Richmondshire District Level 1 Strategic Flood Risk Assessment

Draft Final Report

August 2020

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Revision history

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Draft V1.0 / March 2020	-	Matthew Usher
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Contract

This report describes work commissioned by Matthew Usher, on behalf of Richmondshire District Council, by a letter dated 3 April 2019. Richmondshire District Council's representatives for the contract were Mark Robson and Matthew Usher. Hannah Bishop and Mike Williamson of JBA Consulting carried out this work.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to the client.

Acknowledgements

JBA would like to thank representatives of Richmondshire District Council, North Yorkshire County Council, the Environment Agency, Yorkshire Water Services and Northumbrian Water for information provided to inform this assessment.

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Executive summary

This Level 1 Strategic Flood Risk Assessment (SFRA) is an update to the combined North West Yorkshire Level 1 SFRA, completed in 2010, using up-to-date flood risk information together with the most current flood risk and planning policy available from the National Planning Policy Framework[1] (NPPF) (2019) and the Flood Risk and Coastal Change Planning Practice Guidance[2] (FRCC-PPG). The Environment Agency's revised SFRA guidance[3] (2019) is also followed and adhered to.

The Level 1 SFRA is focused on collecting readily available flood risk information from a number of stakeholders, the aim being to strategically identify the number and spatial distribution of flood risk sources present throughout Richmondshire District Council's (RDC) Local Plan area to inform the application of the Sequential Test.

RDC requires this Level 1 SFRA to initiate the sequential risk-based approach to the allocation of land for development and to identify whether application of the Exception Test is likely to be necessary. This will help to inform and provide the evidence base for the Local Planning Authority's (LPA) Local Plan review.

The strategic assessment revealed that a number of RDC's Call for Sites allocation sites are at varying risk from fluvial, surface water and residual sources. Strategic development consideration assessments for all sites are summarised through a number of strategic recommendations identified in this report and in the development sites assessment spreadsheet in Appendix C. The strategic recommendations broadly entail the following:

- Strategic Recommendation A – consider withdrawal based on significant level of fluvial or surface water flood risk (if development cannot be directed away from areas of risk);
- Strategic Recommendation B – Exception Test required;
- Strategic Recommendation C – detailed consideration of site layout and design around flood risk will be required at the site planning stage;
- Strategic Recommendation D – development can be allocated though subject to the findings of a site-specific Flood Risk Assessment at the planning stage; and
- Strategic Recommendation E – development can be allocated on flood risk grounds subject to suitable consultation with the LPA and Lead Local Flood Authority.

Sites screening assessment (Appendix C and E)

A total of 203 sites were screened against the latest available flood risk information. 170 sites were proposed for residential use, 22 for employment, 3 mixed use, 4 military barracks, 2 commercial, 1 community facility and 1 open space.

Following the flood risk screening, 16 sites are recommended as being potentially unsuitable for development, three of which is due to their location within the functional floodplain, and 13 due to significant surface water flood risk.

There are 5 sites to which Strategic Recommendation B applies, each proposed for residential use. Overall there are 16 potential sites to which Strategic Recommendation C applies. Of these sites, 7 have over 97% of their areas within Flood Zone 1, meaning surface water is the main source of risk requiring mitigation at these sites. For these

[1] https://www.gov.uk/government/publications/national-planning-policy-framework--2
[2] https://www.gov.uk/guidance/flood-risk-and-coastal-change
[3] https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment

sites, the developer should carefully consider site layout and design with a view to removing the development site footprint from the flood zone that is obstructing development i.e. the high and medium risk surface water flood zones. If this is not possible then the alternative would be to investigate the incorporation of onsite storage of water into the site design through appropriate Sustainable Drainage Systems (SuDS), following detailed ground investigation.

Strategic Recommendation D applies to 133 sites with 123 of these sites being wholly within Flood Zone 1 and therefore mainly at risk from surface water flooding.

An assessment of the effects of fluvial climate change on the potential sites was carried out in the absence of suitable modelled data from the Environment Agency. The methodology for this assessment is explained in Section 6.6.2 of this report and in Appendix E.2. It was found that 49 of the 203 sites are at high risk from the effects of fluvial climate change. The effects of climate change on surface water risk has not been modelled nationally, therefore this SFRA has considered that any site at existing surface water risk, as defined by the Environment Agency's national Risk of Flooding from Surface Water map, will likely be at increased risk in the longer term. This accounts for 145 sites.

SFRA recommendations

The main planning policy and flood risk recommendations to come out of this SFRA are outlined briefly below and are based on the fundamentals of the National Planning Policy Framework and the Flood Risk and Coastal Change Planning Practice Guidance. Section 8.2 of this report provides further detail.

SFRA recommendation:

- No development within the functional floodplain, unless development is water compatible;
- Surface water flood risk should be considered with equal importance as fluvial risk;
- The sequential approach must be followed in terms of site allocation and site layout;
- Ensure site-specific Flood Risk Assessment are carried out to a suitable standard, where required, with full consultation required with the LPA, LLFA, the EA, Yorkshire Water and Northumbrian Water;
- Appropriate investigation and use of suitably sourced SuDS;
- Natural Flood Management techniques must be considered for mitigation;
- 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 a site-specific FRA.

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

- Detailed interactive GeoPDF maps showing all available flood risk information together with the assessed sites – Appendix B;
- Development site assessment spreadsheet detailing the risk to each site with recommendations on development – Appendix C;
- A note on the delineation of the functional floodplain following discussion and agreement between RDC, LLFA and the EA – Appendix D;
- Figures showing the proposed sites with their strategic recommendation – Appendix F;

- A User Guide for the SFRA – Appendix G; and
- Site assessment spreadsheet for open spaces detailing the risk to each site – Appendix H.

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Appendices

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

SFRA maps

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Abbreviations

AAP	Area Action Plans
ABD	Areas Benefitting from Defences
ACDP	Area with Critical Drainage Problems
AEP	Annual Exceedance Probability
BGS	British Geological Society
CaBA	Catchment Based Approach
CC	Climate change
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
DCLG	Department for Communities and Local Government
DPD	Development Plan Documents
DRN	Detailed River Network
DTM	Digital Terrain Model
EA	Environment Agency
FAA	Flood Alert Area
FAS	Flood Alleviation Scheme
FCDPAG	Flood and Coastal Defence Project Appraisal Guidance
FCERM	Flood and Coastal Erosion Risk Management Network
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
FRM	Flood Risk Management
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
LDF	Local Development Framework
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
NGO	Non-Governmental Organisation
NPPF	National Planning Policy Framework
NPPG	Planning Practice Guidance
NW	Northumbrian Water
NYFRS	North Yorkshire Fire and Rescue Service
NYLRF	North Yorkshire Local Resilience Forum
PCPA	Planning and Compulsory Purchase Act
PFRA	Preliminary Flood Risk Assessment
RBD	River Basin District
RBMP	River Basin Management Plan
RDC	Richmondshire District Council
RFO	Recorded Flood Outlines
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
RUDP	Replacement Unitary Development Plan
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment
SoP	Standard of Protection
SPD	Supplementary Planning Documents
SuDS	Sustainable Drainage Systems
SUNO	Swale, Ure, Nidd and Ouse management catchment
SWMP	Surface Water Management Plan
UKCIP02	UK Climate Projections 2002
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018
WCS	Water Cycle Study
WFD	Water Framework Directive
WwNP	Working with Natural Processes
YDNP	Yorkshire Dales National Park
YWS	Yorkshire Water Services

1 Introduction

1.1 Commission

Richmondshire District Council (RDC) commissioned JBA Consulting by a letter dated 3rd April 2019 for the undertaking of a Level 1 Strategic Flood Risk Assessment (SFRA) to update the existing North West Yorkshire Level 1 SFRA from 2010. RDC requires this updated Level 1 SFRA to screen and assess flood risk to potential Local Plan development site allocations and to provide strategic recommendations and the evidence to inform the Sequential Test and, where necessary, the Exception Test. This will provide the evidence to support strategic flood risk policies and site allocations in 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 Environment Agency's SFRA guidance for local planning authorities[4] (updated August 2019, at the time of writing) states:

"The SFRA will help various parties consider flood risk when making planning decisions about the design and location of any:

- *Development*
- *Flood risk management features and structures*

In your SFRA, you should assess the:

- *Risk from all sources of flooding*
- *Cumulative impact that development or changing land use would have on the risk of flooding*
- *Effect of climate change on risk*

Your SFRA should identify:

- *Opportunities to reduce the causes and impacts of flooding*
- *Any land likely to be needed for flood risk management features and structures."*

1.3 Richmondshire Level 1 SFRA

This SFRA has been carried out in accordance with Government's latest development planning guidance including the revised National Planning Policy Framework (NPPF) (2019), the Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG) (last updated March 2014, at the time of writing) and the EA's revised SFRA guidance (2019).

The latest FRCC-PPG is available online via:

http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change

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

An updated version of the NPPF was published on 19 June 2019 and sets out Government's planning policies for England and how these are expected to be applied. This revised Framework replaces the previous NPPF published in March 2012 and is available via:

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

This SFRA assesses the spatial distribution of flood risk across the local authority area, outside of the Yorkshire Dales National Park (YDNP), and provides the discussion and guidance required to put this information into practice when taking account of flood risk in development plans and the level of detail required to carry out site specific Flood Risk Assessments (FRAs).

This SFRA makes use of the most up-to-date flood risk datasets, available at the time of submission, to assess the extent of risk, at a strategic level, to potential development allocation sites identified by RDC which acts as the Local Planning Authority (LPA) and North Yorkshire County Council which acts as the Lead Local Flood Authority (LLFA). The SFRA appendices contain interactive GeoPDF maps (Appendix A) showing the potential development sites overlaid with the latest, readily available, gathered flood risk information along with a Development Site Assessment spreadsheet (Appendix C) indicating the level of flood risk to each site following a strategic assessment of risk. Each potential site is assigned a strategic recommendation, discussed in Section E.2 of Appendix E. This information will allow the LPA to identify the strategic development options that may be applicable to each site and to inform on the application of the Sequential Test.

1.4 Aims and objectives

The aims and objectives of this Level 1 SFRA, as advised by the NPPF (2019) and FRCC-PPG and more specifically included in RDC's Brief, are to:

- Update on the previous 2010 SFRA using new or updated flood risk information including climate change allowances, where available.
- Investigate and identify the extent and severity of flood risk from all sources, both presently and in the future, using available data. This assessment will enable the LPA to steer development away from those areas where flood risk is considered greatest, ensuring that areas allocated for development can be developed in a safe, cost effective and sustainable manner.
- Apply the Sequential Test when determining land use allocations
- Safeguarding land from development that has potential for use in current and future flood risk management.
- Use opportunities offered by new development to reduce the causes and impacts of flooding.
- Identify the requirements for site-specific FRAs in particular locations, including those at risk from sources other than flooding from watercourses.
- Review and update the district's flood zone maps including; the functional floodplain, latest climate change allowances, mapping for flood zones 1/2/3a, surface/groundwater risk and modelled flood outlines.
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, using Sustainable Drainage Systems (SuDS), provision for conveyance and storage of floodwater. To present a thorough and updated understanding of all flood risk, based on up-to-date EA modelling.
- Reflect current national policy and legislation including the NPPF and FRCC-PPG to enable the LPA to meet their statutory obligations in relation to flood risk.

- Identify any cross-boundary flooding issues and work collaboratively with all relevant Risk Management Authorities (RMA).
- Adopt a catchment-based approach to flood risk assessment and management to help inform potential catchment-wide approaches and solutions to flood risk management.
- Develop strategic recommendations on the suitability of potential development sites, as an evidence base for local plan making.
- Provide guidance for developers and local authority planning officers on planning requirements in relation to flood risk.
- Provide a reference document (this report) to which all parties involved in development planning and flood risk can reliably turn to for initial advice and guidance.
- Provide a suite of interactive GeoPDF flood risk maps illustrating the interaction between flood risk and potential development sites.
- Ensure any conclusions and recommendations are fully justified and robust, in accordance with the NPPF and NPPG requirements and best practice.

1.5 Consultation

The EA's 2019 SFRA guidance recommends consultation with the following parties, external to RDC:

- 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 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 (RDC) 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, being the current primary development and flood risk guidance information available at the time of the finalisation of this SFRA.

The EA's 2019 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
- shoreline management plans
- local flood risk management strategies
- national planning policy or guidance

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

Where possible, the SFRA should be kept as a 'live' entity and continually updated when new information becomes available. The EA's 2019 SFRA guidance requests for reports and maps to be published online and easily updateable, when required.

This SFRA uses the EA's Flood Map for Planning version issued in February 2020 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. The reader should therefore refer to the online version of the Flood Map for Planning to check whether the flood zones may have been updated since February 2020, via the following link:

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

To assess the surface water risk to the potential development sites, this SFRA uses the EA's Risk of Flooding from Surface Water (RoFSW) dataset, last updated March 2020. This dataset is updated periodically when applicable local surface water modelling is carried out. The reader should therefore refer to the online version of the RoFSW map to check whether the surface water flood outlines have been updated, via the following link:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

2 Study area

The study area for this SFRA is defined by the administrative boundary of RDC located in North West Yorkshire. Richmondshire is a predominantly rural district with main settlements at Richmond, Catterick, Garrison and Leyburn. Richmondshire District has a total area of 1,319km^2; however, the area outside of the YDNP boundary covers an area of approximately 567km^2. In 2014, 88% of the population was located outside the YDNP boundary.

Richmondshire is located within the Swale, Ure, Nidd and Upper Ouse, and River Tees catchments. Flood processes and flood risk issues across the Richmondshire area are intricately linked by the main rivers of the River Swale, Clow Beck, Spa Beck, River Tees, Scorton Beck, Bedale Beck and the River Ure.

Agriculture remains a key economic sector in Richmondshire but there are also many commercial enterprises within the district. Tourism is an important part of the economy with people being attracted by the natural landscape and the Yorkshire Dales National Park. In 2014, roughly 3.62 million people visited the area; tourism provided some £225 million to the economy and supported 3,860 full time jobs. Important communities for visitors include, Richmond, an historic market town and administrative centre for the District, Leyburn, a market town with many amenities, and Middleham with its castle and horse racing. Catterick Garrison is also important to the District's economy and is one of the largest British Army garrison's which is expected to growth further over the next 15 years.

Historically, flood risk across Richmondshire is varied. There is potential flood risk from fluvial, surface water, groundwater, sewers, and residual risk from reservoirs. In some instances, sites may suffer from a combination of more than one source of flooding. 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 and Northumbria River Basin Districts (RBD) and is served by Yorkshire Water Services (YWS), the primary local water and sewerage company. Some areas in the northern part of the study area, however, are served by Northumbrian Water (NW).

