planning system is being carried out, i.e. LPAs allocating land in local plans or determining planning applications for development. The LPA will apply the Sequential Test to strategic allocations for inclusion in the local plan using the whole local planning authority area to increase the possibilities of accommodating development which is not exposed to flood risk, both now and in the future. For other developments, such as windfall developments, developers must supply evidence to the LPA, with a suitable planning application, that the development has passed the test.

This Level 1 SFRA provides the basis for applying the Sequential Test. However, the LPA may decide to perform the test as part of the Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of Strategic Housing Land or Employment Land Availability Assessments. Note: the site screening outcomes from this SFRA do not remove the need for a site-specific Flood Risk Assessment at the planning application stage.

Whether any further work is needed to decide if the land is suitable for development will depend on both the vulnerability of the development and the flood zone it is proposed for.

Table 2 of the FRCC-PPG[13] defines the flood risk vulnerability and flood zone 'incompatibility' of different development types to flooding, 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	✔ *

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

6.3 The Sequential Test for local plan preparation

The NPPF, para 161, states:

"*All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property*". This should also include residual risk.

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.*"

The LPA should seek to avoid inappropriate development in areas at risk of all sources of flooding 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.

13 Flood risk and coastal change - GOV.UK (www.gov.uk)

At a strategic level, this should be carried out through the Local Plan using this Level 1 SFRA. This should be done broadly by:

1. Applying the Sequential Test and if the Sequential Test is passed, applying and passing the Exception Test, if required;
2. Safeguarding land from development that is required for current and future flood management (i.e. using potential for WwNP data as a starting point);
3. Using opportunities offered by new development to reduce the causes and impacts of flooding through effective mitigation;
4. Identifying where flood risk is expected to increase with climate change and where existing development may not be sustainable in the long term; and
5. Seeking opportunities to facilitate the relocation of development including housing to more sustainable locations.

Figure 6-3 presents Diagram 2 of the FRCC-PPG (para 026) which illustrates the Sequential Test process. 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 contained in Part 2 of the report that includes site specific information.

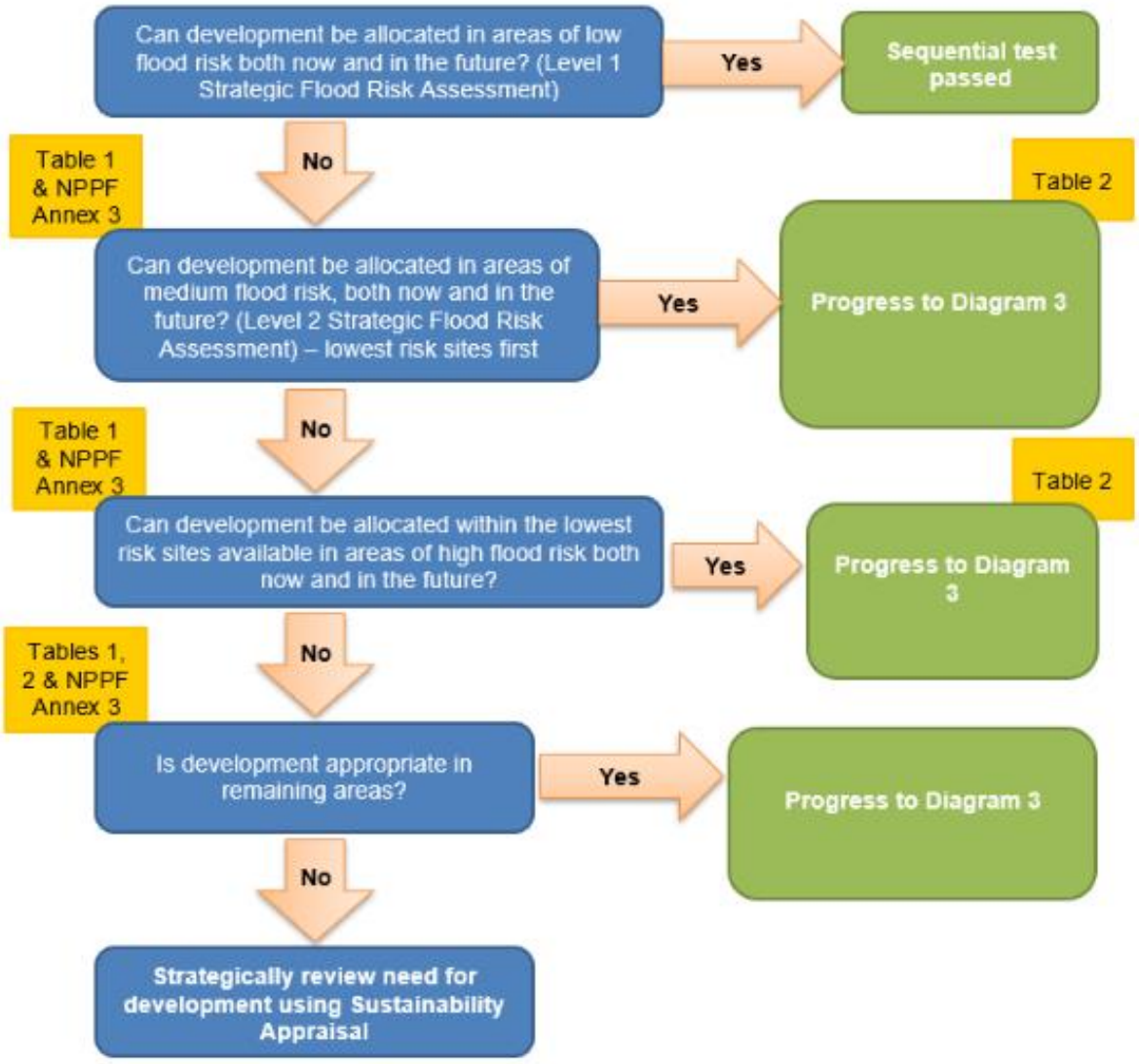

Figure 6-3: Application of the Sequential Test for plan preparation[14]

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),
  - 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),

14 https://www.gov.uk/guidance/flood-risk-and-coastal-change#para25

- 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 3 (rivers),
  - 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 3 plus climate change.

Other sources of flooding also need to be considered. For example, if the site is solely within Flood Zone 1 but is at risk from other sources and/or climate change impacts, the Sequential Test has not been satisfied.

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. The LPA 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 the LPA, however the LPA can consult the EA regarding proposed sites and any local information or consultations with the LLFA should also be taken into account.

This SFRA provides the main evidence required to carry out this process. The process also enables those sites that have passed the Sequential Test and may require the Exception Test, 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 (para 163).

6.4 The Exception Test for local plan preparation

The NPPF, para 164, 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."

Both elements of the test must be passed to enable allocation in the 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 166 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 applied to allocate the site in the 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 2 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.

