North York Moors National Park Authority - Strategic Flood Risk Assessment (Level One)

Final Report – November 2017

Contents

Version Control

September 2017 Draft	Initial draft	Issued to North York Moors National Park Authority and other consultees
November 2017 Final	Updated following comments from North York Moors National Park Authority, Environment Agency and North Yorkshire County Council	Issued to North York Moors National Park Authority

Executive Summary

The Level One Strategic Flood Risk Assessment (SFRA) was prepared by North Yorkshire County Council (NYCC) on behalf of the North York Moors National Park Authority (NYM NPA) using the most up to date data sets available, and in accordance with the National Planning Policy Framework (NPPF) and its associated National Planning Policy Practice Guidance (NPPG). The SFRA has been produced in consultation with other key organisations including the Environment Agency (EA) and NYCC in its capacity as Lead Local Flood Authority (LLFA). The SFRA covers the study area which includes the North York Moors National Park and the area covered by the Helmsley Local Plan, including a small area for which Ryedale District Council is the Local Planning Authority (LPA).

The SFRA includes:

- Updated flood maps including the most current EA Flood Maps for Planning
- The delineation of the functional floodplain (Flood Zone 3b)
- Description of flood risk issues
- Development of planning policy recommendations
- Development of guidance for developers including the use of Sustainable Drainage Systems (SuDS)
- Maps of flood risk around key settlement within the study area

The SFRA may be used by the NYM NPA to inform future development of Local Plans and the supporting Sustainability Appraisal.

Areas of flood risk considered include fluvial and coastal flooding, surface water flooding, groundwater flooding and flood risk from reservoirs. Appendix A includes information on flood risk for key settlements within the study area and flood risk maps are provided in Appendix B. The SFRA also makes a number of recommendations for the consideration of NYM NPA during the production of Local Plans including:

- Avoiding any development within areas of functional floodplain (Flood Zone 3b)
- Provision of a framework for considering other sources of flood risk as part of the Sequential Test process
- Requirements for site-specific Flood Risk Assessments (FRAs) and consideration of SuDs
- Safeguarding of land for Flood Storage in consideration of potential future flood management schemes
- Consideration of potential impacts of change of uses of land in Flood Zone 3ai
- The need to consult and engage with neighbouring Local Planning Authorities

1. Introduction

1.1.Background and study area

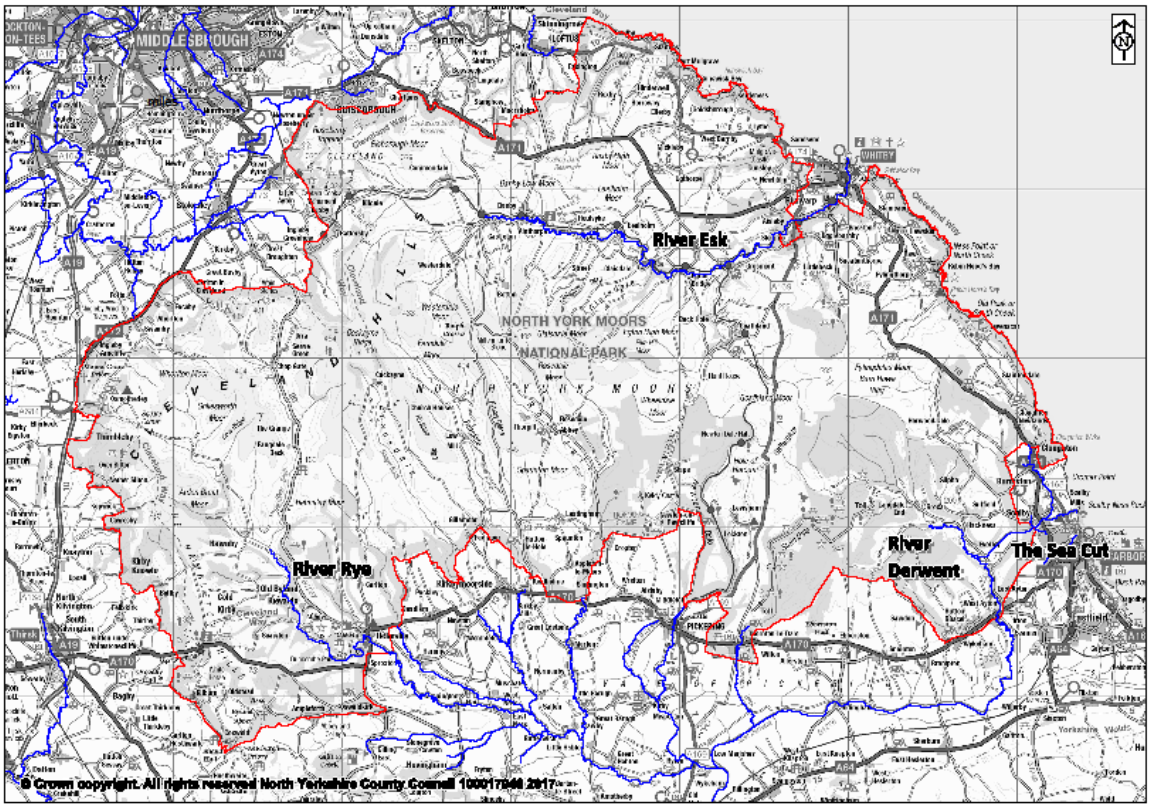
The North York Moors National Park (NYM) was designated in 1952 and covers an approximate area of 1436km^2. It comprises of an isolated upland area about 60km across from east to west and 35km from north to south whose distinctive character lies in the open expanse of its moors, together with areas of farmland, deciduous woodland, conifer forests and a rocky coastline. Planning in the Park is administered by the North York Moors National Park Authority (NYM NPA) for the statutory purposes of conserving and enhancing its natural beauty, wildlife and cultural heritage and to promote opportunities for the understanding and enjoyment of the special qualities of the Park by the public. The NYM NPA is the local planning authority (LPA) for development control and other planning policy matters within the NYM.

The NYM is bounded by the North Sea to the east, the Cleveland Basin to the north and the Vales of Mowbray and Pickering to the west and south. The NYM are characterised by high level moorland dissected by steep-sided river valleys, such as a large portion of the River Esk. The coastline is generally characterised by cliffs and bays, with the land levels generally rising rapidly behind the beaches.

The study area for the Strategic Flood Risk Assessment (SFRA) comprises of the entire NYM plus areas outside the Park that is covered by the Helmsley Local Plan[1] for which Ryedale District Council (RDC) is the LPA.

[1] http://www.northyorkmoors.org.uk/planning/framework/helmsley-plan/Publication-Helmsley-Plan.pdf

Figure 1 Overview of Study Area



1.2.Strategic Flood Risk Assessment - Requirements and objectives

Government guidance on development planning including the National Planning Policy Framework (NPPF)[2] and the National Planning Policy Guidance (NPPG) including the Flood Risk and Coastal Change Planning Practice Guidance[3] requires that flood risk is managed effectively and sustainably through all stages of the planning process. Specifically, it requires Local Plans to take account of flood risk through the development of a SFRA.

A SFRA aims to provide part of the evidence to LPAs during the development of their Local Plans, informing planning policies, land allocations and supporting the production of Sustainability Appraisals (SA). SFRAs are integral in allocation of land for development by facilitating the carrying out of the Sequential Test.

The NYM NPA previously undertook a joint SFRA with Scarborough Borough Council (SBC) and RDC (known as the North East Yorkshire SFRA) in 2006, which was subsequently updated in 2010. However, Government policy, guidance and flood maps underpinning the previous SFRAs are now out of date, and as such a new SFRA has been produced.

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf
[3] Flood Risk and Coastal Change Planning Practice Guidance https://www.gov.uk/guidance/flood-risk-and-coastal-change

The key objectives of this Level 1 SFRA include:

- To ensure NYM NPA are compliant with the NPPF and NPPG
- The determination of risk from all sources of flooding across the study area, including where appropriate risks to and from surrounding areas in the same catchment areas
- To inform the SA of future Local Plans, so that flood risk is fully taken into account when considering allocation options and preparation of plan policies, including policies for flood risk management to ensure that flood risk is not increased
- To provide the basis to apply the Sequential Test to enable development to be directed away from areas of greater flood risk
- To identify the requirements for site-specific flood risk assessments (FRAs)
- To provide a reference document and initial guidance to those involved in development planning
- To provide guidance on Sustainable Drainage Systems (SuDS)

1.3.Overview SFRA methodology

In brief, the methodology employed during the preparation of the Level 1 SFRA included:

- Desk based assessment of flood risk data sets including Environment Agency (EA) Flood Map for Planning, EA Risk of Flooding from Surface Water, EA Areas Susceptible from Groundwater Flooding, and North Yorkshire County Council (NYCC) flood incident records
- Engagement with key stakeholders including NYCC as Lead Local Flood Authority (LLFA), EA, Hambleton District Council (HDC), RDC, SBC, Redcar and Cleveland Borough Council (RCBC), Internal Drainage Boards (IBDs), and Marine Management Organisation (MMO)
- Identification of areas of functional floodplain and production of flood risk maps
- Preparation of guidance to planners and developers

2. Overview of flood risk within NYM NPA

2.1.Potential sources of flooding

In accordance with NPPG, flood risk is a combination of the probability and the potential consequences of flooding from all sources including from rivers and the sea, from surface water, groundwater, overwhelmed sewers and drainage systems, and artificial sources (e.g. reservoirs).

The main sources of flooding within the NYM include:

- Fluvial – flooding from rivers and watercourses may result in inundation of floodplains, areas outside of floodplains, and overtopping and/or breaching of flood defences. Such flooding is commonly caused by the exceedance of channel capacity during higher river flow and is influenced by factors including geographical location, increased rainfall, steepness of the channels / floodplains, runoff rates (which may be associated with soil type and land use), and blocking of channels and culverts.
- Coastal – flooding of land by seawater as a result of one or a combination of direct inundation or the breaching / overtopping of coastal defences. Coastal flooding is influenced by local topography, storm events and high tides.
- Surface water – flooding may occur as a result direct run off or overflowing of drainage systems. Surface water may also influence fluvial flooding due to surface water draining into watercourses.
- Groundwater – flooding may occur as a result of water rising up from the underlying rocks or from water flowing from springs. Flooding may occur following sustained high rainfall causing the water table to rise above normal levels. Groundwater rebound may also occur where abstraction from large aquifers decreases due to a reduction in industrial activities, resulting in a rise in groundwater levels[4]. However, given the nature of the study area groundwater rebound is not predicted to be a significant source of flooding.
- Infrastructure failure – sources of flood risk include flooding from canals, reservoirs and man-made lakes. Flooding may occur when infrastructure is overwhelmed by high rainfall or when a dam or bank fails. Flooding from such sources can happen suddenly and can cause significant damage and danger to life.

2.2.Principal catchment areas

The study area is covered by four main river catchment area; Derwent, Esk, Tees and Ouse (Figure 2).

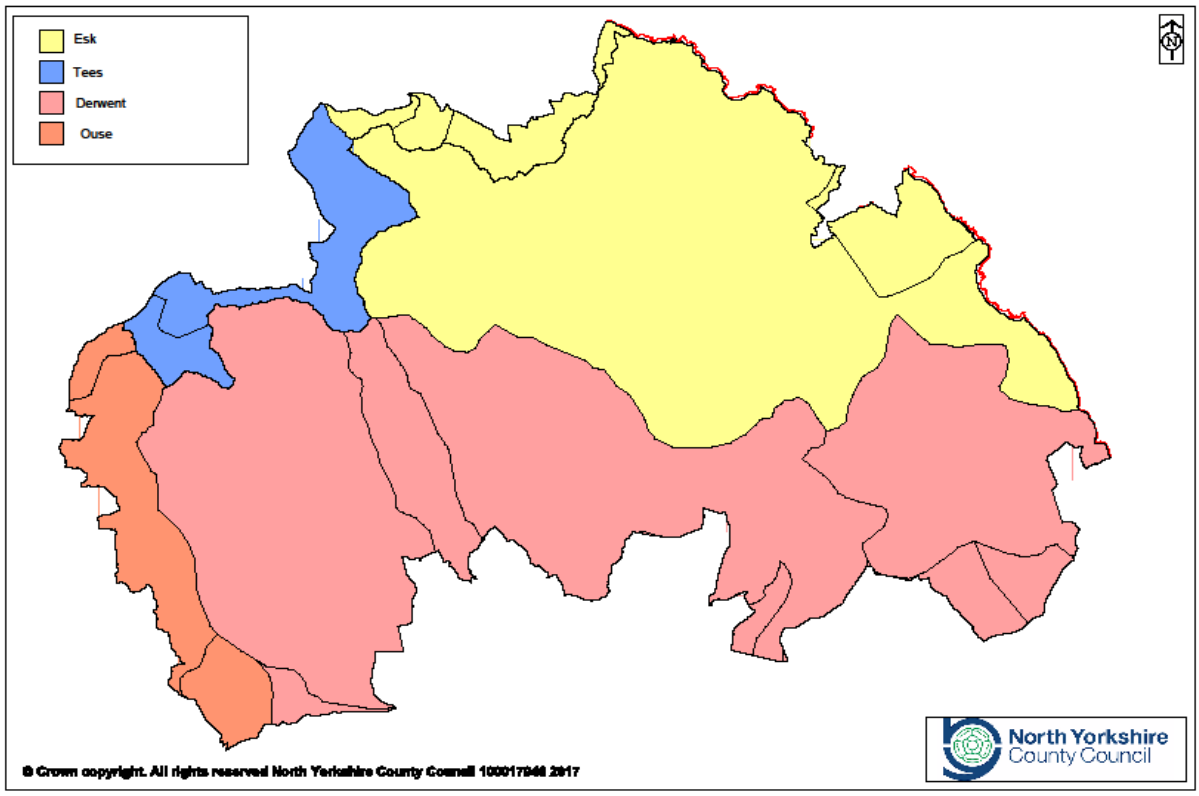
Derwent catchment

The catchment encompasses both the River Derwent and the River Rye, which are important sources of fluvial flood risk within the study area. The River Derwent rises in the NYM, flowing in a southerly direction where it leaves the study area and drains in to the Vale of Pickering. Just north of West and East Ayton, a man-made channel known as the Sea Cut connects the Derwent to the North Sea in order to alleviate flooding downstream. The River Rye and its tributaries drain the southern section of the NYM and leaves the study area at Helmsley.