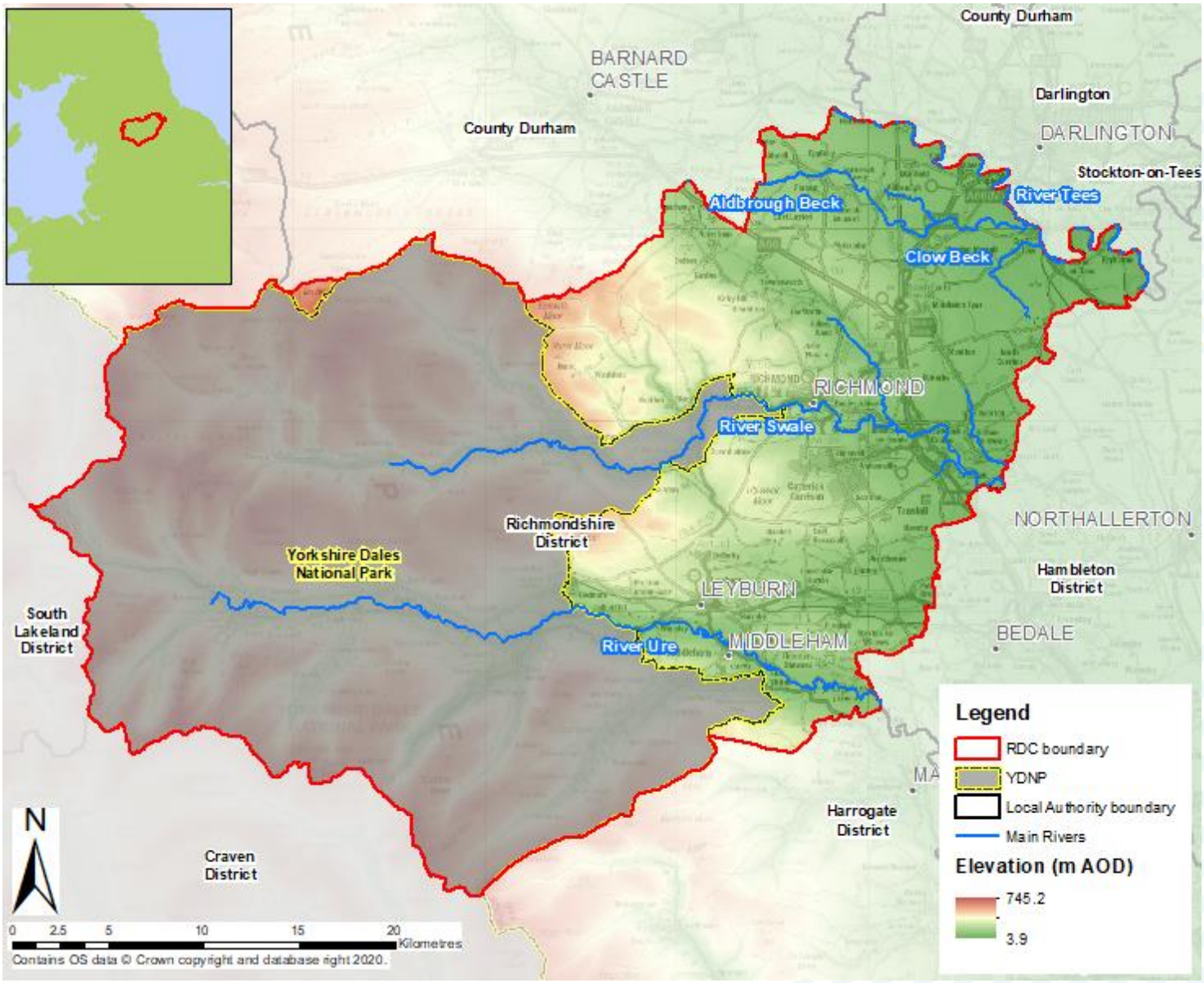

Figure 2-1: Study area (outside YDNP)

2.1 Main rivers

Main rivers are usually larger rivers and streams. The EA carries out maintenance, improvement or construction work on main rivers to manage flood risk and therefore they are designated as the EA's responsibility.

2.1.1 River Tees

The River Tees rises on the eastern slopes of the North Pennines and flows east for 85 miles to finally reach the North Sea between Hartlepool and Redcar near Middlesbrough; the Tees drains an area of approximately 1,800 km^2 and has a number of tributaries including the Rivers Greta, Lune, Balder, Leven, and Skerne. The head of the Tees is dammed to form Cow Green Reservoir which makes regulatory releases into the River Tees to allow abstraction downstream. The River Tees forms the northern boundary of Richmondshire district.

2.1.2 River Swale

The River Swale is the northernmost tributary of the Yorkshire Ouse with its headwaters located in the eastern Yorkshire Dales, from where it flows in an easterly direction. After passing through the major settlements of Richmond and Catterick, the river flows southwards and joins the River Ure at Myton-on-Swale. The Swale has a catchment area of 1,446 km^2 and a length of 118 km. The mains tributaries are Bedale Beck, Cod Beck and the River Wiske.

2.1.3 River Ure

The River Ure is approximately 119 km long from its source to the point where it becomes the River Ouse. The source of the river is Ure Head on Abbotside Common where it flows to the valley floor and along Wensleydale as far as Wensley. The main tributaries of the Ure are Bishopdale Beck and the Rivers Bain, Cover, Burn, Skell and Laver. The catchment of the Ure to its confluence with the Swale is 982 km^2, this is mainly in Richmondshire District and Harrogate Borough.

2.2 Ordinary watercourses

Ordinary watercourses are those that are not designated as Main River and therefore come under the control of the LLFA, who have Permissive Powers to carry out works when necessary. Although NYCC has powers to do works in ordinary watercourses, the responsibility for the maintenance lies with the riparian owner. Hence NYCC is only responsible where it is the riparian owner.

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 (also see 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 influence of bridges, embankments and other features that artificially raise water levels; overtopping or breaching of defences; blockages of culverts; blockages of flood channels/corridors.
- **Tidal** – sea; estuary; overtopping of defences; breaching of defences; other flows (e.g. fluvial surface water) that could pond due to tide locking; wave action (not applicable to Richmondshire District).
- **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.

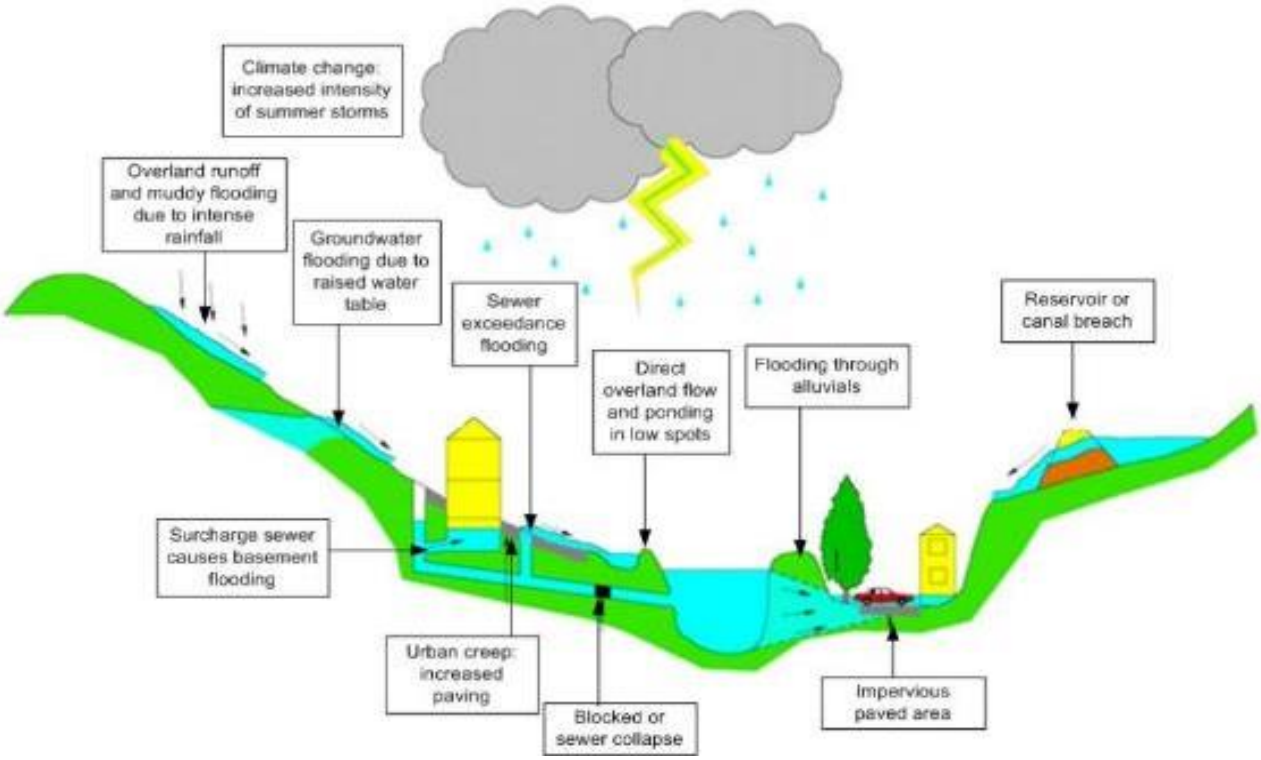

Figure 3-1: Flooding from all sources

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.

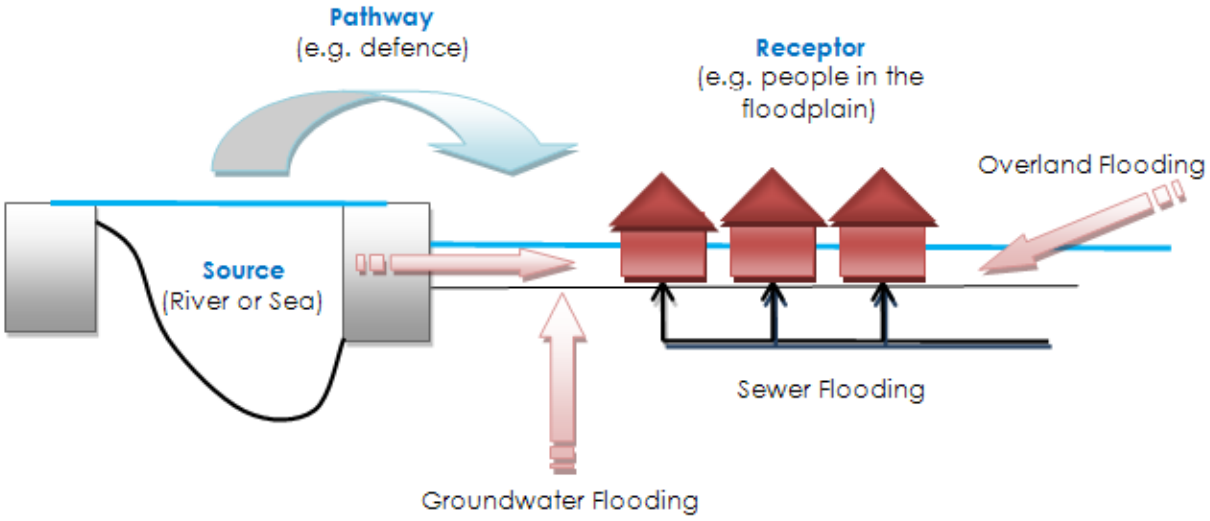

Figure 3-2: Source-Pathway-Receptor Model

The principal sources are rainfall or higher than normal sea levels (though not in Richmondshire District), the most common pathways are rivers, drains, sewers, overland flow and river and coastal floodplains and their defence assets and the receptors can include people, their property and the environment. All three elements must be present for flood risk to arise. Mitigation 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

Likelihood of flooding is expressed as the percentage probability based on the average frequency measured or extrapolated from records over a large number of years. A 1 in 100 AEP (Annual Exceedance Probability) events 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 AEP event of occurring in any one year, not that it will occur once every one hundred years.

Table 3-1 provides an example of the flood probabilities used to describe the fluvial and tidal flood zones as defined in the FRCC-PPG and as used by the EA in their 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. The Flood Map for Planning can be accessed via:

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

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 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 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea. flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea 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.** 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. (Not separately distinguished from Zone3a on the Flood Map)

Table 3-1: NPPF flood zones[5]

[5] Table 1: Flood Zones, Paragraph 065 of the Flood Risk and Coastal Change Planning Practice Guidance

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, wave-action effects, 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 Actual risk

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

Actual 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.

3.3.2 Residual risk

Defended areas, located behind EA, NYCC and private organisation flood defences, remain at residual risk as there is a risk of overtopping or defence breach during significant flood events. Whilst the potential risk of failure may be reduced, consideration of inundation and the impact on development needs to be considered.

Paragraph 041 of the FRCC-PPG defines residual risk as:

"…those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include:

- *The failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;*
- *failure of a reservoir, or;*
- *a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with.*

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."

Even when flood defences are in place, there is always a likelihood that these could be overtopped in an extreme event or that they could fail or breach. Where there is a

consequence to that occurrence, this risk is known as residual risk. Defence failure can lead to rapid inundation of fast flowing and deep floodwaters, with significant consequences to people, property and the local environment behind the defence. 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 overtopped or failed that must be taken into account. Because of this, it is never appropriate to use the term "flood free".

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

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

4 The planning framework and flood risk policy

4.1 Introduction

The main purpose of this section of the SFRA is to provide an overview of the key planning and flood risk policy documents that have shaped the current planning framework. This section also provides an overview and context of 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.

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.

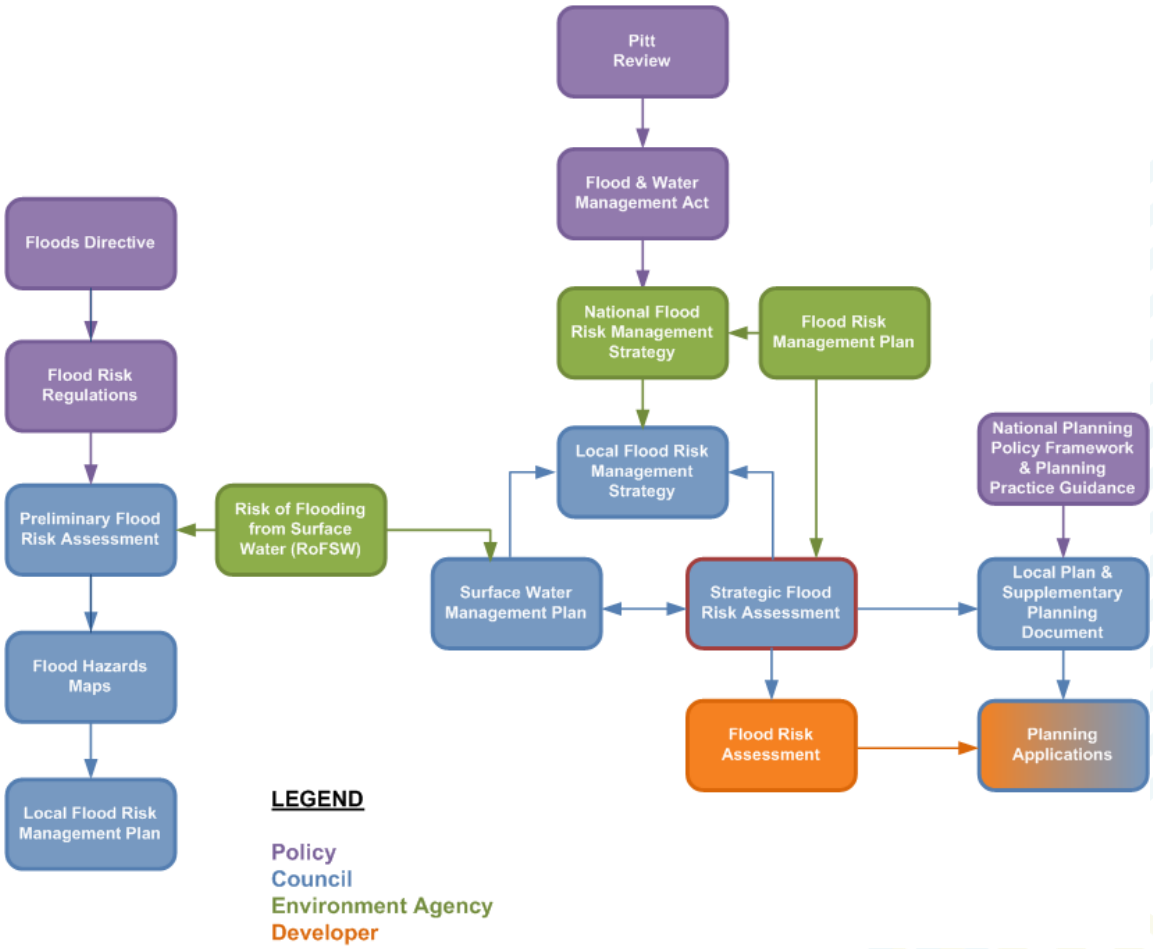

Figure 4-1: Key documents and strategic planning links with flood risk

The remaining flood risk policy information relevant to this study is located in Appendix A.

