

# Broadland Rivers Catchment Flood Management Plan

Summary Report December 2009

# managing flood risk



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Published by:

Environment Agency  
Kingfisher House  
Goldhay Way, Orton Goldhay  
Peterborough PE2 5ZR  
Tel: 08708 506 506  
Email: [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk)  
[www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)

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December 2009

# Introduction

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I am pleased to introduce our summary of the **Broadland Rivers Catchment Flood Management Plan (CFMP)**. This CFMP gives an overview of the flood risk in the Broadland Rivers catchment and sets out our preferred plan for sustainable flood risk management over the next 50 to 100 years.

The Broadland Rivers CFMP is one of 77 CFMPs for England and Wales. Through the CFMPs, we have assessed inland flood risk across all of England and Wales for the first time. The CFMP considers all types of inland flooding, from rivers, ground water, surface water and tidal flooding, but not flooding directly from the sea (coastal flooding). This is covered by Shoreline Management Plans (SMPs). Our coverage of surface and groundwater flooding is however limited due to a lack of available information.

The role of CFMPs is to establish flood risk management policies which will deliver sustainable flood risk management for the long term. This is essential if we are to make the right investment decisions for the future and to help prepare ourselves effectively for the impact of climate change. We will use CFMPs to help us target our limited resources where the risks are greatest.

This CFMP identifies flood risk management policies to assist all key decision makers in the catchment. It was produced through a wide consultation and appraisal process, however it is only the first step towards an integrated approach to flood risk management. As we all work together to achieve our objectives, we must monitor and listen to each others progress, discuss what has been achieved and consider where we may need to review parts of the CFMP.

There are different sources of flooding in the catchment. River flooding results from heavy rainfall running off the land into the river. For example, Norwich is at risk of flooding from the River Wensum, Buxton is at risk from Camping Beck and Bungay is at risk from the River Waveney. Tidal flooding can occur within rivers and

estuaries. There is a risk from tidal flooding on the Yare at Great Yarmouth, Lake Lothing at Lowestoft, and within the Broads. Combined river and tidal flooding can occur when high tides or storm surges may coincide with high river flows to cause flooding. For example, in Wroxham, Hoveton, Horning and Brundall. High tide levels can prevent river flows from draining away and this is called 'tide-locking'. This can affect Norwich (River Wensum), Wroxham, Hoveton and Honing (River Bure). Other sources of flooding include surface water, groundwater and sewer flooding. These may be locally important but are not extensive in this catchment.

We cannot reduce flood risk on our own. We will therefore work closely with all our partners to improve the co-ordination of flood risk activities and agree the most effective way to manage flood risk in the future. We work with many organisations, groups and individuals with an interest in how flood risk is managed including local authorities, Internal Drainage Boards (IDBs), water companies, conservation bodies such as Natural England and the public.

This is a summary of the main CFMP document. If you would like to see the full document an electronic version can be obtained by emailing [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk) or telephoning 08708 506 506. Alternatively, paper copies can be viewed at any of our offices in Anglian Region.

A handwritten signature in black ink that reads "Paul Woodcock". The signature is written in a cursive style with a horizontal line underneath the name.

**Paul Woodcock**  
Regional Director Anglian Region

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↑ Bungay Sluice, River Waveney

# The purpose of a CFMP in managing flood risk

CFMPs help us to understand the scale and extent of flooding now and in the future, and set policies for managing flood risk within the catchment. CFMPs should be used to inform planning and decision making by key stakeholders such as:

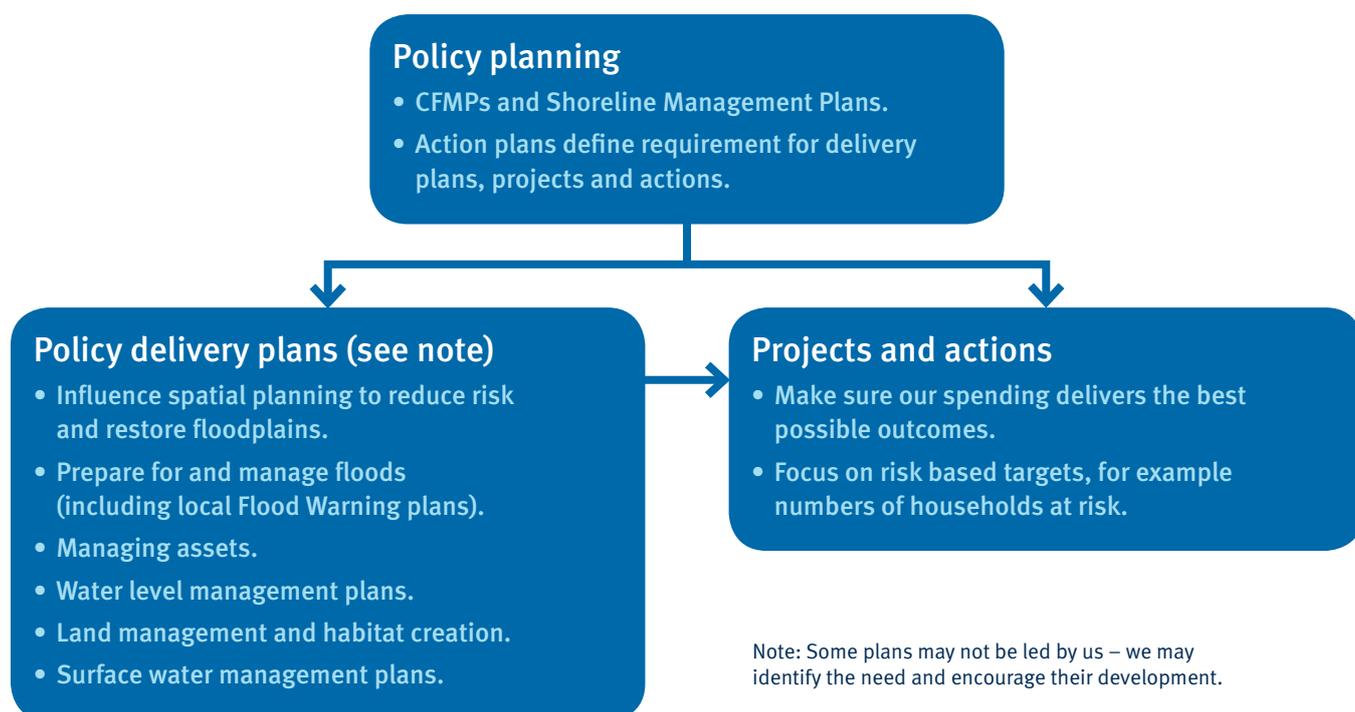
- the Environment Agency, who will use the plan to guide decisions on investment in further plans, projects or actions;
- regional planning bodies and local authorities who can use the plan to inform spatial planning activities and emergency planning;

- Internal Drainage Boards (IDBs), water companies and other utilities to help plan their activities in the wider context of the catchment;
- transportation planners;
- land owners, farmers and land managers that manage and operate land for agriculture, conservation and amenity purposes;
- the public and businesses to enhance their understanding of flood risk and how it will be managed.

CFMPs aim to promote more sustainable approaches to managing flood risk. The policies identified in the CFMP will be delivered through a combination of different approaches. Together with our partners, we will implement these approaches through a range of delivery plans, projects and actions.

The relationship between the CFMP, delivery plans, strategies, projects and actions is shown in Figure 1.