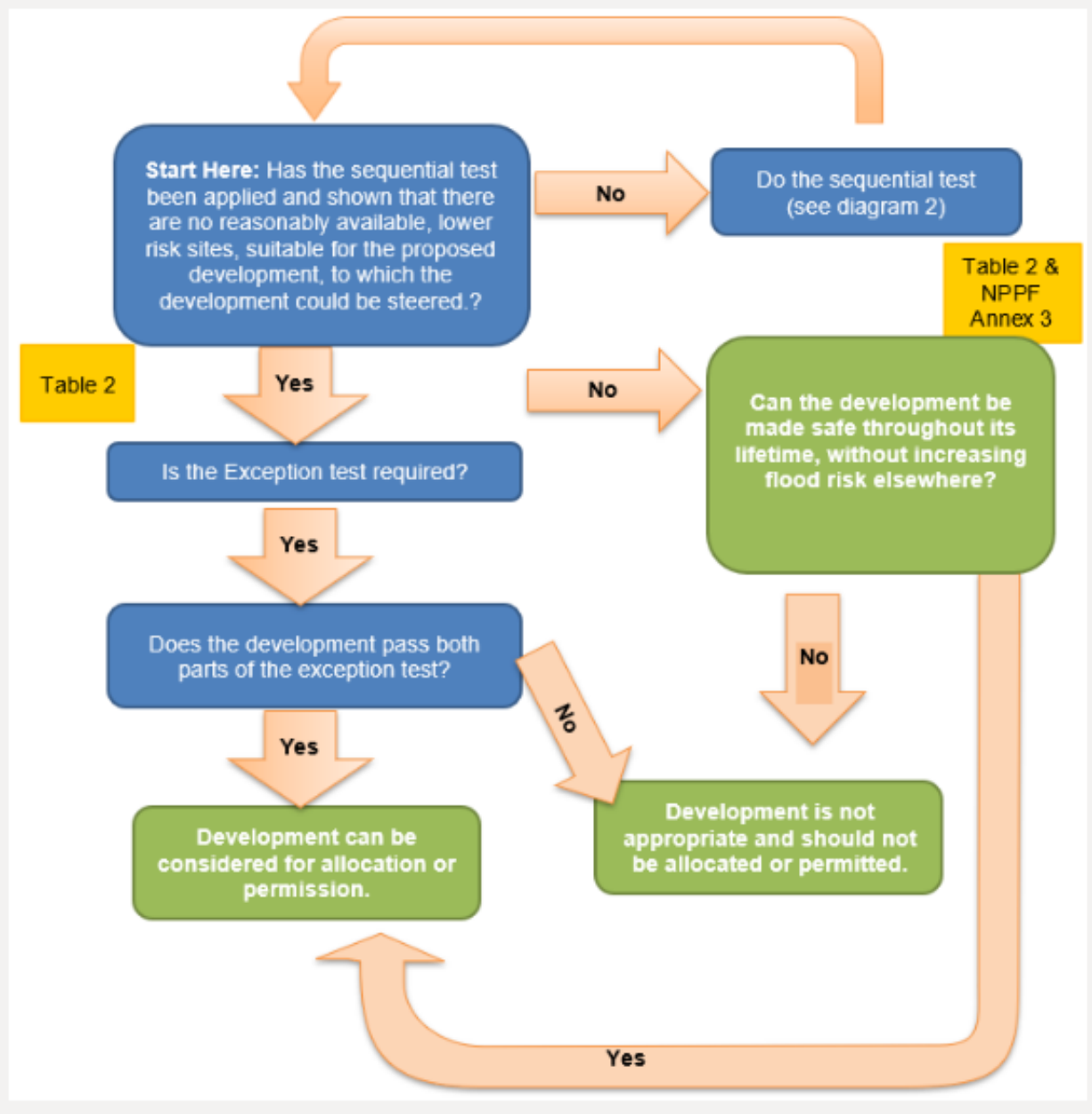

Figure 6-4: Application of the Exception Test to plan preparation

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 the LPA should consider avoiding the site altogether.

Once this process has been completed, the LPA 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 Sustainability Appraisal (SA) and flood risk

The Sustainability Appraisal (Section A.5.4 of Appendix A) of the Local Plan should help to ensure that flood risk is taken into account at all stages of the planning process with a view to directing development away from areas at flood risk, now and in the future, by following

the sequential approach to site allocation, as shown in Figure 6-3. The SA should be informed by this SFRA so that flood risk is fully accounted for when considering allocation options and in the preparation of plan policies, including policies for flood risk management to ensure that flood risk is not increased (para 007 FRCC-PPG).

By avoiding sites identified in this SFRA as being at significant risk or by considering how changes in site layout and design can avoid those parts of a site at flood risk, the Council would be demonstrating a sustainable approach to development. See Part 2 and Appendix 2A of this Level 1 SFRA for further details on site selection methodology.

In terms of surface water, a similar approach should be followed though there should be no recommendation not to allocate a site, as the RoFSW is not detailed enough to inform such decisions. It is there rather to inform the requirement for further work to fully quantify the surface water risk through more detailed modelling, site inspection, review of groundwater conditions and appropriate SuDS.

Once the LPA has decided on a final list of sites to be allocated through the Local Plan, following application of the Sequential Test and, where required, the Exception Test following a Level 2 SFRA, a phased approach to development should be adopted to avoid any cumulative impacts that multiple developments may have on flood risk. For example, for a large strategic site, this could involve a development strategy of designing and constructing higher, upstream development sequentially ahead of development lower down on the site. For any site where it is required, following the Sequential Test, to develop in Flood Zone 3, detailed modelling would be required to ascertain where displaced water, due to development, may flow and to calculate subsequent increases in downstream flood volumes. The modelling should investigate scenarios based on compensatory storage techniques to ensure that downstream or nearby sites are not adversely affected by development on other sites. The LPA must use this approach when reviewing planning applications.

6.5.1 Cumulative impacts

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 160).

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.

Consideration should be given to the following:

- The importance of phasing development, as discussed in Section 6.5.4;
- Cross boundary impacts i.e. there should be dialogue between CBMDC and neighbouring authorities upstream and downstream of the District on flood risk management practices and development;
- Leaving space for floodwater by safeguarding land through the Local Plan and utilising greenspace for flood storage and slowing the flow (see Sections 6.5.35.7.4);
- Ensuring floodplain connectivity; and
- SuDS and containment of surface water onsite as opposed to directing elsewhere (see Section 6.8).

When allocating land for development, consideration should be given to the potential cumulative impact of 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 developments are required to comply with the NPPF 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.

CBMDC have a general duty to engage and cooperate with neighbouring authorities on general growth levels, likely areas for allocation and cross boundary impacts.

Through the Local Plan, CBMDC will 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 the CBMDC area;
- 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 the CBMDC area;
- 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 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.

According to the NPPF, the LPA 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 requires all risk management authorities (RMAs) to cooperate with relevant authorities regarding exercising flood and coastal risk management. Bradford is represented by the Yorkshire Regional Flood and Coastal Committee (RFCC) where cross-boundary resources, projects and data are shared.

6.5.2 Hydrological linkages and cross boundary issues

The main watercourses within the Bradford district all originate from within the Craven District authority boundary. Therefore, major land use changes within neighbouring catchment areas may have a significant impact on flow regimes and flood risk. A number of watercourses that flow through the Bradford district enter into neighbouring catchments and local authority boundaries. Development control and responsible land management across the Bradford district is crucial to ensuring sustainable development within neighbouring authority boundaries.

Figure 6-5 illustrates fluvial hydraulic linkages for the catchments in and around the authority area of CBMDC. The River Aire and River Wharfe enter the Bradford district from the Craven District to the west; upstream land use changes within the Craven district area could influence flood risk along these watercourses. These watercourses then leave the CBMDC area and flow into Leeds district. Close partnerships between CBMDC and the surrounding authorities will need to be maintained.

Where the above strategic solutions are 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.

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 Bradford district. This should be carried out through the successful implementation of the Sequential Test.