The Derwent catchment, which drains the moors and uplands, is responsible for a large proportion of the river flow within the lower parts of the catchment (which are outside of the study area). Further information is available in the EA Derwent Catchment Flood Management Plan[5] or via the EA Catchment Area Explorer[6].

[4] http://www.bgs.ac.uk/research/groundwater/flooding/urban.html
[5] https://www.gov.uk/government/publications/river-derwent-catchment-flood-management-plan

Figure 2 River catchment areas covering the North York Moors National Park



Esk catchment

The River Esk flows in a west to east direction, through a predominately rural catchment area which is covered in the most part by the NYM. The Esk is fed by becks and streams and drains in to the North Sea at Whitby (Whitby is outside the SFRA study area). The Esk is typified by steep valleys and small floodplains which can rise rapidly due heavy or prolonged rainfall. The greatest flood risk is from fluvial flooding but this is intrinsically linked to surface water runoff due to rainfall entering watercourses. Further detail can be found within the EA Esk Catchment Flood Management Plan[7] or via the EA Catchment Area Explorer.

Ouse catchment

A small proportion of the study area, at the western extent of the NYMs is covered by the Ouse catchment area (covered by the Wiske and Cod Beck sub-area). Water drains from the elevated study area in to the Ouse catchment. The Ouse catchment within the study area overlaps with the Hambleton District Council area and is covered by a Level One SFRA

[6] http://environment.data.gov.uk/catchment-planning/
[7] https://www.gov.uk/government/publications/esk-and-coastal-streams-catchment-flood-management-plan

finalised in March 2017[8]. More information on the catchment area can be found within the Ouse Catchment Flood Management Plan[9] or via the EA Catchment Area Explorer.

Tees catchment

The North West edge of the NYMs is covered by parts of the Tees catchment area. Streams and becks, such as Swainby / Potto Beck, drain water from the elevated moors in to the River Leven and River Tees. More information on the catchment area can be found within the Tees Catchment Flood Management Plan[10] or via the EA Catchment Area Explorer

Coastline

The study area has a coastline commencing just north of Boulby and Staithes within the Esk catchment which runs southwards to Long Nab near Cloughton (which is part of the Derwent catchment). The coastline within the study area is covered by the River Tyne to Flamborough Head Shoreline Management Plan (SMP2)[11]. Further information on the SMP is included in Section 3 of this report.

2.3 Risk of fluvial and coastal flooding

2.3.1 Data collation

The following data sets are to be used to inform consideration of fluvial and tidal flood risk within the study area:

Table 1 Data sets used for reviewing flood risk from rivers and the sea within the study area

Data	Source
Flood Map for Planning	Environment Agency
Main Rivers	Environment Agency
Detailed River Network	Environment Agency
Areas Benefitting from Flood Defence	Environment Agency
Spatial Flood Defences	Environment Agency
Flood Storage Areas	Environment Agency
Historical Flood Map	Environment Agency
Recorded Flood Outlines	Environment Agency
Flood Alert Areas	Environment Agency
Risk of Flooding from River and Seas	Environment Agency
Flood Warning Areas	Environment Agency
District Council Flooding records	North Yorkshire County

[8] https://www.hambleton.gov.uk/localplan/downloads/file/31/strategic_flood_risk_assessment_level_1_march_2017
[9] https://www.gov.uk/government/publications/river-ouse-catchment-flood-management-plan
[10] https://www.gov.uk/government/publications/river-tees-catchment-flood-management-plan
[11] https://www.gov.uk/government/publications/shoreline-management-plans-smps/shoreline-management-plans-smps

	Council Local Flood Risk Management Strategy (LFRMS)
North Yorkshire County Council Highway Local Flooding – by area	North Yorkshire County Council LFRMS
North Yorkshire Fire and Rescue Incidents	North Yorkshire County Council LFRMS
NYCC Flooding Incidents Recorded	North Yorkshire County Council LFRMS
North Yorkshire Preliminary Flood Risk Assessment (PFRA) Locally Significant Flooding Issues and Potential Schemes	North Yorkshire County Council PFRA

In addition to the data sets above, more detailed modelling for the catchment areas within or adjacent to the NYM NPA were requested from the EA including for the following areas:

- River Esk and Iburndale Beck
- River Derwent
- River Rye (Helmsley)
- Burniston Beck
- Pickering Beck
- Leven Bridge
- Stokesley
- Potto Beck
- Church Beck
- River Seven (Sinnington)

Of the data sets requested the only modelled flood outlines provided which overlapped with the study area was for the River Esk, River Derwent, River Rye (at Helmsley), Burniston Beck and Pickering Beck. These modelled flood outlines were used to inform the delineation of the functional floodplain (Section 2.3.10).

2.3.2 Flood Map for Planning

The EA Flood Map for Planning is the main dataset used by planners for predicting the location and extent of fluvial and tidal flooding and helps inform the application of the Sequential Test. It uses a tiered system to categorise flood risk, as show an in Table 2 below.

Table 2 Flood zones and annual probability of flooding from rivers and the sea.

Flood Zone	Annual Probability of Flooding
1	**Low Probability:** This zone comprises land assessed as having a less than 1 in 1,000 (<0.1%) annual probability of river or sea flooding (all land outside Zones 2 and 3).
2	**Medium Probability**: This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%).
3	**High Probability (Flood Zone 3a)**: This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year. **Flood Zone 3ai**: this zone covers land which would normally be classified as functional flood plain but is removed due to the fact that it has been built upon. **Functional Floodplain (Flood Zone 3b)**: This zone comprises land where water has to flow or be stored in times of flood. *It should be noted that The Flood Map for Planning does not map the extent of the Functional Floodplain or Flood Zones 3ai.*

Flood zones (FZ) were originally prepared by the EA using a broad-scale modelling methodology to determine extents and depths of floodplain inundation for 1% and 0.1% AEP flood events. However, the EA has instigated an ongoing programme of updates of FZs using more detailed hydraulic models and FZs are considered to have a good level of accuracy. The Flood Map for Planning used for the SFRA was up to date as of July 2017.

FZ3 delineates areas that have a high chance of flooding, whilst FZ2 highlights those areas that will flood in a more extreme event. FZ1 delineates those areas where fluvial flooding is unlikely. The FZs are precautionary in the respect that they do not take account of flood defences (which can be breached and/or overtopped) and therefore represents a worst-case scenario of flooding. However, there are also limitations to and assumptions within the data which need to be considered when using them:

- The information provided is largely based on modelled data and is therefore indicative rather than specific. Locations may also be at risk from other sources of flooding, such as high groundwater levels, surface water run-off, or failure of infrastructure which are not considered within the flood maps.
- They do not take account of climate change and primarily cover main rivers only.

- They are designed only to give an indication of flood risk in an area of land and are not sufficiently detailed to show whether an individual property is at risk of flooding. Individual properties may not always face the same chance of flooding as the areas that surround them.
- The Flood Map for Planning (Rivers and Sea) does not provide information on flood depth, speed or volume of flow.

Figure B1 in Appendix B illustrates flood risk zones across the study area.

2.3.3 The risk of flooding from river and seas map

The Risk of Flooding from River and Seas 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. The map bands the likelihood of flooding into four risk categories:

- High – greater than to equal to 1 in 30 (3.3%) chance in any given year
- Medium – less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) chance in any given year
- Low – less than 1 in 100 (1%) but greater than or equal to 1 in 1,000 (0.1%) chance in any given year
- Very Low – Less than 1 in 1,000 (0.1%) chances in any given year

The RoFRS shows the chance of flooding from rivers and/or the sea, based on cells of 50m x 50m, with each cell being allocated one of the risk categories illustrated above. The modelling utilises local influences including the presence and standard of existing defences, and benefits from utilising local knowledge.

It is important to note that the RoFRS acts as supplementary evidence with regards to flood risk and should be taken as indicative only. It is not suitable for planning purposes, and property level assessments.

The RoFRS also includes a suitability rating which provides a narrative on the scale at which the data can be appropriately used for (County, Town, street, etc.), which should be considered when using the data set.

A RoFRS map of the study areas is included in Appendix B (Figure B2).

2.3.4 Areas Benefitting from Flood Defence

The EA Flood Map for Planning (Rivers and Sea) Areas Benefiting from Defence illustrates areas that benefit from the presence of defences to a minimum standard of 1 in 100 (1%) chance of flooding each year from Rivers, or 1 in 200 (0.5 %) chance of flooding each year from the sea. If these defences were not present then these areas would flood.

Based upon the latest version of the data sets (dated May 2017 and accessed July 2017) the study area does not contain any locations which benefit from defences to a specified standard.

2.3.5 Flood Storage Areas

The EA Flood Map for Planning identifies Flood Storage Areas (FSA). These areas act as a balancing reservoir, storage basin or balancing pond and attenuate an incoming flood peak to a flow level that can be accepted downstream, or delay the timing of a flood peak so that its volume is discharged over a longer time interval. Such areas, where present, are commonly incorporated into functional floodplain areas (FZ3b).

At the time of writing, the most current data set (dated May 2017 and accessed July 2017) does not identify any FSAs within the study area. However, the EA Outline Reservoir Flood Map included an area defined as the Pickering Flood Alleviation Scheme FSA which has been considered as a FSA for the purpose of the SFRA and is included as part of the functional floodplain (see section 2.3.10).

2.3.6 Flood Warning Areas

Flood Warning Areas are geographical areas where flooding may occur and as such the EA provide a Flood Warning Service. They generally contain properties that are expected to flood from rivers or the sea. The purpose of Flood Warnings is to alert people that flooding is expected and they should take action to protect themselves and their property. At the time of writing the report, Flood Warning Areas are located at the following locations within the study area (* denotes Flood Warning Areas not wholly within the study area):

- Mowthorpe
- Cowbar
- Ruswarp *
- Sinnington *
- Newbridge *
- Thornton Le Dale *
- Leaholme
- Egton Bridge

Figure B3 (in Appendix B) illustrates the locations of Flood Warning Areas within the study area.

2.3.7 Flood Alert Areas

The Flood Alert Areas are located where flooding may occur from rivers and sea (and in some locations groundwater). A Flood Alert Area may also overlay Flood Warning Areas. In some coastal locations a Flood Alert may be issued for spray or overtopping and be defined by a stretch of coastline.

A Flood Alert is issued by the EA 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 Alerts are issued earlier than Flood Warnings to provide advance notice of the possibility of flooding and may be issued when there is less confidence that flooding will occur in a Food Warning Area.

The Flood Alert Aresa within the study area illustrated in Figure B4 in Appendix B. They chiefly cover low lying areas within the Esk valley, along the North Sea coastline, the upper Derwent Valley (including around the Sea Cut, Hackness and West and East Ayton), the Rye and its tributaries including around Helmsley and Thornton Le Dale.

2.3.8 Historic Flood Map

The EA Historic Flood Map (HFM) is a GIS layer which identifies all known flood outlines from river, sea and groundwater flooding since 1946. In some instances not all information is complete including source of flood, data of floods etc. There is generally good correlation between the HFM and EA Flood Zone 2 and 3 maps and the HFM has been used to delineate the functional floodplain (see section 2.3.10).

When using the HFM it should be noted that where it shows flooding to areas of land it does not necessarily mean that properties within this area flooded internally or that if an area is not covered by the mapped flood extents that they have not been flooded previously. The map also does not show the frequency or depth of flooding. It is important that such limitations are understood when using the HFM.

Recorded Flood Outline maps are also available from the EA. This data set differs from the HFM as it only contains flood outlines deemed “considered and accepted”, which have met certain criteria including the availability of photographic evidence, recorded flood levels and evidence that the outline represents the peak water level. The Recorded Flood Outline was crossed checked for consistency with the HFM; there is constancy between the two within the study area with the exception of a small area along the south bank of the Esk downstream from Ruswarp.

The HFM identifies historic flooding events within the study area along the River Rye at and upstream from Helmsley, and along the Esk valley including at Danby, Leaholm, Glaisdale, Egton Bridge, Grosmont, and Ruswarp. There are historical flooding outlines at the northern

extent of Sinnington due to flooding from the River Seven, and flooding from River Derwent at West and East Ayton and upstream of the Sea Cut at Mowthorp Bridge. Historical coastal flooding at Staithes is also included in the HFM.

A HFM for the study area is included in Appendix B (Figure B5).

2.3.9. North Yorkshire County Council Records

NYCC maintain records of flooding as part of their role as LLFA and have also collated detail of flood incidents for the production of a Local Flood Risk Management Strategy (LFRMS), Preliminary Flood Risk Assessment (PFRA) and internally for emergency planning purposes following flood events in 2015. Sources of information include:

- NYCC and District Council Flooding records
- NYCC Highway Flooding records
- North Yorkshire Fire and Rescue records

Historic records up to 2015 were accessed and checked for incidents clearly originating from fluvial and coastal sources. In many instances the source of the flooding was not known or recorded but records identifying flooding as a result of fluvial flooding have been considered as part of the SFRA.

The LLFA are also required to maintain a register of flooding investigations under section 19 (s19) of Flood and Water Management Act 2010 (FWMA). At the time of drafting there were no s19 investigations reports for fluvial or tidal flooding published by NYCC within the study area. More information on the role of NYCC in their capacity as LLFA under FWMA is available in the NYCC PFRA[12]. Consultation was also undertaken with other LPAs including SBC, HDC, RDC and RCBC regarding possible incidents of fluvial and coastal flooding but no additional information was provided at the time of drafting the SFRA.

Locally significant flooding issues and potential schemes were identified as part of the NYCC PFRA but all those identified are located outside of the study area. For reference and in order to consider potential impacts of future planning on areas adjacent to the study area, these locations included:

- Burniston and Cloughton
- Pickering
- Kirbymoorisde
- Thirsk

[12] https://www.northyorks.gov.uk/flood-and-water-management

- Northallerton

Although these locations are outside of the boundary of the study area, due to the elevated nature of the study area resulting in water draining into the surrounding areas, the impact to areas adjacent to the study area need to be carefully considered during Local Plan production. The potential impact of planning policies within the study area, planning allocations and individual planning applications all need to consider the potential impacts outside of the study area.

It should also be noted that NYCC, in their capacity as LLFA, are due to update the PFRA in 2017 but at the time of writing the SFRA no further information was available about the timeframes and scope of the works. New / updated PFRAs should be considered by the NYM NPA and developers where appropriate.