Figure 1 The relationship between CFMPs, delivery plans, projects and actions



# Catchment overview

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The Broadland Rivers CFMP area is located in the east of England. Map 1 shows the location and extent of the Broadland Rivers CFMP, it includes the catchment of five major rivers: the Rivers Ant, Bure, Wensum, Yare and Waveney. These catchments drain into a tidally dominated area of inland waterways known as the Broads, and finally out to sea through the mouth of the River Yare at Great Yarmouth. The downstream limit of the CFMP area is located at the Norfolk and Suffolk Shoreline Management Plan (SMP) boundaries. The SMPs deal with coastal flood management issues along their boundaries from Sheringham to Lowestoft (North Norfolk SMP) and Lowestoft to Harwich (Essex and South Suffolk SMP). The CFMP considers tidal flood risk further inland which includes tidal flooding within the Broads, Lowestoft and Great Yarmouth.

The CFMP covers an area of around 3,200 km<sup>2</sup> and has a population of over 64,000 people. It is predominantly rural and over 80% of the agricultural land is grade two or three. There is higher quality grade one agricultural land in the north east of the CFMP area. The main urban areas are Norwich, Great Yarmouth and Lowestoft.

Around 30 per cent of the Broadland Rivers CFMP area is made up of the Broads, a tidally dominated area of inland waterways. The Broads contains around 50 shallow lakes, formed from medieval peat pits which were flooded by rising sea levels. The Broads is a nationally and internationally designated area for its unique habitat, and is heavily used for tourism, particularly boating with around 280 km of navigable waterway. The rivers of the area can be affected by both river flooding and tidal flooding. In the past some of the worst floods have been due to a combination of the two. Internal Drainage Boards (IDBs) play an important role in managing land drainage within the low-lying Broads while the Broads Authority manage navigation.

The topography of the Broadland Rivers CFMP area is comparatively flat. Upstream of Norwich the catchment area is relatively hilly. As the rivers reach the Broads, they become wide and flat. Here the land is mostly below sea level making the Broads tidal in nature.

The underlying geology of the CFMP area is dominated by chalk and limestone. However the underlying rock is covered in most areas with glacial deposits of sand, silt and clay. Where the chalk or limestone occurs at the surface, especially in the North of the CFMP area, runoff can infiltrate the rock delaying the response of rivers to rainfall and reducing peak flood flows. However, elsewhere the non-porous glacial deposits lie over the chalk and limestone bedrock. This means that these areas respond more quickly to rainfall as water runs directly off the land and into the rivers.

Within the CFMP area, there are a number of sites designated for their environmental importance including Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites. The Broads has the equivalent status of a National Park, making tourism an important industry for the area. There are over 90 Sites of Special Scientific Interest (SSSIs) throughout the area. Scheduled Monuments (SMs) and listed buildings, designated for their heritage value, are also distributed across the CFMP area.

Map 1 Location and extent of the Broadland Rivers CFMP area



↑ River Wensum, Bintree Mill

# Current and future flood risk

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## Overview of the current flood risk

Flood risk has two components: the chance (probability) of a particular flood and the impact (or consequence) that the flood would have if it happened. The probability of a flood relates to the likelihood of a flood of that size occurring within a one year period, it is expressed as a percentage. For example, a 1% annual probability flood has a 1% chance or 0.01 probability of occurring in any one year, and a 0.5% annual probability flood has a 0.5% chance or 0.005 probability of occurring in any one year. The flood risks quoted in this report are those that take account of flood defences already in place.

There is a long history of river flooding in parts of the Rivers Yare, Wensum, Waveney and Bure, when heavy rainfall or melting snow result in high water levels in the river channels. In the past many thousands of properties have flooded in Norwich, with notable events in 1878 and 1912. More recently, river flooding affected over 200 properties across the CFMP area in October 1993.

Currently the main sources of flood risk for people, property, infrastructure and the land are:

- river flooding from the River Wensum in Norwich. There is also risk from the River Bure and Camping Beck at Buxton and the River Waveney at Bungay. River flooding can be increased in the upper reaches of the catchment, for example in Fakenham and Horstead, due to mill structures which restrict the flow of water;
- combined river and tidal flooding in settlements such as Wroxham, Hoveton, Horning and Brundall;
- tidal flooding due to high tide levels combining with a storm surge. There is a risk from tidal flooding on the Yare at Great Yarmouth, Lake Lothing at Lowestoft, and within the Broads;
- the impacts of rivers not being able to flow freely to the sea at high tide (called tide locking), such as at Norwich (River Wensum), Wroxham, Hoveton and Honing (River Bure);
- failure or the overwhelming of pumping stations causing localised flooding. Towns and villages at risk from the failure of pumping stations include East Dereham, Wymondham, Fakenham, North Walsham, Aylsham, Martham, Repps, Thurne, Caister, Hemsby, Upton, Winterton and Stokesby;
- breaching/failure of embankments. In particular breaching/failure of embankments in Norwich, Great Yarmouth, and within the Broads. This type of flooding is difficult to predict but could cause rapid flooding of the areas immediately behind the embankments, leading to a severe risk of loss of life;
- surface water and sewer flooding caused by the inadequate capacity of the sewage system, or by sewers unable to drain freely into rivers. In the past this has caused problems in Lowestoft, Beccles, Great Yarmouth, Norwich and Gorleston.

**Table 1 Number of people and properties at risk in the catchment**

	Risk from a 1% annual probability river flood <sup>1</sup>	Risk from a 0.5% annual probability tidal flood <sup>1</sup>	Combined river/ tidal flood <sup>2</sup>
Number of people at risk	1,400	2,000	500
Number of properties at risk	650	1,000	500

**Table 2 Critical infrastructure at risk**

	Risk from a 1% annual probability river flood <sup>1</sup>	Risk from a 0.5% annual probability tidal flood <sup>1</sup>	Combined river/ tidal flood <sup>2</sup>
Critical Infrastructure at risk	Two electricity sub-stations, Four wastewater treatment works Sections of A-road	Five wastewater treatment works Sections of A-road Sections of railway	Two electricity sub-stations Sections of A-road

## What is at risk?

Within the Broadland Rivers CFMP area people, property, the economy and the environment can be affected by river flooding, tidal flooding and by a combination of both.

Table 1 shows the numbers of people and property at risk in the catchment. This combined flooding applies to certain areas of the catchment that are affected by both river and tidal flooding. It is not simply the 1% river flood and 0.5% tidal flood risks added together. It can be seen that the greatest risk is from the 0.5% annual probability tidal flood.

At present there are around 3,900 people at risk from flooding in the Broadland Rivers CFMP, which is approximately 0.6% of the total population within the CFMP area. There is approximately 670 km<sup>2</sup> of grade one and two agricultural land in the CFMP area and approximately 10% of this is at risk of flooding. Table 2 summarises the critical infrastructure that is at risk in the catchment.

It is difficult to assess the current impact of flooding to environmental features but the internationally important sites of: Breydon Water (Ramsar, SPA, SSSI), The Broads (SAC), Broadlands (Ramsar, SPA), Norfolk Valley Fens (SAC) and Little Ouse Valley Fens (SAC) are at risk from the impacts of flooding. Forty-seven other SSSIs may also be at some flood risk.

<sup>1</sup> These figures do not include the risk from a combined river/tidal flood.

<sup>2</sup> Combined flooding applies to certain areas of the catchment that are affected by both river and tidal flooding. It is not simply the 1% river flood and 0.5% tidal flood risks added together.

Some parts of the catchment are affected by river flooding and some parts are affected by tidal flooding. There are also parts of the catchment that are affected by both types of flooding, however this is not simply the 1% river flood and 0.5% tidal flood risks added together. Around 16% of the people at risk from the 1% annual probability river flood are located in Buxton with Lamas. The remaining people at risk from river flooding are located in towns

and villages scattered throughout the CFMP area. Around 85% of the people at risk from the 0.5% tidal flood are located in Lowestoft. They are at risk from flooding via Lowestoft Harbour and Oulton Broad. Around 15% of the people at risk from a combined river/tidal flood are located in Horning, and a further 15% are located in Hales.