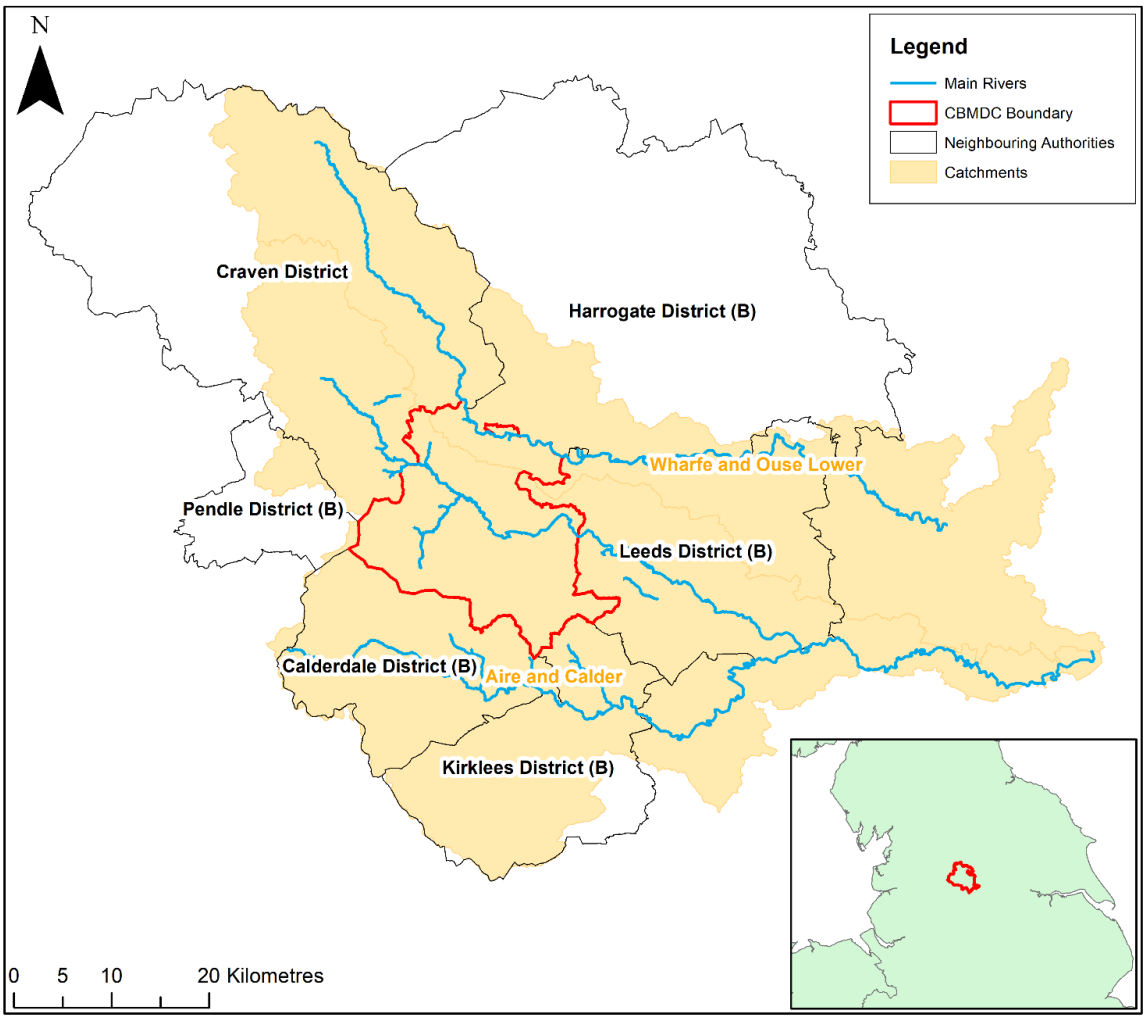

Figure 6-5: Hydrological linkages for catchments in and around the Bradford district

6.5.3 Safeguarding land for flood storage

Where possible, the LPA may look to allocate land designed for flood storage functions. Such land can be explored through the site allocation process whereby an assessment is made, using this SFRA, of the flood risk at assessed sites and what benefit could be gained by leaving the site undeveloped. In some instances, the storage of floodwater can help to alleviate flooding elsewhere, such as downstream developments. Where there is a large area of a site at risk that is considered large enough to hinder development, it may be appropriate to safeguard this land for the storage of floodwater.

Section 14; Paragraph 161 of the NPPF states that, 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 sites assessed through this SFRA may include any current greenfield sites:

- That are considered to be large enough (>1 hectare) to store floodwater to achieve effective mitigation;
- With large areas of their footprint at high or medium surface water flood risk (based on the RoFSW);
- That is within the functional floodplain (Flood Zone 3b);

- With large areas of their footprint at risk from Flood Zone 3a or 2; and
- That are within Flood Zone 1 but 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 site clearance of existing buildings, conversion to greenspace and contaminated land assessments.

By using the sequential approach to site layout, the LPA and developers should be able to avoid the areas at risk and leave clear for potential flood storage. See the interactive mapping hosted on CBMDC's online web-GIS system to spatially assess the areas of the sites at risk, that can be accessed via this link.

6.5.4 Phasing of development

Flood risk should be considered at all stages of the planning process with a view to directing development away from areas at flood risk, now and in the future, by following the sequential approach to site allocation, as shown in Figure 6-6.

Using a phased approach to development, based on modelling results of floodwater storage options, should ensure that any sites at risk of causing flooding to other sites are developed first to ensure flood storage measures are in place before other sites are developed, thus ensuring a sustainable approach to site development. Also, it may be possible that flood mitigation measures put in place at sites upstream could result in a net reduction in downstream flows helping to alleviate flooding at downstream or nearby sites. Large strategic multiple development sites should also carry out development phasing within the overall site boundary to avoid cumulative impacts within the site, as well as off the site.

6.6 Guidance for developers

This SFRA provides the evidence base for developers to assess flood risk at a strategic level and to determine the requirements of an appropriate site-specific FRA. Before carrying out an FRA, developers should check with the LPA whether the Sequential Test has been carried out. If not, the developer must apply the Sequential Test as part of their FRA by comparing their indicative development site with other available sites to ascertain which site has the lowest flood risk. The EA provides advice on this via:

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

Table 6-1 identifies, for developers, when the Sequential and Exception Tests are required for certain types of development and who is responsible for providing the evidence and those who should apply the test if required.

Development	Sequential Test Required?	Who applies the Sequential Test?	Exception Test Required?	Who applies the Exception Test?
Allocated sites	No (assuming the development type is the same as that submitted via the allocations process)	LPA should have already carried out the test during the allocation of development sites	Dependent on land use vulnerability (see Table 2 of the FRCC-PPG)	LPA to advise on the likelihood of test being passed. The developer must also provide evidence that the test can be passed by providing planning justification and producing a detailed FRA

Development	Sequential Test Required?	Who applies the Sequential Test?	Exception Test Required?	Who applies the Exception Test?
				otherwise the development would not be permitted
Windfall Sites	Yes	Developer provides evidence, to the LPA that the test can be passed. An area of search will be defined by local circumstances relating to the catchment and for the type of development being proposed	Dependent on land use vulnerability	Developer must provide evidence that the test can be passed by providing planning justification and producing a detailed FRA
Regeneration Sites Identified Within Local Plan	No	-	Dependent on land use vulnerability	LPA to advise on the likelihood of test being passed. The developer must also provide evidence that the test can be passed by providing planning justification and producing a detailed FRA
Redevelopment of Existing Single Properties	No	-	Dependent on land use vulnerability	Developer must provide evidence that the test can be passed by providing planning justification and producing a detailed FRA
Changes of Use	No (except for any proposal involving changes of use to land involving a caravan, camping or chalet site)	Developer provides evidence to the LPA that the test can be passed	Dependent on land use vulnerability	Developer must provide evidence that the test can be passed by providing planning justification and producing a detailed FRA

Table 6-1: Development types and application of Sequential and Exception Tests for developers