Locations where fluvial flooding and coastal flooding was identified are listed below. This list includes outlines those by the EA HFM where it is clearly attributable to fluvial or tidal flooding:

- Staithes
- Rievaulx
- Helmsley
- Leaholm
- Coxwold
- Osmotherley
- Kildale
- Thorton Le Dale
- East Ayton
- West Ayton
- Boltby
- Thirlby
- Castleton
- Easington
- Cowbar
- Sinnington
- Egton Bridge
- Grosmont

2.3.10. Functional Floodplain

Government policy requires that SFRAs identify flood risk zones including areas of functional floodplain (FZ3b), in agreement with the EA. Functional floodplain is broadly defined as "land where water has to flow or be stored at times of flooding"[13]. FZ3b should take account of local circumstances and not be defined solely on rigid probability parameters. As such, FZ3b is not delineated within the EA Flood Map for Planning.

The NPPG (paragraph 15)[14] states that *"land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood (such as a flood alleviation scheme) in an extreme (0.1% annual probability) flood, should provide a starting point for consideration and discussion to identify the functional floodplain".*

[13] NPPG Flood Risk and Coastal Change, Table 1 - Flood Map (Paragraph: 065 Reference ID: 7-065-20140306). https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-1-Flood-Zones

[14] NPPG Flood Risk and Coastal Change Paragraph: 015 Reference ID: 7-015-20140306 https://www.gov.uk/guidance/flood-risk-and-coastal-change#Assessment-to-identify-functional-floodplain

Furthermore it requires that delineation of function floodplain should consider the effects of defences and flood risk management infrastructure. Areas which would naturally flood, but which are prevented from doing so by existing defences, infrastructure or buildings, would not normally be part of the functional floodplain. In addition, the guidance states that areas intended to flood, such as FSA should also be identified as functional floodplain e.g. an upstream FSA designed to protect communities further downstream should be safeguarded from development and identified as FZ3b.

The methodology to delineate FZ3b was agreed with the EA and has been implemented as follows:

Where detailed site specific modelling is available

Detailed modelling was available for Helmsley[15], Esk and Iburndale Beck[16], and a small area of Burniston Beck[17] and Pickering[18] . FZ3b was delineated in the following way:

- 5% AEP was used as an initial indicator of the extent of FZ3b. For areas where a 5% AEP scenario was not available, 4% AEP scenario outlines were used. Defended scenarios, where by flood event modelling considers the presence of existing flood defences, were used were available. Undefended scenarios were used in the absence of Defended scenarios.

- Modelled flood outlines were compared to the HFM outlines and FZ3b was extended to cover previously flooded areas but only within the spatial extent covered by FZ3.

- Locations of FSAs were checked within the study area for inclusion as part of FZ3b but none were present within the EA FSA Map. However, the Pickering FSA was identified as part of the EA Reservoir Flood Map and added to FZ3b.

- Areas of developed land (building, roads and critical infrastructure) were removed from FZ3b using a 1: 10 000 scale map and GIS layers identifying critical infrastructure, roads and railways. The areas of developed land were defined as FZ3ai.

- FZ3a was created by removing FZ3b and FZ3ai from FZ3.

Where no detailed site specific modelling is available

[15] Helmsley Flood Risk Mapping, JBA, 2006.
[16] River Esk and Iburndale Beck Flooding Map Study, Halcrow, 2008.
[17] Burniston Beck Section 105, Kennedy & Donkin, 1999.
[18] Pickering Beck Data Improvements (JBA Consulting 2011)

- Any FZ3 without detailed modelling was delineated as FZ3b. This precautionary approach ensures that flood risk is not underestimated through a lack of detailed evidence. Developers will need to assess the flood risk in these locations via a site-specific FRA. The FRA will need to demonstrate that the proposal meets NPPF guidelines and will be safe for its lifetime, without increasing risk to others. FRAs will need to provide evidence to justify any departure from the precautionary FZ3b designation.

- Areas of developed land within FZ3b were removed using a 1:10 000 scale map and GIS layers identifying critical infrastructure, roads and railways[19]. These areas were defined as FZ3a, in order to differentiate between those areas of developed functional floodplain which were based on modelled data (i.e. FZ3ai)

- As stated within Table 2 (Flood zones and annual probability of flooding from rivers and the sea), FZ3a covers areas of 1% or greater probability of fluvial flooding (>0.5% tidal), and therefore FZ3a may also include areas of greater flood risk (including FZ3b (and FZ3ai). Developers must therefore carefully consider the potential presence of FZ3b (and FZ3ai) and the associated flood risk as part of a site-specific FRA to support planning applications in these locations.

Locations where detailed modelled layers were used to delineate FZ3b are identified in Figure B6.

FZ3ai is areas of land *where water would flow or be stored in times flooding were it not for the existence of development or infrastructure*. FZ3ai was created by removing developed areas from FZ3b (as described above) and represents land that would be in FZ3b were it not already developed. Delineating FZ3ai may allow NYM NPA to assess risk within FZ3a by showing locations where flows maybe restricted. If any potential development sites in FZ3ai become available for new or further development the risk at the sites and their influence on flood risk in the surrounding area should be carefully considered.

2.3.11. Internal Drainage Boards

Internal Drainage Boards (IDBs) are public bodies that manage water levels in areas where there is a special need for managing flood risk and in England and Wales. Each IDB has permissive powers to undertake work to provide water level management within their Internal Drainage District (IDD). IDBs undertake works including maintenance of rivers,

[19] Development Limits are normally used within Local Plans to delineate developed areas from undeveloped areas but no Development Limits were available within the study area. Therefore, delineation was undertaken using 1:10 000 scale maps to identify settlement boundaries by following the outline for built up areas, natural features and boundaries were possible.

drainage channels and outfalls, and facilitating drainage of new developments and advising on planning applications.

There are two IDBs which partially overlap with the study area:

- Vale of Pickering IDB
- Swale and Ure IDB

Both IDBs were consulted during the production of the SFRA in May 2017. Vale of Pickering responded to advise that only a small proportion of the IDB is within the study area; north of West Ayton, and included one IDB maintained watercourse in the area known as Thorn Park Drain. The maps provided by Vale of Pickering IDB are included in Appendix B.

In areas of where IDBs are responsible for managing watercourses, they should also be consulted on planning applications and the use of SuDS.

2.3.12. Areas likely to be affected by fluvial flooding

The Flood Maps indicate that areas of highest flood risk are present predominantly along the Esk Valley, the Rye, the River Derwent and the Sea Cut. However, much of the study area is sparsely populated and is largely rural in nature.

Key receptors include Helmsley, Lealholm, Egton Bridge, West Ayton, Sinnington, Thorton Le Dale and Staithes. More detail regarding fluvial and tidal flood risk are described in Appendix A (Flood Risk at Key Settlements within the Study Area) and illustrated in the flood maps contained in Appendix B.

It is also important that potential impacts of Plans and proposed development consider transboundary impacts to settlements including Pickering, Sleights and parts of Thornton Le Dale and Sinnington.

2.4.The risk of surface water flooding

Surface water flooding may occur as a result of rainfall leading to water flows downhill along slopes, valleys and low points, filling up of depressions and leading to flooding. Surface-runoff and resultant flooding depends on the intensity and duration of rainfall, as well as the nature of the receiving environment including topography and surface type (including soil type and vegetation cover).

The study area is largely rural in nature and is covered by moorland sloping down to lower lying land. Urban areas are generally more susceptible to surface water flooding due to them being covered by less permeable substrates (e.g. roads, pavements etc.) and require less rainfall (duration and / or intensity) for surface water flooding to occur than rural areas.

Rural areas may be less prone to surface water flooding depending on the nature of farming practices, soil types and vegetation cover. Rainfall may also result in the overwhelming of sewers leading to back up or surcharging of sewers.

In some instances it may be difficult identify sources of flooding which may result from multiple sources (e.g. combination of surface and fluvial flooding), and due to the elevated nature of much of study area, surface water run-off flows into watercourses contributing to an increase in fluvial flood risk.

2.4.1. Risk of flooding from Surface Water Maps

The Risk of Flooding from Surface Water (RoFSW) maps produced by the EA is a national data set which identifies areas susceptible to surface water flooding. It replaced the Flood Map for Surface Water (uFMfSW) in 2016, and provides an overview of the scale and distribution of surface water flood risk in England. RoFSW map is the primary source used in the SFRA for considering flood risk associated with surface water and identifies areas of low, moderate and high vulnerability to surface water flooding as listed below:

- Low vulnerability - areas which have a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)
- Moderate vulnerability - areas which have a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%)
- High vulnerability - areas which have a chance of flooding of greater than 1 in 30 (3.3%)

Any land not covered by these areas is considered to have a very low probability of surface water flooding (e.g. greater than 1 in 1000 chance of flooding). The RoFSW maps used for this Level 1 SFRA only considers the extent of flooding and additional data sets available for depth, speed, hazard and direction have not been considered.

When using the RoFSW data for planning purposes, it should be considered in conjunction with two additional data sets; suitability and the model used to derive surface water flood risk. The suitability data set identifies the scale at which the data is appropriate to be used to assess flood risk from surface water.

In addition, there are a number of limitations with regards to the RoFSW map which must also be considered including the lack of consideration of future scenarios (including climate change) (see Section 4.5) and other sources of flooding which may interact with surface water flooding. While consideration should be made to the spatial suitability of the flood risk, in any case the RoFSW should not be used to identify individual properties which may or may not flood but be used to help in form FRAs.

The RoFSW map identifies that much of the increased vulnerability from surface water flooding (3.3% chance or greater) are in rural areas away from main towns and villages. However, areas of high vulnerability include:

- Along the Esk valley and its tributaries including around the settlements of Castleton, Danby, Leaholm
- Draining of elevated moors onto the Tees catchment area around Swainby
- In the west of the study area including at or adjacent to Boltby, Coxwold, and Kilburn
- Surface water run off draining in a southerly direction towards the Vale of Pickering including at Hutton Le Hole and Sinnington

More detail on surface water risk is included in the PDF maps in Appendix B (Figure B7) and on description of flood risk at key settlements in Appendix A.

2.4.2. Critical Drainage Areas

A Critical Drainage Area (CDA) is an area which has been notified to the LPA as such by the EA in line with the NPPF. In these locations, there needs to be a high standard of management for surface water and seek to ensure that any new development will contribute to a reduction in flooding risk. Based upon the information available at the time of writing, there are no CDAs within the study area.

2.4.3. Records of surface water flooding incidents

NYCC maintain records of flooding as part of their role as LLFA and also collated detail regarding incidents for the production of their LFRMS, PFRA and internally for emergency planning purposes following flood events in 2015. Sources of information include:

- NYCC and District Council Flooding records
- NYCC Highway Flooding records
- North Yorkshire Fire and Rescue records
- Sewer Flood Records

In many instances the source of the flooding was not known or recorded. The study area is covered by Highway Areas 3 and 4, and NYCC Highways were consulted but no further information was available at the time of writing. Consultation was also undertaken with other LPAs including SBC, HDC, and RDC regarding possible incidents of surface water flooding but no additional information was provided.

The s19 investigation register includes a report of a flooding incident on the A169 at Blue Bank, south of Sleights in 2016. The report finds that the flooding was as a result of obstruction and damage to a series of culverts on the moor as a result of the action of a utility company during its undertaking of non-related works. There is no previous history of failure of these culverts to convey surface water, and the opportunity has been taken as a result of the incident to undertake upgrades to further reduce the risk of future incidents (addition to cyclic inspection schedules, plus improvements to highway alignment and

intended increased capacity of drainage system). The report which provides more detail on the incident can be accessed on the investigation register[20].

Yorkshire Water (YW) is responsible for most of the district's drainage network within the study area, with the Tees catchment area in the north the responsibility of Northumbria Water (NW). DG5 Registers record location of sewer networks and flood incidents attributable these networks.

Information from the YW DG5 register was accessed during the production of the report but the NW register was not accessed within the timeframes for the production of the SFRA. As DG5 Registers normally record incidents at property level, due to the sensitive nature of this information it is not appropriate to provide any further detail within the SFRA.

It is worth noting that many settlements with the study areas are served by combined sewers which may be more susceptible to overcapacity during period of intense rain. Sewer requirements and capacity will need to be considered in detail as part site specific FRAs.

Locations where surface water flooding was identified are as follows. Locations were only included where it is clearly attributable to surface water flooding:

- Leaholm
- Ruswarp
- Egton Bridge
- Helmsley
- Hackness
- West Ayton
- Hinderwell
- Byland Abbey
- C1 Easby to Kildale Road
- Dunsley
- Commondale
- Ellerby
- Ugthorpe
- Runwicks Bay
- Robin Hoods Bay
- Goathland
- Fylingthorpe
- Staithes

[20] https://www.northyorks.gov.uk/flood-and-water-management

2.5.Groundwater flooding

Groundwater flooding is caused by the elevation of underground aquifers and can result from a range of factors including:

- prolonged periods of rainfall resulting in the raising of groundwater levels leading to flooding
- river level rise leads to water passing through banks of watercourses, leading to the flooding of superficial aquifers resulting in water level rise and flooding
- rebound – if abstraction of groundwater stops, levels may return to natural levels resulting in flooding

The EA national dataset, Areas Susceptible to Groundwater Flooding (AStGWF) has been used as the primary source to consider the risk from groundwater flooding. The data sets were developed for use by LLFAs to produce PFRAs. The AStGWF should not be used as the sole source of information for site-specific FRAs but as a prompt for more detailed investigations in to the risk posed. It is important to note that the AStGWF sets do not consider possible risk from groundwater rebound.

The AStGWF shows the proportion of each 1km square grid where geological and hydrogeological conditions show that groundwater might emerge. Each $1km^2$ is represented by one of four categories (*< 25%; >= 25% <50%; >= 50% <75%; >= 75%)* showing the proportion of each 1km square that is susceptible to groundwater emergence. It does not show the likelihood of groundwater flooding occurring but should be used to identify areas of risk for further investigation.

Figure B8 (in Appendix B) shows that the study area is at relatively low risk from groundwater flooding with higher risk areas in North Yorkshire located outside of the study area. There are however areas increased risk particular to the north and the west of the study area (i.e. near Thimbeby, Swainby, Faceby, Carleton, Ingleby Greenhow, Battersby, Newton Musgrave, and Harwood Dale).