The distribution of properties at risk from a river flood, a tidal flood or a combined river and tidal flood,

taking into account current flood defences, is illustrated in Map 2. Table 3 summarises where there is flood risk to more than 25 properties in the catchment.

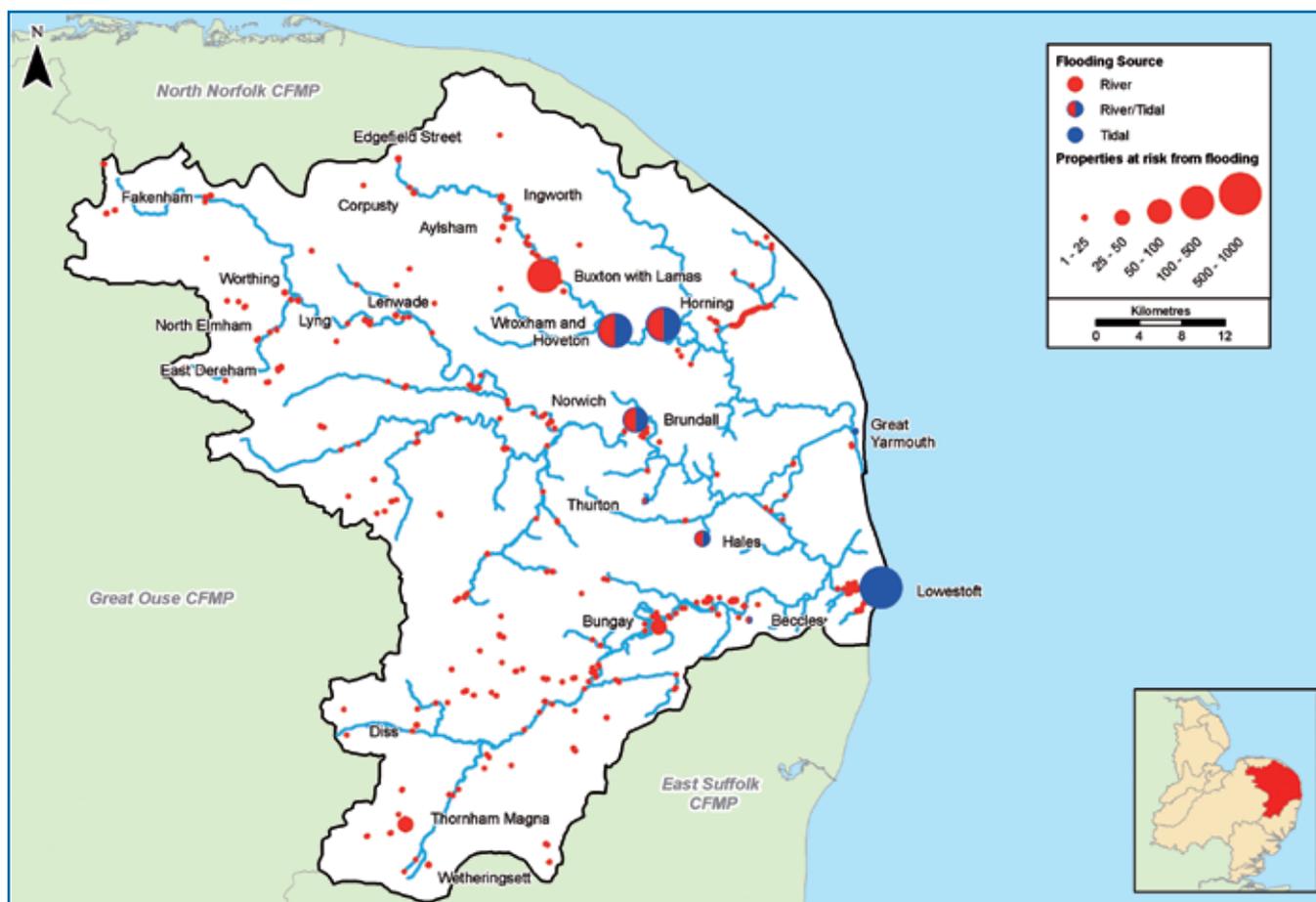
We recognise that there is also a potential risk from surface water and groundwater flooding. However, further studies following on from the CFMP are needed by us and our partners to quantify this potential risk.

**Table 3** Locations of towns and villages with 25 or more properties at risk from a 1% annual probability river flood, a 0.5% annual probability tidal flood or the combined river and tidal flood, taking account of current flood defences

Number of properties at risk	Locations		
	At risk from 1% annual probability river flood	At risk from 0.5% annual probability tidal flood	Combined river/ tidal flood <sup>3</sup>
500 to 1,000	None	Lowestoft	None
100 to 500	None	None	Wroxham/ Hoverton, Horning
50 to 100	Buxton with Lamas	None	Brundall
25 to 50	Bungay, Thornham Magma	None	Hales

<sup>3</sup> Combined flooding applies to certain areas of the catchment that are affected by both river and tidal flooding. It is not simply the 1% river flood and 0.5% tidal flood risks added together.

**Map 2 Flood risk to property in a 1% annual probability river flood, 0.5% annual probability and combined flooding, taking into account current flood defences**



## How we currently manage the risk in the catchment

The catchment has a history of flooding, generally due to high rainfall that can lead to extensive flooding of the river valleys, tidal surges that raise inland water levels and the breaching/overtopping of flood defences. Over time engineering schemes have been implemented to reduce flood risk in the catchment, including:

- the embanking of rivers. Embanked rivers at Breydon Water provide protection up to the 5% annual probability tidal flood;
- the strengthening, raising and protection of embankments as part of the Broadland Flood Alleviation Project (BFAP). The

BFAP embankments provide protection between the 20% annual probability and 4% annual probability tidal flood. Banks are being strengthened and raised to the standard of protection that existed in 1995, taking into account the effects of climate change. Erosion protection is being installed where necessary;

- constructing flood walls. Flood walls in Norwich provide protection up to the 1% annual probability river flood and are in good condition. Flood walls in Great Yarmouth provide protection up to the 0.5% annual

probability tidal flood. We are currently in the process of repairing and upgrading the walls in Great Yarmouth.

These measures have all reduced flood risk in the catchment and around 4 % of the total catchment population currently live in areas that benefit from flood risk management schemes.

In addition to these engineering schemes, other flood risk management activities are carried out in the catchment. These include activities which help to reduce the probability of flooding and those that address the consequences of flooding.

Activities that reduce the probability of flooding include:

- maintaining and improving existing flood defences and structures;
- maintaining river channels;
- maintenance of drainage networks by Internal Drainage Boards (IDB).

Activities that reduce the consequences of flooding include:

- working with local authorities to influence the location, layout and design of new and redeveloped property and ensuring that only appropriate development is allowed on the floodplain through the application of Planning Policy Statement 25 (PPS25);
- understanding where flooding is likely by using flood risk mapping;

- providing flood forecasting and warning services;
- promoting awareness of flooding so that organisations, communities and individuals are aware of the risk and are prepared in case they need to take action in time of flood;
- promoting resilience and resistance measures for those properties already in the floodplain.



↑ River Bure, Stokesby

## The impact of climate change and future flood risk

In the future, flooding can be influenced by climate change, changes in land use (for example urban development) and rural land management. Using river models we tested the sensitivity of the rivers in the CFMP area to these drivers. For urbanisation, we tested the sensitivity of the rivers in the catchment to an increase in projections of urban growth up to 2100. Increasing urbanisation had an impact on flood risk.