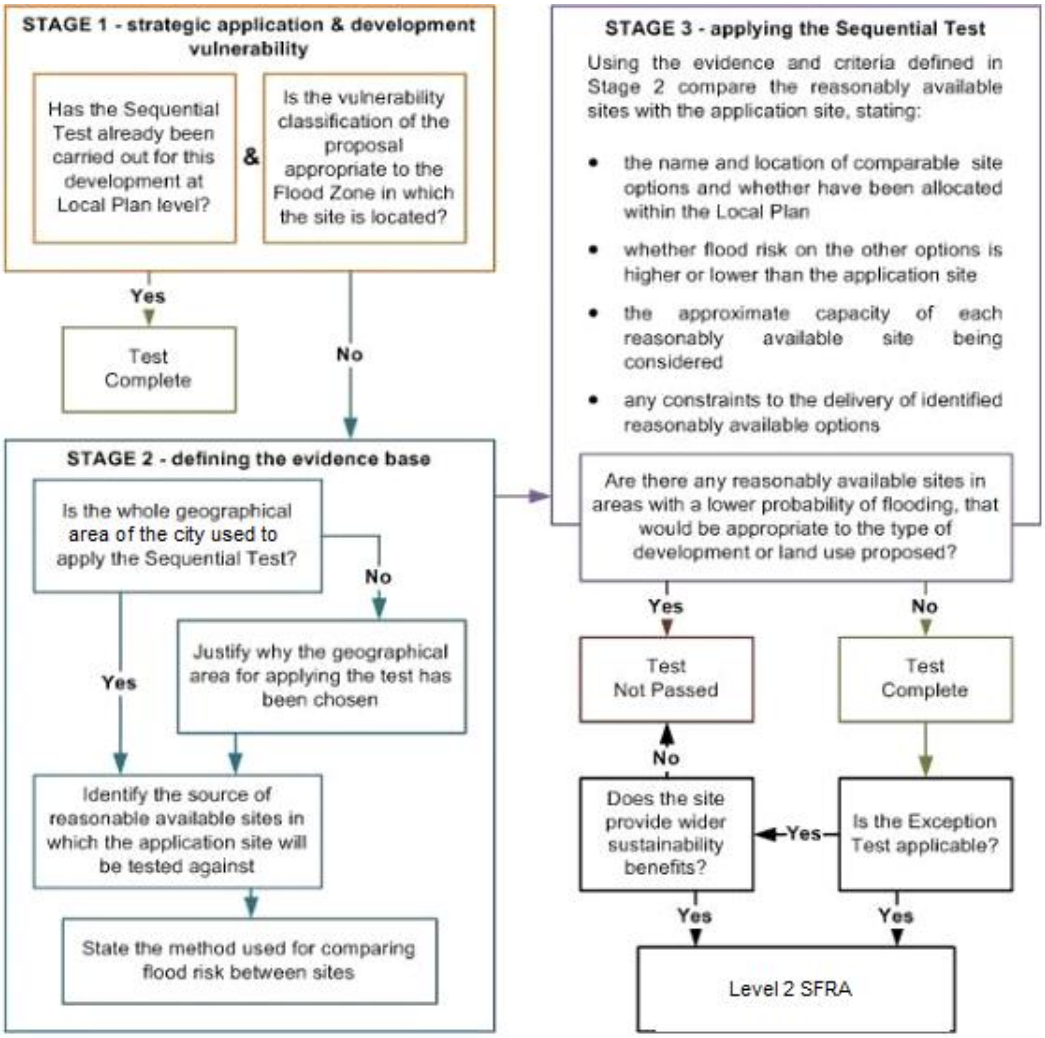

Figure 6-6: Development management Sequential Test process[15]

The Sequential Test does not apply to change of use applications unless it is for change of land use to a caravan, camping or chalet site, or to a mobile home site or park home site. The Sequential Test can also be considered adequately demonstrated if both of the following criteria are met:

- The Sequential Test has already been carried out for the site (for the same development type) at the strategic level (Local Plan informed by SFRA); and
- The development vulnerability is appropriate to the flood zone (see Annex 3 of the NPPF).

If both these criteria are met, reference should be provided for the site allocation of the Local Plan document and the vulnerability of the development should be clearly stated.

When applying the Sequential Test, the following should also be considered:

- The geographic area in which the Test is to be applied;
- The source of reasonable available sites in which the application site will be tested against; and

15 https://www.gov.uk/guidance/flood-risk-and-coastal-change

- The evidence and method used to compare flood risk between sites.

Sites could be compared in relation to flood risk; Local Plan status; capacity; and constraints to delivery including availability, policy restrictions, physical problems or limitations, potential impacts of the development on the local area, and future environmental conditions that would be experienced by the inhabitants of the development.

The test should conclude if there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use that has been put forward in the Local Plan.

The LPA should now have sufficient information to be able to assess whether the site has passed the Sequential Test. If the Test has been passed, then the developer should apply the Exception Test in the circumstances set out by Table 1 of the FRCC-PPG and Annex 3 of the NPPF.

In all circumstances, where the site is within areas at risk of flooding and where a site-specific FRA has not already been carried out, a site-specific FRA should be completed in line with the NPPF and the FRCC-PPG.

In addition to the formal Sequential Test, the NPPF sets out the requirement for developers to apply the sequential approach to locating development within the site. As part of their application and masterplanning discussions with applicants, LPAs should seek whether:

- Flood risk can be avoided by substituting less vulnerable uses or by amending the site layout;
- Less vulnerable uses for the site have been considered; or
- Density can be varied to reduce the number, or the vulnerability of units located in higher risk parts of the site.

When initially considering the development options for a site, developers should use this SFRA, the NPPF and the FRCC-PPG to:

- ***Identify whether the site is***
    - *A windfall development, allocated development, within a regeneration area, single property or subject to a change of use to identify if the Sequential and Exception Tests are required.*
- ***Check whether the Sequential Test and/or the Exception Test have already been applied***
    - *Request information from the LPA on whether the Sequential Test, or the likelihood of the site passing the Exception Test, have been assessed;*
    - *If not, provide evidence to the LPA that the site passes the Sequential Test and will pass the Exception Test.*
- ***Consult with the LPA, the LLFA and the EA and the wider group of flood risk consultees, where appropriate, to scope an appropriate FRA if required***
    - *Guidance on FRAs is provided in Section 6.11 of this SFRA;*
    - *Also, refer to the EA guidance online, the NPPF and the FRCC-PPG;*
    - *Consult the LLFA on surface water and ordinary watercourses.*
- ***Submit FRA to the LPA for approval. The LPA may then consult the EA, if required. The EA will then review the FRA in relation to their remit and give recommendations to the LPA.***

6.7 Planning for climate change (NPPF)

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 161).

Local plans 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.

See Section 6.7.2 and Part 2 of the report (that includes site specific information) for further details on how climate change has been factored into the site screening process.

6.7.1 EA climate change allowances

The EA revised the climate change allowances in 2021, for use in FRAs and SFRAs and will, at the time of writing, use these revised allowances when providing advice. There have been several updates carried out to the allowances since the release of UKCP18.

Developers should refer to the climate change allowances on the Government website[16] to ensure those outlined below are the most up-to-date available.

The climate change allowances are predictions of anticipated change for:

- Peak river flow by EA management catchment (see Table 6-2); and
- Peak rainfall intensity (see Table 6-3).

Peak river flow allowances show the anticipated changes to peak flow by management catchment. Management catchments are sub-catchments of river basin districts. Both the central and higher central allowances for the 2080s epoch are required to be assessed for SFRAs. See Section 6.7.2 for the assessment of climate change for this Level 1 SFRA.

		Total potential change anticipated for peak river flows (based on a 1981 to 2000 baseline)		
Management catchment	**Allowance category**	**2020s (2015-2039)**	**2050s (2040-2069)**	**2080s (2070-2125)**
Aire and	Upper end	24%	31%	51%
Calder	Higher central	15%	18%	31%
	Central	11%	13%	23%
Wharfe and	Upper end	22%	29%	48%
Lower Ouse	Higher central	14%	18%	31%
	Central	11%	13%	23%

Table 6-2: Recommended peak river flow allowances for the Aire and Calder management catchment

To gauge the impacts of climate change on surface water, the EA states the allowances for peak rainfall intensities provided in Table 6-3 should be used for small (less than 5 km^2) and urban catchments. The peak river flow allowances (Table 6-2) should be used for any large rural drainage catchments. The EA advises that SFRAs and FRAs should assess both the central and upper end allowances to gauge the range of impacts. An understanding of present day surface water flood risk is provided by the National Surface Water Map. Following the 2022 update to FRCC-PPG, SFRAs are now required to assess present day and future surface water flood risk. Due to this requirement being introduced at a very late stage in the project, it has not been possible for this to be undertaken for the Level 1 SFRA. As an alternative, the low risk RoFSW outline has been considered as a proxy for the climate change enhanced medium risk surface water extent within the site screening assessment. Climate change enhanced surface water modelling will be completed as part of the Level 2 SFRA assessment.

	Total potential change anticipated for the...		
Allowance Category	**2020s (2015-2039)**	**2050s (2040-2069)**	**2080s (2070-2115)**
Upper end	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 6-3: Peak rainfall intensity allowances in small and urban catchments for England

16 https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

6.7.2 Climate change data in the City of Bradford District

To represent the increased flood risk resulting from climate change in fluvially dominated scenarios, peak inflows were uplifted according to the EA guidelines. For consistency and based on Environment Agency advice, the fluvial uplifts for the Aire and Calder have been consistently applied within the detailed models used to inform the SFRA, including modelled areas within the Wharfe catchment. Increases of 23% (central), 31% (higher central) and 51% (upper end) were applied to represent the allowances. The Aire and Calder climate change allowances have been applied across the Wharfe catchment as they represent similar predicted increases in peak flow when compared to the Wharfe catchment, ensure consistency and are marginally more conservative.