The NYCC PFRA also identified possible interaction between groundwater emergence and surface water resulting in increased flood risk in localised areas. The PFRA predicted that up to 138 properties and 123 dwellings within the County may be at risk from groundwater flooding. However, based upon the AStGWF data set most of these are expected to be out with the study area. A map of the study area is available in Appendix B (Figure B8) and Appendix A includes detail on groundwater risk for certain settlements within the study area.

2.6 Flooding from artificial sources

2.6.1 Canals

Canals are a source of flood risk due the potential overtopping or breaching of canals and retaining structures. The Canal and Rivers Trust have produced a dataset containing spatial data of the location of canal centre lines. This data was been reviewed and there are no canals within the study area, and is therefore not considered further.

2.6.2 Reservoirs

Reservoirs are enclosed water bodies (natural or man-made) used to store water. Due to the retention of large volumes of water reservoirs carry a residual flood risk. This residual risk is largely due to the potential for failures or breaches of reservoir infrastructure. However, very few catastrophic failures have occurred in Great Britain and since 1925 there has been no loss of life due to reservoir failures[21].

Reservoirs holding more than 25,000 cubic metres of water are regulated by the EA under the Reservoirs Act 1975 in England and Wales. The Act provides a legal framework to ensure the safety of reservoirs and provides for regular inspections by reservoir engineers. LPAs must consider potential breaches or failures within emergency plans.

The EA hold a Reservoir Flood Map outlining areas which may be flooded if the reservoirs they regulate fail or were to release the water held. There are 6 reservoirs included in the map the study area:

- Lockwood Beck Reservoir and Scaling Dam Reservoir - both to the north of the study area near Guisborough
- Randymere (covered reservoir) - central study area near Goathland
- Arden Hall Lake - east of the study area near Hawnby
- Cod Beck Reservoir - east of the study area near Osmotherley
- Elleron Lake - south of study area near Pickering

The Reservoir Flood Map also included “Pickering Flood Storage Reservoir” which has been included within the Functional Floodplain (FZ3b) (see section 2.3.10).

Due to the sensitivity of the information no further information on the reservoir flood risk is provided within the SFRA. While the likelihood of incidents occurring is considered low,

[21] http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/Lessons_from_Historical_Dam_Incidents.sflb.ashx

emergency plans and applications for developments which may be effected must consider potential risks.

3. Flood risk management schemes

3.1.Existing flood defence assets within the study area

Fluvial

The EA provided a data set of existing flood defence assets within the area to inform the SFRA. As the study area is largely moorland and rural agricultural land, there is in general a low level of flood defence infrastructure within the study area. Existing flood defence assets include:

> River Esk - commencing at Castleton and progressing eastward till the river discharges in to the North Sea at Whitby (which is outside the study area). The flood defence is in the form of "high ground" to an unknown protection standard. The flood defences are for the most part for the protection from fluvial flooding but also provides some protection from tidal flooding downstream from Briggswath.
>
> River Rye - Defences (high ground above a river channel with an unknown standard of protection) start at Seph Mouth, where the River Seph meets the Rye. The defences continue through Helmsley, and out of the study area. There are also high ground defences for the River Riccal to the east of Helmsley starting at Riccal Bridge (A170) heading southwards.
>
> River Derwent - High ground fluvial defences (to an unknown defence standard) commence south of Estell Lane near Hilla Green Farm, continuing southward to the weir head and sluice at the Sea Cut. From this intersection, the defences continue to West and East Ayton and out of the study area. There is an additional 1/100 protection embankment at West Ayton around the wear and old bridge. The Sea Cut runs eastward providing 1/50 protection from fluvial flood risk in the form of an embankment (with areas of higher ground protection) which provides protection within the Derwent catchment. The Sea Cut leaves the study area at Scalby.

The EA also undertakes maintenance activities on main rivers including maintaining flood barriers, removing obstructions, controlling vegetation growth and repairing defence infrastructure. The EA have produced a 2017/18 maintenance programme, which can be accessed online[22]. Future maintenance plans should be considered post March 2018.

[22] https://www.gov.uk/government/publications/river-and-coastal-maintenance-programme

FWMA places duty on NYCC, as LLFA, to establish and maintain a register of structures or features, which are considered to have a significant effect on flood risk including details of ownership and the state of repair. The Register should record how NYCC intend to manage these assets including their ongoing maintenance programme, with prioritisation of assets located in a high risk area or have been assessed to have the potential to effect flood risk. At the time of writing, the only assets on the register within the study area are those identified in the s19 report for Staithes.

Highway drains and culverts are also important in managing flood risk, particularly in areas susceptible to surface water flooding and flood risk can be significantly increased in the event of blocked gullies and drains.

Tidal

The coastline of the study area runs from north of Boulby to Long Nab near Cloughton (but doesn't include the area from Sandsend to Whitby / Saltwick Nab). The approach with regards to flood protection measures and coastal erosion is largely governed by the River Tyne to Flamborough Head SMP2.

The SMP2 produced in 2007 defines the risks to people and developed areas, the potential consequence of different management approaches, and identified preferred policies for managing risks and creating opportunity for sustainable management. The SMP2 sets out procedures for monitoring the effectiveness of the preferred policies.

The SMP2 produced four possible policy options:

- **No active intervention** - decision not to invest in providing or maintaining defences
- **Hold the line** - maintain or change the level of protection provided by defences
- **Advance the line** - build new defences seaward of the existing defence line where significant land reclamation is considered
- **Managed realignment** - by allowing the shoreline to move backwards or forwards with management to limit or control change

The SMP2 splits the coast into policy units which make up Management Areas (MA) in order to effectively manage sections of the coastline. The information contained within Table 3 should be considered for future development purposes, and used to inform strategy with regard to investment in flood defence, monitoring of coastal erosion and whether areas of coastal regeneration area will be sustainable in the long-term.

Table 3 SMP2 policies for areas of the coastline within the study area.

Management Area	**Short Term (Present Day to 2025)**	**Medium-Term Policy (**2025 to **2055)**	**Long-Term Policy (2055 – 2105)**	**Benefits and damage of proposed polices**
MA18 (Hummersea Scar to Cowbar)	No active intervention	No active intervention	No active intervention.	● Potential loss of one property at Boulby Village by 2105
MA19 (Cowbar to Staithes)	To hold the line in all areas currently defended. Monitor the retreat of adjacent cliffs and relocate the Cowbar Lane to the west of Cowbar Cottages as necessary	As retreat of the cliff to the east of Cowbar Cottages continues, works may be required to reinforce existing defences. In other areas existing defences would be maintained / replaced, subject to the need being identified by monitoring.	Defence would be maintained beneath Cowbar Cottages and maintain the integrity of the north breakwater. Other defences to Staithes would be retained.	● Maintain access to the North side of Staithes ● Maintain protection of Cowbar Cottages ● Maintain defence of the harbour and village
MA20 (Staithes to Cobble Dump)	Detailed examination of significant of Port Mulgrave in maintaining stability of coastal slopes. Otherwise no active intervention.	Anticipated retreat of Port Mugrave, no active invention elsewhere.	No active intervention	● Progressive loss of harbour area ● Potential loss of properties by 2055 and loss of footpaths

MA21 (Cobble Dump to Sandsend Ness)	Maintain and improve defences at Runswick Bay; otherwise no active intervention	Maintain defences at Runswick Bay; in all other areas, no active intervention	No active intervention.	● Potential loss of 2 properties at Runswick Bay in long-term ● Potential loss of sailing club frontage in long-term ● Potential loss of properties at Kettleness (post 2105)
MA25 (Saltwick Nab to Hundale Point)	Hold the line at Robin Hood's Bay village but no active intervention anywhere else	Maintain defences at Runswick Bay but in all other areas, no active intervention	No active intervention	● Protection provided for Robin Hood's Bay Village but possible loss of 9 properties at northern end of Village ● Monitor and address slop stability issues

3.2.Recent and Future Flood Risk Management Schemes

Since the previous SFRA update (2010) a number of flood alleviation schemes (FAS) have taken place outside of the study area. The Pickering FAS however was completed and part of the FSA is located within the study area.

The UK Government has committed to invest up to £2.5 billion to reduce the risks of flooding and coastal erosion between April 2015 and March 2021. These schemes aim to reduce flood risk to more than 300,000 households by March 2021. The EA published (April 2017) an updated programme for flood and coastal erosion investment which identifies the following schemes within or in close proximity to the study area[23] (* denotes outside study area):

- Hutton Lane Inland FAS
- Charltons Inland FAS
- Guisborough FAS *
- Stokesley FAS *
- Great Ayton FAS*
- Potto Village defence feasibility study *

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

- Pickering Flood Risk Management Plan (FRMP) *
- River Wiske Flood FRMP *

Other potential schemes may arise from studies being commissioned by NYCC in their capacity as LLFA. A feasibility study is proposed in order to identify small schemes for high risk yet dispersed properties across a Rye catchment area. The study aims to act as a pilot to refine the method of applying a catchment based approach to dispersed risk, and to develop an understanding of the most effective techniques to address issues experienced by dispersed communities at high risk of flooding. The feasibility study is expected to be undertaken within the 2017/2018 financial year.

In July 2017, there was also an announcement from Defra of 34 Natural Flood Management (NFM) projects[24]. This includes 3 projects within the North Yorkshire area including the Derwent Villages NFM Demonstration Project. The Derwent Villages NFM aims to alleviate flooding around Sinnington, Thornton Le Dale and Hovingham, although the full details of the scheme including the location is not yet known.

Significant coastal monitoring has been conducted by SBC which has including monitoring of beach profiles, seabed levels, coastal erosion rates and coastal defences. These reports can be accessed on the North East Coastal Observatory[25] website, along with Project Appraisal Reports (PAR) for proposed flood schemes. Locations within the study area subject to monitoring include Runswick Bay and Robin Hoods Bay, while ongoing monitoring has informed seawall repairs at Staithes and coastal protection / stabilisation works at Sandsend (outside the study area).

The flood and coastal erosion investment programme[26] (updated in March 2017) has announced the following coastal defence schemes within the study area:

- Robin Hoods Bay PAR & Works
- Runswick Bay Appraisal and Works

4. Considering Flood Risk in Local Plans

The NPPF underpins the process by which LPAs must account for flood risk as an integral part of the planning process. The overarching aims set out by the NPPF for the management of flood risk at a LPA are captured in Paragraph 100 of the NPPF:

[24] https://www.gov.uk/government/news/schemes-across-the-country-to-receive-15-million-of-natural-flood-management-funding
[25] http://www.northeastcoastalobservatory.org.uk
[26] https://www.gov.uk/government/publications/programme-of-flood-and-coastal-erosion-risk-management-schemes

"Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change, by:

• applying the Sequential Test;

• If necessary, applying the Exception Test;

• safeguarding land from development that is required for current and future flood management;

• using opportunities offered by new development to reduce the causes and impacts of flooding;

• where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to facilitate the relocation of development, including housing, to more sustainable locations."

The SFRA aims to assist in this process through the provision of an evidence base upon to inform decisions.

4.1.Flood risk and Local Plans

A Local Plan sets out local policies and identifies how land is to be used, and adopted Local Plans provide the framework for development across England[27]. In the process of allocating land within Plans, the LPA should ensure that flood risk is appropriately assessed and managed. This SFRA will form the basis of the assessment of flood risk but care must be undertaken to ensure any data limitations are considered.

NPPG outlines a sequential approach, which seeks to ensure that development is sustainably delivered and directs development, where possible, to areas of lower flood risk. It outlines the aim to keep development out of medium and high flood risk areas (FZ2 and FZ3) and areas affected by other sources of flooding.

The Sequential Test considers appropriate locations for development based upon the purpose of land allocations and their vulnerability to flood risk. Only where development cannot be directed away from areas of increased flood risk should flood risk be mitigated or controlled through design or layout of developments or by the use of SuDS. It is a requirement of the NPPF to ensure that other sources of flood risk should be treated consistently with fluvial and coastal sources and that they are considered through the Sequential Test.

[27] https://www.gov.uk/guidance/local-plans

4.2.Flood Risk Vulnerability Classification

When applying the Sequential Test it is imperative to consider the flood risk vulnerability of land uses. When land allocations are for mixed sites the most vulnerable land class should be used. The NPPG describes land vulnerability classifications[28] which includes the following categories; essential infrastructure, highly vulnerable, more vulnerable, less vulnerable, and water-compatible.

4.3.Sequential Test for Fluvial and Coastal Sources

The Sequential Test must be utilised in both allocating sites through Local Plans and determining applications, and aims to steer new development to areas with the lowest likelihood of flooding.

The Sequential Test follows a stepwise process for fluvial and tidal flooding and is illustrated graphically in the NPPG[29]:

- Can the development be allocated entirely within FZ1? If so the test is passed.

- If all development cannot be allocated in FZ1, can the remaining development be allocated in FZ2? If so the allocation is accepted, subject to an Exception Test for highly vulnerable developments.

- If allocations cannot be allocated in FZ1 or FZ2, can development be allocated in the lowest risk sites within FZ3?

- Only water compatible and essential infrastructure is permitted in FZ3b and must pass the Exception Test and demonstrate flood risk will not be increased by the development. No other development should be permitted in FZ3b.

Any essential or water compatible infrastructure in FZ3b must be designed and constructed to:

- Remain operational and safe for users in times of flood
- Result in no net loss of floodplain storage
- Not impede water flows and increase flood risk elsewhere

Table 4 adapted from the NPPG[30] shows which classification of infrastructure is permitted in which FZ, although the Sequential Test approach should always be followed, and seek to find reasonable alternative in FZ1 and FZ2 in the first instance.