For climate change we tested the following changes up to 2100:

- 20% increase in peak flow in all watercourses. This will increase the probability of large-scale flood risk;
- a total sea level rise of 800 mm by the year 2100. This will increase the probability of tidal flooding and increase the length of time watercourses will not be able to flow freely to the sea at high tide (tide-locked). Climate change was shown to have a significant impact on flood risk.

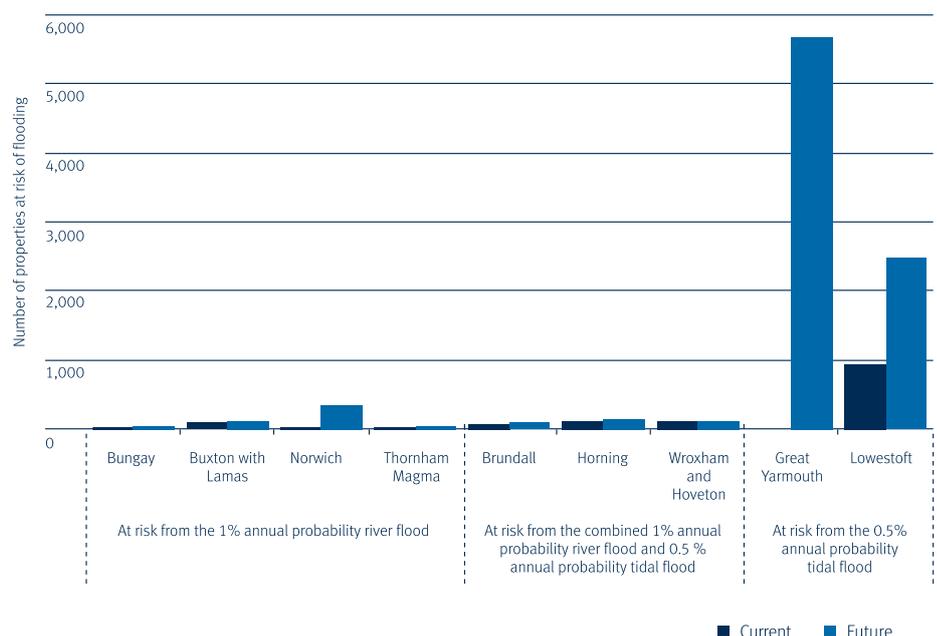
For rural land management, we adjusted the river models to represent the effect of reducing and increasing intensive farming practices. At a catchment scale this had a limited impact on flood risk. Therefore, changes in rural land management were not taken forward into the final future scenario.

In the Broadland Rivers CFMP area, climate change and urbanisation were shown to have the greatest impact on flood risk. Therefore, the scenario used to model future flood risk was based on urbanisation and climate change as described.

It can be seen that river flood risk increases mainly in Norwich. Tidal flood risk increases mainly in Great Yarmouth. Figure 2 shows the difference between current and future flood risks at key locations in the CFMP area. Following on from the CFMP, organisations need to work together to investigate flood risk from other sources (for example surface water and ground water flooding) in more detail.

In the future, increasing river flows due to climate change will mean that floodplain habitats may be flooded more frequently, although, the number of sites at risk and extent of flooding will not change significantly. Some sites may benefit from an increase in flooding, these include: River Wensum SSSI, Gunton Park Lake SSSI, the Stanley and Alder Carrs SSSI and Sweetbriar Road Meadows SSSI. The most significant impact of future changes in flooding to biodiversity will occur in the Broads. A rise in sea level will reduce the area of habitat, and cause saltwater to move further inland which will have a significant impact on freshwater habitats. Almost all of the component SSSI sites of the Broads SAC and Broadland SPA/Ramsar will be affected by a rise in sea level, as well as Breydon Water SPA/Ramsar.

**Figure 2** Current and future (2100) flood risk to property from a 1% annual probability river flood, 0.5% annual probability tidal flood and combined river/tidal flood, taking into account current flood defences



# Future direction for flood risk management

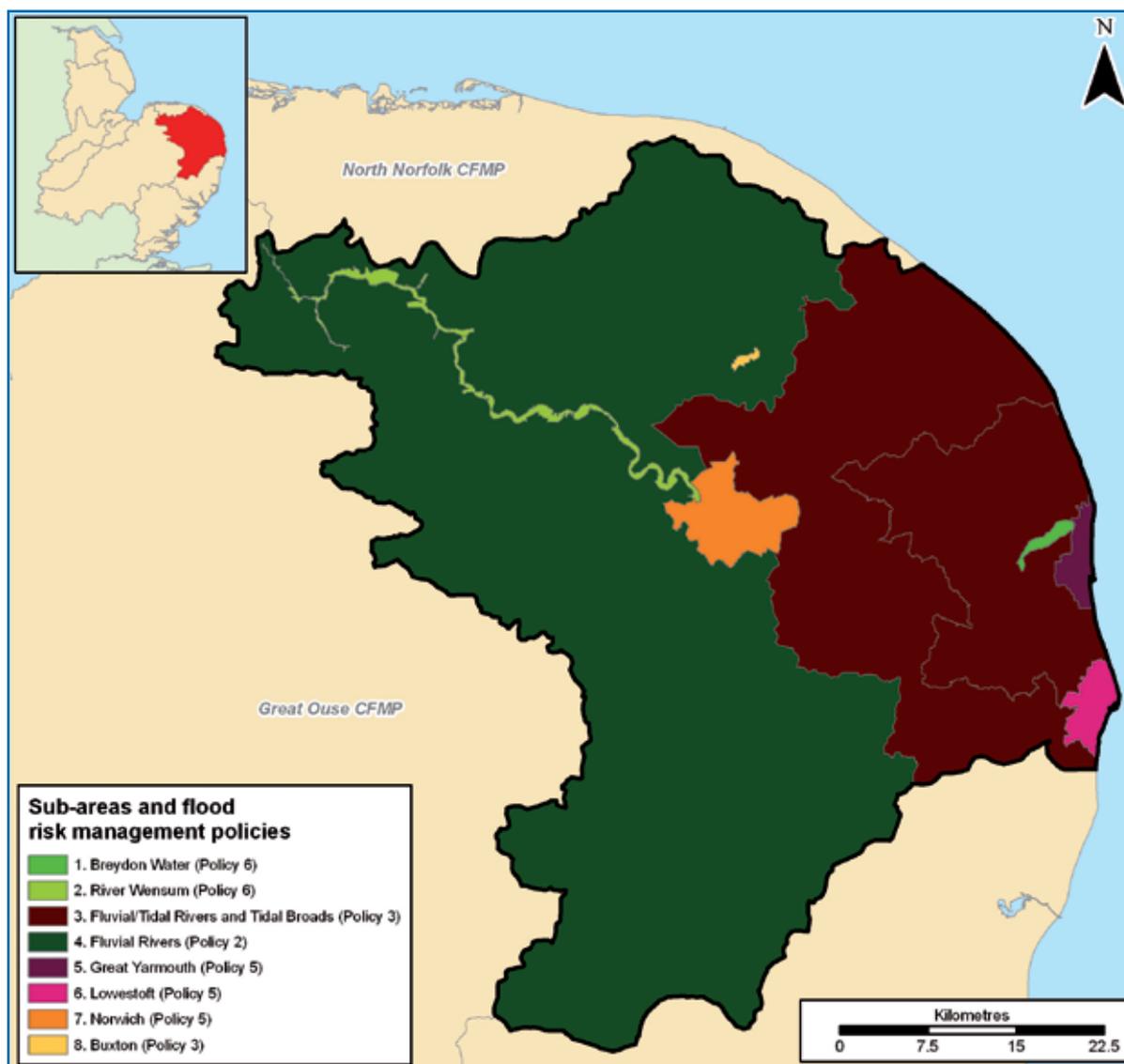
## Approaches in each sub-area

We have divided the Broadland Rivers catchment into nine distinct sub-areas which have similar physical characteristics, sources of flooding and level of risk. We have

identified the most appropriate approach to managing flood risk for each of the sub-areas and allocated one of six generic flood risk management policies, shown in Table 4.