The site assessment spreadsheet (contained in Part 2 of the report) highlights the additional risk to each site as a result of climate change modelling undertaken for this Level 1 SFRA update. The study has used the hydraulic models provided by the Environment Agency directly to inform the study; updates are limited to hydrological boundaries, where scaling factors reflecting current fluvial flow uplifts have been applied and used for climate change enhanced events. Within the spreadsheet, the Risk of Flooding from Fluvial Climate Change columns indicate the area of each site that intersects with each modelled flood outline. The climate change scenarios refer to the additional risk from climate change i.e. to understand the full risk the additional risk resulting from climate change should be considered in combination with the present day risk.

The climate change scenarios assessed were:

- 1 in 1000 year + upper end climate change allowance
- 1 in 100 year + central climate change allowance
- 1 in 100 year + higher central climate change allowance
- 1 in 100 year + upper end climate change allowance
- 1 in 30 year + upper end climate change allowance

Where detailed models are available, they have been used to directly, where possible, quantify the future impacts of climate change. In some cases, due to limitations in running the models, it has been necessary to adopt a proxy approach. The use of a proxy approach is a short term interim measure; updated modelling is currently being completed and outputs are expected to be available later in 2023 for use within the Level 2 assessment. Further details are contained in Appendix B and Appendix C. In adopting this approach, it has only been possible to quantify the future risk associated with the 1 in 1000 year event in areas that have a detailed hydraulic model. Outside of these areas, a conservative approach should be taken to allocations that are in close proximity to the present day 1 in 1000 year extent defined by the FMfP.

The climate change modelled flood outlines are hosted on CBMDC's online web-GIS portal, that can be accessed via this link.

6.8 Sustainable drainage systems (SuDS)

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. 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) announced, in December 2014, that the local planning authority, in consultation with the LLFA, should be responsible for delivering SuDS[17] through the planning system. Changes to planning legislation gave 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'[18], published in March 2015. A Practice Guidance[19] document has also been developed by the Local Authority SuDS Officer Organisation (LASOO) to assist in the application of the non-statutory technical standards.

The Design and Construction Guidance (DCG) 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 via:

https://www.water.org.uk/wp-content/uploads/2020/01/Water-UK-SuDS-brochure.pdf

CBMDC 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.

To satisfy the NPPF, applicants must demonstrate that priority has been given to the use of SuDS in their development proposals. SuDS should be provided by default unless demonstrated to be inappropriate. Where priority use of SuDS cannot be achieved, applicants must justify this by submitting robust and acceptable evidence.

The latest SuDS guidance for new housing developments in the Bradford District can be found in the 'Homes and Neighbourhoods: A Guide to Designing in Bradford'[20].

6.8.1 SuDS and the NPPF, 2023

The NPPF, para 169, 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;

———————————————————————————————————

17 http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/

18 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf

19 http://www.susdrain.org/files/resources/other-guidance/lasoo_non_statutory_suds_technical_standards_guidance_2016_.pdf

20 https://www.bradford.gov.uk/planning-and-building-control/planning-policy/homes-and-neighbourhoods-a-guide-to-designing-in-bradford/

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, are to include SuDS, providing multiple benefits that contribute to many other NPPF policies, including climate change, biodiversity net gain, green and blue infrastructure, 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. At a strategic level, this should mean identifying opportunities for a variety of SuDS components according to geology, soil type, topography, groundwater/mine water conditions, their potential impact on site allocation, and setting out local SuDS guidance and opportunities for in perpetuity adoption and maintenance.

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 sustainable drainage systems must be maintained.

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

6.8.2 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. Developers should also establish that proposed outfalls are hydraulically capable of accepting the runoff from SuDS through consultation with the LLFA, EA and YW as appropriate.

The EA may also look at the potential impact of an outfall structure through the planning consultation and Environmental Permitting Regulation process. It should be noted that detailing 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 SuDS (March 2015).

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

- Flood risk outside the development;
- Peak flow control;
- Volume control;
- Flood risk within the development;
- Structural integrity;
- Designing for maintenance considerations; and
- 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 6-7), will be required, where source control is the primary aim. Source control includes interception of the first 5mm rainfall and water quality treatment 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. Defra will use this research to inform its drainage policy development.

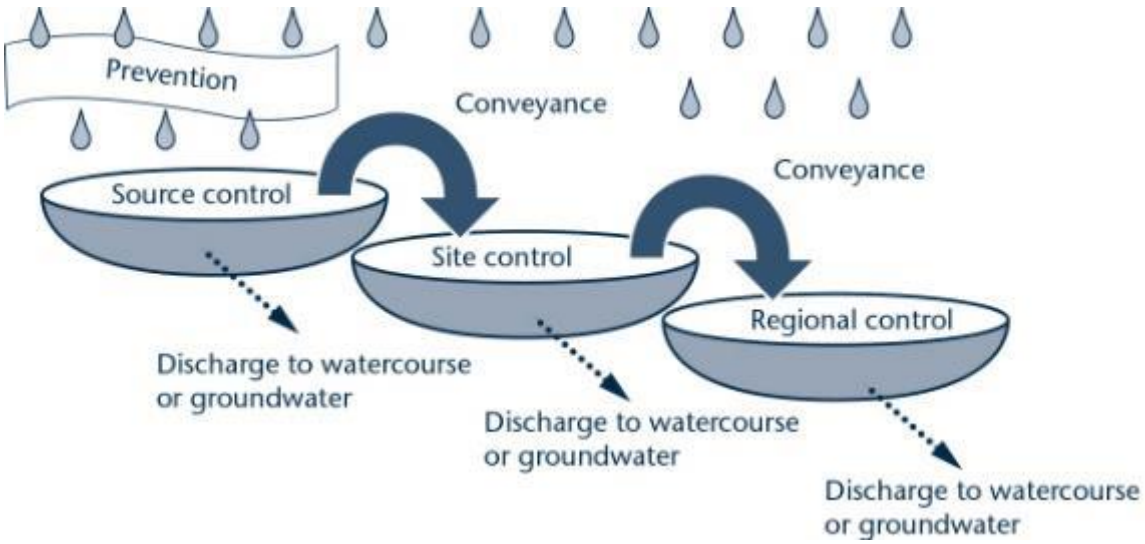

Figure 6-7: SuDS management train principle[21]

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 LPA may set local requirements for planning permission that include more rigorous obligations than the non-statutory technical standards. 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 LPA should always be contacted with regards to its local requirements at the earliest opportunity in development planning.

The CIRIA SuDS Manual[22] 2015 should also be consulted by the LPA and 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-statutory technical standards and goes further to support the cost-effective delivery of multiple benefits.

6.8.3 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

21 CIRIA (2008) Sustainable Drainage Systems: promoting good practice – a CIRIA initiative

22 https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

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 ensure that existing overland flow paths are retained within the development. 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, as shown by the RoFSW dataset and the implications of other sources of flooding. 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. Floor levels should always be set a minimum of 300 mm above ground level (or 300 mm freeboard above design flood level) to reduce the consequences of any localised flooding unless local guidance states otherwise.

6.8.4 Surface Water Drainage (CBMDC Development Management Standards)

Development should demonstrate compliance with Building Regulations (H3) – Hierarchy of surface water disposal. Consideration should be given to discharge surface water to soakaway, infiltration system and watercourse in that priority order. Only in the event of such techniques proving impracticable will disposal of surface water to an alternative outlet be considered. All development to have a separate foul and surface water drainage system.

The surface water drainage design of a development should accommodate:

1 in 2 year event + Climate Change within pipeline.

1 in 30 year event + Climate Change no site flooding.

1 in 100 year event + Climate Change no flooding to building, essential infrastructure, access and egress or to neighbouring land.