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[28] NPPG Flood Risk and Coastal Change Table 2: Flood risk vulnerability classification, Paragraph: 066 (Reference ID: 7-066-20140306). https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-2-Flood-Risk-Vulnerability-Classification

[29] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/575188/flood2_021.pdf

[30] NPPG Flood Risk and Coastal Change, Table 3: Flood risk vulnerability and flood zone 'compatibility', Paragraph: 067 (Reference ID: 7-067-20140306). https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-3-Flood-risk-vulnerability

Table 4 Classification of infrastructure and what flood zones they are permitted in

	Essential Infrastructure	Water Compatible	High Vulnerability	Moderate Vulnerability	Low Vulnerability
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	x	Exception test required	✓
Zone 3b	Exception test required	✓	x	x	x

4.4.The Sequential Test: other forms of flooding

In addition to applying the Sequential Test to flooding from rivers and the sea, the NPPF requires other forms of flood risk to be taken into account. In this SFRA, data on the following types of flood risk (excluding rivers and the sea) has been collated and considered:

- Surface water flooding
- Groundwater flooding
- Flooding from reservoirs

In order to ensure that the other sources of flooding area considered through the Sequential Test, it is proposed that:

- Surface water flooding - areas of moderate or high vulnerability to surface water flooding are considered significant and needs to considered during the Sequential Test
- Groundwater - areas of moderate (≥50% <75%) or high risk (≥75%) to groundwater flooding are considered significant and needs to considered during the Sequential Test
- Artificial sources - are considered on a case by case basis where appropriate

The SFRA relies to a significant degree on national data sets but local factors may result in significant variation in susceptibility to flooding. Therefore other sources of flooding may, even when considered to be low risk in national datasets, need to be investigated further through site-specific FRA. Local factors should be considered on a case by case basis may include:

- History of groundwater or surface / artificial sources water flooding
- Local topography e.g. presence of steep gradients over which water might flow
- High groundwater levels or the presence of marsh vegetation
- Large impermeable areas adjacent to the site or arrangements strata that may facilitate groundwater flooding
- Presence of ditches, springs, canals or other water features adjacent to the site

4.5.Climate Change

Climate change is predicted to increase the risk of flooding and the NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and the NPPG explain when and how FRAs should be used including demonstrating how flood risk will be managed now and over the development's lifetime by considering climate change. Making an allowance for climate change in the SFRA will help to minimise vulnerability and provide resilience to flooding and coastal change in the future.

The NPPG[31] outlines the requirement for considering the climate change as part of SFRA and site-specific FRAs. The climate change allowances are predictions of anticipated change for:

- peak river flow by river basin district
- peak rainfall intensity
- sea level rise
- offshore wind speed and extreme wave height

Climate change allowances need to be considered by planners for allocations of sites in Local Plans, and by developers as part of their site-specific FRA.

4.5.1. Peak River Flow

The allowance to be made for the predicted impact of climate change on peak river flows throughout the UK is subject to the location, timescale (design-life of the proposed development) and the vulnerability classification of the proposed development.

The peak river flow factors are based upon the relevant River Basin Management Area which for the majority of the area is the Humber but the Tees catchment area falls within the Northumbria area.

Table 5 EA Recommended Peak Flow Allowances per River Basin within the study area

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Northumbria	Upper end	20%	30%	50%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
Humber	Upper end	20%	30%	50%
	Higher central	15%	20%	30%
	Central	10%	15%	20%

[31] NPPG Flood risk assessments: climate change allowances https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

4.5.2. Peak Rainfall Intensity

Peak rainfall intensity is considered across England as a whole, rather than on a regional basis. FRAs should assess both the central and upper end allowances to understand the range of impacts.

Table 6 EA Recommended Peak Rainfall Intensity allowances for the study area.

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

4.5.3. Sea Level Rise

Sea level rise factors are considered on a regional basis, which in this instance are the North West / North East (North of Flamborough Head) coastal region. Sea level rise should be considered for coastal areas in conjunction with SMP2 and coastal erosion maps.

Table 7 EA Recommended Sea Level Rise allowances for the study area.

	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 (m)
North west / north east	**87.5mm**	**210mm**	**300mm**	**390mm**	**0.99m**

4.5.4. Offshore Wind Speed and Extreme Wave Height

Wave heights may change because of increased water depths resulting from climate change. Table 8 outlines the recommended allowances for speed and wave height for England. A 10% sensitivity allowance to understand the range of impact should be considered for use and advice should be sought from the EA for FRAs and Level 2 SFRAs.

Table 8 EA recommended Offshore Wind Speed and Extreme Wave Height Allowances for the study area.

	1990 to 2055	2056 to 2115
Offshore wind speed allowance	+5%	+10%
Offshore wind speed sensitivity test	+10%	+10%
Extreme wave height allowance	+5%	+10%
Extreme wave height sensitivity test	+10%	+10%

4.5.5. High ++ Allowances

High++ allowances may need to be applied for projects which are considered to be extremely sensitive to flood risk and have long lifespans e.g. into the 22nd century, and

developments that that significantly alter current settlement patterns e.g. new settlements. The high++ allowances can be found in the EA Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities[32]. The guidance should be considered in more detail and advice sought from the EA regarding the most appropriate use of climate change allowances for site-specific FRAs.

4.5.6. Fluvial and Coastal Flood risk - consideration of climate change in the SFRA

Climate change allowances are available for Helmsley and Esk / Iburndale. Where no modelled outlines exist a qualitative approach has been used. The qualitative approach assumes that the current extent FZ2 will be entirely taken up by FZ3 in the future (post 2039). Therefore for sites within FZ2, the possibility of these sites being within FZ3 at some point in the future should be considered, depending on the expected life time of the development, and particularly when a developments design life extends into the second half of the century and beyond.

A more detailed assessment of the impacts of climate change could be carried out as part of a Level 2 SFRA or site-specific FRA, which may require further climatic modelling based upon the recommended parameters outlined above should they be deemed necessary following consultation with the EA.

4.5.7. Surface Water Flood Risk - consideration of climate change in the SFRA

There are no modelled outputs for climate change allowances and therefore a qualitative approach has been used. The qualitative approach uses the same surface flood risk categories up to 2039 but, for periods after 2039 the risk categories should be changed so the spatial extent of low vulnerability categories are taken up by the moderate vulnerability category and areas of moderate vulnerability are covered entirely by areas of high vulnerability.

As with flood risk from rivers and the sea, the appropriate allowance for climate change will be applied depending on the predicted lifetime of the development being considered. A more detailed assessment of the impacts of climate change could be carried out as part of a Level 2 SFRA or site-specific FRA, and this may require further climatic modelling based upon the recommended parameters outlined above should they be deemed necessary following consultation with the EA.

4.6.Exception Test

Where it is not possible at the Local Plan stage to allocate all development within areas of lower flood risk, and Exception Test is required (See Table 4). The Exception Test, as required by Paragraph 102 of the NPPF, is undertaken for locations where the Sequential

[32] https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities

Test alone cannot deliver acceptable locations, based upon vulnerability classification, but where development is necessary for social or economic reasons.

The NPPF requires demonstration that the proposed development provides wider sustainability benefits to the community that outweigh flood risk and a site-specific FRA is undertaken to demonstrate that the proposed development will be safe for its lifetime, and without increasing flood risk elsewhere. Where possible it should aim to reduce flood risk overall.

4.7.Sustainability Appraisal and the Exception Test

LPAs are required to produce a SA of Local Plans. Sustainability is a fundamental consideration in passing the Exception Test. In meeting the first part of the Exception Test 'wider sustainability benefits' maybe fulfilled by meeting a pre-defined number of sustainability objectives within the SA. If a development has the wider benefit for example significantly reducing climate change impacts, this should be expressed in terms of the sustainability objectives that it helps fulfil.

The question of whether sustainability benefits outweigh flood risk is a matter of judgement and the more SA objectives that are met by the proposal the more likely the sustainability benefits will outweigh flood risk. The extent to which SA objectives are met should also be considered and requires an element of judgement. Sustainability benefits should be measured wherever possible so that an assessment of the magnitude of benefit can be made. However, regardless of the benefits the second part of the Exception Test must also be satisfied.

5. Recommendations for planning

The following recommendations are provided based upon SFRA process undertaken. They should be considered by NYM NPA as advice only. NYM NPA should consider other factors including local knowledge, site specific information and advice from other parties including the EA, LLFA, other LPAs, water companies, IDBs etc.

Recommendation 1 – No Development within the Functional Floodplain

No development should be permitted within the Functional Floodplain (FZ3b), unless there are exceptional circumstances for Essential Infrastructure or for Water-compatible activities. Essential infrastructure would need to pass an Exceptions Test, and any site would need to ensure that there is no increased flood risk to other areas. Where the proposed development only has a small proportion of the site within FZ3b then redesign of the site, including the site boundary, should be explored to avoid these areas.

Recommendation 2 – Consider other sources of flood risk as part of the Sequential Test process

Other sources of flood risk should be considered within the Sequential Test process. Table 9 outlines a potential approach to consideration of surface water and groundwater flood risk.

Table 9. Consideration of other forms of flooding and their vulnerability as part of the Sequential Test.

	Essential Infrastructure	Water Compatible	High Vulnerability	Moderate Vulnerability	Low Vulnerability
Surface Water Flood Risk - very low vulnerability	✓	✓	✓	✓	✓
Surface Water Flood Risk - low vulnerability	✓	✓	✓	✓	✓
Surface Water Flood Risk - moderate vulnerability	✓	✓	Exception Test required where supported by other risk factors	✓	✓
Surface Water Flood Risk - high vulnerability	Exception Test required where supported by other risk factors	✓	Exception Test required where supported by other risk factors	Exception Test required where supported by other risk factors	✓
Groundwater Flood Risk - low risk (<25% & ≥25%<50%)	✓	✓	✓	✓	✓
Groundwater Flood Risk - moderate risk (≥50%<75%)	✓	✓	Exception Test required where supported by other risk factors	✓	✓
Groundwater Flood Risk - high risk (≥75%)	Exception Test required where supported by other risk factors	✓	Exception Test required where supported by other risk factors	Exception Test required where supported by other risk factors	✓

Recommendation 3 - Site-specific Flood Risk Assessments (FRAs)

Site-specific FRA is required to be produced by developers (or on their behalf) for all the proposals which meet the following criteria:

- Sites within FZ2 or FZ3
- Sites located within FZ1 and have an area of 1 hectare or greater
- Where sites are located in surface water and ground water risk areas of moderate or above
- Sites are within critical drainage (currently none in the study area)
- Where the proposal is for change of use to a higher vulnerability classification
- Proposed developments are in close proximity (i.e. 25 metres) to main rivers, water courses or mean high water springs

The scope and methodology of FRA should be approved by NYM NPA in consultation with the EA, LLFA, and where appropriate (e.g. spatially overlap), other LPAs.

Recommendation 4 - Use of Sustainable Drainage

The scoping and design of a SuDS, which needs to be included as part of site-specific FRA, should be integrated within the early stages of the site design in order to incorporate appropriate SuDS within the development. Specific regard should be paid to the current NYCC SuDs guidance[33]. Consulting the NYM NPA, LLFA, relevant water companies and IDB (where appropriate) early in the planning process regarding the site design stage and the FRA is recommended.

Recommendation 5 - FZ3ai

If a site is located within FZ3ai then any redevelopment of the site should have regard to restrictions set out in policies of the Local Plan (where available). Such sites should look to reduce risk when designing the new development, and where FZ3ai is included within the site footprint consideration should be given to allow water to flow naturally or be stored in times of flood.

Recommendation 6 - Safeguarded Land for Flood Storage

NYM NPA may wish to allocate land to be ring-fenced for flood storage. These may be locations where flood risk from any source is so significant that it prevents development, including sites located within FZ3b. Advice on possible locations should be sought from the EA, LLFA and other LPAs, and potential future schemes (see Section 3.2) should be considered.

[33] North Yorkshire County Council SuDs Design Guidance https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf

Recommendation 7 - Duty to Cooperate with other LPAs

The Localism Act 2011 requires LPAs to engage constructively and actively to ensure the effectiveness of planning. Given the nature of study area with elevated rural areas which form upper catchment areas of Derwent, Esk, Tees and Ouse, sources of flooding which originate in the study area may impact on neighbouring areas. Therefore, it is important that meaningful and early engagement on potential land allocations, plan policies, and proposed developments is undertaken with other LPAs.

6. Guidance for Planning Applications – considering flood risk

The NPPF (Paragraph 103) requires LPAs to only consider proposed developments appropriate where they don't increase flood risk elsewhere, where the most vulnerable areas of development are located in areas of lowest flood risk, and where the development is flood resilient and resistant. In order to achieve this applications for proposed developments are subject to the Sequential Test and need to be supported by site-specific FRAs.

6.1. Site-specific FRA

The NPPG requires that a FRA should accompany planning applications submitted to the LPA for certain developments including[34]:

- 1 hectare or greater and located in FZ1
- for new development (including minor development and change of use) in FZ2 and 3
- in FZ1 which has critical drainage problems (as notified to the LPA by the EA)
- at risk from other sources of flooding e.g. surface water

FRAs must demonstrate to the decision-maker how flood risk will be managed over the development's lifetime, and in doing so consider climate change allowances and future flood risk (see Section 4.5). Site-specific FRAs should help determine whether the proposed development will increase flood risk, outline flood risk mitigation measures and their effectiveness, while providing the evidence to allow LPAs to apply the Sequential Test (and Exception Test where necessary).

Site-specific FRAs should be relevant and proportional to the flood risk and utilise existing information and guidance including the information contained within this SFRA, flood maps available from the EA website, and the following guidance:

[34] NPPG Paragraph 103 Footnote 5. https://www.gov.uk/guidance/national-planning-policy-framework/10-meeting-the-challenge-of-climate-change-flooding-and-coastal-change#footnote5

- NPPG checklist for site - specific FRAs[35]
- EA standing advice on flood risk[36]
- North Yorkshire County Council SuDS Design Guidance[37]
- Flood risk assessment: local planning authorities guidance[38]

It is important that the scope of FRAs are considered early in the planning process, and should be agreed by the LPA in consultation with key bodies (which may include the EA, LLFA, other LPAs, water companies and IDBs).

6.2.Sequential Test for Planning Applications

As with Local Plans, the Sequential Test for planning applications aims to steer new development to areas with the lowest probability of flooding. In the first instance a developer should check the Local Plan (where available), to see if the proposed site is an allocated site, a windfall site, or is subject to a change of use in order to identify if a Sequential Test is required.

Where proposed development is an allocated site (i.e. the site is included in the Local Plan) and the proposed use of the site is in accordance with the Local Plan and the vulnerability of the proposed use is appropriate for being located with that FZ, then a Sequential Test should have already been undertaken and is therefore not required. Confirmation that a Sequential Test is not required should be sought from NYM NPA, and the planning application should clearly document that a Sequential Test is not required.