To select the most appropriate policy, the plan has considered how social, economic and environmental objectives are affected by flood risk management activities under each policy option.

Map 3 Sub-areas and flood risk management policies



## Table 4 Flood risk management policy options

### → Policy 1

#### **Areas of little or no flood risk where we will continue to monitor and advise**

This policy will tend to be applied in those areas where there are very few properties at risk of flooding. It reflects a commitment to work with the natural flood processes as far as possible.

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### → Policy 2

#### **Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions**

This policy will tend to be applied where the overall level of risk to people and property is low to moderate. It may no longer be value for money to focus on continuing current levels of maintenance of existing defences if we can use resources to reduce risk where there are more people at higher risk. We would therefore review the flood risk management actions being taken so that they are proportionate to the level of risk.

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### → Policy 3

#### **Areas of low to moderate flood risk where we are generally managing existing flood risk effectively**

This policy will tend to be applied where the risks are currently appropriately managed and where the risk of flooding is not expected to increase significantly in the future. However, we keep our approach under review, looking for improvements and responding to new challenges or information as they emerge. We may review our approach to managing flood defences and other flood risk management actions, to ensure that we are managing efficiently and taking the best approach to managing flood risk in the longer term.

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### → Policy 4

#### **Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change**

This policy will tend to be applied where the risks are currently deemed to be appropriately-managed, but where the risk of flooding is expected to significantly rise in the future. In this case we would need to do more in the future to contain what would otherwise be increasing risk. Taking further action to reduce risk will require further appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

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### → Policy 5

#### **Areas of moderate to high flood risk where we can generally take further action to reduce flood risk**

This policy will tend to be applied to those areas where the case for further action to reduce flood risk is most compelling, for example where there are many people at high risk, or where changes in the environment have already increased risk. Taking further action to reduce risk will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.

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### → Policy 6

#### **Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits**

This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists), but would only be implemented in specific locations within the area, after more detailed appraisal and consultation.

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# Breydon Water

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## Our key partners are:

**Broadland Environmental Services Ltd**

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**Water Management Alliance Internal Drainage Boards**

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**Broads Authority**

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**Natural England**

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**Royal Society for the Protection of Birds**

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**Norfolk Wildlife Trust**

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## The issues in this sub-area

There is no risk to people and properties from the 1% annual probability river flood in the Breydon Water sub-area. This sub-area contains the whole of the Breydon Water SSSI and part of the Breydon Water SPA and Ramsar site. There is no agricultural land or critical infrastructure located within the Breydon Water sub-area.

Breydon Water is an important area of intertidal flats. It is exposed daily at low tide and is home to different species of birds, including many rare breeds. There are embankments around the edge of Breydon Water to protect the surrounding marshes (outside this sub-area) from tidal flooding. The current condition of the habitat is 100% favourable. In the future, rises in sea level and low tide level will be restrained by the current flood embankments; this is a process known as 'coastal squeeze'. As a result of this, the area of intertidal mud exposed will be reduced. It is estimated that by 2100, 99% of the habitat will be flooded at low tide, causing a loss of feeding ground for the bird population.

## The vision and preferred policy

**Policy option 6:** Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

Breydon Water is a unique sub-area in the Anglian Region. The vision is to continue current flood risk management activities in the short term and in the long term, consider setting back the defences to create an area of new intertidal habitat.

## The key messages

- In the short term continue with the current flood risk management activities.
- In the long term to mitigate the effect of coastal squeeze investigate the feasibility of setting back the defences.

## Proposed actions to implement the preferred policy

### In the short term:

- Continue with the current flood risk management activities.
- Continue with the current level of flood risk management, including the Broadland Flood Alleviation Project (BFAP) to maintain the flood embankments.

- Carry out ongoing monitoring/survey studies to investigate the change in inter-tidal sediment, habitat and salt marsh area.

### In the long term:

- Work with our partners to develop a flood risk study for Breydon Water to investigate the feasibility of creating compensatory habitats by setting back the defence line.



↑ Breydon Water

# River Wensum

## Our key partners are:

Water Management Alliance Internal Drainage Boards

North Norfolk District Council

Breckland Council

Broadland District Council

## The issues in this sub-area

There is low risk to people and property in this sub-area. Properties at risk are scattered in isolated settlements throughout the sub-area. Risk to agriculture in this sub-area is widespread and relatively frequent. Currently 30 properties are at risk from the 1% annual probability river flood within the River Wensum sub-area. The properties at risk are concentrated in villages such as Fakenham, Worthing, Lyng and Lenwade. The majority of the agricultural land at risk is grade three and four. There are sections of A-road at risk in the 1% annual probability river flood. Table 5 details flood risk to people and property in this sub-area.

**Table 5 Risk to people and property within the River Wensum sub-area during a 1% annual probability river flood, taking into account current flood defences**

	Current	Future (2100)
Number of people	60	83
Number of properties	30	47

The floodplain in the River Wensum sub-area can provide an area to store water during flood events. The storage of floodwaters can reduce the impact of flooding to people and properties in urbanised areas downstream, for example in the city of Norwich. Currently there is low risk to people and properties in this sub-area and the storage of floodwaters will not increase this risk.

The River Wensum (SAC, SSSI), which is positively impacted by flooding, is located in this sub-area. Riverside habitats along the River Wensum (SAC, SSSI) will benefit from seasonal inundation due to increases in flooding in the future, this may help restore the river to a more natural state.

## The vision and preferred policy

**Policy option 6:** Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

In this largely rural area, the aim is to manage flood risk by maximising the potential of the floodplain to retain water to benefit locations elsewhere in the catchment. Storing water on this floodplain can reduce flood risk to settlements downstream. This approach may involve:

- restoring river channels, water meadows and the natural floodplain;
- reducing runoff from agricultural land;
- structural measures to control water levels and retain more water on the floodplains;
- engineered schemes to store floodwater.

Locally, the floodplain storage areas may provide long-term benefits for the river environment and wetland habitats.

Within this sub-area reducing bank and channel maintenance will increase the ability of the floodplain to store water by improving the flow between the river and its floodplain. However, where flood risk may be more concentrated, such as in towns and villages, existing actions to manage flooding may be continued.

To be able to use the floodplain for flood risk management, planners must prevent development that affects the ability of the floodplain to retain water.

## The key messages

- Storing water on the floodplain in these areas can reduce flood risk to settlements downstream.
- Development that affects the ability of the floodplain to retain water should be prevented.
- Maintenance work on rivers should aim to increase the capacity of the floodplain to retain water.
- Storing water on the floodplain could provide long-term benefits for the river environment and wetland habitats.

## Proposed actions to implement the preferred policy

- Produce a flood storage study for this sub-area to investigate the most appropriate storage options and locations for floodplain storage. The study should also consider opportunities to enhance the environment by improving the natural state of the river and its habitat.

- Identify opportunities where bank and channel maintenance can be reduced to improve the flow between the river and its floodplain to increase water storage on the natural floodplain.
- Continue with the flood warning service including the maintenance of flood warning infrastructure (such as river flow gauging stations) and flood awareness plans.
- Continue with the River Wensum Restoration Strategy to restore the river to a more natural state.
- Work with partners to develop emergency response plans for transport links at risk from flooding.
- Reduce the consequences of flooding by improving public awareness of flooding.
- Encourage planners to develop policies to prevent inappropriate development in the floodplain using measures set out in Planning Policy Statement 25 (PPS25). Any new development should be resilient to flooding and provide opportunities to improve river environments and make space for water.