Runoff from greenfield development restricted to 2l/s/ha or the peak rate to be established by calculation as per table 4.2, C697. New connections to watercourses must be restricted to greenfield runoff rates up to 1:100 year storm plus climate change. The existing system is to be proved structurally and hydraulically to the nearest open outfall. Existing connections to watercourses to be restricted with a minimum 50% reduction to existing peak flow rates up to 1:100 year storm plus climate change. If the existing system can be proven structurally and hydraulically to the outfall a 30% restriction will be permitted.

Brownfield connection to the public sewer to be restricted with a minimum 30% reduction to existing peak flow rates up to 1:100-year storm plus climate change. Existing peak rainfall intensity to be 50mm/hr in lieu of detailed rainfall calculations.

Soakaways/Infiltration systems to have infiltration tests to be carried out as per BRE 365. Prior to use of infiltration system, Environment Agency to be consulted to assess if the discharge point lies within a ground water protection zone.

Surface runoff should be passed through the correct levels of treatment prior to discharge to an outfall. The levels of treatment are dependent on the pollution risk from the development and the receiving outfall. Table 6-4 below gives an outline guide on the levels of treatment to be adopted. However, individual sites should be assessed on their own merits.

	Receptor			
Catchment Profile	**Normal River, Watercourse, Ground Water, Environment**	**Sensitive River, Watercourse, Ground Water, Environment**	**Surface Water Sewer**	**Combined Water Sewer**
Residential < 100 houses	1	2	1	1
Residential 100-500 houses	2	2	2	1
Residential 500+ houses	3	3	3	1
Offices & parking < 20 cars	1	2	1	1
Offices & parking 20-100 cars	2	2	2	1
Offices & parking 100-500 cars	2	3	2	1
Offices & parking 500+ cars	3	3	3	1
Retail park typical 1000+ cars	2	3	2	1
Industrial estate	3	3	3	1
Highway	2	2	2	1

Table 6-4: Surface Water Treatment Matrix

6.9 Finished floor levels

6.9.1 Modified ground levels

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

Modifying ground levels to raise land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for floodwaters. However, care must be taken as raising land above 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 analyses through 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 would normally be on a level-for-level, volume-for-volume basis on land that does not currently flood but is adjacent to the floodplain (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). Guidance

on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624.

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.

6.9.2 Raised floor levels

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

The EA advises that minimum FFLs should be set 300mm above the 1% AEP plus climate change peak river flood level, where the latest climate change allowances have been used (see Section 6.7 for the climate change allowances). The 1% AEP fluvial flood event plus an allowance for climate change is considered to be the 'design flood event' for new development (para 002 FRCC-PPG). An additional allowance may be required because of risks relating to blockage in the channel or at structures that are present and should be considered as part of an FRA.

Allocating 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 rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route from the development to safe areas.

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 300mm above the design flood level and waterproof construction techniques used.

6.10 Property Flood Resilience (PFR)

PFR measures should only be applied retrospectively to existing development that is at flood risk, as new development should be directed away from areas at flood risk. However, Para 167 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. Resistance and resilience measures may aim to help residents and businesses recover more quickly following a flood event.

It should be noted that it is not possible to completely prevent flooding to all communities and businesses.

Research carried out by the DLUHC and the EA has recommended that the use of resistance 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 above this level.

It should be noted that 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 (see Section 7) 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 in conjunction with pumps of a sufficient capacity. Pumps help manage residual flood risks not addressed by resistance measures alone such as rising groundwater.

6.10.1 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, flood water can also flow 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.

6.10.2 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 a number of ground spot levels required to better understand the flood mechanisms for flood water arriving at the property (e.g. along road, pavements, etc.). The depth of flooding at each property will help guide the selection of resistance measures proposed. Surveys will need to include consideration of issues such as:

- Detailed property information;
- An assessment of flood risk, including property (cross) threshold levels;
- Routes of water ingress (fluvial, ground and surface water flooding);
- An assessment of impact of flood waters;
- A schedule of measures to reduce risk (resistance and resilience);
- Details of recommendations (including indicative costs);
- Advice on future maintenance of measures; and
- Advice on flood preparedness.

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 identify possible weaknesses in any deteriorating brickwork or mortar.

6.11 Flood Risk Assessment

A flood risk assessment is required for all sites and should be proportionate to the risk and appropriate to the scale, nature and location of the development taking account flooding from all sources. Freeboard allowance for 1:100 year fluvial flood levels should be: 600mm for dwellings; 400mm for offices/commercial; 300mm for industrial/warehousing.

Ordinary watercourses should not be culverted and are to be re-opened where possible. Works to ordinary watercourse may require a Land Drainage Consent from CBMDC as Lead Local Flood Authority.

Further guidance in relation to preparation of Flood Risk Assessments (FRAs) can be found online on the gov.uk website.

7 Emergency Planning

The provisions for emergency planning for local authorities as Category 1 responders are set out by the Civil Contingencies Act, 2004 and the National Flood Emergency Framework for England, December 2014[23]. This framework is a resource for all involved in emergency planning and response to flooding from the sea, 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 players 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;
- Providing clarity on the means of improving resilience and minimising the impact of flooding 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 sub-regional and local level, outlining the major risk of 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[24] (September 2019). It would however be for the LPA to review and approve flood risk emergency plans with their emergency planners.

This SFRA contains useful data to allow emergency planning processes to be tailored to the needs of the area and be specific to the flood risks faced. The interactive mapping hosted on CBMDC's online web-GIS system (assessable via this link) and accompanying GIS layers should be made available to emergency planners to help prepare for any flood event and throughout the planning process. Emergency planning arrangements will be assessed in greater detail, including local site assessment within the Level 2 SFRA.

7.1 Civil Contingencies Act

Under the Civil Contingencies Act (CCA, 2004)[25], the LLFA and LPAs 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;

23 https://www.gov.uk/government/publications/the-national-flood-emergency-framework-for-england

24 https://www.adeptnet.org.uk/floodriskemergencyplan

25 https://www.gov.uk/preparation-and-planning-for-emergencies-responsibilities-of-responder-agencies-and-others#the-civil-contingencies-act

- 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 authority must also co-operate with other Category 1 responders (such as the emergency services and the EA) to provide the core response.

7.1.1 West Yorkshire Resilience Forum (WYRF)

CBMDC is a partner of the West Yorkshire Resilience Forum (WYRF)[26]. The role of the Resilience Forum is to ensure an appropriate level of preparedness to enable an effective multiagency response to emergency incidents that may have a significant impact on the communities of Bradford District Council and other areas within West Yorkshire. WYRF consists of representatives from the Emergency Services, Yorkshire's local authorities (CBMDC, Calderdale Metropolitan Borough Council, Kirklees Metropolitan Council, Leeds City Council and Wakefield Metropolitan District Council), NHS England, the EA, the Met Office and National Highways.

7.1.2 Community Risk Register

As a strategic decision-making organisation, the WYRF prepared a Community Risk Register (CRR)[27], last updated in 2021 at the time of writing, which considers the likelihood and consequences of the most significant risks and hazards the area faces, including fluvial and urban flooding. This SFRA can help to complement this and inform future updates. The CRR is considered as the first step in the emergency planning process and is designed to reassure the local community that measures and plans are in place to respond to the potential hazards listed within the CRR.

7.1.3 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[28].

7.1.4 Local flood plans

This SFRA provides a number of flood risk data sources that should be used when producing or updating flood plans. The LPA 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;

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26 https://www.westyorkshire.police.uk/WYRF

27 https://www.westyorkshire.police.uk/advice/emergency-plans/reports-community-risk-register/reports-community-risk-register

28 https://www.gov.uk/guidance/resilience-in-society-infrastructure-communities-and-businesses#community-resilience

- Inform emergency planners in understanding the possibility, likelihood and spatial distribution of all sources of flooding (emergency planners may however have access to more detailed information);
- 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 which 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 following guidance written by the EA and ADEPT is aimed at LPAs to help assist in setting up their own guidelines on what should be included in flood risk emergency plans:

https://www.adeptnet.org.uk/floodriskemergencyplan

As LLFA, CBMDC has produced a Local Flood Risk Management Strategy which explains how local flood risk is managed in the Bradford district. This strategy is available online via:

https://www.bradford.gov.uk/media/4008/bradford-lfrms-final.pdf

7.2 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 provide appropriate flood warning and instructions so users and residents are safe in a flood. This will include both physical warning signs and written flood warning and evacuation plans. Those using the 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, taking into account all relevant considerations, that a development can be considered safe without the provision of safe access and egress, 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 ensure that plans are suitable. This should be done in consultation with development management officers. Given the cross-cutting nature of flooding, it is recommended that further discussions are held internally to the LPA between emergency planners and policy planners/development management officers, the LLFA, drainage engineers and also to external stakeholders such as the emergency services, the EA, YW, and Canal & River Trust (if applicable).