5 Flood risk across Richmondshire Local Plan Area

5.1 Flood risk datasets

This section of the SFRA provides a strategic overview of flood risk from all sources within Richmondshire, outside of the Yorkshire Dales National Park. The information contained is the best available at the time of publication and is intended to provide RDC with 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) (February 2020 version)
	EA Risk of Flooding from Rivers and Sea map
	Modelled Flood Outlines (MFO) from latest available EA Flood Risk Mapping Studies
	EA Historic Flood Map (HFM) (May 2019)
	EA Recorded Flood Outlines (RFO) (May 2019)
	EA Areas Benefitting from Flood Defences (ABD) (May 2019)
	EA Flood Warning Areas (May 2019)
Pluvial (surface water runoff)	EA Risk of Flooding from Surface Water (RoFSW)
	NYCC Preliminary Flood Risk Assessment 2011 and update 2017
Sewer	Yorkshire Water Historical Flood Incident Data
Groundwater	JBA 5m Resolution Groundwater Flood Map
Reservoir	EA Reservoir Flood Maps (available online)
All sources	Humber Flood Risk Management Plan 2015 to 2021
	Northumbria Flood Risk Management Plan 2015 to 2021
	Humber River Basin Management Plan (June 2018)
	Northumbria River Basin Management Plan (June 2018)
	River Tees Catchment Flood Management Plan (2009)
	Swale, Ure, Nidd and Ouse Catchment Flood Management Plan (2009)
	NYCC Local Flood Risk Management Strategy (2014)
	NYCC Historic Flood Records
	NYCC Level 1 SFRA
Flood risk management infrastructure	EA Spatial Flood Defence data (May 2019)
	LLFA FRM asset register

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 SFRA Maps in Appendix B present the EA's Flood Map for Planning which shows the fluvial coverage of flood zones 2 and 3 across the study area.

5.2.1 Main river

The EA decides which watercourses are Main Rivers. It consults with other risk management authorities and the public before making these decisions.

The EA describes Main Rivers as usually being larger rivers and streams with other rivers known as ordinary watercourses. The EA carries out maintenance, improvement or construction work on Main Rivers to manage flood risk and will carry out flood defence work to Main Rivers only.

As noted in Section 2, the study area contains the Main Rivers of the Rivers Swale, Tees and Ure. The mechanisms of flooding along these watercourses and their tributaries can be described as fluvial in nature. The Flood Map for Planning is used to assess fluvial risk to RDC's potential development sites.

The Flood Map for Planning indicates that the majority of fluvial risk within the study area comes from the River Swale that runs through the centre of the study area. The River Tees can also be described as posing significant risk towards the north-east of the boundary.

5.2.2 Ordinary watercourses

Ordinary watercourses are any watercourse not designated as Main River. These watercourses can vary in size considerably and can include rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows.

LLFAs, district councils and internal drainage boards have statutory permissive powers to carry out flood risk management work on ordinary watercourses.

5.2.3 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 and tidal flooding (tidal flooding does not apply to Richmondshire). 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 AEP (1%) fluvial event (Flood Zone 3) and the 1 in 1000 AEP (0.1%) fluvial flood events (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 worst-case scenario of flooding. The flood zones do not consider sources of flooding other than fluvial and tidal (although tidal does not apply to RDC), and do not take account of climate change. As directed by the FRCC-PPG, this SFRA subdivides Flood Zone 3 into Flood Zone 3a and Flood Zone 3b (functional floodplain – see Section 5.2.4).

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 5.2.5.

This SFRA uses the Flood Map for Planning issued in February 2020 to assess fluvial risk to the potential development sites, as per the NPPF and the accompanying FRCC-PPG. The Flood Map for Planning is updated at quarterly intervals by the EA, as and when new modelling data becomes available. The reader should therefore refer to the online version of the Flood Map for Planning to check whether the flood zones may have been updated since February 2020:

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

5.2.4 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 065 of the FRCC-PPG defines Flood Zone 3b as:

"…land where water has to flow or be stored in times of flood. 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."

Paragraph 015 of the FRCC-PPG explains that:

"…the identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. However, land which would naturally flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood (such as a flood attenuation scheme) in an extreme (0.1% annual probability) flood, should provide a starting point to help identify the functional floodplain.

The area identified as functional floodplain should take into account the presence and effect of all flood risk management infrastructure including defences. Areas which would naturally flood, but which are prevented from doing so by existing defences and infrastructure or solid buildings, will not normally be identified as functional floodplain. If an area is intended to flood, e.g. an upstream flood storage area designed to protect communities further downstream, then this should be safeguarded from development and identified as functional floodplain, even though it might not flood very often."

The EA's most up-to-date Historic Flood Map (HFM), Areas Benefitting from Defences (ABD), Recorded Flood Outlines (RFO) and Flood Storage Areas (FSA) datasets were assessed with regards to using them to update the functional floodplain where appropriate. A technical note is provided in Appendix D which explains the methodology used in creating the functional floodplain outline.

The Brough Beck (2003) and Gilling Beck (2006) modelled outlines were also used to update the functional floodplain. Flood Zone 3 and the previous functional floodplain were also used in this instance with Flood Zone 3 being used in areas where the functional floodplain exceeded Flood Zone 3 outlines.

The functional floodplain outline was assessed and agreed upon by the LPA, the LLFA and the EA, based on their in-depth local knowledge.

5.2.5 EA Risk of Flooding from Rivers and the Sea map

This 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 Appendix B maps. The RoFRS map splits the likelihood of flooding into four risk categories:

- High – greater than or equal to 1 in 30 AEP event (3.3%) chance in any given year
- Medium – less than 1 in 30 AEP event (3.3%) but greater than or equal to 1 in 100 AEP event (1%) chance in any given year

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

Paragraph 013 of the FRCC-PPG states that SFRAs should address surface water flooding issues by identifying areas of surface water flooding and areas where there may be drainage issues that can cause surface water flooding. The EA's Risk of Flooding from Surface Water (RoFSW) map along with information within the LFRMS (see Section A.6.4 of Appendix A) should assist with this and various mitigative measures, i.e. SuDS, should be identified. Sections 6.5 and 0 provide 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 AEP design standard of new sewer systems. Some older sewer and highway drainage networks will have a lower capacity than what is required to mitigate for the 1 in 30 AEP event. There is also residual risk associated with these networks due to possible network failures, blockages or collapses.

Risk of Flooding from Surface Water dataset

The Risk of Flooding from Surface Water (RoFSW), formally referred to as the updated Flood Map for Surface Water (uFMfSW) is the third-generation national surface water flood map, produced by the EA, aimed at helping to identify areas where localised, flash flooding can cause problems even if the Main Rivers are not overflowing. The

RoFSW, used in this SFRA to assess risk from surface water, has proved extremely useful in supplementing the EA Flood Map for Planning by identifying areas in Flood Zone 1, which may have critical drainage problems. However, any sites identified to be at risk from surface water flooding should be assessed in more detail, following this SFRA, as the RoFSW is a national-scale dataset and may therefore overestimate or underestimate risk.

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

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

The National Modelling and Mapping Method Statement, May 2013 details the methodology applied in producing the map. The RoFSW is displayed on the SFRA maps.

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 large 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.

Flooding from the sewer network mainly occurs 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.

YWS is the water company responsible for the management of the majority of the drainage networks across the District. NW covers a smaller section of Richmondshire.

5.3.3 Areas with Critical Drainage Problems and Critical Drainage Areas

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[6] states that a 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."

This statement refers to sites within an ACDP, not a CDA. At the time of writing there are no ACDPs or CDAs in Richmondshire.

CDAs can be designated by LPAs or LLFAs for their own purposes. The EA do not have to be consulted on sites that are within a CDA if such sites are in Flood Zone 1.

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

5.3.4 Locally agreed surface water information

EA guidance, from within the Flood and Water Management Act (FWMA) (2010)[7], on using surface water flood risk information recommends that NYCC, as a 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".

Following on from the LLFA consultation on the RoFSW in 2013 before its release, the EA stated that the Flood Map for Surface Water (2010) and the Areas Susceptible to Surface Water Flooding (2008) maps do not meet the requirements of the Flood Risk Regulations and are not compatible with the 2013 RoFSW mapping. Consequently, these datasets cannot be used 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.

As there is no NYCC-wide SWMP, RDC should 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 District, 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 and the sea, does not generally pose a significant risk to life due to the slow rate at which the water level rises. However, groundwater flooding can cause significant damage to property, especially in urban areas, and can pose further risks to the environment and ground stability.

There are several mechanisms that increase the risk of groundwater flooding including prolonged rainfall, high in-bank river levels, artificial structures, groundwater rebound and mine water rebound. Properties with basements or cellars or properties that are located within areas deemed to be susceptible to groundwater flooding are at particular risk. Development within areas that are susceptible to groundwater flooding will generally not be suited to 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 broad-scale assessment of the groundwater flood hazard. The map is categorised by grid code where each code is explained in Table 5-2.

[7] https://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

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 (metres above ordnance datum) minus modelled groundwater table in mAOD.

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

This dataset shows that the areas with the highest levels of groundwater vulnerability are located close to the A66 around Newsham and Ravensworth, at Catterick, Scotch Corner, and to the south around areas such as Leyburn and Middleham. A high proportion of Richmondshire District is categorised as very little or no risk or flooding from groundwater being unlikely to occur.

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.

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 the assessment.

The groundwater vulnerability dataset is shown on the SFRA Maps in Appendix B.

This SFRA uses groundwater data in the form of JBA's 5m groundwater map, which provides a general broad scale assessment of the groundwater flood hazard. Where development is shown to lie within areas that are susceptible

to groundwater flooding detailed site hydrogeological investigation and risk assessment should be carried out at the Flood Risk Assessment stage to fully understand the risk from this source.

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 considered to be residual and is dependent on a number of factors. As canals are manmade systems that are heavily controlled, it is unlikely they will respond in the same way as a natural watercourse during a storm event. Flooding is more likely to be associated with residual risks, similar to those associated with river defences, such as overtopping of canal banks, breaching of embanked reaches or asset (gate) failure as highlighted in Table 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
Leakage 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 are no canals in the Richmondshire district area.

5.5.2 Reservoirs

A reservoir can usually be described as an artificial lake 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 Flood and Water Management Act (2010) 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 North Yorkshire Local Resilience Forum to develop these plans. See Section 7.1.1 for more information on the North Yorkshire Local Resilience Forum.

Paragraph 014 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 will also need to evaluate in Strategic Flood Risk Assessments (and when applying the Sequential Test) 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."

5.5.3 Reservoir Flood Map (RFM)

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

The maps show the largest area that might be flooded if a reservoir were to fail and release the water it holds, including information about the depth and speed of the flood waters. In September 2016, the EA produced the RFM guidance 'Explanatory Note on Reservoir Flood Maps for Local Resilience Forums – Version 5[8]' which provides information on how the maps were produced and what they contain.

The RFM can be viewed nationally at:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

The RFM shows that there is one reservoir within the RDC boundary. This is the Thornton Steward reservoir owned by Yorkshire Water Services, shown in Figure 5-1. The RFM extent shows the worst credible area that is susceptible to dam breach flooding. The map should be used to prioritise areas for evacuation/early warning. It is worth considering that reservoirs within the UK have an extremely good safety record with no incidents resulting in the loss of life since 1925.

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 is located within, and/or whether emergency draw-down of the reservoir will add to the extent of flooding;
- Emergency planning requirements with appropriate officers to ensure safe, sustainable development.

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/558441/LIT_6882.pdf

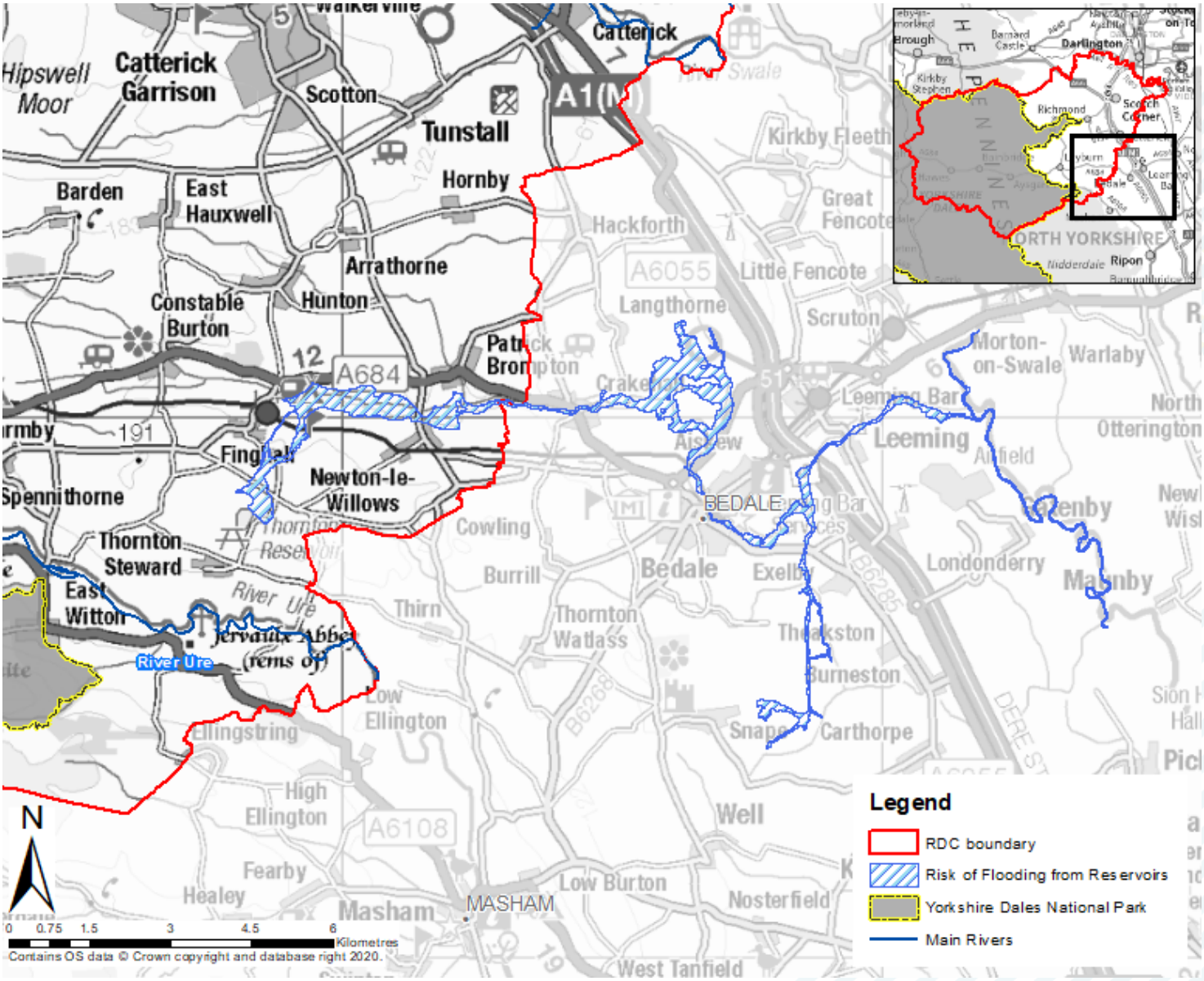

Figure 5-1: Risk of Flooding from Reservoirs in the RDC area

5.6 Historic flooding

As LLFA, NYCC is required, under the FWMA, to maintain and update its historic flood incidents database as and when any flood incidents occur. The LLFA has a statutory responsibility to investigate and report upon any 'significant' flood events.