↑ River Wensum

# Fluvial/Tidal Rivers and Tidal Broads

## Our key partners are:

North Norfolk District Council

Broadland District Council

South Norfolk Council

Waveney District Council

Great Yarmouth District Council

## The issues in this sub-area

This sub-area covers the Norfolk Broads. Parts of the sub-area (fluvial/tidal rivers) are affected by both river and tidal flooding and other parts (tidal broads) are affected by tidal flooding only. The sub-area is predominantly rural containing many small settlements with low population densities and scattered individual properties. Land use is mainly for agriculture, conservation, and an economy based on tourism. There is a high density of internationally designated environmental sites on the floodplain, both defended and undefended. There are 240 km of embankments along rivers in the Broads, and work is currently ongoing to improve these as part of the Broadland Flood Alleviation project (BFAP). Embanked watercourses carry water from upstream across these sub-areas to the coast where they drain into the sea. Flood defences can fail or be overwhelmed which means that some areas have significant residual risk despite the presence of these defences. This means that the consequences of flooding still have the potential to be high.

Currently 693 properties within this sub-area are at risk from flooding. The properties at risk are concentrated in the fluvial/tidal rivers area in settlements such as Wroxham, Brundall, Horning, Gillingham and Geldeston. Tables 6 and 7 detail flood risk to people and property in this sub-area.

There is mainly grade two and three agricultural land at risk of flooding in this sub-area. There are also some A-roads, an electricity sub-station and two railway stations at risk in the fluvial/tidal rivers area during a combined river/tidal flood.

**Table 6 Risk to people and property within Fluvial/Tidal Rivers during a combined river/tidal flood (1% annual probability river flood/0.5% annual probability tidal flood). These figures take into account current flood defences**

	Current	Future (2100)
Number of people	890	991
Number of properties	685	756

**Table 7 Risk to people and property within the Tidal Broads during a 0.5% annual probability tidal flood, taking into account current flood defences**

	Current	Future (2100)
Number of people	14	386
Number of properties	8	211

## The vision and preferred policy

**Policy option 3:** Areas of low to moderate flood risk where we are generally managing existing flood risk effectively.

Historically these areas have been heavily managed by a number of organisations to reduce the probability of river and tidal flooding. Although flood risk is not expected to increase significantly in the future, as there are people, property, agricultural land and environmental sites at risk of flooding, it is still feasible and effective to continue with the current level of flood risk management. In the shorter term this will be achieved by continuing with the Broadland Flood Alleviation Project. We need to make sure that the flood risk management activities carried out in this sub-area do not cause adverse effects for internationally designated conservation sites.

In the long term, alternative, more sustainable ways to manage flood risk at the current level should be applied. Flood awareness plans should be produced to encourage people to sign up to, and respond to flood warnings and inform them about actions they can take to protect themselves and their property. Flood awareness and emergency response plans should be used to manage the consequences of flooding from the existing defences failing. Where flood risk is more concentrated, for example in settlements such as Wroxham and Horning, buildings need to be adapted to make them more resilient to flooding. This may include raising property threshold levels.

## The key messages

- In the short term, it is still feasible and effective to maintain the flood defences.
- The long term focus will be to manage the consequences of flooding using flood awareness and emergency response and by making buildings resilient to flooding.
- The implementation of this policy must not cause adverse effects for internationally designated conservation areas.
- Organisations must work together to achieve a long term integrated flood risk management approach for the Broads.

## Proposed actions to implement the preferred policy

### General actions across the sub-area:

- Continue with the Broadland Flood Alleviation Project (BFAP) to maintain the flood embankments.
- Work with partners to ensure that environmental opportunities are incorporated into flood risk management activities. This should include the creation of flood storage areas in order to manage water levels, as identified by the BFAP Wetland Task Group.
- Develop a flood risk study for the Broads to follow on from BFAP and determine the best way to continue with the current level of flood risk management.
- Continue with the flood warning service including the maintenance of flood warning infrastructure such as river flow gauging stations.
- Reduce the consequences of flooding by improving public awareness of flooding and encouraging people to sign up to, and respond to, flood warnings. Flood awareness plans will inform people about the risk of defences breaching and the actions they can take to protect themselves and their property.
- Work with partners to develop an emergency response plan for critical infrastructure and transport links at risk of flooding.
- Work with partners to develop an emergency response plan to manage flood risk from the defences failing or being overwhelmed.

### Actions specific to Fluvial/Tidal Rivers:

- Develop a resistance and resilience plan for properties at most risk in areas such as Wroxham and Hoveton. This may investigate raising of property threshold levels and internal and external resistance and resilience measures.

### Actions specific to Tidal Broads:

- Water Management Alliance and Lowestoft Consortium Internal Drainage Boards to continue with maintenance of the non-main rivers and IDB drains.

# Fluvial Rivers

## Our key partners are:

Breckland Council

Broadland District Council

Borough Council of King's Lynn and West Norfolk

Mid Suffolk District Council

North Norfolk District Council

South Norfolk Council

Suffolk Coastal District Council

Lowestoft IDB Consortium

Water Management Alliance Internal Drainage Board

## The issues in this sub-area

Within this large sub-area there is low risk to people and property, located in small settlements and isolated areas scattered along the river corridors throughout the rural region. Currently 498 properties within this sub-area are at risk from the 1% annual probability river flood. There is mainly grade three agricultural land, some A-roads, two electricity sub-stations and five sewage treatment works at risk in the 1% annual probability river flood. Table 8 details flood risk to people and property in this sub-area.

**Table 8 Risk to people and property within the Fluvial Rivers sub-area during a 1% annual probability river flood, taking into account current flood defences**

	Current	Future (2100)
Number of people	1,019	1,235
Number of properties	498	617

There is also a risk to people and properties from surface water flooding.

## The vision and preferred policy

**Policy option 2:** Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions.

In these rural reaches the current activity to manage flooding is out of proportion with the level of flood risk, or is not effective. In general, overall flood risk management activities will be reduced within the sub-areas, however where flood risk is more concentrated (for example in towns and villages) existing actions to manage flooding may be continued.

The preferred approach is to reduce bank and channel maintenance in some locations. This will enable limited resources to be targeted to other areas of the catchment where the risks are greater, to ensure value for money. The preferred approach will also help improve the flow between the river and its floodplain and so improve wetland and aquatic habitats.

Flood warning is an important way of managing the consequences of flooding throughout the catchment. Therefore, the local flood warning infrastructure (such as river flow gauging stations) needs to be maintained.

## The key messages

- Where feasible, flood risk management activities will be reduced as the current activity to manage flooding is out of proportion with the level of flood risk.
- Reducing bank and channel maintenance will help naturalise rivers and improve the flow between the river and its floodplain.
- Maintain flood warning infrastructure (such as river flow gauging stations) to ensure that an effective flood warning service can be provided throughout the catchment.

## Proposed actions to implement the preferred policy

- Investigate options to cease or reduce current bank and channel maintenance and flood defence maintenance. In addition, changes in land use, development of sustainable farming practices and environmental enhancement should be investigated to mitigate an increase in flooding in the future.
- Continue with the flood warning service including the maintenance of flood warning infrastructure (such as river flow gauging stations) and public awareness plans.
- Work with partners to develop emergency response plans for critical infrastructure and transport links at risk from flooding.
- Encourage planners to develop policies to prevent inappropriate development in the floodplain using measures set out in Planning Policy Statement 25 (PPS25). Any new development must not increase risk to existing development, should be resilient to flooding and provide opportunities to improve river environments and make space for water.