It may be useful for both the LLFA and spatial planners to consider whether, as a condition of planning approval, flood evacuation plans should be provided by the developer which aim to safely evacuate people out of flood risk areas, using as few emergency services 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 goes ahead, 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 and LLFA regarding maintenance and updating of the plan.

7.2.1 What should the plan include?

Upon full acknowledgement and understanding of the hazard to a site, flood warning and evacuation plans should include the information stated in Table 7-1. Advice and guidance on plans are accessible from the EA website and plan templates are available for businesses and local communities. The LPA should consider the guidance provided by the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) on Flood Risk Emergency Plans for New Development[29]. This guidance will also help developers and building owners / management to produce suitable emergency plans, and should ensure emergency planners, the WYRF, the emergency services and other risk management authorities are involved appropriately in the planning process. The guidance aims to support robust consideration of whether proposed development will be safe.

Consideration	Purpose
Availability of existing flood warning system	The EA offers a flood warning service that currently covers designated Flood Warning Areas in England and Wales. In these areas, they can provide a full Flood Warning Service.
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 occupants 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. In particular, sites that will be visited by members of the public on a daily basis 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 staff/occupants/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 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 NPPF. This is closely linked to its occupiers.

29 https://adeptnet.org.uk/floodriskemergencyplan

Consideration	Purpose
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.

Table 7-1: Flood warning and evacuation plans

7.2.2 EA Flood Warning Areas (FWA) and flood awareness

The EA monitors river levels within the main rivers affecting the authority area 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 Flood Warning Areas, encouraging residents to take action to avoid damage to property in the first instance.

More information on flood warnings is provided by the EA via:

https://www.gov.uk/government/publications/flood-warnings-what-they-are-and-what-to-do

at the time of writing there are 25 FWAs in operation across the Bradford district. The FWAs are located along the River Aire, River Wharfe and their tributaries to protect the properties and businesses within the Plan Area. The FWAs are shown on the interactive mapping hosted on CBMDC's online web-GIS system (assessable via this link).

Live information on flood warning and flood alerts is available via:

https://flood-warning-information.service.gov.uk/

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.

https://www.gov.uk/sign-up-for-flood-warnings

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 ensure that adequate pre-planning response and recovery arrangements are in place.

8 Planning policy and flood risk recommendations

The following planning policy recommendations relating to flood risk are designed to enable the LPA to use the information provided in this Level 1 SFRA to inform Local Plan policy direction:

Recommendation 1: No development within the functional floodplain

…other than for essential infrastructure and water compatible uses, which must still pass the Exception Test where required, shall be permittable as per the NPPF and FRCC-PPG.

Development within functional floodplain must not result in a net loss of floodplain storage, nor should it impede flood flows or increase flood risk elsewhere. Sites containing areas of functional floodplain may still be developable if the developable site boundary can be removed from the functional floodplain or the area of functional floodplain is kept free from development and obstruction and allowed to flow freely. The Areas in, under or over all watercourses or waterbodies are considered Flood Zone 3b.

Due to coarse mapping scales and limited data quality, not all features of Flood Zone 3b are mapped. Where Flood Zone 3b is not mapped by any other source, Flood Zone 3b policy should relate to the actual confirmed alignment of the watercourse, culverted section or waterbody identified through site investigation rather than the alignment shown in Flood Zone 3b Mapping outputs, where datasets differ. This also applies to areas where culverts are involved and/or discovered through site investigation.

Existing development, including changes of use, within the functional floodplain must take account of the policy approaches listed in Section 5.2.2 of this report. Owners of any existing building or structure located within Flood Zone 3b or the future Flood Zone 3b must consult the LPA if any construction is planned to be carried out beyond the current development footprint. Any development or redevelopment must not extend beyond the current footprint and, where possible, the development footprint should be reduced. Where existing buildings are to be demolished, consideration should be given to reducing the new building footprint and increasing the area of open space. All redevelopments or plans for extensions to existing buildings in Flood Zone 3b or the future Flood Zone 3b must be subject to planning approval through a formal planning application. It is likely that any redevelopment beyond current development footprints will be refused on flood risk grounds.

Recommendation 2: Consider surface water flood risk

…with equal importance alongside fluvial risk.

SuDS on all new development must adhere to industry standards and to the applicable runoff discharge rate and storage volume allowances stated by the LLFA.

Site-specific FRAs should always consider surface water flood risk management and options for onsite flood storage through appropriate SuDS. A Sustainable Drainage Strategy should always be submitted which clearly takes account of the findings of the site-specific FRA and specify the proposed design, constructions, adoption and management and maintenance arrangements of the proposed SuDS components. The LPA and LLFA must always be consulted during this process, as should YW and the EA, if required.

All SuDS must be designed to meet industry standards, as specified below, including any replacement standards/documents which update or are in addition to those listed:

- Technical Standards for Sustainable Drainage Systems (Defra);
- Non-technical Standards for Sustainable Drainage Systems (Defra);
- Homes and Neighbourhoods: A Guide to Designing in Bradford (CBMDC) SPD;
- C753 The SuDS Manual; and
- Sewerage Sector Guidance (2020).

Recommendation 3: Sequential approach to site allocation and site layout

…must be followed by the LPA to ensure sustainable development when either allocating land in Local Plans or determining planning applications for development.

The overall aim of the Sequential Approach (outlined in Section 6.2) applied by developers and regulated by the LPA should be to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account.

Where there are no reasonably available sites in a suitable location for the type of development, the flood risk vulnerability of land uses and reasonably available sites in areas of medium flood risk should be considered, applying the Exception Test if required.

This SFRA, the NPPF and FRCC-PPG must be consulted throughout this process along with the LLFA, EA, and YW.

Recommendation 4: recommended requirements for a site-specific Flood Risk Assessment

…from a developer when a site is:

- Located within Flood Zone 2 and/or Flood Zone 3;
- Greater than 1 ha in area;
- Within Flood Zone 1 where any part of the site is identified by the Risk of Flooding from Surface Water maps as being at risk of surface water flooding;
- Identified by the EA as having critical drainage problems (within an Area with Critical Drainage Problems);
- Situated over or within 8 metres of a culverted watercourse or where development will be required to control or influence the flow of any watercourse;
- Within 20 metres of a Main River (due to potential increase in risk associated with climate change);
- Identified as being at increased flood risk from climate change;
- At risk of flooding from other sources of flooding or at residual risk;
- Subject to a change of use to a higher vulnerability classification which may be subject to other sources of flooding; and
- Situated in an area currently benefitting from defences.

Information on when a Flood Risk Assessment would be required and what the requirements are can be found on https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications within the 'Flood risk assessments if you're applying for planning permission' guidance.

Before deciding on the scope of the FRA, this SFRA should be consulted along with the LPA and the LLFA, and the EA and YW if appropriate. The FRA should be submitted to and be approved by the LPA.

Recommendation 5: Natural Flood Management techniques

…must be considered, where possible, to aid with flood alleviation and implementation of suitable SuDS, depending on the location.

The national Working with Natural Processes mapping (included in this SFRA) should be consulted in the first instance, followed by local investigation into whether such techniques are appropriate and whether the benefits are proportionate to the work required to carry out the identified Working with Natural Processes approaches.

Natural drainage features should be maintained and enhanced and there should be a presumption against culverting of open watercourses. Development must not take place over the top of existing culverts and, where possible, culvert removal should be explored.