The flood risk across the NYCC area is varied but in the upper catchments, where Richmondshire is located, the higher elevation and steep terrain can lead to more rapid runoff from the surrounding land, and a faster rise in the levels of local watercourses. The flood risk tends to be from small watercourses and/or surface water occurring as a result of localised rainfall events and when specific local triggers within the catchment are reached. Historically, records from many incidents have been captured and collated, though the record is not complete. In particular, records for more localised events, involving smaller watercourses, surface runoff and groundwater have not always been captured.

Flood risk from groundwater sources has been difficult to confirm for some historical events due to the lack of records of confirmed cases of groundwater flooding as it can

be masked by flooding from rivers and surface water; groundwater has not historically been identified as a major problem and is less common than other forms of flooding.

The LFRMS (2014) identified major flood events (river and combined river and surface water) within NYCC's area as being in 1999, 2000, 2004, 2007, and 2012.

Figure 5-2 shows NYCC's historic flood incidents for RDC, which includes multiple sources of flooding. The historic (compiled) dataset that was provided did not state the date or source of the event meaning conclusions are very limited. The recorded flood incidents include flooding of property, gardens to property, highways and footpaths.

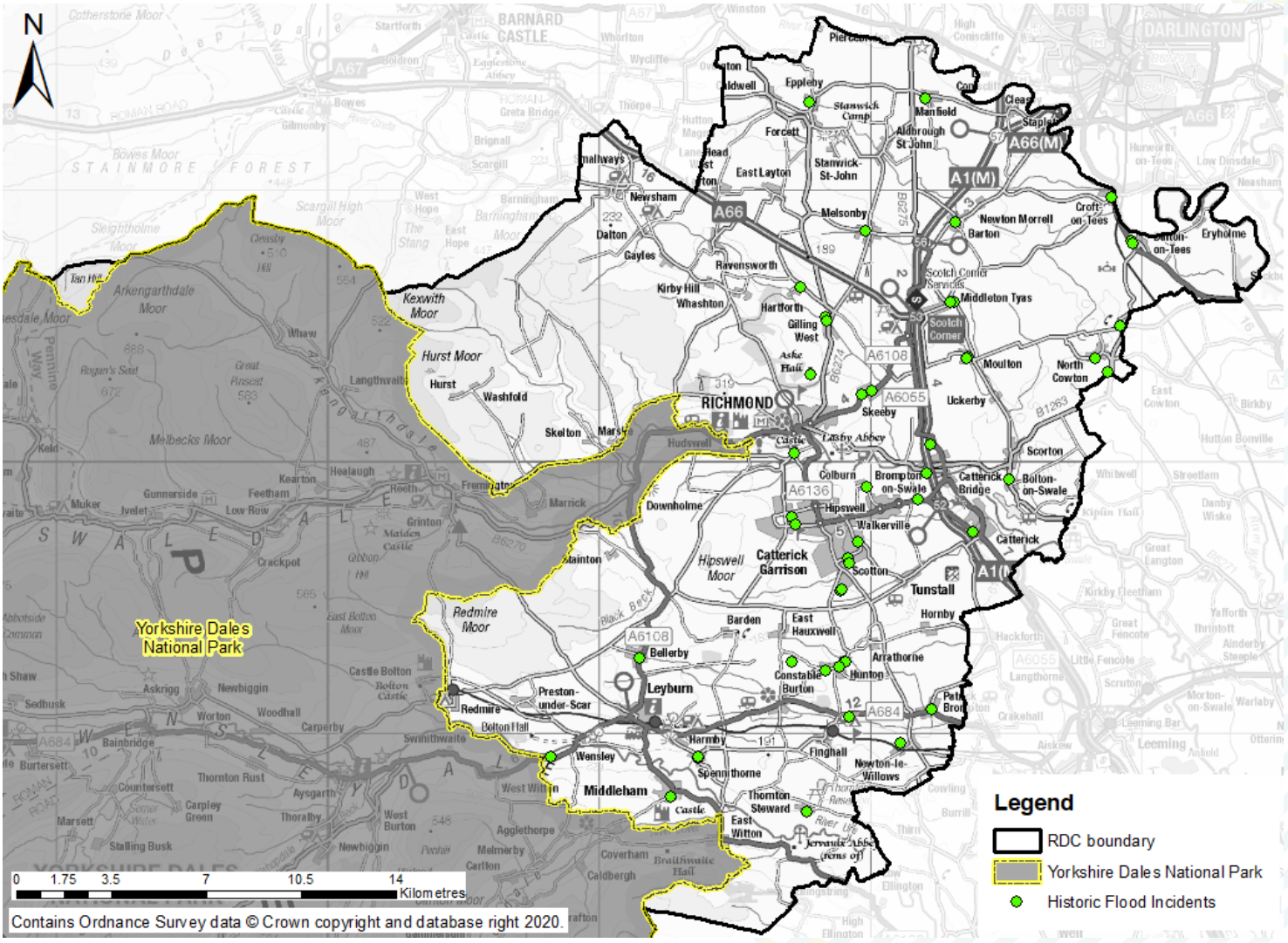

Figure 5-2: NYCC historic flood records

5.6.1 Historic surface water flooding

The LFRMS (2014) states that historically surface water flooding has been associated more with urban areas where the impermeable surfaces are greater; however, more recent flood events have shown that surface water runoff is an increasing issue in rural areas.

Sewer flooding is often caused by excess surface water entering the drainage network. The DG5 Register from Yorkshire Water was analysed to investigate the occurrence of sewer flooding incidents across the RDC area. The DG5 Register is used to record flood

risk attributable to water company-controlled sewer networks, whether that be from foul, combined and / or surface water sewers.

It was found that there were several sewer flooding events that have been recorded by the water company over the past decade relating to both internal and external flooding to property. However, these events have not been georeferenced, so no comments can be made about their spatial extent and distribution. Also, the DG5 data did not include any dates so it is difficult to determine if the events were recent or historic.

5.6.2 Historic combined pluvial/fluvial flooding – notable incidents

Summer 2007 floods

This was the wettest May/June since records began in 1766, with one month's rainfall falling in a few hours[9]. The extreme rainfall event was related to unusually high Atlantic Ocean water temperatures which resulted in a more southerly jet stream that brought rain bearing depressions over the UK. Flash flooding accumulated in rivers and extended the water to the floodplain. A much higher proportion of the flooding was sourced from surface water rather than rivers. Two-thirds of properties flooded because of overwhelmed sewers and drains.

November – December 2015 floods

The floods of December 2015, caused by Storm Desmond, which brought periods of heavy rainfall from a succession of Atlantic storms, all large Main Rivers (Ouse, Ure, Swale and Tees) surcharged simultaneously[10]. Flooding occurred from a number of additional sources in combination.

The Association of British Insurers estimated that the final costs for homes, businesses and motor vehicles from flood damage, caused by Storms Desmond, Eva and Frank in 2015, was £1.3 billion[11]. The personal impact on residents and communities such as; long-term health impacts and disruption is difficult to quantify.

30th July 2019 flood

The 30th July 2019 flood affected Wensleydale and Swaledale after forming over the Pennines. The equivalent of July's typical rainfall fell in 2 hours and the event was in excess of the 1000-year return period[12]. Rapidly rising water levels occurred in several watercourses contributing to fluvial flooding and drains were also overwhelmed causing the flooding. There were warnings in place for thunderstorms for the 30th but not for the intensity or duration.

5.6.3 EA Historic Flood Map

The Historic Flood Map (HFM) is a spatial dataset, available from the EA, 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

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[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292924/geho1107bnmi-e-e.pdf

[10] Local Flood Risk Management Strategy (LFRMS) (2016)

[11] https://www.lancashire.gov.uk/media/900010/section-19-flood-investigation-report-december-2015-floods.pdf

[12] https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/Richmondshire%20July%202019%20Section%2019%20Report.pdf

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.

The HFM shows areas of flooding being centred along the River Swale near urban areas of Richmond and Catterick. There is also flooding associated with the River Ure to the south of the district near Middleham. The River Tees runs along the north-east boundary of the district and the HFM shows there is flooding associated with this river near towns of Croft-on-Tees and Low Coniscliffe.

The HFM and RFO datasets are shown on the SFRA maps in Appendix B.

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 actual 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.

5.7.1 EA inspected assets (Spatial Flood Defences)

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

- Asset type (flood wall, embankment, high ground, demountable defence, bridge abutment);
- Flood source (fluvial, tidal, fluvial and tidal combined) (tidal does not apply to RDC);
- Design Standard of Protection (SoP);
- Asset length;
- Asset age;
- Asset location; and
- Asset condition.

See Table 5-4 for condition assessment grades using the EA's Condition Assessment Manual[13] (CAM).

[13] Environment Agency. (2012). Visual Inspection Condition Grades. In: EA Condition Assessment Manual. Bristol: Environment Agency. p9.

The design standard of protection (SoP) for a flood defence is a measure of how much protection a flood defence gives. If the SoP is 100, the defence protects against a flood with the probability of occurring once in 100 years.

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
Just south of Hurworth-on-Tees	2 Embankments	Fluvial	River Tees	5 (2)	4 (2)
Croft-on-Tees	3 Embankments 4 Flood Walls	Fluvial	River Tees	75 (6) 100 (1)	1 (3) 2 (1) 3 (3)
Near Stapleton and Low Coniscliffe	2 Embankments	Fluvial	River Tees	5 (1) 10 (1)	3 (1) 5 (1)
Near Cliffe	1 Embankment	Fluvial	River Tees	5 (1)	4 (1)
Number in brackets = number of assets					

Table 5-5: Major flood defences in Richmondshire district

In total, there are 32 flood defence assets within Richmondshire District, according to the EA's Spatial Flood Defence dataset. Table 5-5 highlights the main locations within the district that have significant FRM assets, the majority of which are located on the River Ure near Middleham and River Tees running along the northern boundary. There are a number of flood defence assets within RDC that have an unknown design standard.

Of the 32 constructed fluvial flood defence assets within Richmondshire, 5 are floodwalls and 27 are flood embankments. The floodwalls aim to prevent the flooding of residential and commercial properties and infrastructure. There is one embankment with design standards of 10, that have been assessed at condition grade 5 meaning the condition is rated as 'Very Poor' according to the CAM (as discussed in Table 5-4) meaning that there are severe defects resulting in complete performance failure.

Along the majority of the Main Rivers within Richmondshire District, there are areas of high ground, offering protection from fluvial flooding. The condition grade of the majority of these defences is stated as 2/3, which means 'Good/Fair', as per the EA's CAM meaning there could be defects that could reduce the performance of the asset or the defects are only minor and would not compromise performance.

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) were 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 SFRA Maps in Appendix B.
- Promoting awareness of flooding so that organisations, communities and individuals are aware of the risk and therefore sufficiently prepared in the event of flooding.
- 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.

5.7.2 NYCC assets and future Flood Risk Management schemes

NYCC owns and maintains a number of assets throughout the district which includes culverts, bridge structures, gullies, weirs and trash screens. The majority of these assets will lie along ordinary watercourses within smaller urban areas where watercourses may have been culverted or diverted, or within rural areas. All these assets can have flood risk management functions as well as an effect on flood risk if they become blocked or fail. In most cases responsibility lies with the riparian / landowner.

NYCC (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 programme and prioritise maintenance programme. Critical assets (i.e. culverts in poor condition) to be prioritised for designated works.

5.7.3 Water company assets

The sewerage infrastructure within Richmondshire District is likely to be based on Victorian sewers from which there may be a risk of localised flooding associated with

the existing drainage capacity and sewer system. Yorkshire Water and Northumbrian Water are responsible for the management of the adopted sewerage systems for their respective areas. This includes surface water and foul sewerage. There may however be some private foul and surface water sewers in the district as only those connected to the public sewer network prior to 1st July 2011 were transferred to the water companies under the Private Sewer Transfer in October 2011 if they met certain criteria. In addition, there are likely to have been sewers and drains constructed since this transfer date which have not been offered for adoption or have not met the requirements of a Section 104 adoption agreement and therefore these remain private too. Surface water sewers discharging to watercourses were not part of this transfer and would therefore not be under the ownership of the sewerage undertaker, unless they were offered for adoption either at the time of construction under a Section 104 agreement or retrospectively 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) or 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 (although coastal erosion is not applicable to RDC) by protecting, restoring and emulating the natural regulating functions of catchments, rivers, floodplains and coasts (not applicable).

Both the European Commission and UK Government are actively encouraging the implementation of WwNP measures within catchments and coastal areas in order to assist in the delivery of the requirements of various EC Directives relating to broader environmental protection and national policies. It is fully expected that the sustained interest in WwNP implementation across the UK will continue in the post-Brexit era as a fundamental component of the flood risk management tool kit.

Evidence base for WwNP to reduce flood risk

There has been much research on WwNP, but to date it has never been synthesised into one location. This has meant that it has been hard for flood risk managers to access up-to-date information on WwNP measures and to understand their potential benefits. The EA has produced the WwNP evidence base which includes three interlinked projects:

- Evidence directory
- Mapping the potential for WwNP
- Research gaps

The evidence base can be accessed via:

https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk

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

- Their potential FCRM benefits and multiple benefits
- Any gaps in knowledge
- Where it has been done before and any lessons learnt
- Where in a catchment they might not be most effective

The evidence directory presents the evidence base, setting out the scientific evidence underpinning it. Its purpose is to help flood risk management practitioners and other responsible bodies access information which explains what is known and what is not about the effectiveness of the measures from a flood risk perspective. There is also a guidance document which sits alongside the evidence directory and the maps which explains how to use them to help make the case for implementing WwNP when developing business cases.

Open access opportunity maps

The open access opportunity maps can be used with key partners to help think about the types of measure that may work in a catchment and where to potentially locate them. The maps cover those WwNP measures that have been prioritised – based on the need for mapping – in consultations with Environment Agency staff and external partners.

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

The WwNP types are listed in Table 5-6.

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.[2] • Constraints data • Gully blocking potential (a subset of run-off attenuation features on steeper ground) • Data derived from OS Terrain 50 (2016) to classify each run-off attenuation feature based on median slope.
Tree planting (3 categories)	• Floodplain: Flood Zone 2 from Flood Map for Planning (April 2016) and new constraints layer • Riparian: 50m buffer OS water features 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[14]

The WwNP datasets are available via:

https://catchmentbasedapproach.org/learn/working-with-natural-processes-evidence-base/

They are also included on the SFRA Maps in Appendix B 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 5.2.5), which are in close proximity to a watercourse and that do not

[14]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/677592/Working_with_natural_processes_mapping_technical_report.pdf

contain properties, are possible locations for floodplain reconnection. It may be that higher risk areas can be merged, depending on the local circumstances.

- Runoff Attenuation Features (Run-off attenuation features are based on the premise that areas of high flow accumulation in the RoFSW) maps are areas where the runoff hydrograph may be influenced by temporary storage if designed correctly):
  - Runoff Attenuation Features 1% AEP
  - Runoff Attenuation Features 3.3% AEP
- Tree Planting:
  - Floodplain Woodland Potential and Riparian Woodland Potential – woodland provides enhanced floodplain roughness that can dissipate the energy and momentum of a flood wave if planted to obstruct significant flow pathways. Riparian and floodplain tree planting are likely to be most effective if close to the watercourse in the floodplain, which is taken to be the 0.1% AEP flood extent (Flood Zone 2), and within a buffer of 50 metres of smaller watercourses where there is no flood mapping available. There is a constraints dataset that includes existing woodland.
  - Wider Catchment Woodland Potential – slowly permeable soils have a higher probability of generating 'infiltration-excess overland flow' and 'saturation overland flow'. These are best characterised by gleyed soils, so tree planting can open up the soil and lead to higher infiltration and reduction of overland flow production.