Proposed developments not covered by a Local Plan (windfall sites) and applications proposing changes of use to caravan, camping chalet site, or to a mobile home site must be supported by evidence to allow the NYM NPA to conduct a Sequential Test including:

- Comparison of proposed development site with potential reasonable alternatives in regards to flood risk, impacts resulting from the development, and relevant policies within the Local Plan
- Consider locating elements of the proposal with a greater vulnerability to flood risk in areas of lower flood risk

[35] NPPG Site-specific flood risk assessment: Checklist. Paragraph: 068 Reference ID: 7-068-20140306 https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section

[36] NPPG Flood risk assessment: local planning authorities guidance https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities

[37] North Yorkshire County Council SuDS Design Guidance https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf

[38] NPPG Flood risk assessment: local planning authorities https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities

- Determine whether reasonable alternatives exist in areas of lower flood risk when considering all sources of flood risk, the lifespan and vulnerability of proposals
- A site-specific FRA including proposals for mitigating flood risk

Developers should seek advice and confirmation from NYM NPA as to whether a site specific FRA is required. Where a FRA is required, the NYM NPA should provide advice following consultation with consultees (including the LLFA, EA, YWL, IDBs and other LPAs etc.) on the evidence base required and scope of the FRA to support NYM NPA undertaking a Sequential Test.

All proposals should take into account the likelihood of flooding from other sources, as well as from rivers and the sea. **Recommendation 2** contained within this report identifies possible Sequential Test criteria for other sources of flooding.

6.3.Guidance on the Sustainable Drainage Systems

SuDS encompass a range of drainage approaches that can be used to manage surface water in a way that mimics the natural environment. Development may for example increase the area of impermeable substrate leading to increased volumes and flow rate of surface water resulting in increased flood risk. The aim of SuDs is to reduce surface water flood risk through the re-use and / or storage of surface water. SuDs design may include a range of possible solutions or techniques and should be clearly and carefully defined within the FRA which supports the development.

There are a number of benefits to SuDs including:

- Reducing peak flows to sewers and watercourses which can lessen the risk of flooding downstream
- Improvements to water quality, particularly compared to conventional surface water sewers
- Reduction in water demand through rainwater harvesting
- Creation of habitats
- Allowing natural groundwater recharge where appropriate

Guidance by NYCC[39] in its capacity as the LLFA, for SuDS design highlights that the three most important requirements are that people and property should be protected from flooding, that development should not increase flood risk off site, and that SuDS should be economically maintained for the lifetime of the development. Applications should include detail how SuDs will be maintained of over the lifetime of the project including who is responsible for its maintenance.

[39] https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf

The NYCC guidance provides direction on relevant designs for the successful implementation of SuDS and is the basis on which planning consultations from NYM NPA will be considered by the LLFA. Different SuDS are appropriate in different circumstances and for different types of development. Factors to consider include:

- the type of development
- the sensitivity of receptors for the drained water
- the quality of drained water and the regulations that govern discharge
- the physical and hydrogeological properties of the soil and underlying geology

The NYCC guidance applies to all major development[40] for which NYCC in the capacity of LLFA are a statutory consultee. It is also advised that the relevant IDB is consulted on the proposal.

The suitability of potential SuDs for particular developments should be determined by NYM NPA in consultation with relevant advisors. Further information on types of SuDs available is included in Appendix C.

[40] http://www.legislation.gov.uk/uksi/2015/595/contents/made

Appendix 1 – Flood Risk at Key Settlements within the Study Area

Contents

Introduction

This Appendix (Appendix A) provides a brief narrative of the flood risk for a number of settlements within the North Yorks Moors National Park to accompany the flood risk maps provided in Appendix B.

The following settlements were originally requested for inclusion by the North Yorks Moors National Park Authority but due to the absence of significant flood risk flood risk, maps were not produced for the following locations:

- Ampleforth
- Cold Kirby
- Egton
- Fadmoor
- Pockley
- Newton on Rawcliffe
- Oswaldkirk
- Hutton Buscel

Ainthorpe (Figure A1)

Previous Flood Events and Their Extent - Flooding from the River Rye as a result of channel overcapacity occurred in 2000. Flooding, as recorded in the Environment Agency (EA) Historical Flood Map (HFM) was located in areas adjacent to the Rye and north of the village.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain (Flood Zone (FZ) 3b) was derived by using the extent of the EA FZ3 in the absence of detailed modelling layers (e.g. 5% AER) and is located to the north of the village. Ainthorpe is located entirely within the FZ1, with FZ2 and FZ3 (3b and 3a) to the north of the village. Areas at high risk from surface water (SW) are largely located in the same spatial extent as FZ2 and FZ3 (in areas immediately adjacent to the Rye). There are also other areas of moderate and high vulnerability to SW flooding within the settlement. According the AStGW Map the area is not considered to be at high risk from groundwater (GW) flooding (it is covered by <25% and 25% < 50% risk categories).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the extent of current flood risk and the local topography Ainthorpe is not considered to be particularly sensitive to climate change.

Aislaby (Figure A2)

Previous Flood Events and Their Extent - There is a historic incident of flooding from NYCC Highways on the C181 but the source of flooding is not recorded.

Floodplain Delineation and Flood Risk In and Around the Settlement - Aislaby is entirely within FZ1, with small isolated areas of high vulnerability to SW flooding located within the settlement. The area is predicted to be at a low risk of GW flooding based upon the Areas Susceptible to Groundwater Flooding (AStGWF) map.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change. However, this should be considered in further detail during Local Plan production and as part of site-specific Flood Risk Assessments (FRAs).

Appleton le Moors (Figure A3)

Previous Flood Events and Their Extent - There are no records of historical flooding events within or in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely located within FZ1, with the closest location of FZ2, FZ3a and FZ3b (delineated from EA FZ3) in close proximity to the River Seven to the west and the south. There are very limited areas at moderate / high risk of SW flooding, with the probability of GW flooding predicted to be low by the AStGWF map.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change. However, this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Battersby and Battersby Junction (Figure A4)

Previous Flood Events and Their Extent - There are no records of historical flooding events within or in close proximity to the settlement.

Floodplain Delineation Flood Risk In and Around the Settlement - FZ3b was derived by using the extent of the EA FZ3 in the absence of detailed modelling layers (e.g. 5% AER). The settlements are located largely within FZ1, with a small area of FZ3a within Battersby. FZ2 and FZ3b are located to the west of Battersby in close proximity to Hills Beck and other tertiary watercourses nearby. Areas at high risk from SW flooding within or close to the settlements include near Mea Beck.

The settlements area located in areas of moderate / high risk from GW flooding; they are covered AStGWF grids of <75% and ≥50%<75% probability of flooding which should be considered further during the Local Plan production and in FRAs.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change. However, this should be considered in further detail during Local Plan production and as part of site-specific FRAs. There may however be a degree of sensitivity to SW flooding due to the existing risk and predicted increased rainfall as a result of climate change.

Boltby (Figure A5)

Previous Flood Events and Their Extent - Flooding occurred in June 2005 as a result of ordinary watercourses exceeding channel capacity and the absence of flood defences. The flood outlines are represented in the EA HFM. Flooding appears to be associated with Gurtof Beck and Lunshaw Beck and was recorded within Boltby, heading southwards following Gurtof Beck down to Thirlby. The flood outline to a large extent covers the same spatial area as FZ2. There is also a record of flooding within a property in Boltby but the source of flooding is not known.

Floodplain Delineation and Flood Risk In and Around the Settlement - FZ3b was derived by using the extent of the EA FZ3 in the absence of detailed modelling layers (e.g. 5% AER) and is located to the south and east of the settlement. Boltby is located within FZ1 and FZ2.

There are areas within the settlement, as well as to the north and east, which are classed as highly vulnerable to SW flooding. As with fluvial flood risk, these are located in close proximity to Gurtoff and Lunshaw Beck, and other drains and ditches. The settlement is at a relatively low risk of groundwater flooding and is located in areas identified as ≤25% and ≥25 %< 50% probability of GW flooding by the AStGWF map.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement maybe sensitive to climate change. Particular with regards to increased risk from fluvial flooding, should areas of FZ2 be covered by FZ3, then this increases the risk of flooding for parts of the settlement.

Carlton in Cleveland (Figure A6)

Previous Flood Events and Their Extent - There are no records of historical flooding events within or in close proximity to the settlement.

Floodplain Delineation Flood Risk In and Around the Settlement - Carlton in Cleveland is located entirely within FZ1. The closest areas of FZ2 and FZ3 (FZ3a and 3b) are to the west near Faceby Beck. Areas of low, moderate and high susceptibility to SW flooding are located within and to the west of the village.

Carlton in Cleveland is predominantly covered by a 1km square grid for ≤ 75% superficial deposit GW flood risk and with adjacent areas covered by areas of ≤ 50% <75% (based on the AStGWF map), and as such he areas potentially susceptible to GW flooding.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement but based upon the spatial extent of fluvial and surface water flood risk, the village and its surrounds are not considered to be particularly susceptible to climate change effects.

Castleton (Figure A7)

Previous Flood Events and Their Extent - There was significant flooding in autumn 2000 due to overtopping of flood defences of the Esk (flood defences on the Esk commence in Castleton and according to EA data are to an unspecified standard). Flooding was a result of periods of intense rainfall leading to rapid raise in river levels due to steep sided river valleys. Flooding outlines are recorded eastwards from Station Road Bridge crossing the Esk down to Eller Stang Bridge and was largely confined to areas close to the River Esk. The only flooding recorded in built up areas is to the east of Castleton around Eller Stang Bridge. Two historical drainage incidents originally identified from the 2010 SFRA are located within the village but the source and cause of flooding (e.g. sewer or watercourse flooding) is not available.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER) and is located in close proximity to the River Esk. Relatively small areas of FZ3a are located in the village where FZ3b overlaps with roads and bridges. The majority of the Castleton is located in FZ1.

Areas of high vulnerability to SW flooding are generally in the same spatial extent as FZ3b. More isolated high risk areas are located to the south of Castleton, draining surface water runoff in to Danby Beck. Castleton is located in grids of ≤ 25% <50% chance of GW flooding, and therefore it is considered that the areas is not particularly susceptible to flooding.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

The CFMP covering the Esk (sub section rural Esk) identified steep sided valleys are susceptible to increased rainfall leading to flooding, and climate change was identified as a key driver for increased flood risk in the catchment.

However, in consideration of the local topography and the current spatial extent of flood risk zones, should FZ2 be covered by FZ3b as a result of climate change, the area at higher risk will increase. However, there are little or no developed areas within the spatial footprint of these FZs and

therefore Castleton is not considered to be highly sensitive to climate change but further consideration should be considered during Local Plan production and as part of site-specific FRAs.

Charltons (Figure A8)

Previous Flood Events and Their Extent - There are no records of historical flooding events within or in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). The settlement is located entirely within FZ1. FZ3b is located in close proximity to Wileycat Beck and Alumwork Beck, along with smaller areas of FZ3a.

There are isolated areas of high and moderate risk of SW flooding within Charltons and the probability of GW flooding between >= 50% <75%.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Due to local topography and spatial extent of current flood risk zones the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Chop Gate (Figure A9)

Previous Flood Events and Their Extent - There are no records historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER) and is located to the south and east of Chop Gate.

The settlement is covered by FZ1. FZ3a, FZ3b and FZ2 are located outside the village in close proximity to River Seph (and Raisdale and Bilsdale Becks which drains into the river). Areas of high vulnerability to SW flooding are generally located in lower lying areas which are broadly in the same spatial extent as FZ3. There are isolated areas of high and moderate vulnerability to SW following issues and drains from higher land to the east (towards Hagg wood) and North West (toward Cock Flat).

Chopgate and the surrounds are predicted to be at low risk from GW flooding based upon the AStGWF (<25% probability category).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Due to local topography and spatial extent of current flood risk zones, the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Commondale (Figure A10)

Previous Flood Events and Their Extent - An incident was recorded within the settlement due to "drainage issues" and another due to sewer flooding was also identified.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). FZ1, 2 and

3a and 3b are all located within the settlement, with FZ3 located within close proximity to Commondale Beck (and Ravengill Beck, Whiteley Beck and Sleddale Beck which drain in to Commondale Beck) which flows north to south through the settlement.

There are areas at moderate and high risk from SW flooding present in lower lying land in and around the above mentioned Becks which drain elevated moorland. The settlement is in an area of low probability of GW flooding (AStGFW category <25%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Due to local topography and spatial extent of current flood risk zones, the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Coxwold (Figure A11)

Previous Flood Events and Their Extent - The only flooding incident identified is a historic flooding record caused by SW runoff flooding the C88.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER) and is located to the east of Coxwold with areas of FZ3a defined where it overlaps with roads and buildings.

The settlement is predominantly covered by FZ1, with small areas of FZ3a to the east. FZ3b is located near Wakendale Beck and Green's Beck. Areas of moderate and high risk of SW flooding are located within the spatial extent of FZ3 and outside of the village to the north and east. The settlement is considered at low risk of GW flooding (located predominantly in a <25% probability area).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

The local topography and spatial extent of the flood risk zones have been considered. Based upon the qualitative assessment the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs. There is potential for SW risk to increase due to climate change but these areas are largely located outside of the settlement.

Danby (Figure A12.1 and Figure 12.2)

Previous Flood Events and Their Extent - There was significant flooding in autumn 2000 due to overtopping of flood defences of the Esk (although according to EA data they flood defences are to an unspecified standard). Flooding was a result of periods of intense rainfall leading to rapid raise in river levels due to steep sided river valleys. Recorded flood outlines (recorded in EA HFM data set) are located mainly outside of Danby moving eastwards along the Esk.

Floodplain Delineation and Flood Risk In and Around the Settlement - FZs 1, 2 and 3 are all located within the settlement. Danby is referenced, along with Lealholm, as being most at risk from flooding within the Esk and Coastal Stream CRMP. The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). Areas of FZ3a are located within Danby and where FZ3b overlaps with roads and buildings. FZ3b is located in close proximity to the

Esk which is the key source of fluvial flood risk, and where Ewe Crag Beck cuts through the settlement.

There is significant area of high and moderate risk from SW flooding within the settlement, both centrally and along the low lying floodplain in the vicinity of the River Esk.

The settlement is predicted to be at relatively low risk from GW flooding (categorised as ≥25% <50% in the AStGWF map).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

The floodplain has a relatively shallow gradient at Danby, as represented by the difference between special extents of flood risk zones. When considering the qualitative approach outlined in section 4.5 of the SFRA, and the spatial extent of FZ2 is covered by FZ3, then the area at higher risk would be increased significantly. However, these locations are largely downstream from Danby in largely undeveloped areas and therefore the settlement is not considered to be highly sensitive to climate change. However, this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Easington Figure (Figure A13)

Previous Flood Events and Their Extent - No records historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER).