Recommendation 6: Phasing of development

…must be carried out by the LPA on a site by site basis and also within sites by the developer to avoid any cumulative impacts of flood risk (reinforced by the NPPF).

Using a phased approach to development, should ensure that any sites at risk of causing flooding to other sites are developed first to ensure that flood storage measures are in place and operational before other sites are developed i.e. to ensure no net loss in flood storage, thus contributing to a sustainable approach to site development during all phases of construction. It may be possible that flood mitigation measures put in place at sites upstream could provide a wider benefit and alleviate flooding at downstream or nearby sites.

Development phasing within large strategic sites of multiple developments should also be considered where parts of such sites are at flood risk.

Recommendation 7: Planning permission for at risk sites

…can only be granted by the LPA where a site-specific FRA shows that:

- The NPPF and FRCC-PPG have been referenced together with appropriate consultation with the LLFA, the EA, and YW, where applicable;
- The effects of climate change have been taken into account using the latest allowances developed by the EA;
- There is no loss in floodplain storage resulting from the development i.e. where development takes place in a fluvial flood zone or is at risk from surface water flooding, compensatory storage must be found to avoid loss of floodplain and subsequent displacement of water which may cause flooding elsewhere;
- The development will not increase flood risk elsewhere;
- For greenfield or previously developed sites, the development should meet greenfield runoff rates (in line with the CBMDC LFRMS and SuDS guidance), achieved through providing SuDS and source control as appropriate or through the use of appropriate flow and volume control devices;
- There is no adverse effect on the operational functions of any existing flood defence infrastructure;
- Proposed resistance/resilience measures designed to deal with current and future risks are appropriate;
- The development will be safe for its lifetime and has passed the Exception Test, if applicable; and
- An appropriate Emergency Plan is included that accounts for the possibility of a flood event and shows the availability of safe access and egress points accessible during times of flood.

9 Conclusions and recommendations

9.1 Conclusions

This Level 1 SFRA provides a single repository planning tool relating to flood risk and development in the Bradford District. Key flood risk stakeholders namely the EA, LPA/LLFA and YW 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 SFRA also provides interactive mapping hosted on CBMDC's online web-GIS system (accessible via this link and site specific screening (contained in Part 2 of the report) illustrating the level of risk to potential development sites.

The flood risk information, assessment, guidance and recommendations of the SFRA will provide the LPA with the evidence base required to apply the Sequential Test, as required under the NPPF and demonstrate that a risk-based, sequential approach has been applied in the preparation of its new Local Plan.

Whilst the aim of the sequential approach is the avoidance of high flood risk areas, in some locations where the council is looking for continued growth and/or regeneration, this will 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. As this is a strategic study, detailed local information on flood risk is not fully accounted for. For a more detailed assessment of specific areas or sites, a Level 2 SFRA should be carried out following on from the completion of a Level 1 assessment. A Level 2 SFRA will be required if a site is at risk from fluvial flooding, both in the present day or future, and/or a site is within the high or medium risk RoFSW extent.

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, the LPA should look to update this SFRA. The Level 1 SFRA should be considered to be and maintained as, a 'live' entity which is updated as and when required (when new modelling or flood risk information becomes available). The LPA and LLFA can decide to update the SFRA and the EA as a statutory consultee on local plans can also advise on when an update is required to inform the local plan evidence base.

9.1.1 Summary of risk

The risk across the district is varied:

- The main fluvial risk comes from the River Aire, River Wharfe and their tributaries through the north and centre of the district;
- Surface water risk is spread across the district, with areas surrounding the main river channels being the most at risk;
- Groundwater risk is located primarily to the west of Bradford City Centre, Keighley, Burley-in-Wharfedale and Addingham; and
- Reservoir flood risk is mainly confined to areas downstream of where the reservoir is located, which includes main river channels and their tributaries into which floodwater would flow.

9.1.2 Recommendations for further work

The SFRA process has developed into more than just a planning tool. Sitting alongside the SA, LFRMS and FRMP, it can be used to provide a much broader and inclusive vehicle for integrated, strategic and local flood risk management and delivery.

There are a number of plans and assessments listed in Table 9-1 that may be of benefit to the LPA, in developing their flood risk evidence base to support the delivery of the 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.

Type	Study	Reason	Timeframe
Understanding of local flood risk	Level 1 SFRA update (keeping the SFRA 'live')	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
	Level 1 SFRA update; Level 2 SFRA; site-specific FRA	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. This could be a requirement for CBMDC if part of a Level 2 SFRA assessment or third party if required to support a site specific FRA.	Short term
	Level 2 SFRA	Further, more detailed assessment of flood risk to high-risk sites, large strategic sites, as notified by the Level 1 SFRA.	Short term

Type	Study	Reason	Timeframe
	Preliminary site-screening FRAs/ outline drainage strategy	Further, more detailed assessment of larger strategic sites, if the LPA feels this is prudent.	Short term
	Local Flood Risk Management Strategy Review	It is recommended that the 2016 LFRMS is updated in 2023 to ensure it remains consistent with the National Flood and Coastal Erosion Risk Management Strategy that was updated and published July 2020.	Short term
	SWMP/ drainage strategy/ detailed surface water modelling	CBMDC has not developed a SWMP for any areas of the Bradford district. It is recommended that the LLFA uses information from this SFRA to ascertain whether certain locations at high surface water flood risk may benefit from a SWMP or a detailed surface water modelling study.	Short to medium 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, runoff attenuation features, rewetting of moorland and sphagnum moss planting where the research indicates that it would be beneficial within the district.	Short term
Data collection	Flood Incident data	CBMDC, as LLFA, has a duty to investigate and record details of significant flood events within their area. General data collected for each incident, should include 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.	Ongoing
	FRM Asset Register	CBMDC has a responsibility to update and maintain a register of structures and features, which are considered to have an effect on flood risk.	Ongoing
Risk Assessment	Asset Register Risk Assessment	CBMDC, as LLFA, should carry out a strategic flood risk assessment of structures and features on the Asset Register to inform capital programme and prioritise maintenance programme.	Short term/ ongoing
Capacity	SuDS review/ guidance	The LLFA should clearly identify its requirements of developers for SuDS in new developments. Internal capacity,	Short term

Type	Study	Reason	Timeframe
		within CBMDC should be in place to deal with SuDS applications, set local specification and set policy for adoption and future maintenance of SuDS.	
Partnership	Yorkshire Water	The LLFA should continue to collaborate with Yorkshire Water on sewer and surface water projects. The LPA should work with the relevant water companies 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	CBMDC 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 CBMDC's existing flood risk partnerships.	Ongoing

Table 9-1: Plans and assessments beneficial to developing the flood risk evidence base

9.1.3 Level 2 SFRA

The LPA should review the sites where they expect the main housing numbers and employment sites to be delivered, drawing on the site specific information within Part 2 of the report and the interactive mapping hosted on CBMDC's online web-GIS system (that can be accessed via this link) . A Level 2 SFRA may be required for sites where any of the following applies:

- The Exception Test is required;
- Further evidencing i.e. climate change modelling is required at the strategic level in order to allocate; and
- A large site, or group of sites, are within Flood Zone 3 and have strategic planning objectives, which means they cannot be relocated or avoided.

A Level 2 SFRA should build on the source information provided in this Level 1 assessment and should show that a site will not increase risk elsewhere and will be safe for its lifetime, once developed.

A Level 2 study may also further assess locations and options, in more detail, for the implementation of open space, or Green Infrastructure, to help manage flood risk in key areas and also to assess residual risk.

Ultimately, the LPA will need to provide evidence in their Local Plan to show that housing numbers, economic needs and other sites can be delivered. Proposals within the Local Plan may be rejected if a large number of sites require the Exception Test to be passed but with no evidence that this will be possible.

Appendices

Appendix A - Planning Framework and Flood Risk Policy

Following the introduction to the planning framework and flood risk policy located in Section 4, the remainder of the policy information is located within this appendix and gives background into the policy documents that are relevant to CBMDC.

Appendix B – Functional floodplain delineation

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

Appendix C – Hydraulic Models

Excel spreadsheet indicating the models and events that have been run with climate change uplifts applied.

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