Limitations

The effectiveness of WwNP measures is site-specific and depends on many factors, including the location and scale at which they are used. It may not always be possible to guarantee that these measures alone will deliver a specified standard of defence. Consequently, flood risk management measures should be chosen from 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.

WwNP in RDC

At Stean Moor within Nidderdale AONB, WwNP was implemented through wetland creation and 170km of moorland grip blocking to increase flood water storage and attenuation runoff[15]. Although, to date there has been a shortfall recorded in implemented WwNP within this district.

RDC open space site assessment

RDC provided a GIS layer of Open Spaces within the Local Plan area; the Open Spaces spreadsheet provides a breakdown of each site and the area (in hectares) and percentage coverage of each fluvial flood zone and each surface water flood zone. Fluvial Flood Zones 3b, 3a, 2 and 1 are considered in isolation. Any area of a site within the higher risk Flood Zone 3b that is also within Flood Zone 3a is excluded from Flood Zone 3a and any within Flood Zone 3a is excluded from Flood Zone 2. This allows for the sequential assessment of risk at each site by addressing those sites at higher risk first. The same approach applies to the surface water flood zones.

Overall, there were 645 sites assessed, 335 were amenity, 41 were green corridors, 189 were natural and semi-natural greenspaces, and 80 were outdoor. Table 5-7

[15] https://naturalprocesses.jbahosting.com/#9/54.4748/-1.0794

shows the number of sites within each fluvial flood zone and Table 5-8 shows the number of sites within each surface water flood zone.

Open space land use	Number of sites within...			
	Flood Zone 1	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Amenity	285	38	41	3
Green Corridors	26	11	14	6
Natural and Semi-Natural Greenspaces	135	45	39	20
Outdoor Sports	54	15	12	15
TOTAL	**500**	**109**	**106**	**44**

Table 5-7: Number of open space sites at risk from each Flood Map for Planning flood zone

Open space land use	RoFSW flood zone		
	Low risk (1 in 1000)	Medium risk (1 in 100)	High risk (1 in 30)
Amenity	195	99	66
Green Corridors	37	30	21
Natural and Semi-Natural Greenspaces	134	95	84
Outdoor Sports	39	23	18
TOTAL	**405**	**247**	**189**

Table 5-8: Number of open space sites at risk from surface water flooding as per the RoFSW map

Appendix I comprises a table showing the sites that are the highest risk sites in terms of fluvial risk and are located within the functional floodplain, and those sites that are at significant surface water risk. These sites should be left as greenfield open space to allow natural flooding and provide flood storage which will provide wider ecological benefits and community value. The table in Appendix I shows there are 13 sites that are located within the functional floodplain and also considered to be at significant surface water risk. These sites are displayed in Table 5-9 below.

Site ID	Site area (ha)	% area in FZ3b	% area at medium risk (1 in 100 AEP event)	% area at high risk (1 in 30 AEP event)
JBA37	1.91	0.19	13.42	4.14
JBA38	0.28	100.00	14.77	9.59
111	21.63	100.00	41.02	19.00
265	4.21	96.25	17.09	13.06
416	1.26	59.95	34.61	20.24
417	0.60	49.47	23.93	16.79
418	0.22	100.00	48.54	34.33
436	0.13	35.73	18.67	0.00
442	0.83	62.36	73.53	63.45
453	10.79	19.92	33.71	27.21
511	12.01	29.77	27.02	15.21
616	0.52	67.26	41.11	37.34
619	1.34	100.00	99.86	0.00

Table 5-9: Open space sites located within the functional floodplain and at a significant level of surface water risk

5.7.5 EA flood risk management activities and Flood and Coastal Erosion Risk Management 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.
- Prepare for and manage flood events effectively.

The current 6-year FCERM investment programme runs from 1 April 2015 to 31 March 2021. The EA regularly reviews the programme to take into account changes such as:

- serious flooding.
- local partnership funding contributions.
- new flood risk information.

We develop projects to reduce flooding and coastal erosion by working with:

- local authorities.
- internal drainage boards.
- local communities.

Follow the link below for the latest news:

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

The potential works in the District, at the time of writing, associated with the FCERM Development Programme includes:

- Natural Flood Management Scheme - North Yorks - Upper Ure / Bishopdale to help reduce fluvial flood risk. In construction at the time of writing and due for completion 2020/21.
- Natural Flood Management Scheme - North Yorks – Brompton to help reduce fluvial flood risk. In construction at the time of writing and due for completion 2020/21.

6 Development and flood risk

6.1 Introduction

This section of the SFRA provides a strategic assessment of the suitability, relative to flood risk, of the assessed sites to be considered through the Local Plan.

The information and guidance provided in this chapter (also supported by the SFRA Maps in Appendix B and the Development Site Assessment spreadsheet in Appendix C) 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.

There are several consequential development considerations which could come out of the site assessment sequential testing process. The LPA should refer to Appendix E and Appendix C, for details on the site assessments carried out for this SFRA.

The LPA must use Appendix C to record its decisions on how to take each site forward or whether to remove a site from allocation, based on the evidence and strategic recommendations provided in this Level 1 SFRA. Recording decisions in the Sites Assessment Spreadsheet demonstrates that a sequential, sustainable approach to development and flood risk has been adopted.

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.

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

Figure 6-1 illustrates the FRM hierarchy with an example of how these may translate into each authorities' management decisions and actions.

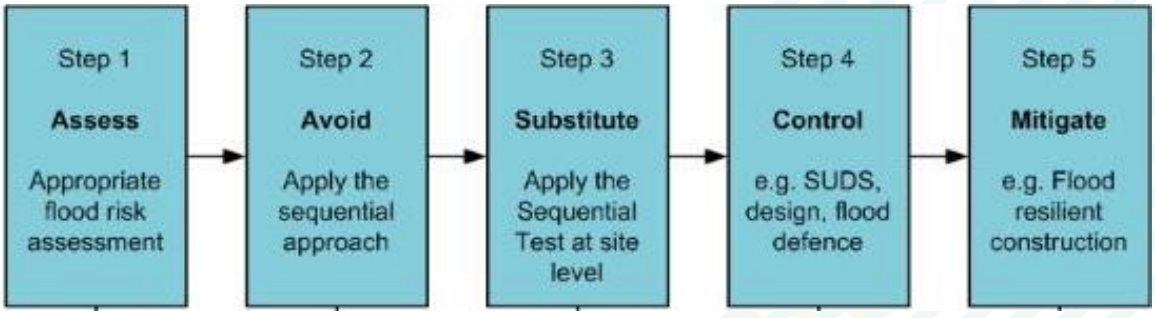

Figure 6-1: Flood risk management hierarchy

Using the EA's Flood Map for Planning, the overall aim of the Sequential Approach should be to steer new development to low risk Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, the flood risk vulnerability of land uses and reasonably available sites in Flood Zone 2 should be considered, applying the Exception Test if required.

Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in higher risk Flood Zone 3, be considered. This should take into account the flood risk vulnerability of land uses and the likelihood of meeting the requirements of the Exception Test if required.

There are two different aims in carrying out the Sequential Approach 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. This SFRA does not remove the need for a site-specific Flood Risk Assessment at a development management stage.

The following sections provide a guided discussion on why and how the Sequential Approach should be applied, including the specific requirements for undertaking Sequential and Exception Testing.

6.3 Local Plan Sequential & Exception tests

The Flood Risk and Coastal Change Planning Practice Guidance, para 019, states the aim of the Sequential Test is:

"…to steer new development to areas with the lowest probability of flooding. The flood zones as refined in the Strategic Flood Risk Assessment for the area provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required."

The National Planning Policy Framework, paras 160-161, sets out the Exception Test as below:

"The application of the exception test should be informed by a strategic or site-specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. For the exception test to be passed it should be demonstrated that:

a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

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

The LPA should seek to avoid inappropriate development in areas at risk 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.

At a strategic level, this should be carried out as part of the LPA's Local Plan. 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);
3. Using opportunities offered by new development to reduce the causes and impacts of flooding;
4. Identifying where flood risk is expected to increase with climate change so that 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 6-2 illustrates the Sequential and Exception Tests as a process flow diagram using the information contained in this SFRA to assess sites put forward in the Local Plan against the EA's Flood Map for Planning flood zones and development vulnerability classification.

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 spreadsheets in Appendix C. This spreadsheet will help show that the LPA, through the SFRA, has applied the Sequential Test for sites at fluvial risk and also considered surface water flood risk in equal standing and thus considered development consideration options for each assessed SHLAA site.

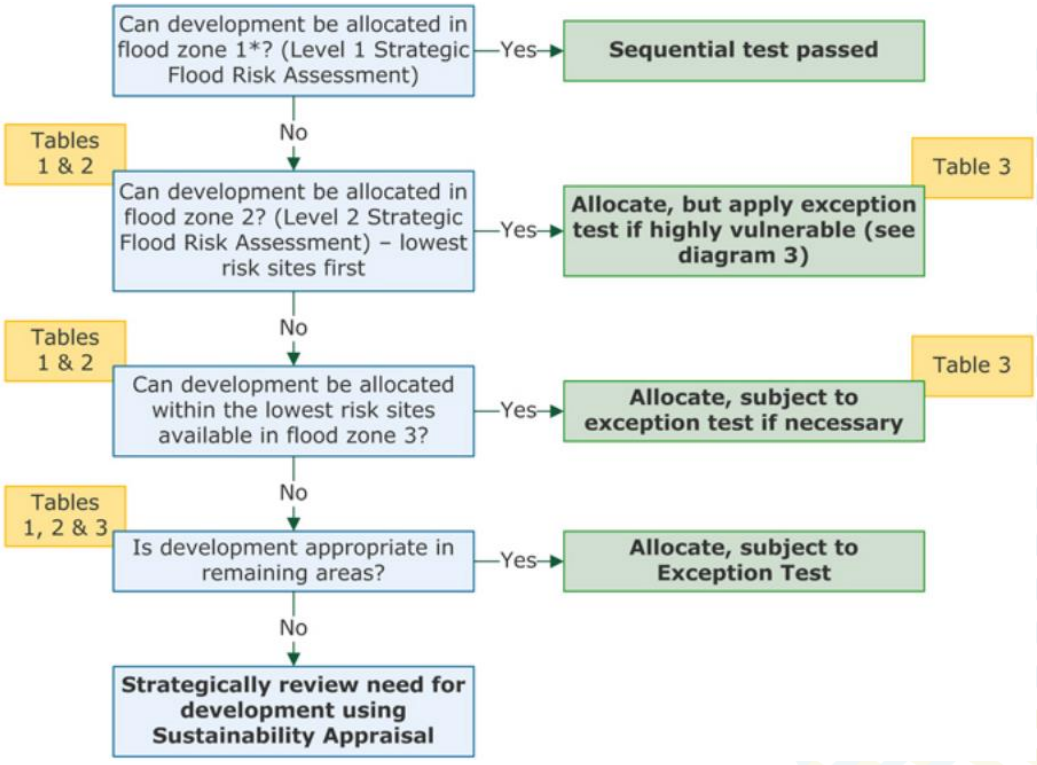

Figure 6-2: Local Plan sequential approach to site allocation[16]

[16] https://www.gov.uk/guidance/flood-risk-and-coastal-change#Sequential-Test-to-Local-Plan

**Other sources of flooding also need to be considered*

(Tables 1, 2, 3 refer to the Flood Zone and flood risk tables of the FRCC-PPG Paragraphs 065-067).

The approach shown in Figure 6-2 provides an open demonstration of the Sequential Test being applied in line with the NPPF and the FRCC-PPG. The EA works with local authorities to agree locally specific approaches to the application of the Sequential Test and any local information or consultations with the LLFA should 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. Following application of the Sequential Test the LPA and developers should refer to 'Table 3: Flood risk vulnerability and flood zone 'compatibility'' of the FRCC-PPG (Paragraph 067) when deciding whether a development may be suitable or not.

Although passing the Exception Test will require the completion of a site-specific FRA, the LPAs should be able to assess the **likelihood** of passing the test at the Local Plan level by using the information contained in this SFRA to answer the following questions:

a. Can development within higher risk areas be avoided or substituted?
b. Is flood risk associated with possible development sites considered too high; and will this mean that the criteria for Exception Testing are unachievable?
c. Can risk be sustainably managed through appropriate development techniques (resilience and resistance) and incorporate Sustainable Drainage Systems without compromising the viability of the development?
d. Can the site, and any residual risks to the site, be safely managed to ensure that its occupiers remain safe during times of flood if developed?

Where it is found to be unlikely that the Exception Test can be passed due to few wider sustainability benefits, the risk of flooding being too great, 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 its 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.

6.4 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 6-2. The SA should be informed by this SFRA so that flood risk is fully taken into account 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 010 FRCC-PPG).

By avoiding sites identified in this SFRA as being at significant risk, such as those listed in Section E.1.1 of Appendix E or by considering how changes in site layout can avoid those parts of a site at flood risk, such as any site included within Recommendation C

(Section E.1.3 of Appendix E), the Council would be demonstrating a sustainable approach to development.

In terms of surface water, the same approach should be followed whereby those sites at highest risk should be avoided or site layout should be tailored to ensure sustainable development. This should involve investigation into appropriate SuDS techniques (see Section 0).

Surface water flood risk should be considered with the same importance as fluvial flood risk.

Once the LPA has decided on a final list of sites following application of the Sequential Test and, where required, the Exception Test following a Level 2 SFRA, a phased approach to development should be carried out to avoid any cumulative impacts that multiple developments may have on flood risk. For example, 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.

6.4.1 Cumulative impacts

The NPPF (2019) 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 156)

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, the cumulative impact may be to change the flood response of the catchment.

Consideration should be given to the following:

- The importance of phasing of development, as discussed in Section 6.4.4;
- Cross boundary impacts i.e. there should be dialogue between RDC and neighbouring authorities upstream and downstream of Richmondshire, primarily those also located within NYCC's authority area. Decisions on flood risk management practices and development in these authorities should involve discussion with RDC given the possible downstream impacts of development on flood risk (see Section 6.4.2);
- Leaving space for floodwater, utilising greenspace for flood storage and slowing the flow (see Sections 6.4.3 and 5.7.4); and
- SuDS and containment of surface water onsite as opposed to directing elsewhere (Section 0).

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.

Through the Local Plan, the LPA should consider the following strategic solutions:

- Use of sustainable flood storage and mitigation schemes to store water and manage surface water runoff in locations that provide overall flood risk reduction as well as environmental benefits,
- In areas where flood risk is being managed effectively, there will be a need in the future to keep pace with increasing flood risk as a result of climate change,
- Assessment of long-term opportunities to move development away from the floodplain and to create blue/green river corridors throughout Richmondshire,
- 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 Richmondshire,
- 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 North Yorkshire Flood Risk Partnership (NYFRP) is a partnership body comprising the EA, YWS, the internal drainage boards, the County Council, and the district councils.

6.4.2 Hydrological linkages and cross boundary issues

Richmondshire is a largely rural district therefore any large scale development in the catchments of the River Ure, River Swale and River Tees could have a significant impact on flow regimes and subsequent flood risk in downstream authority areas, namely Harrogate, Hambleton, Darlington and Stockton-on-Tees.

Figure 6-3 illustrates fluvial hydraulic linkages for the catchments in and around the Richmondshire District. Richmondshire receives the River Tees from County Durham; upstream land use changes in the County Durham authority area could have an effect on fluvial flood risk along this watercourse. The Main Rivers, Ure and Swale, originate within Richmondshire and flow directly into the districts of Harrogate and Hambleton.

It is important that the strategic solutions stated above are fully considered in development planning in these catchments, to ensure there are no adverse effects on flood risk in the downstream authorities of Harrogate and Hambleton.