↑ River Bure, upstream of Horstead Mill

# Great Yarmouth

## Our key partners are:

Great Yarmouth Borough Council

Norfolk County Council

Anglian Water

## The issues in this sub-area

In this urban sub-area, we are currently carrying out improvements to the Great Yarmouth flood defences. This will help to reduce flood risk now and into the future. We also need to look beyond this, as there is still residual risk and a risk of the defences failing in the future. The preferred approach is to continue with the current flood risk management activity and also develop a flood risk study for Great Yarmouth. The aim of the study is to investigate how we can manage the residual flood risk in the future. This may include creating new flood defences and also the possibility of a tidal barrier on the River Yare.

There are flood walls in Great Yarmouth along the River Yare and in the harbour. However some are in a poor condition and have a high risk of failure. There is development behind these flood walls, so if the defences were to fail the consequences would be significant. The current flood defences in Great Yarmouth will also become increasingly ineffective against storms which are expected to become more frequent and intense in the future. Table 9 details flood risk to people and property in this sub-area.

**Table 9** Risk to people and property within the Great Yarmouth sub-area during a 0.5% annual probability tidal flood, taking into account current flood defences

	Current	Future (2100)
Number of people	0	10,309
Number of properties	8	5,600

## The vision and preferred policy

**Policy option 5:** Areas of moderate to high flood risk where we can generally take further action to reduce flood risk.

In this urban sub-area, we are currently carrying out improvements to the Great Yarmouth flood defences. This will help to maintain the current level of flood risk into the future. We also need to look beyond this, as there is still residual risk and a risk of the defences failing. The preferred approach is to develop a flood risk study for Great Yarmouth. The aim of the study is to investigate how we can take further action to reduce the actual and residual flood risk. The study should investigate improving the defences or the possibility of constructing a tidal barrier on the River Yare.

Different approaches are required for different sources of flooding, as defences do not reduce the risk from urban drainage issues and surface water flooding. Within Great Yarmouth, investigations into the impacts of surface water flooding may identify the need for further management.

The risk of flooding cannot be completely removed and other measures need to be taken to reduce the flood risk. Within the town the urban environment needs to be adapted to make it more resilient to flooding, for example as commercial sites are redeveloped, the location and layout of buildings could be designed to help reduce flood risk. The risk of flooding cannot be reduced entirely, therefore flood awareness must continue to be promoted.

## The key messages

- Continue with improvement works to the defences in Great Yarmouth.
- Develop a study to look at options to manage residual flood risk in the future.

- Organisations need to take an integrated approach to managing river, tidal and surface water flooding.
- Any redevelopment of floodplain areas is an opportunity to increase their flood resilience.
- Emergency response and flood awareness plans will be used to manage flood risk from the flood defences failing or being overwhelmed.
- Work with partners to develop a Surface Water Management Plan for Great Yarmouth.
- Encourage planners to develop policies for regeneration to follow the principles of PPS25, incorporate resilience measures so that the location, layout and design of development can help to mitigate persistent flood risk and provide opportunities to improve the environment and make space for water.
- Improving public awareness and encouraging people to sign up to, and respond to, flood warnings. Flood awareness plans will inform people about the risk of defences breaching and actions they can take to protect themselves.
- Emergency response plans to manage flood risk from the defences failing or being overwhelmed, and work with partners to manage flood risk to critical infrastructure.

## Proposed actions to implement the preferred policy

- Continue with the current flood risk management activities, including works to improve the existing defences.
- Develop a flood risk study to investigate how we can manage the future flood risk through improving flood risk management activities. This may be Develop a flood risk study to investigate how we can manage the residual future flood risk through improving flood risk management activities. This may be through creating new flood defences and also the possibility of a tidal barrier on the River Yare.



↑ Great Yarmouth

# Lowestoft

## Our key partners are:

Waveney District Council

Suffolk County Council

Anglian Water

## The issues in this sub-area

There are 941 properties at risk of tidal flooding in the current 0.5% annual probability tidal flood. There is no agricultural land at risk, but there are some A-roads, five electricity sub-stations and one railway station at risk in the 0.5% annual probability tidal flood. There is also risk from surface water and sewer flooding. Table 10 details flood risk to people and property in this sub-area.

**Table 10** Risk to people and property within the Lowestoft sub-area during a 0.5% annual probability tidal flood, taking into account current flood defences

	Current	Future (2100)
Number of people	1,808	4,051
Number of properties	941	2,485

Lowestoft is also at risk from surface water and sewer flooding due to the high concentration of impermeable surfaces.

## The vision and preferred policy

**Policy option 5:** Areas of moderate to high flood risk where we can generally take further action to reduce flood risk.

In this densely populated urban sub-area the preferred approach to manage flood risk in Lowestoft is to continue with and implement the recommendations from the Lowestoft Standards of Protection Study. This study should add to the understanding of flood risk in the town and investigate options to manage this risk.

As river defences do not reduce the risk from all sources of flooding, organisations must work together to manage the risk of surface water flooding.

The risk of flooding cannot be completely removed and other measures need to be taken to reduce the flood risk. The flood warning service in Lowestoft should be improved and flood awareness plans produced to encourage people to sign up to and respond to the flood warnings. Within the town the urban environment needs to be adapted to make it more resilient to flooding, for example as commercial sites are redeveloped, the location and layout of buildings could be designed to help reduce flood risk.

## The key messages

- Continue with and implement the recommendations from the Lowestoft Standards of Protection Study.
- Any redevelopment of floodplain areas is an opportunity to increase their flood resilience.
- Organisations must work together to provide an integrated approach to urban drainage issues and surface water flooding.
- Flood awareness and emergency response plans should be used to manage the consequences of flooding.

## Proposed actions to implement the preferred policy

- Continue with and implement the outcomes of the Lowestoft Standards of Protection Study. This study should add to the understanding of flood risk in the town and investigate options to manage this risk.
- Investigate the feasibility of improving current maintenance activities.
- Develop a flood warning plan to consider improvements to the current flood warning service.
- Reduce the consequences of flooding by: improving public awareness of flooding; encouraging people to sign up to, and respond to flood warnings.
- Work with partners to develop a Surface Water Management Plan for Lowestoft.
- Encourage planners to develop policies for new development and regeneration (including commercial sites) to incorporate resilience measures so that the location, layout and design of development can help to reduce flood risk. Planners should prevent inappropriate development in the floodplain using measures set out in Planning Policy Statement 25 (PPS25), and ensure that any new development does not increase the risk to existing development. Any new development or regeneration should provide opportunities to improve the river environment and make space for water.



↑ Lowestoft

# Norwich

## Our key partners are:

Norwich City Council

Broadland District Council

Water Management Alliance Internal Drainage Boards

## The issues in this sub-area

The probability of river flood risk in this settlement has been reduced by the implementation of flood defences. Currently 20 properties within this sub-area are at risk from the 1% annual probability river flood. There is a small amount of mainly grade four agricultural land at risk in the 1% annual probability river flood, but there is no critical infrastructure at risk. However, as Norwich is highly urbanised with significant development behind the defences, if the defences in this area were to fail the consequences could be significant. Table 11 details flood risk to people and property in this sub-area from river flooding.

**Table 11 Risk to people and property within the Norwich sub-area during a 1% annual probability river flood, taking into account current flood defences**

	Current	Future (2100)
Number of people	37	702
Number of properties	20	353

Currently a flood wall and an embanked footpath manage the risk of river flooding. The benefits of this approach will reduce in the future as storms are expected to become more frequent and intense.

High concentrations of impermeable surfaces within this sub-area also increase the risk of surface water and sewer flooding.

## The vision and preferred policy

**Policy option 5:** Areas of moderate to high flood risk where we can generally take further action to reduce flood risk.