The settlement is entirely within FZ1.

There are areas of high and moderate risk from SW flooding within the settlement. Risk of groundwater flooding is variable (located in AStGWF categories of <25% and >50% <75%)

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to local topography and spatial extent of current flood risk zones the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Egton Bridge (Figure A14.1 and 14.2)

Previous Flood Events and Their Extent - There was significant flooding in autumn 2000 due to overtopping of flood defences of the Esk (although according to EA data they flood defences are to an unspecified standard). Flooding was as a result of periods of intense rainfall leading to rapid raise in river levels due to steep sided river valleys. Recorded flood outlines (recorded in EA HFM data set), are found within Egton Bridge and broadly covers the same spatial extent as FZ2.

Floodplain Delineation and Flood Risk In and Around the Settlement - FZ1, 2 and 3 are all located within the settlement. The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a located within Egton Bridge and where FZ3b overlaps with roads and buildings.

There are areas of high and moderate vulnerability to SW flooding within the centre of the settlement. Significant areas of risk are located within the same areas covered by FZ3b and 2, as well as areas of high risk to SW flooding in the centre of Egton Bridge.

Egton Bridge is also covered by a grid of probability of flooding of >= 50% <75% (based upon the AStGWF map).

Egton Bridge is covered by an EA Food Warning area.

Sensitivity to Climate Change - The topography, climate change factors and current flood risk extents were considered. Due to the relatively shallow floodplain in the area, as represented by the greater spatial extent between FZs, there is potential sensitivity to climate change. However, due to its size and the location flood risk zones only a small proportion of the settlement is predicted to be impacted by climate change. However, Egton Bridge is still considered to be relatively sensitive to climate change and it is important that it is considered in further detail during Local Plan production and as part of site-specific FRAs.

Faceby (Figure A15)

Previous Flood Events and Their Extent - No records historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The village is entirely within FZ1. FZ3b, FZ3a and FZ2 area located to the east close to Faceby Beck. There are high and moderate areas of SW flood risk within the centre of Faceby and to and westwards along the boundary of NYM NPA. The GW flooding risk at Faceby is variable, the northern portion of the village being categorised as ≥50% ≤75% while the south is categorised as a <25% of flooding (according to the AStGWF).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to local topography and spatial extent of current flood risk zones the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Fylingthorpe (Figure A16)

Previous Flood Events and Their Extent - Records identified a historic “drainage incident” but there was not adequate details on the nature and source of flooding.

Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. There are areas of flood risk from SW within and in areas adjacent to the settlement due to land draining from elevated areas inland eastward. More significant areas of high and moderate vulnerability include to the south of the settlement around lower lying areas in proximity to Marnar Dale Beck, and more centrally in areas adjacent to Thorpe Beck.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to local topography and spatial extent of current flood risk zones the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Glaisdale (Figure A17)

Previous Flood Events and Their Extent - There was significant flooding in autumn 2000 due to overtopping of flood defences of the Esk (although according to EA data they flood defences are to an unspecified standard). Flooding was a result of periods of intense rainfall leading to rapid raise in river levels. The flood outline is presented in the EA HFM and the flood extent commences upstream of Oak Scar down to Beggars Bridge with the widest flood extent around the cricket ground and adjacent farms land. The flood outline has a similar spatial extent to FZ3b. Two additional incidents were identified as a result of Main River flooding.

Floodplain Delineation and Flood Risk In and Around the Settlement - FZ3b was derived by using the extent of the EA FZ3 in the absence of derailed modelling layers (e.g. 5% AER). The settlement is covered by FZ1, FZ2, and FZ3a. The majority of the settlement is located within FZ1 with FZ3a and FZ3b located to the east.

Areas of high vulnerability are generally located in the same spatial footprint as FZ2 and FZ3, with smaller extents of high / moderate SW risk in the south of Glaisdale.

The settlement is in an area of low probability of GW flooding (<25% category on AStGWF).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Glaisdale is in an area of relatively shallow floodplain and as a result it is potentially susceptible to fluvial flooding. Based upon the qualitative assessment, if areas of FZ2 were covered by the FZ3 as a result of climate change, then the spatial extent of the settlement at greater flood risk will be increased. However, much of the area covered by FZ2 and FZ3 is away from the developed areas and therefore is not considered particularly sensitive to climate change. However, it is imperative that climate change is considered in further detail during Local Plan production and as part of site-specific FRAs.

Goathland (Figure A18)

Previous Flood Events and Their Extent - Flooding incidents identified include an overflowing culvert on the C82, and flooding attributed to sewers.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a defined within the settlement and where FZ3b overlaps with roads and buildings.

The settlement is located predominantly within FZ1. FZ2, FZ3a and FZ3b are located to the east and west of the settlement around Eller Beck and West Beck respectively. There are areas of high and moderate vulnerability to SW flooding located within the settlement.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to local topography and spatial extent of current flood risk zones the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Grosmont (Figure A19)

Previous Flood Events and Their Extent - There was significant flooding in autumn 2000 due to the overtopping of flood defences of the Esk (although according to EA data they flood defences are to an unspecified standard). Flooding was a result of periods of intense rainfall leading to rapid raise in river levels. The flood outline is presented in the EA HFM which covers a similar spatial extent to FZ2. Two additional incidents have been recorded in 2013 but no source of flooding was specified.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a defined within the settlement and where FZ3b overlaps with roads and buildings. FZ3b and FZ2 are located in areas adjacent to the Esk and Murk Esk to the south.

The settlement is located within FZs 1, 2 and 3.

SW flood risk is located largely in the spatial extent covered by FZ3b and FZ2 with additional areas in lower lying areas and around watercourses draining into the Esk e.g. Cat Scar Beck to the north.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Given the local topography and based upon a qualitative assessment, if areas of FZ2 were covered by the FZ3b as a result of climate change, then the spatial extent at greater risk of flooding will increase. However, much of these areas are away from Grosmont itself. Therefore, the settlement is not considered to be particularly sensitive to climate change but should be carefully considered during Local Plan production and as part of site-specific FRAs.

Hackness (Figure A20)

Previous Flood Events and Their Extent - There was flooding in autumn 2000 due to overtopping of flood defences of the Derwent. Flooding was a result of periods of intense rainfall leading to rapid raise in river levels but covered a relatively small spatial area around Spa Bridge. There have also been to reported SW flooding incidents near the Primary School.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a located within the settlement and where FZ3b overlaps with roads and buildings. FZ3 and FZ2 are located in areas adjacent to the Derwent, Back Race Drain, and Crossdale Beck which are the main sources of fluvial flood risk.

The settlement is covered by FZ1, FZ2 and FZ3.

The majority of the areas vulnerable to SW flooding over covered by the spatial extent of FZ3, although there are additional high risk areas within Hackness.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to local topography and spatial extent of current flood risk zones the settlement is not considered particularly sensitive to climate change but this should be considered in further detail during Local Plan production and as part of site-specific FRAs.

Hawnby (Figure A21)

Previous Flood Events and Their Extent - Flooding occurred in 2005 due from the River Rye exceeding channel capacity. The flood extent covered a similar spatial extent as FZ2.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). Areas of FZ3a defined where FZ3b overlaps with roads and buildings.

The settlement is covered by FZ1, with FZ2 and FZ3 (a&b) located adjacent to the Rye and Ladhill Beck, which are the main sources of fluvial flooding around Hawnby.

Areas of SW flood risk area generally located within the spatial extent of FZ3.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to the local topography and based upon a qualitative assessment, if areas of FZ2 were covered by the FZ3 as a result of climate change then the area at risk of flooding would increase. However, the settlement is largely located away from these areas and therefore Hawnby is not considered to be sensitive to climate change.

Hawsker (Figure A23)

Previous Flood Events and Their Extent - Two incidents of flooded properties were identified from records within Hawsker but no source of flooding was recorded.

Floodplain Delineation and Flood Risk In and Around the Settlement - Hawsker is entirely within FZ1.

Areas of high and moderate vulnerability to SW flooding are located within Hawsker around lower lying land near drains and culverts. Risk of GW flooding is considered to be relatively low (AstGWF grid ≥25% <50%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Due to local topography and based upon the qualitative assessment Hawsker is not considered being sensitive to climate change.

Hinderwell (Figure A23)

Previous Flood Events and Their Extent - Records accessed identified a sewer flooding incident.

Floodplain Delineation and Flood Risk In and Around the Settlement - Hinderwell is located entirely within FZ1.

There are isolated areas of high and moderate vulnerability to SW flooding within the settlement. The risk of GW flooding is considered to be relatively low (>=25% <50%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to the local topography and based upon a qualitative assessment, the settlement is not considered to be particularly sensitive to climate change.

Ingleby Greenhow (Figure A24)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a defined within the settlement and where FZ3b overlaps with roads and buildings.

The majority of the settlement is within FZ1, with FZ2 and FZ3a located adjacent Ingley Beck.

There are also areas of high and moderate vulnerability to SW flooding in lower lying areas around Ingleby Beck. There is relatively low risk from GW flooding at Ingleby Greenhow (AStGWF grid >=25% <50%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to the local topography and based upon a qualitative assessment, the settlement is not considered particularly sensitive to climate change.

Lastingham (Figure A25)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a defined where FZ3b overlaps with the settlement and other roads and buildings.

The settlement is largely located within FZ1. FZ3a is present in the south of the village, while FZ3b outside located outside the settlement in close proximity to Ing Beck.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Due to the local topography and based upon a qualitative assessment, the settlement is not considered sensitive to climate change.

Helmsley (Figure A26.1 and Figure A26.2)

Previous Flood Events and Their Extent - The most recent significant flood event to impact upon Helmsley occurred in June 2005. A period of intense rainfall resulted in rapid rises and high flood flows within the River Rye. High flood levels were also experienced in Helmsley during the floods of 2000. Other flooding issues within Helmsley include surface runoff flooding and sewer / drainage issues.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was delineated using 4% AEP undefended dataset for Helmsley.

The settlement is located within FZ1, FZ2, FZ3a, FZ3ai, and FZ3b. A significant number of properties are located within FZ2 and FZs3. The principle sources of flooding in Helmsley are the River Rye, Borough Beck and Spittle Beck.

There are areas of high and moderate risk from SW flooding within Helmsley.

Sensitivity to Climate Change - An allowance for climate change produced as part of the 2006 Helmsley Flood Risk Mapping Study indicates that Helmsley is not particularly sensitive to climate change. Areas within increased flood risk areas are predominantly upstream to the west and out of town to the east, and are located in rural areas.

However, as such modelling was undertaken in 2006, the qualitative approach has been used to consider climate change further. If FZ3 covered the existing extent of FZ2, then Helmsley could be significantly impacted by climate change. Local Plan and FRAs need to carefully consider impacts of climate change.

Lealholm (Figure A27.1 and A27.2)

Previous Flood Events and Their Extent - There was significant flooding in autumn 2000 due to overtopping of flood defences of the Esk. Flooding was a result of periods of intense rainfall leading to rapid raise in river levels. The flood outline is presented in the EA HFM and covers a similar spatial extent to FZ2. There have been a number of additional flood incidents within the settlement but in many cases no clear source of flooding was available.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a located where FZ3b overlaps the settlement and other roads and buildings.

The settlement is located in FZ1, FZ2 and FZ3a. Areas of FZ3b are located in areas adjacent to the Esk which is the main source of fluvial flood risk at Lealhom.

There are areas of high and moderate vulnerability to SW flooding within the settlement, as well as to the east and west. The settlement is considered to be at relatively low risk to GW flooding (located in an areas of ≤25% <50% probability).

Lealholm is covered an EA Food Warning area.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon a qualitative assessment, if the FZ3 covered the spatial extent of FZ2 this would increase the number of properties at risk from flooding within the settlement. Lealholm is therefore considered moderately sensitive to climate change and this should be considered in more detail during the production of Local Plans and for site-specific FRAs.

Levisham (Figure A28)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. There appears to be little risk from SW and GW flooding.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk and local topographic conditions the settlement appears not to be sensitive to climate change.

Lockton (Figure A28)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. There appears to be little risk from SW and GW flooding.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk and local topographic conditions the settlement appears not to be sensitive to climate change.

Kilburn (Figure A29)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1.

There are isolated areas of high and moderate vulnerability to SW flooding within Kilburn and to the north associated with small water coursers. GW flooding risk is relatively low (AStGWF map category >= 25% <50% probability).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk and local topographic conditions the settlement appears not to be sensitive to climate change.

Lythe (Figure A30)

Previous Flood Events and Their Extent - Two records of flooding were identified within the village; one from Fire and Rescue Services (FRS) with no recorded flood source and another due to “drainage issues”.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. There appears to be little risk from SW and GW flooding at present.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk and local topographic conditions the settlement appears not to be sensitive to climate change.

Mickleby (Figure A31)

Previous Flood Events and Their Extent - Flood records show a flooding incident in 1998 as a result of “drainage issues” within the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1.

There are isolated areas of high SW flood risk within the development and a variable risk of GW flooding (AStGWF categories <25% and >50%≤75% probability).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk and local topographic conditions the settlement appears not to be sensitive to climate change.

Newholm (Figure A32)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - Newholm is entirely within FZ1.

The closest areas of high and moderate vulnerability to SW are to the west of the settlement in close proximity to Newholm Beck and other drains / issues. There is a relatively low risk of GW flooding (AStGWF category ≤25%- <50%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the current flood risk and local topographic conditions the settlement appears not to be sensitive to climate change.

Osmotherley (Figure A33)

Previous Flood Events and Their Extent - Flooding records include flooding at the ford on the Osmotherley to Thirlby Road and a potential GW flooding incident within Osmotherley.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1.

FZ3a / FZ3b (derived from EA FZ3) and FZ2 are located to the east of the settlement around Cod Beck which runs southward from Cod Beck Reservoir. Flood risk potential from Cod Beck Reservoir should be considered during Local Plan production and in FRAs.

There are areas of high and moderate SW flood risk within the settlement along North End and School Lane and GW flood risk when considering the AStGWF map is predicted relatively low (grids of <25% and 25%≤50% probability).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the current flood risk and local topographic conditions, the settlement appears not to be sensitive to climate change.

Port Mulgrave (Figure A23)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1 and the risk from SW and GW is predicted to be low.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change.

Ravenscar (Figure A34)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1 and the risk from SW and GW is predicted to be low.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change.