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

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

These issues highlight the importance of the NYFRP and the need to work together on flood risk management, particularly where actions could exacerbate flooding in downstream communities. The need for consistent regional development policies controlling runoff or development in floodplains within contributing districts is therefore crucial as this would have wider benefits for North Yorkshire authorities as a whole as well as Richmondshire. Appropriate flood risk management policies will be required in the Local Plan.

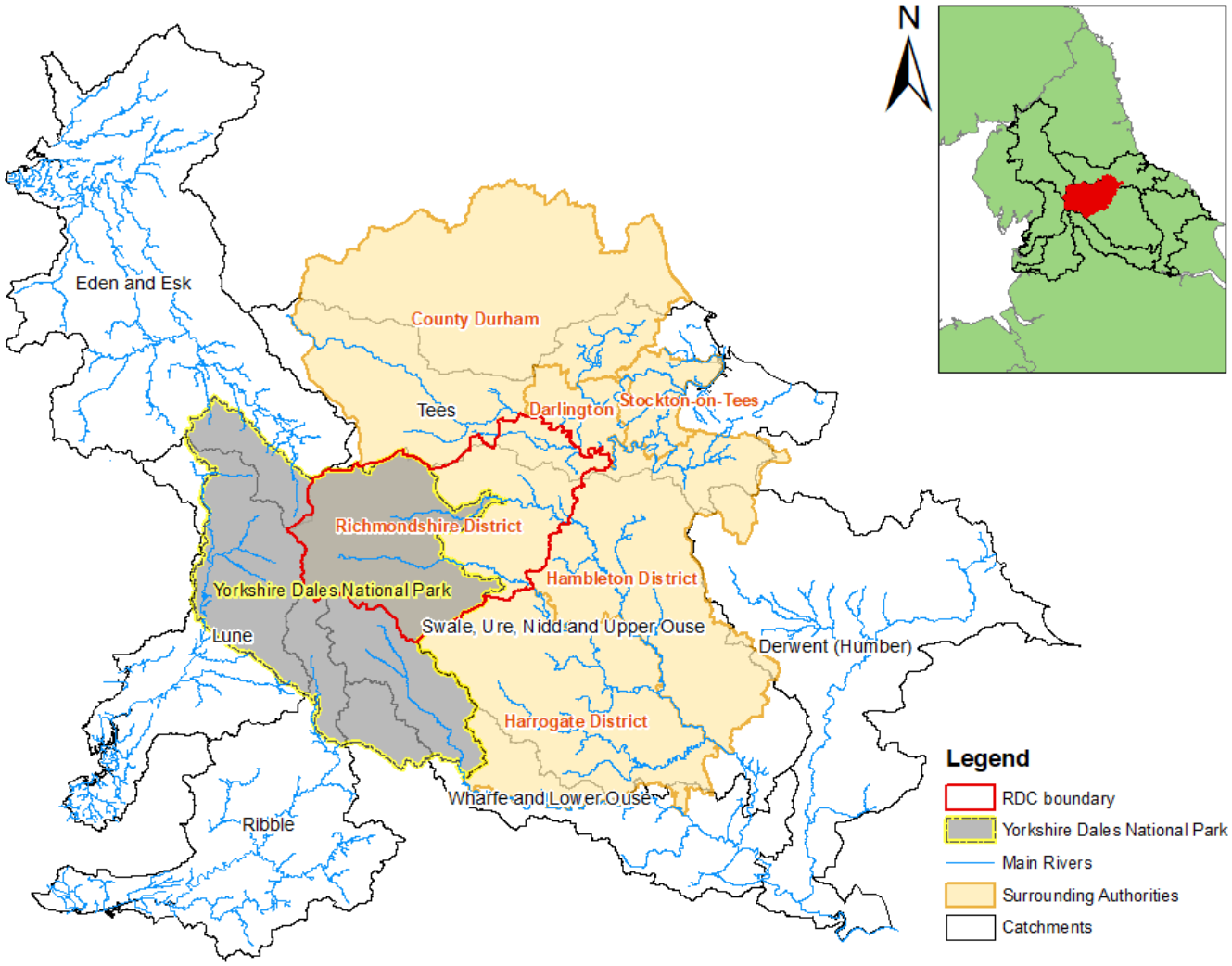

Figure 6-3: Fluvial hydraulic linkages for catchments in and around the Richmondshire district

6.4.3 Safeguarding land for flood storage

Where possible, the LPA may look to allocate land for flood storage functions. Such land can be explored through the site allocation process whereby an assessment is made, of the flood risk at assessed sites and what benefit could be gained by leaving the site undeveloped. A strategic assessment has been carried out as part of this SFRA, see Section 5.7.4.

In some instances, the storage of flood water 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 flood water.

Section 14 Paragraph 157 of the NPPF states that, to avoid where possible, flood risk to people and property they 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 flood water 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, and
- That are large enough and within a suitable distance to receive flood water 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 SFRA Maps in Appendix B to spatially assess the areas of the sites at risk.

6.4.4 Phasing of development

Flood risk should be 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 6-2.

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 in order 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 alleviate flooding at downstream or nearby sites. Large strategic multiple development sites should also carry out development phasing within the overall site boundary so as to avoid cumulative impacts within the site, as well as off the site (see Section 5.7.4 for information on Natural Flood Management and Working with Natural Processes).

6.5 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	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
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

Development	Sequential Test Required?	Who Applies the Sequential Test?	Exception Test Required?	Who Applies the Exception Test?
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

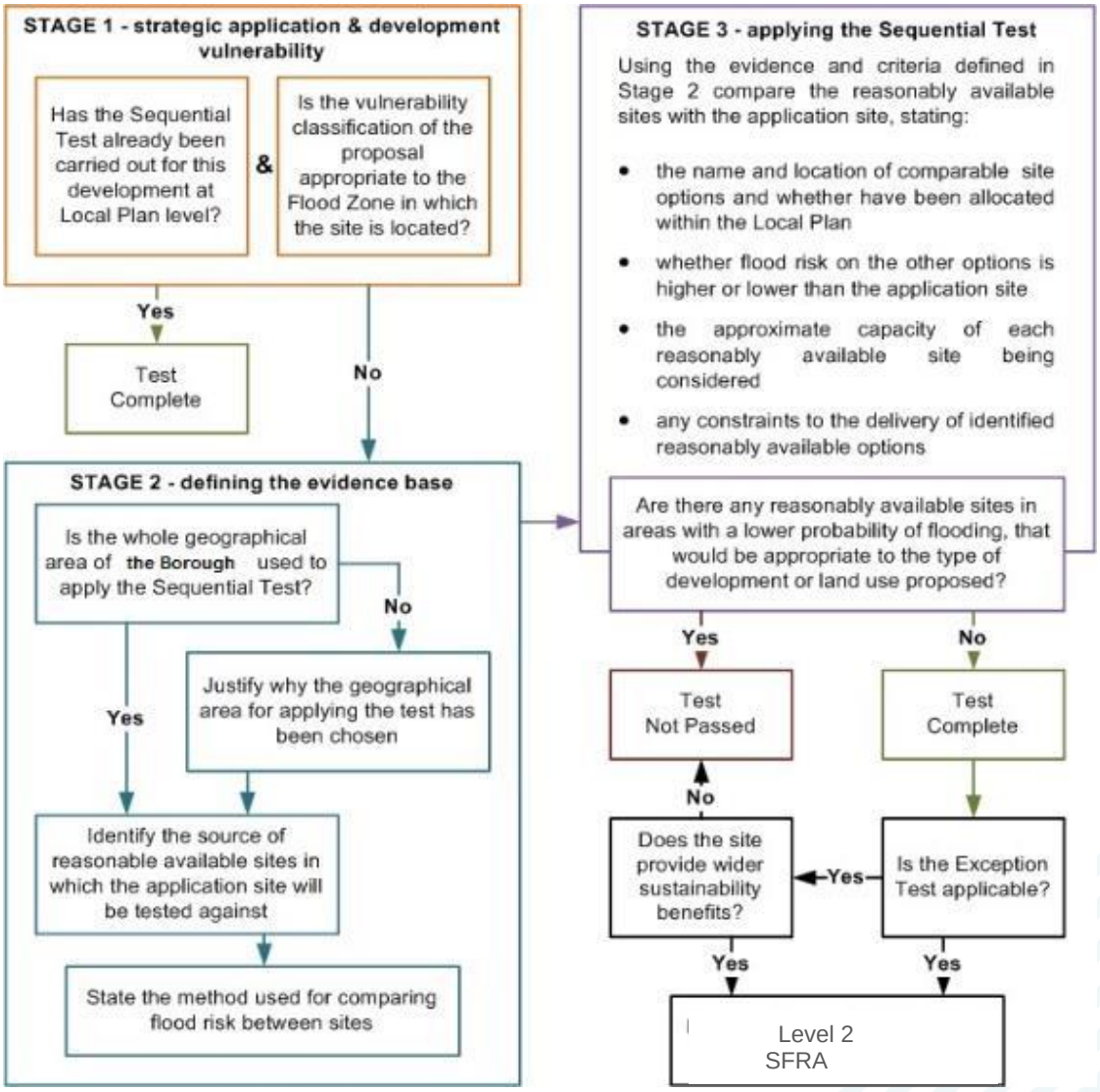

Figure 6-4: Development management Sequential Test process

Figure 6-4 shows what developers should do with regards to applying the Sequential Test if the LPA has not already done so.

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); and
- The development vulnerability is appropriate to the Flood Zone (see Table 3 of the FRCC-PPG).

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**
- **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 or not the indicative 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 tables 1 and 3 of the FRCC-PPG.

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 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 or not:

- 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 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 Appendix E.3.4 of this SFRA;*
    - *Also, refer to the EA Standing Advice, the NPPF and the FRCC-PPG;*
    - *Consult the LLFA*
- ***Submit FRA to the LPA and the EA for approval, where necessary***

6.6 Planning for climate change (NPPF, 2019)

In relation to flood risk and climate change in the planning system, the revised 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 157).

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.

6.6.1 EA climate change allowances

The EA revised the climate change allowances in 2016, for use in FRAs and SFRAs and will use these revised allowances when providing advice. There have been several updates carried out to the allowances since the release of UKCP18. The allowances are available online via:

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

The revised climate change allowances are predictions of anticipated change for:

- Peak river flow by River Basin District (see Table 6-2 for Humber and Northumbria RBD allowances. These allowances are the same for both RBDs);
- Peak rainfall intensity;
- Sea level rises; and
- Offshore wind speed and extreme wave height.

RBD	Allowance Category	Total Potential Change Anticipated for…		
		2020s (2015-2039)	2050s (2040-2069)	2080s (2070-2115)
Humber and Northumbria	H++	+20%	+35%	+65%
	Upper end	+20%	+30%	+50%
	Higher central	+15%	+20%	+30%
	Central	+10%	+15%	+20%

Table 6-2: Recommended peak river flow allowances for the Humber and Northumbria RBDs

Allowance Category	Total Potential Change Anticipated for…		
	2015-2039	2040-2069	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

The peak rainfall intensity allowances apply to the whole of England for small catchments (less than 5 km^2) and urban catchments, though for the Humber or Northumbria RBDs for large rural catchments. SFRAs and FRAs should assess both the central and upper end allowances to gauge the range of impacts.

The EA will also require consideration, if appropriate, of the 'high++ allowances' for peak river flows and mean sea level rise (although sea level rise does not apply to RDC) where a development is considered to be very sensitive to flood risk and with lifetimes beyond the end of the century. This could include infrastructure projects or developments that significantly change existing settlement patterns. The high++ allowances can be found in the EA's *Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities*[17], which uses science from UKCP09. This guidance is based on the Government's policy for climate change adaptation and is specifically intended for projects or strategies seeking Government FDGiA funding. However, RMAs in England may also find it useful in developing plans and making FCERM investment decisions even if there is no intention of applying for central government funding. This is important for any future large-scale infrastructure used to support the delivery of strategic sites such as flood defence schemes.

[17] Environment Agency Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities

Although, it is anticipated that increases in river flows will lie somewhere within the range of the central to upper end estimates of the February 2016 allowances, more extreme change cannot be discounted. The high++ allowances can be used to represent more severe climate change impacts and help to identify the options that would be required.

UKCP18

In November 2018 Defra released a new set of UK Climate Projections (UKCP18). These projections replace the UKCP09 projections which have been used for the past ten years. In February 2019, the EA stated that the 2016 guidance is being revised in line with the UK Climate Projections 2018 and to contact the EA for interim guidance when preparing a flood risk assessment for a development or local plan affected by tidal flooding. A further update was provided in December 2019 whereby the EA stated the following updates to the guidance:

1. Updated the sea level rise allowances using UKCP18 projections.
2. Added guidance on how to
    a. calculate flood storage compensation,
    b. use peak rainfall allowances to help design drainage systems,
    c. account for the impact of climate change on storm surge,
    d. assess and design access and escape routes for less vulnerable development.
3. Changed the guidance on how to apply peak river flow allowances so the approach is the same for both flood zones 2 and 3.

6.6.2 Climate change data in Richmondshire

At the inception of this Level 1 SFRA, a request was made to the EA for the provision of modelled climate change flood outlines, based on the latest 2016 allowances, for all applicable fluvial hydraulic models in the Richmondshire area, outside of the YDNP. This would enable an up to date assessment of the risk from climate change to the potential development sites, as required by the EA's 2019 updated SFRA guidance.

However, such climate change information was not available, mainly due to the available EA models being old and therefore pre-climate change allowances. The EA has not provided any indication as to whether there will be any updates to models in the short term. However, it is recommended that this Level 1 SFRA is updated if and when the EA carries out any model updates.

A precautionary and pragmatic approach has therefore been adopted to assessing future flood risk in this SFRA, whereby the assumption is that all potential development sites identified to be at existing risk from fluvial flooding, are at risk from the effects of climate change. We have also assumed that any site wholly within Flood Zone 1 that is within 20 metres of Flood Zone 2 may be at long term fluvial risk. Appendix E.2 discusses this approach and the sites affected.

The effects of climate change on surface water risk has not been modelled nationally, therefore this SFRA has considered that any site at existing surface water risk, as defined by the Environment Agency's national Risk of Flooding from Surface Water map, will likely be at increased risk in the longer term.

The Sites Assessment Spreadsheet in Appendix C indicates the sites that may be at increased risk in the long term, based on the approaches outlines above. Appendix E.2 provides more detail on the approaches taken and discussion on the sites considered to be at long term risk.

6.7 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 amount of properties that are directly at risk from surface water flooding.

The Department for Communities and Local Government (DCLG) (now Ministry of Housing, Communities & Local Government (MHCLG)) announced, in December 2014, that the local planning authority, in consultation with the LLFA, should be responsible for delivering SuDS[18] 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'[19], published in March 2015. A Practice Guidance[20] document has also been developed by the Local Authority SuDS Officer Organisation (LASOO) to assist in the application of the non-statutory technical standards.

NYCC Sustainable Drainage[21]

In order 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.

In order to satisfy the NPPF and its accompanying PPG, 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.

NYCC has developed SuDS Design Guidance (last updated 2018) detailing the requirements as LLFA. It provides direction to the relevant design guidance for the successful implementation of SuDS and is the basis on which planning consultations from LPAs will be assessed.

6.7.1 SuDS and the revised NPPF, 2019

The Revised NPPF (2019), para 165, 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;

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

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

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

21 https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/NYCC%20SuDS%20Design%20Guidance%202018%20Update.pdf

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".

As since 2014, the NPPF still states only 'major' developments should incorporate SuDS. However, all developments, both major and minor, can include some kind of SuDS, providing multiple benefits that contribute to many other NPPF policies, including climate change. Where site conditions may be more challenging, the types of SuDS may need to be adapted to the site's opportunities and constraints. At a strategic level, this should mean identifying SuDS opportunities and constraints. At a strategic level, this should mean identifying SuDS opportunities according to geology, soil type, topography, groundwater / minewater conditions, their potential impact on site allocation, and setting out local SuDS guidance and opportunities for adoption and maintenance.