Historically, defences have been constructed to reduce the probability of flooding. However, flood defences can fail or be overwhelmed and may become less effective in the future. Different approaches are required for different sources of flooding, as river defences do not reduce the risk from urban drainage issues and surface water flooding. The preferred approach for Norwich is to manage the probability of river flooding by storing water on the floodplain upstream. Within the city the urban environment should to be adapted to make it more resilient to flooding. For example as commercial sites are redeveloped, the location and layout of buildings could be designed to help reduce flood risk. The risk of flooding cannot be reduced entirely, therefore flood awareness should continue to be promoted amongst these communities.

## The key messages

- Where possible, flood risk should be managed by storing water on the floodplain upstream of settlements at risk.
- Any redevelopment of floodplain areas is an opportunity to increase their flood resilience.
- Organisations must work together to provide an integrated approach to urban drainage issues and surface water flooding.
- Flood awareness plans should be used to manage the consequences of flooding.

## Proposed actions to implement the preferred policy

- Develop a flood storage study to investigate the feasibility of creating storage areas, natural or engineered, along the river Wensum upstream of the city to manage future flood risk.
- Continue current maintenance activities through the town.
- Flood forecasting and warning study to improve the current flood warning service.
- Develop a flood awareness plan to encourage people to sign up to, and respond to flood warnings. The flood awareness plan will inform people about the risk of defences breaching and the actions they can take to protect themselves and their property.
- Encourage planners to develop policies for new development and regeneration (including commercial sites) to incorporate resilience measures so that the location, layout and design of development can help to reduce flood risk. Planners should prevent inappropriate development in the floodplain using measures set out in Planning Policy Statement 25 (PPS25), and ensure that any new development does not increase the risk to existing development. Any new development or regeneration should provide opportunities to improve the river environment and make space for water.
- Work with partners to develop an emergency response plan to manage flood risk from the defences failing or being overwhelmed.
- Work with partners to develop a Surface Water Management Plan for Norwich.



↑ River Wensum, Norwich

# Buxton

## Our key partners are:

**Broadland District Council**

**Water Management Alliance Internal Drainage Boards**

## The issues in this sub-area

Buxton is located in and around the floodplains of the River Bure and Camping Beck. Currently 104 properties within this sub-area are at risk from the 1% annual probability river flood. The majority of the properties are at risk of flooding from Camping Beck. There is no risk from tidal flooding. There is mainly grade three agricultural land at risk in the 1% annual probability river flood, but there is no critical infrastructure at risk. Table 12 details flood risk to people and property in this sub-area.

**Table 12** Risk to people and property within the Buxton sub-area during a 1% annual probability river flood, taking into account current flood defences

	Current	Future (2100)
Number of people	235	283
Number of properties	104	126

## The vision and preferred policy

**Policy option 3:** Areas of low to moderate flood risk where we are generally managing existing flood risk effectively.

Buxton is located in the floodplain and as a result has a history of flooding. Although flood risk is not expected to increase significantly in the future, as there is a concentration of people and property within the floodplain, it is still feasible and effective to continue with the current level of flood risk management. In the short term this will be achieved by continuing with existing flood risk management activities. However, in the long term, alternative, more appropriate ways to manage flood risk at the current level should be applied. A flood risk study should be developed for Buxton. This study should add to the understanding of flood risk, particularly along Camping Beck and investigate options to manage this risk.

## The key messages

- The current level of flood risk management should be continued.
- Develop a flood risk study for Buxton to investigate alternative, more appropriate ways to manage flood risk at the current level.

## Proposed actions to implement the preferred policy

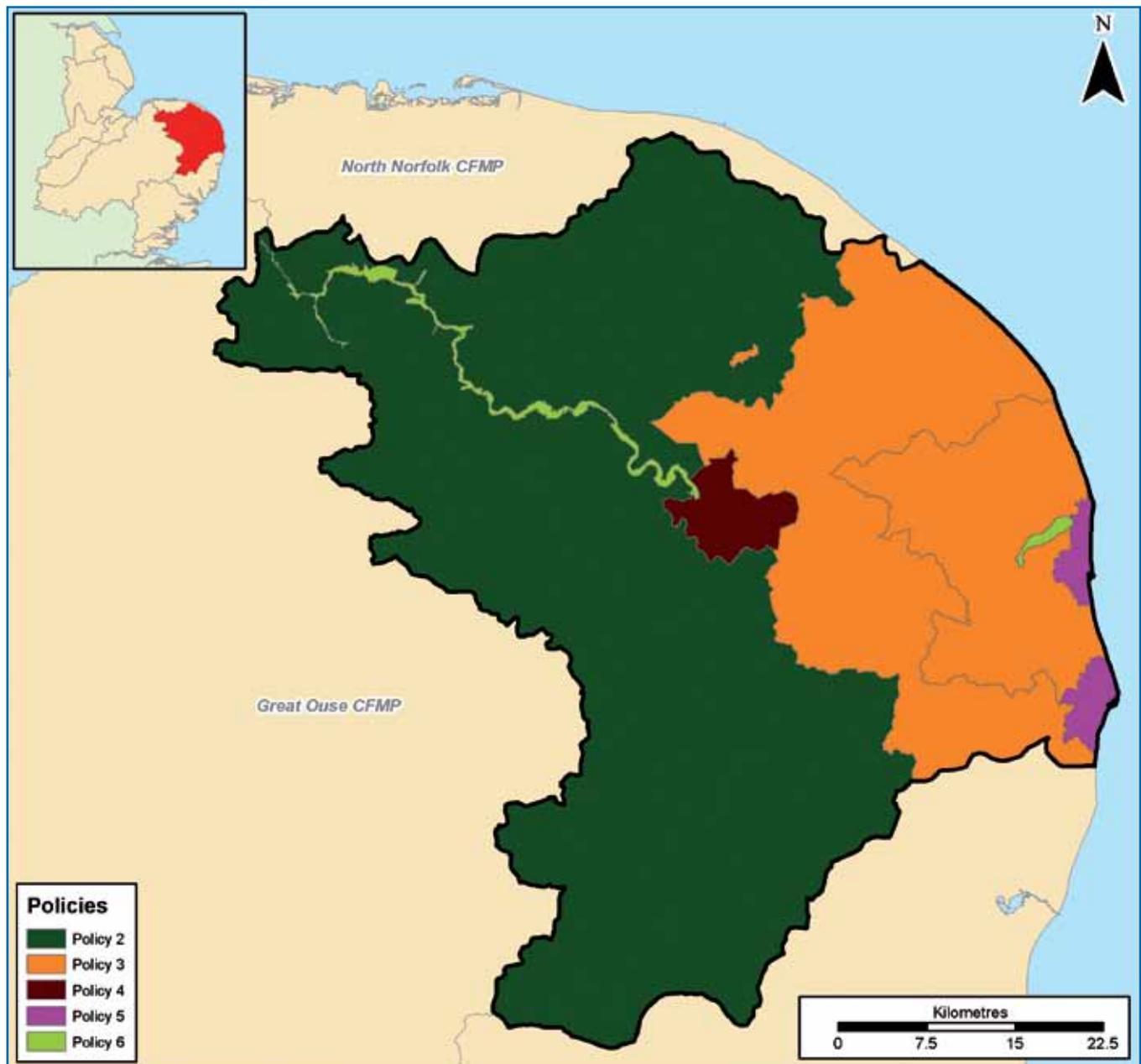
- In the short term, continue with the current flood risk management activities including the flood warning service.
- In the longer term, develop a flood risk study to confirm the level of risk in Buxton and investigate alternative flood risk management actions. This could include changes to the Flood Warning service.
- Reduce the consequences of flooding by improving public awareness of flooding.



↑ River Bure, Buxton

# Map of CFMP policies

Map 4 The flood risk management policies for the Broadland Rivers CFMP area



# Notes

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# Notes

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