Robin Hoods Bay (Figure A16)

Previous Flood Events and Their Extent - The records accessed identified a sewer flooding incident within the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1, with FZ3b located below mean high water springs (North Sea).

There are moderate and high vulnerability areas to SW flooding within Robin Hoods Bay including along Station Road and around Kings Beck, Marnar Dale Beck and Lingers Beck which flow west to east in to the North Sea. GW flooding risk is considered relatively low around the settlement according the AStGWF map (grids of <25% and >25% <50%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change.

Rosedale Abbey (Figure A35)

Previous Flood Events and Their Extent - Flood incidents occurred in 2000, 2009 and 2010 but no source of flooding was available. The previous SFRA (2010) identified sewer flooding as a result of over capacity from extreme rainfall.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), with areas of FZ3a defined where FZ3b overlaps the settlement and other roads and buildings.

The main fluvial flood risk is from the Northdale Beck and River Seven which conjoin at the settlement. FZ3 and FZ2 are located in areas around these watercourses within the village. There is potentially significant risk of SW flooding with the spatial extent of moderate and high vulnerability areas parts of the settlement. The risk of GW flooding is considered to be relatively low based upon the AStGWF (<25%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change.

However, the Rosedale Abbey may be sensitive to climate change with regards to SW flooding (if the moderate risk areas become high risk) while increased rainfall may also have an impact on fluvial flooding.

Runswick Bay (Figure A23)

Previous Flood Events and Their Extent – There have been flooding incidents in 1998, 2000 and 2013 but the extent and source of flooding was available at the time of writing the report. Sewer flooding incidents have also been recorded within the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. There are areas of increased SW flooding risk within the settlement including around Hinder Well Lane and around Runswick and Nettledale Becks.

A Runswick Bay coastal defence scheme has been approved to prevent coastal erosion and adapt to climate change.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered to be particularly sensitive to climate change.

Sawdon (Figure A36)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1, with the closest areas of fluvial flood risk associated with Sawdon Beck (FZ3b delineated using EA FZ3). The current risk from SW and GW flooding is not considered to be significant.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not considered sensitive to climate change.

Sinnington (Figure 37.1 and 37.2)

Previous Flood Events and Their Extent - Records show previous flooding events in 1999, 2000 and 2007 due to the flooding from River Seven and flood outlines are included on the EA HFM map. The reasons for flooding were reported as channel exceedance and overtopping of flood defences. It should be noted that flood defence assets do not cover the entire settlement they commence on the boundary of the NYM NPA. There are also reports of flooding in 2008 and 2013.

Floodplain Delineation Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). Areas of FZ3a defined where FZ3b overlaps with the settlement and other roads and buildings. The principal source of fluvial flooding is the River Seven.

The settlement is located in FZ1, FZ2, and FZ3a. Areas of high and moderate SW risk are largely overlaid by the spatial extent of FZ3.

Sinnington is covered by EA Flood Alerts.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Due to the local topography and based upon a qualitative assessment, if areas of FZ2 were covered by FZ3 as a result of climate change then the proportion of the settlement (within NYM NPA) would increase considerably. The settlement is therefore predicted to be sensitive to climate change and further consideration is required as part of the Local Plan production process and part of any FRAs.

Sleights (Figure 38.1 – 38.4)

Previous Flood Events and Their Extent - Much the settlement is located outside of the study area but Sleights in general has been subject to flooding events in 1930, autumn 2000 and summer 2007. The 2000 flood which is included on the EA HFM was as a result of the Esk overtopping flood defences (see Figure 38.3 for extent to the west of Sleights). Eastward along Esk and downstream of Sleights, flooding also occurred in 2000 due to overtopping (Figure 38.1). There have also been reports within Sleights of surface and sewer flooding. Sewer flooding was also reported at Ruswarp.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain (FZ3b) west of sleights (Figure 38.3) was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER).

The functional floodplain east of Sleights to the south of Briggswath and Ruswarp (Figure 38.1) was defined using 4% AER defended modelled scenario (combining outlines of Tidal and Fluvial models from Esk and Iburndale Beck Flood Risk Mapping Study (2008)).

The principal source of flooding is the River Esk and Iburndale Beck. However, Sleights is outside the study area, and FZ2 and FZ3 do not overlap with any of the settlement within the study area. However, it is important that Local Plan allocations and policies, and proposed developments through FRAs consider the potential downstream impacts on Sleights, Briggswath and Ruswarp.

Similarly with Briggswath, most of the developed settlement is outside of the study area. However, the parts of Ruswarp to the south of the Esk over overlaid by FZ3b, FZ3ai, FZ2, and FZ1. However, much of the settlement is located within the extent of FZ1 and FZ2.

With regards to SW flood risk, areas of high and moderate risk are generally found within the same spatial extent as FZ3. Areas of SW flood risk for Sleights, Ruswarp and Briggswath (which are located within the study area) are illustrated in Figures 38.2 and 38.4.

Ruswarp is covered by an EA Flood Warning Area.

Sensitivity to Climate Change - To the west of Sleights (Figure 38.3) there is not a specific climate change allowance. In consideration of the local topography and using the qualitative approach, due to the relatively shallow gradient of the floodplain the area at risk of flood risk should FZ2 be taken up by FZ3 would increase substantially. However, the area of land is not currently developed or part of the settlement and therefore is not considered to be sensitive to climate change.

Climate Change Allowances were available for Tidal and Fluvial Defended scenarios for the study area illustrated in Figure 38.1. The climate allowances, with regards to the parts of the study area may result in an increase in flood risk to southern parts of Ruswarp. The modelled outlines for the climate change allowance cover largely the same extent as FZ2.

Sneaton (Figure 38.1 and 38.2)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. The current risk from SW and GW flooding is not considered significant.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is not predicted to be sensitive to climate change.

Stainsacre (Figure A22)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. FZ2 is located to the south of the settlement along Stainsacre Beck. The current risk from SW and GW flooding is not considered significant.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement appears not to be sensitive to climate change.

Staintondale (Figure A39)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. FZ3b (delineated from EA FZ3) and FZ2 are located to the east of Staintondale.

There are isolated areas of moderate and high SW flood risk in low lying areas around ditches and drains which run west to east. The risk of GW flooding is considered to the variable according to the AStGWF map (covered by grids <25% to >50<75%).

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is considered not to be sensitive to climate change.

Staithes (Figure A40)

Previous Flood Events and Their Extent - The flood records accessed identified a number of records including flooding in 1999, 2000, 2005, 2013 and 2016. Potentially the most significant was in 2013 and the outline is recorded on EA HFM Map. Flooding was as a result of a combination of a tidal surge, and increased rainfall leading to surface and fluvial flooding from Staithes Beck and Gungutter. Drainage and sewer flooding within Staithes have also been recorded.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain (FZ3b) was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), and

FZ3a was delineated from FZ3b within Staithes (and Dalehouse), and where it overlaps with roads and buildings. The settlement is located mainly within FZ1 with smaller areas covered by FZ3. The main sources of flood risk are tidal flooding and from flooding associated with Staithes Beck and Gungutter. Dalehouse, which is in land from Staithes, is covered by FZ3a and is potentially at risk from SW flooding.

The area is considered to be at relatively low risk from GW flooding based upon the AStGWF map.

The area is covered in part by the Cowbar Flood Warning Area.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the topography and spatial extent the flood risk zones the area is not considered particularly sensitive to climate change with regards to fluvial flooding. However, there may be increased sensitivity to tidal flooding due to climate change and coastal erosion (although the current policy for Staithes in the SMP2 is to maintain defences).

Swainby (Figure A41)

Previous Flood Events and Their Extent - There are records of historic flood events in 2007, 2008 and 2012 but the source of flooding was not recorded.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain (FZ3b) was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER), and is located outside the settlement in close proximity to Swainby Beck. FZ3a was delineated from FZ3b within the settlement and where it overlaps with roads and buildings.

Large areas of the settlement are located within FZ1 and FZ2, while FZ3a is located centrally near Swainby Beck. The main source of fluvial flood risk is from Swainby Beck which runs through the centre of the settlement.

There are also significant areas of moderate and high SW flood risk within Swainby and the surrounding area. Based upon the AStGWF map the area is considered susceptible to GW flooding (the settlement is covered by ≥50<75% and ≤75% grids).

In addition the potential effects of flooding downstream of Swainby e.g. at Potto should be considered in Local Plans and FRAs.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk and local topographic conditions the settlement the areas is considered to be moderately sensitive to climate change. Based upon the qualitative assessment, if as a result of climate change FZ3 covered the same extent as FZ2, then the proportion of the settlement at risk of flooding would increase significantly. There is also an increased risk from SW flooding overtime due to climate change.

Thornton Le Dale (Figure A42)

Previous Flood Events and Their Extent - The flood records accessed identified flood events in 1998, 2000, 2007, 2008 and 2012 but the source of flooding were not always recorded. The 2010 SFRA did identify three instances of Main River flooding but the dates of flooding were not available.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). FZ3a was delineated from FZ3b within the settlement and where it overlaps with roads and buildings.

The main source of fluvial flood risk is Thornton Beck which flows through the settlement in two channels. The majority of Thornton Le Dale is located within FZ1, with FZ2, FZ3ai and FZ3b located around Thornton Beck towards the east of the settlement.

There are areas of moderate and high SW flood risk within the settlement including around Malton Gate and the A170, and along the southern boundary of the study area.

The risk of GW flooding based upon the AStGWF is considered to be low (covered by grids of probability <25%).

Thornton Le Dale is covered an EA Food Warning area.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is predicted not to be sensitive to climate change.

Ugthorpe (Figure A43)

Previous Flood Events and Their Extent - There are no records of historic flood events within and in close proximity to the settlement.

Floodplain Delineation and Flood Risk In and Around the Settlement - The settlement is entirely within FZ1. There current risk from SW and GW flooding is considered to be low.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement. Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement appears not to be sensitive to climate change.

W&E Ayton (Figure 44)

Previous Flood Events and Their Extent - More recent flooding incidents occurred in 1990, 1999, 2000 and 2002. The outlines of the fluvial flooding in spring 1999 and autumn 2000, which were as a result of the Derwent overtopping flood defences are included on the EA HFM.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain (FZ3b) was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). FZ3a was delineated from FZ3b within the settlements and where it overlaps with roads and buildings.

Within the study area the settlement is located within FZ1, FZ2, and FZ3a. FZ3a is located in close proximity to the River Derwent (with FZ3b located outside the settlement to the north).

Areas which may be susceptible to SW flooding are largely located within the spatial extent of FZ3, or are away from the main settlement. The proportion of the settlement which is located within the study area is considered to be at low risk from GW flooding based upon the AStGWF map.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement is predicted not to be sensitive to climate change.

Wass (Figure A45)

Previous Flood Events and Their Extent - There are no records of historic flood events within Wass but two records of SW flooding from NYCC Highways to the south of Wass near Byland Abbey.

Floodplain Delineation and Flood Risk In and Around the Settlement - The functional floodplain (FZ3b) was defined using EA FZ3 in the absence of more detailed modelled layers (e.g. 5% AER). The settlement is located predominantly within FZ1. FZ2, FZ3a and FZ3b located south of Hambleton Lane.

Based upon the AStGWF map there is a low to moderate risk from GW flooding (>= 25% <50%). There are areas of high and moderate vulnerability to SW flooding within Wass.

Sensitivity to Climate Change - There is no specific climate change allowances for the settlement.

Based upon the current flood risk, local topographic conditions, and following the qualitative method outlined in the SFRA, the settlement appears not to be sensitive to climate change.

Appendix B - Flood Risk Maps

The Maps can be accessed separately but the list below details the flood risk maps produced as part of the Level 1 Strategic Flood Risk Assessment

Contents

Study Area Flood Risk Maps

Appendix C – Types of SuDs

Types of SuDS Systems

There are a number of attenuation and infiltration elements that may come together to form SuDS systems including:

Source Control and Prevention Techniques

Green roofs: vegetated roofs which offer a means of reducing the volume and rate of run off from roofed areas and can also offer additional benefits such as improving the insulation of buildings and extending the life of the roof.

Rainwater harvesting: collect rainwater from roofs and other appropriate hard surfaces. Water is held in containers and pumped to the point of use, e.g. flushing toilets.

Permeable pavements: allow water to filter through a hard standing area rather than simply running off. Infiltration is usually achieved through the use of pervious surface materials. While in some circumstances drainage may simply be to the ground, a need to protect the aquifer or unsuitable drainage may require the construction of a storage reservoir area, usually beneath the surface.

Infiltration trenches and basins: Infiltration basins are depressions into which run off collects and then infiltrates into the ground. Infiltration trenches also allow infiltration of water through their base and sides, and are filled with a permeable material.

Conveyance

Swales: channels that can be constructed along roads or incorporated within green areas in order to transfer runoff to storage areas or may form a limited storage area themselves. They provide an alternative to a traditional piped drainage system, and the flow of water, across vegetation, when at low velocity, provides a filtering function.

Filter drains: trenches that have been lined with a geotextile material and filled with gravel. They contain a perforated pipe that carries flow along the trench. Oil residues and sediments are removed by filtering, absorption and microbial action in the surrounding soil.

Passive Treatment (Site control or regional control)

Ponds and wetlands: can be integrated into a sustainable drainage system to provide a storage area for runoff. The vegetation around wetlands can provide a cleaning function. Allowing native plant species to colonise wetlands, or using species of local provenance, can also ensure a sustainable drainage system provides the maximum opportunities for wildlife.

Filter strips: vegetated sections of land that are designed to receive runoff from upstream development. They are usually positioned between a hard surfaced area and a receptor for the water, such as a stream or another SuDS component. Runoff is cleaned by vegetated filtering, settlement and infiltration. Filter strips also slow run off velocity and can be designed to enhance the biodiversity value of a site.

Bio-retention: areas are made up of shallow landscaped depressions that include a number of soil and vegetation features aimed at filtering and reducing runoff. CIRIA guidance states that bio-retention areas should contain components including grass filter strips, ponding areas, organic / mulch areas, soil, woody and herbaceous plants and a sand bed for drainage

Detention basins: allows temporary storage and a controlled release of runoff during storm events. They are, in normal circumstances, dry vegetated depressions that can often be used for other recreational purposes during dry weather. However, during a flood event they form a storage pool, receiving runoff and storing it, allowing water to continue on its journey only when the outflow level is reached.