In terms of what kind of evidence would show SuDS to be inappropriate for a certain site, it is possible that clarity on what evidence is required may be subsequently set out in the revised FRCC-PPG, and that these circumstances would be exceptional.

Maintenance options must clearly identify who will be responsible for SuDS maintenance 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.

6.7.2 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 water body;
3 To surface water sewer;
4 To combined sewer.

Effects on water quality should also 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, Yorkshire Water and Northumbrian Water as appropriate.

The non-statutory technical standards for sustainable drainage systems (March 2015) sets out appropriate design criteria based on the following:

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

Many different SuDS techniques can be implemented. As a result, there is no one standard correct drainage solution for a site. In most cases, using the Management Train principle (see Figure 6-5), will be required, where source control is the primary aim.

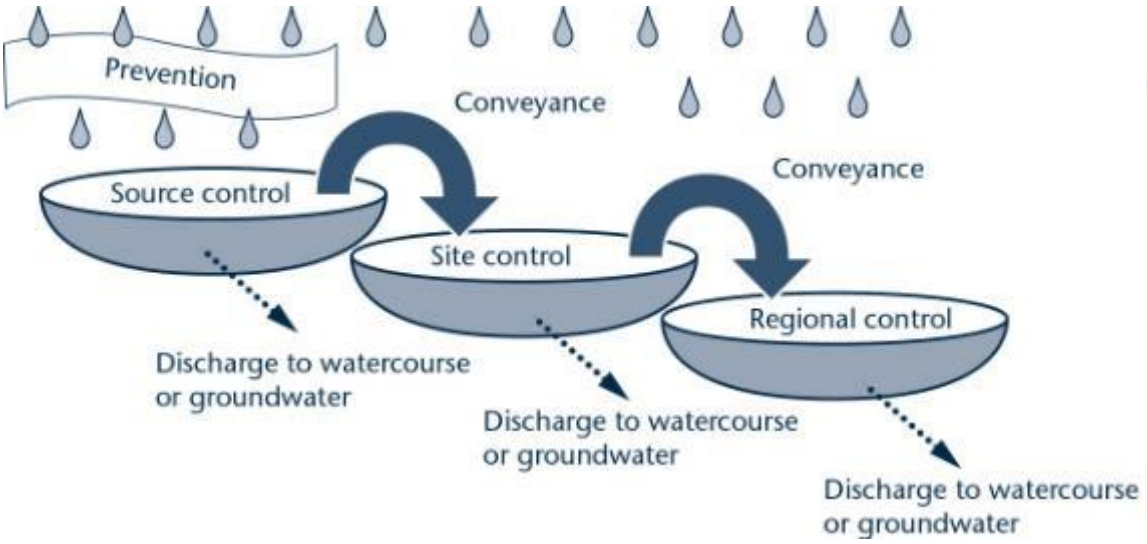

Figure 6-5: SuDS management train principle

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 (NYCC SuDS Guidance) 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 Drainage for new developments

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and a consequent potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and other drainage infrastructure.

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

Managing surface water discharges from new development is crucial in managing and reducing flood risk to new and existing development.

Carefully planned development can also play a role in reducing the amount 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.

6.8.1 Overland flow paths

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

Master planning 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. This is considered to be an appropriate approach to reduce the risk of flooding to new developments. Green infrastructure should be used wherever possible to accommodate such flow paths. **Floor levels should always be set a minimum of 600 mm above ground level** to reduce the consequences of any localised flooding, unless local guidance states otherwise.

The effectiveness of a flow management scheme within a single site is heavily limited by site constraints including (but not limited to) topography; geology and soil (permeability); development density; existing drainage networks both on-site and in the surrounding area; adoption issues; and available area. The design, construction and ongoing maintenance regime of such a scheme must be carefully defined at an early stage and a clear and comprehensive understanding of the catchment hydrological processes (i.e. nature and capacity of the existing drainage system) is essential.

6.9 Property Flood Resilience (PFR)

PFR measures should only be applied retrospectively to existing development that is at flood risk, as new development should not be constructed in areas at flood risk. Para 163 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 then DCLG (now the MHCLG) and the EA has recommended that the use of resistance measures should generally be limited to a nominal protection height of 600mm 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 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.

6.9.1 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.

6.9.2 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
- 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.

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 Environment Agency 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).

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 SFRA Maps in Appendix B and accompanying GIS layers should be made available for consultation by emergency planners during an event and throughout the planning process.

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 North Yorkshire Local Resilience Forum (NYLRF)

The role of the North Yorkshire Local Resilience Forum (NYLRF) is to co-ordinate the actions and arrangements between responding services in the area to provide the most effective and efficient response to civil emergencies when they occur.

The NYLRF are legally required to make sure that the duties stated in the Civil Contingencies Act 2004 are delivered. These are to:

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

7.1.2 North Yorkshire Community Risk Register[26]

As a strategic decision-making organisation, the LRF prepared a Community Risk Register (CRR), which considers the likelihood and consequences of the most significant risks and hazards the area faces, including fluvial, coastal, surface water and urban flooding. This SFRA can help to inform this. 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 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[27]. NYCC provide information for emergency situations on their website:

https://www.northyorks.gov.uk/flood-recovery-advice-and-guidance

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.

[26] https://www.emergencynorthyorks.gov.uk/node/10
[27] https://www.gov.uk/guidance/resilience-in-society-infrastructure-communities-and-businesses#community-resilience

Generally, owners with individual properties at risk should write their own individual flood plans, however larger developments or regeneration areas, such as retail parks, hotels and leisure complexes, should consider writing one collective plan for the assets within an area.

This SFRA can help to:

- Update these flood plans if appropriate;
- Inform emergency planners in understanding the possibility, likelihood and spatial distribution of all sources of flooding (emergency planners may however have access to more detailed information, such as for Reservoir Inundation Maps, which have not been made available for this SFRA);
- 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 Environment Agency and the Association of Directors of Environment, Economy, Planning and Transport is aimed at Local Planning Authorities to help assist in setting up their own guidelines on what should be included in the flood risk emergency plans:

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

7.2 Flood warning and evacuation plans

Developments that include areas that are designed to flood (e.g. ground floor car parking and amenity areas) or have a residual risk associated with them, 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 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 an indicative development can be considered safe without the provision of safe access and exit, 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, YWS, NW, Internal Drainage Boards 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 service resources as possible. North Yorkshire Local Resilience Forum are essential to establish the feasibility / effectiveness of such an approach, prior to it being progressed. 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.

North Yorkshire's emergency plans are created by the NYLRF. NYCC's resilience and emergencies unit are responsible for planning a wide variety of potential incidents and emergencies that could affect North Yorkshire.

7.2.1 What should the Plan include?

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 there are templates available for businesses and local communities.

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 are able to 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 FRCC-PPG. This is closely linked to its occupiers.

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 across England and, based upon weather predictions provided by The Met Office, make an assessment of 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 a defined FWA, 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

There are 9 FWAs in operation across the study area. The FWA's are located along the Rivers Swale and Tees to protect the properties and businesses. The FWAs are shown on the SFRA maps in Appendix B.

Live information on flood warning and flood alerts for any location in England 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 and 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 Summary and Recommendations

8.1 Summary

This Level 1 SFRA provides a single repository planning tool relating to flood risk and development in Richmondshire outside of the Yorkshire Dales National Park. Key flood risk stakeholders namely the EA, LPA, LLFA, YWS, NW, local emergency services, emergency planners, local resilience forums, and Swale & Ure Drainage Board were consulted to collate all available and relevant flood risk information on all sources into one comprehensive assessment. Together with this main report, this SFRA also provides a suite of interactive GeoPDF flood risk maps (Appendix B) and a development site assessment spreadsheet (Appendix C) illustrating the level of risk to potential development sites.

The flood risk information, assessment, guidance and recommendations provided in this 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 based on current available information, detailed, site-specific local information on flood risk is not fully accounted for. For a more detailed assessment of specific areas or sites, a Level 2 SFRA may be carried out following on from the completion of a Level 1 assessment, if required.

The data and information used throughout the SFRA process is the most up-to-date data available at the time of writing (February 2020). 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 when to update the SFRA, and the EA as a statutory consultee on local plans can also advise the LPA to update the SFRA.

8.1.1 Summary of risk

The risk across the RDC area is varied:

- The main fluvial risk comes from:
  - the River Swale that runs through the centre of the district affecting Richmond, Catterick and Brompton-on-Swale,
  - the River Ure in the south of the district affecting south of Wensley, Middleham and the area around Thornton Steward, and
  - the River Tees that runs along the northern boundary affecting Low Coniscliffe, Croft-on-Tees, and south of Hurworth-on-Tees.
- Surface water risk is spread across the whole of Richmondshire district. The main areas of risk are primarily centred around the Main Rivers;
- The areas with the highest levels of groundwater vulnerability are located close to the A66 around Newsham and Ravensworth, at Catterick, Scotch Corner, and to the south around areas such as Leyburn and Middleham. A high proportion of Richmondshire District is categorised as very little or no risk; and

- The main reservoir risk according to the RFM comes from the Thornton Steward reservoir affecting Finghall, north of Newton-le-Willows and just south of Patrick Brompton.

8.2 Planning and flood risk policy recommendations

The following planning flood risk policy recommendations 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…

…as per the National Planning Policy Framework (2019) and Flood Risk and Coastal Change Planning Practice Guidance, unless in exceptional circumstances such as for essential infrastructure, which must still pass the Exception Test, or where development is water compatible.

Development must not impede the flow of water within the functional floodplain nor should it reduce the volume available for the storage of floodwater. Sites within the functional floodplain may still be developable if the site boundary can be removed from the functional floodplain or the site can accommodate the risk on site and keep the area of functional floodplain free from development or obstruction and allowed to flow freely.

Refer to tables 1 to 3 of the FRCC-PPG.

Recommendation 2a: Consider surface water flood risk…

…with equal importance alongside fluvial risk including possible withdrawal, redesign or relocation for sites at significant surface water risk.

Sustainable Drainage Systems on all new development must adhere to industry standards and to the applicable runoff discharge rate and storage volume allowances stated by the Lead Local Flood Authority.

Site specific Flood Risk Assessments should always consider surface water flood risk management and options for on-site flood storage through appropriate Sustainable Drainage Systems. The Local Planning Authority and Lead Local Flood Authority must always be consulted during this process, as should Yorkshire Water, Northumbrian Water and the EA, if required.

Recommendation 2b: Use of appropriately sourced SuDS…

…required for all major developments of 10 or more residential units or equivalent commercial development. This is in accordance with Para 163 of the National Planning Policy Framework (2019).

As per the NPPF (2019), in terms of Sustainable Drainage Systems, development in areas at flood risk should only be permitted where Sustainable Drainage Systems are incorporated into the design, unless clear evidence demonstrates this would be inappropriate.

Sustainable Drainage Systems scoping and design, as part of a site-specific Flood Risk Assessment, must be included within the early stages of the site design in order to incorporate appropriate Sustainable Drainage Systems within the development.

The Local Planning Authority, Lead Local Flood Authority, Yorkshire Water and Northumbrian Water (if appropriate) must be consulted during the site design stage and the Flood Risk Assessment must be submitted to and approved by the Local Planning Authority, considering all consultation with key stakeholders.

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

- NYCC SuDS Guidance
- Interim national standards published in March 2015
- Technical Standards for Sustainable Drainage Systems (Defra)
- C753 The SuDS Manual
- Sewers for Adoption 8

Recommendation 3: Sequential approach to site allocation and site layout...

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

The overall aim of the Sequential Approach should be to steer new development to low risk Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, the flood risk vulnerability of land uses and reasonably available sites in Flood Zone 2 should be considered, applying the Exception Test if required.

Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in higher risk Flood Zone 3a, be considered. This should take into account the flood risk vulnerability of land uses, residual surface water and/or groundwater flood risk and the likelihood of meeting the requirements of the Exception Test, if required.

This SFRA, the National Planning Policy Framework and Flood Risk and Coastal Change Planning Policy Guidance must be consulted throughout this process along with the Local Planning Authority, Lead Local Flood Authority, EA, Yorkshire Water and Northumbrian Water.

Recommendation 4: Requirement for a site-specific Flood Risk Assessment…

…from a developer when a site is:

- Any site located within Flood Zone 2 or 3
- Any site that has an area greater than 1 ha
- 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
- Identified as being at increased flood risk in future
- 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
- Situated in an area currently benefitting from defences
- Within a council designated Critical Drainage Area

Before deciding on the scope of the Flood Risk Assessment, this SFRA should be consulted along with the Local Planning Authority, Lead Local Flood Authority, Yorkshire Water and Northumbrian Water. The Flood Risk Assessment should be submitted to and be approved by the Local Planning Authority including suitable consultation with the Lead Local Flood Authority

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. Where possible, culvert removal should be explored.

Recommendation 6: Phasing of development…

…must be carried out by the Local Planning Authority on a site by site basis and also within sites by the developer to avoid any cumulative impacts of flood risk (reinforced by the revised National Planning Policy Framework (2019)).

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, 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 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 Local Planning Authority where a site-specific Flood Risk Assessment shows that:

- The National Planning Policy Framework and Flood Risk and Coastal Change Planning Practice Guidance have been referenced together with appropriate consultation with the Lead Local Flood Authority, the EA, Yorkshire Water and Northumbrian Water, 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 previously developed sites, the development should look to meet greenfield runoff rates where practicable (in line with the Non-Statutory Technical Standards for Sustainable Drainage (March 2013)), achieved through providing Sustainable Drainage Systems 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
- Whether the development will be safe for its lifetime and has passed the Exception Test, if applicable
- 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.

8.2.1 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 8-1 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	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 • shoreline management plans • local flood risk management strategies • 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.	Short term
	Level 2 SFRA	**Further, more detailed assessment of flood risk to high risk sites, large strategic sites, as notified by this Level 1 SFRA. Dependant on the availability EA river model data.**	**Short term**
	Preliminary site-screening FRAs / outline drainage strategy	Further, more detailed assessment of larger strategic sites such as 407.	Short term
	Local Flood Risk Management Strategy Review	It is recommended that the LFRMS is updated to ensure it remains consistent with the National Flood and Coastal Erosion Risk Management Strategy that, at the time of writing, is due to be published in late 2020.	Short term
	SWMP / drainage strategy / detailed surface water modelling	NYCC has not developed a SWMP for the district, nor for any areas or communities within Richmondshire. It is recommended that the LLFA uses information from this SFRA to ascertain	Short to Medium term

Type	Study	Reason	Timeframe
		whether certain locations at high surface water flood risk may benefit from a SWMP or a detailed surface water modelling study.	
	Water Cycle Study	NYCC has not developed a WCS for the district, nor for any areas or communities within Richmondshire. If the Local Plan highlights large growth and urban expansion, the LLFA should produce a WCS to look at capabilities of water and sewerage providers.	Short to Medium term
	Climate change assessment for Level 1 update or Level 2 SFRA	Modelling of climate change, using the EA's 2016 allowances. It was found that none of the EA's fluvial models had modelled climate change.	Short term
	Possible CDA delineation	Whether the delineation of CDAs may be appropriate for areas particularly prone to surface water flooding. Detailed analysis and consultation with the LLFA, YWS, NW and any relevant Internal Drainage Board would be required. It may then be beneficial to carry out a local SWMP or drainage strategy for targeted locations with any such critical drainage problems.	Medium term
Flood storage and attenuation	Community Infrastructure Levy (CIL) and Green Infrastructure (GI)	For new developments, GI assets can be secured from a landowner's 'land value uplift' and as part of development agreements. The LPA could include capital for the purchase, design, planning and maintenance of GI within its CIL programme.	Short term
	Working with Natural Processes	Promote creation of floodplain and riparian woodland, floodplain reconnection and runoff attenuation features where the research indicates that it would be beneficial in Richmondshire.	Ongoing
Data collection	Flood Incident data	NYCC, 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.	Short term
	FRM Asset Register	NYCC 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	NYCC, as LLFA, should carry out a strategic flood risk assessment of structures and features on the Asset Register to inform capital programme and prioritise its 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, within NYCC should be in place	Short Term / Long Term

Type	Study	Reason	Timeframe
		to deal with SuDS applications, set local specification and set policy for adoption and future maintenance of SuDS.	
Partnership	Yorkshire Water / Northumbrian Water	The LLFA should continue to collaborate with YWS/NW on sewer and surface water projects. The LPA should be kept informed and carry out an assessment of water company assets to ensure they are operational and resilient at all times across the catchment and that capacity for new development is appropriate.	Ongoing
	EA	RDC and NYCC 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 NYCC's existing flood risk partnerships.	Ongoing

Table 8-1: Recommended further work for RDC or developers

8.2.2 Level 2 SFRA

The LPA should review the sites where they expect the main housing numbers and employment sites to be delivered, using Section E.1 of Appendix E, the SFRA maps in Appendix B and the development site assessment spreadsheet in Appendix C. 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,
- 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 cluster of sites are within Flood Zone 2 or are at significant risk of surface water flooding.

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.

As discussed in Section 6.5, a Level 2 assessment can be used to model the February 2016 climate change allowances, where current EA models are available. 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 its 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.

As sites within this Level 1 assessment have been reviewed by the LPA in the consideration of planning applications, then further advice or guidance may be required to establish how best to progress future development proposals, possibly by a further review of the SFRA.

Table 8-2 highlights those sites that should or could go through a Level 2 SFRA. All Strategic Recommendation B sites **should** have a Level 2 SFRA completed assuming the LPA want to allocate. Those sites with Strategic Recommendation A **could** go through a Level 2 assessment in order to assess depths and hazards of flooding. Certain Strategic Recommendation C sites may also benefit from a more in-depth assessment through a Level 2 SFRA.

Site Ref	Site Name	Proposed Use	Strategic Rec.	Should/Could
36	Land to rear of the Laurels	Residential	A	Could
121	Land at Gough Road	Residential	A	Could
128	Land East of Cookson Way	Residential	A	Could
143	Old Wastewater Treatment Works	Residential	B	**Should**
204	Land to South of Sour Beck (Site 1), Catterick Garrison	Residential	B	**Should**
217	Land East of Byng Road	Residential	A	Could
227	Gatherley Rd – Phase 2	Residential	A	Could
240	Land W of Moor Rd	Residential	A	Could
248	Land at Pallett Hill Quarry	Residential	B	**Should**
250	Land N of Eppleby	Residential	A	Could
258	Land at Teeside Farm	Residential	A	Could
261	Land N of Mill Farm	Residential	A	Could
283	Land adj Bedale Rd	Residential	A	Could
290	Swale House	Residential	A	Could
323	Land East of Access Rd	Employment	A	Could
331	Site 1, Park House	Residential	A	Could
332	Site 2, Park House	Residential	A	Could
342	Land at Marygate	Residential	B	**Should**
382	Land North of Loos Road	Residential	A	Could
404	Land South of Loos Road	Residential	B	**Should**
413	Plum Tree House	Residential	A	Could
415	Land NW Catterick Central Junction	Employment	A	Could

Table 8-2: Sites that should or could go through a Level 2 SFRA based on their strategic recommendation

The EA should always be consulted as to whether a Level 2 SFRA is required.

Appendices

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 Appendix A and gives background into the policy documents that are relevant to RDC.

B SFRA maps

Interactive GeoPDF maps

The SFRA Maps consist of all flood risk information used within the SFRA, by way of interactive GeoPDFs. Open the Overview Map in Adobe Acrobat. The Overview Map includes a set of five squares; clicking on one of these squares will open up on of the Index Maps. The Index Maps then contains a set of index squares covering the authority area at a scale of 1:10,000. Clicking on one of these index squares will open up a more detailed map of that area (scale = 1:10,000) by way of a hyperlink.

Within the detailed maps, use the zoom tools and the hand tool to zoom in/out and pan around the open detailed map. In the legend on the right-hand side of the detailed maps, layers can be switched on and off when required by way of a dropdown arrow. The potential development site reference labels can also be switched on and off if, for example, smaller sites are obscured by labels.

The table below shows the datasets that are included in the maps with a short description of what they show.

Dataset	Description
Areas Benefitting from Defences	This dataset shows those areas that benefit from the presence of defences in a 1 in 100 (1% AEP) chance of flooding each year from rivers; or 1 in 200 (0.5% AEP) chance of flooding each year from the sea (not applicable to RDC). Note: in mapping these areas, it is assumed that flood defences and other operating structures act perfectly and give the same level of protection as when the assessment of the area was done.
Council Boundary	A shapefile showing RDC's administrative area.
Detailed River Network	Dataset from the Environment Agency symbolised to show the Main Rivers and Ordinary watercourses flowing through the study area.
Flood Alert Areas	Geographical areas where it is possible for flooding to occur from rivers, sea and, in some locations, groundwater. Flood Alerts are issued to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early/low impact preparations for flooding.
Flood Warning Areas	Geographical areas where we expect flooding to occur and where the Environment Agency provide a Flood Warning Service.
Flood Zone 3b (functional floodplain)	The functional floodplain was delineated as part of this 2019 SFRA (see Appendix D for methodology note) as it is not included in the Flood Map for Planning. This zone is for the use of LPAs and developers.
Flood Zones 2 and 3	The flood zones that are included within the Environment Agency's Flood Map for Planning. Note: Flood Zone 3b was delineated so Flood Zone 3 is therefore classed as Flood Zone 3a.
Historic Flood Map	Dataset from the Environment Agency showing the maximum extent of all individual Recorded Flood Outlines from river, the sea and

	groundwater. It differs from the Recorded Flood Outlines dataset as the HFM only contains outlines that are 'considered and accepted'.
JBA Groundwater Map	The JBA 5m Groundwater map provides a general broad-scale assessment of the groundwater flood hazard and is categorised into grid code which is explained in Section **Error! Reference source not found.** of the report.
LLFA Boundary	A shapefile of NYCC's administrative area.
Main River buffer	EA guidance states that a buffer is required along all watercourses, which may be needed for access, maintenance or future flood risk management to make sure development in these areas does not increase flood risk. An 8-metre buffer, either side of each watercourse, has therefore been used in this SFRA, based on typical EA advice. Note: this buffer area is indicative and any plans for development should, through an FRA, further investigate the area required for the buffer zone.
National Parks	A shapefile showing the Yorkshire Dales National Park. This area is excluded due to the National Parks being a separate Planning authority.
Recorded Flood Outlines	Dataset from the Environment Agency showing all records of historic flooding from rivers, the sea, groundwater and surface water. This dataset contains a consistent list of information about the recorded flood.
Risk of Flooding from Reservoirs	Dataset showing the maximum extent of flooding risk from reservoirs according to the EA's Reservoir Flood Map (RFM). The extent shows the worst credible area that is susceptible to dam breach flooding. Note: the chance of reservoir failure is very rare and there is an extremely good safety record in the UK with no loss of life due to reservoir flooding since 1925.
Risk of Flooding from Rivers and Sea (RoFRS)	Dataset from the Environment Agency showing the chance of flooding from rivers and/or the sea, based on cells of 50m. Each cell is allocated one of four flood risk categories, taking into account flood defences and their condition.
Risk of Flooding from Surface Water (RoFSW)	Previously known as the updated Flood Map for Surface Water (uFMfSW); shows the extent of flooding from surface water that could result from a flood. Note: this data cannot be used at property level.
Spatial Flood Defences	Dataset from the Environment Agency showing all flood defences currently owned, managed or inspected by the EA. It has been symbolised to show raised flood walls and embankments within the study area.
Working with Natural Processes	There are 6 shapefiles located on the maps showing working with natural processes interventions that can be used as more natural forms of flood management.
Yorkshire Water Boundary	A shapefile of YWS's administrative area.

C Development site assessment spreadsheet

Excel spreadsheet containing an assessment of flood risk to the potential development sites based on Flood Zones 2, 3a and 3b, as delineated through this SFRA, and also the Risk of Flooding from Surface Water (RoFSW).

D Functional floodplain delineation

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

E Strategic Recommendations of the proposed sites

Following on from the introduction to the strategic recommendations for sites and the site assessment spreadsheet in Appendix C, this Appendix details the strategic recommendations for sites.

F Strategic Recommendation figures

Figures mapping the sites across the study area categorised by strategic recommendation to easily show which sites may be allocated and those that may need more work before that is possible.

G Richmondshire Level 1 SFRA User Guide

A support document to provide guidance on the use of the SFRA to developers, spatial planners, development management, flood risk management and emergency planners.

H Open space site assessment spreadsheet

Excel spreadsheet containing an assessment of flood risk to the open space sites based on Flood Zones 2, 3a and 3b, as delineated through this SFRA, and also the updated Flood Map for Surface Water (RoFSW

I Open space sites at greatest risk of fluvial or surface water flooding

Table below showing those open space sites that are at the greatest risk of flood risk and should be left as open space to flood naturally.

Site ID	Site area (ha)	% area in FZ3b	% area at medium risk (1 in 100 AEP event)	% area at high risk (1 in 30 AEP event)
JBA18	0.003	**100.00**	0.00	0.00
JBA28	15.52	**90.29**	1.28	0.90
JBA29	1.33	**100.00**	0.00	0.00
JBA30	1.28	**100.00**	0.00	0.00
JBA31	0.36	**100.00**	0.00	0.00
JBA32	0.87	**100.00**	0.00	0.00
JBA33	0.08	**100.00**	0.00	0.00
JBA34	0.05	**100.00**	0.00	0.00
JBA35	0.04	**100.00**	0.00	0.00
JBA36	0.01	**100.00**	0.00	0.00
JBA37	1.91	**0.19**	**13.42**	4.14
JBA38	0.28	**100.00**	**14.77**	9.59
1	0.68	0.00	**98.27**	**91.12**
5	2.12	0.00	**53.47**	**49.50**

Site ID	Site area (ha)	% area in FZ3b	% area at medium risk (1 in 100 AEP event)	% area at high risk (1 in 30 AEP event)
6	0.46	0.00	**64.45**	**59.13**
36	0.16	0.00	**32.35**	**29.78**
40	0.54	0.00	**16.30**	**13.70**
58	0.35	0.00	**11.83**	0.00
68	0.32	0.00	**30.82**	**18.84**
70	0.86	0.00	**19.99**	**14.04**
88	4.05	0.00	**10.31**	5.48
90	0.22	0.00	**69.83**	**34.43**
95	0.78	**59.57**	0.00	0.00
111	21.63	**100.00**	**41.02**	**19.00**
113	0.20	0.00	**14.63**	3.32
115	0.37	0.00	**18.42**	**11.79**
137	0.02	0.00	**57.35**	**12.97**
159	0.07	0.00	**30.77**	**13.21**
162	0.68	0.00	**58.49**	**48.01**
183	0.36	0.00	**26.36**	**12.92**
184	0.32	0.00	**74.83**	**55.87**
187	1.02	0.00	**16.69**	7.43
193	0.13	0.00	**33.44**	4.21
194	0.41	0.00	**68.51**	**44.73**
201	11.39	0.00	**11.84**	8.35
203	9.02	0.00	**12.27**	9.52
212	0.07	0.00	**41.76**	6.36
216	0.01	0.00	**100.00**	2.75
235	1.26	**11.85**	0.89	0.31
241	0.20	0.00	**33.45**	**19.10**
254	5.51	0.00	**18.91**	**13.84**
257	2.12	**25.46**	2.90	1.11
265	4.21	**96.25**	**17.09**	**13.06**
270	1.42	0.00	**13.33**	9.16
278	1.50	**6.51**	0.00	0.00
293	0.10	0.00	**15.94**	6.37
313	1.17	0.00	**14.57**	**11.75**
317	0.15	0.00	**32.04**	**28.19**
358	0.44	0.00	**59.57**	**51.80**
364	0.10	0.00	**10.57**	2.46
365	0.04	0.00	**34.60**	**31.68**
368	11.43	0.00	**26.80**	**18.83**
391	0.19	0.00	**66.65**	0.00
392	1.41	0.00	**11.10**	9.45

Site ID	Site area (ha)	% area in FZ3b	% area at medium risk (1 in 100 AEP event)	% area at high risk (1 in 30 AEP event)
411	0.16	0.00	**30.07**	**23.90**
413	17.19	**99.99**	0.00	0.00
416	1.26	**59.95**	**34.61**	**20.24**
417	0.60	**49.47**	**23.93**	**16.79**
418	0.22	**100.00**	**48.54**	**34.33**
423	0.13	0.00	**41.71**	**37.29**
424	0.26	0.00	**11.81**	8.89
436	0.13	**35.73**	**18.67**	0.00
442	0.83	**62.36**	**73.53**	**63.45**
448	0.11	**1.69**	0.03	0.00
453	10.79	**19.92**	**33.71**	**27.21**
456	1.86	0.00	**12.57**	**10.88**
461	0.05	0.00	**18.15**	0.17
479	2.59	0.00	**20.29**	**14.08**
510	1.01	0.00	**20.26**	8.03
511	12.01	**29.77**	**27.02**	**15.21**
512	1.04	**100.00**	0.00	0.00
530	0.26	0.00	**86.93**	**80.46**
555	0.51	0.00	**63.25**	**56.76**
558	0.24	0.00	**11.27**	4.57
574	0.24	0.00	**42.31**	**33.24**
575	0.37	0.00	**13.24**	3.23
583	0.23	0.00	**42.45**	**33.62**
584	2.45	0.00	**24.65**	**20.55**
588	0.06	0.00	**22.68**	**16.86**
589	0.41	0.00	**97.25**	**94.50**
591	0.08	0.00	**77.05**	**67.99**
598	0.63	**2.74**	1.15	0.70
601	0.30	**85.14**	4.25	0.58
603	0.14	0.00	**12.64**	3.93
604	0.04	0.00	**18.89**	0.15
606	2.40	0.00	**24.13**	**19.47**
613	12.51	**12.76**	8.78	5.24
616	0.52	**67.26**	**41.11**	**37.34**
618	1.47	**100.00**	5.37	4.59
619	1.34	**100.00**	**99.86**	0.00
621	0.23	0.00	**18.67**	5.45
631	0.01	0.00	**100.00**	**88.01**
650	0.27	**100.00**	9.42	5.12
659	0.65	0.00	**25.45**	**23.09**

Site ID	Site area (ha)	% area in FZ3b	% area at medium risk (1 in 100 AEP event)	% area at high risk (1 in 30 AEP event)
672	1.64	**70.26**	6.26	3.37
674	3.24	**3.19**	5.14	4.44
682	13.71	**3.34**	1.43	0.33
696	0.31	0.00	**40.09**	**26.91**
700	1.78	**31.28**	0.59	0.19
705	0.28	0.00	**65.91**	**56.44**
729	1.43	0.00	**29.41**	**17.12**
731	1.01	0.00	**44.71**	**28.53**
735	0.03	0.00	**18.11**	**14.38**
744	0.12	0.00	**49.73**	**36.32**
758	3.43	0.00	**10.85**	7.01
761	0.23	0.00	**23.39**	7.80
768	0.06	0.00	**15.96**	**11.74**
769	0.21	0.00	**77.20**	**69.91**
772	2.03	0.00	**21.66**	0.00
779	5.79	**77.54**	5.59	3.45
780	4.19	**69.58**	4.91	2.22
781	37.77	0.00	**27.92**	**24.78**
782	12.83	**93.57**	0.00	0.00
783	14.57	**93.81**	0.17	0.00
784	7.80	**99.94**	0.00	0.00

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