# The South West River Basin District Flood Risk Management Plan 2021 to 2027

December 2022

This is a joint plan prepared by the following risk management authorities:

Bournemouth, Christchurch and Poole Council

Cornwall Council

Council of the Isles of Scilly

Devon County Council

East Devon District Council

Environment Agency

Exeter City Council

Mid Devon District Council

North Devon District Council

North Somerset Council

Plymouth City Council

Somerset County Council

South Hams District Council

South West Water

Teignbridge District Council

Torbay Council

Torridge District Council

Wessex Water

We are the Environment Agency. We protect and improve the environment.

We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

Published by:

Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH

www.gov.uk/environment-agency



Further copies of this report are available from our publications catalogue: http://www.gov.uk/government/publications or our National Customer Contact Centre: 03708 506 506

Email: enquiries@environment-agency.gov.uk

# Foreword

There are 293,202 people at risk of flooding from rivers and the sea, and 268,894 people at risk of flooding from surface water in the South West River Basin District (RBD). The South West RBD hosts a variety of landscapes, causing the area to be at risk of river, surface water, coastal and groundwater flooding.

Since the production of the first cycle Flood Risk Management Plan (FRMP) in 2015, dominant flood risk in the South West RBD has been from frequent rainfall fronts approaching from the Atlantic. A combination of heavy rainfall, river water levels, alongside powerful wave action and tidal surge, have had significant impacts on some communities, businesses, transport networks, infrastructure, rural areas and the environment, both on the coast and inland. Frequent and heavy rainfall has also had an impact on the South West RBD's urban and agricultural areas, with surface water causing significant flood events in Cornwall, Devon, Somerset and Dorset over the past 6 years.

Pre-2015, an extremely wet and stormy period between 2012 and 2014 caused significant coastal flooding to hundreds of properties in Devon and Cornwall, fluvial flooding in Somerset and groundwater flooding in Dorset. There was also extensive damage to critical transport infrastructure across the South West.

With a rapidly changing climate, events such as these are expected to be more frequent and intense. There is a need to share knowledge, learn, plan and work together alongside other Risk Management Authorities (RMAs) and partners to improve the overall resilience of our local places where possible, and adapting to these risks where it's not. It will be important to embrace evolving techniques to achieve these goals, whilst also exploring their ability to achieve other benefits such as enhancing the environment through the use of nature based solutions.

Partnerships and collaboration are key. The more we work and plan together, the more we can learn from one another and deliver for local people, places, and our environment. Over the last 3 years we have worked in partnership with Local Lead Flood Authorities (LLFAs) and others to develop the South West FRMP and would like to thank these

contributors for their valuable input. This has been a challenging time with the impacts of coronavirus. These tests reinforced how precious the environment around us is for our health and wellbeing, and the importance of protecting and enhancing it.

The FRMPs mark an important contribution towards helping to locally deliver the ambitions of the ‘National Flood and Coastal Erosion Risk Management Strategy for England’ and the government’s 25 Year Environment Plan. They focus on the more significant areas of flooding and describe the risk of flooding now and in the future.

These plans will help us:

- identify measures (actions) that will reduce the likelihood and consequences of flooding
- improve resilience, which is the capacity of people and places to plan for, better protect, respond to, and recover from flooding and coastal change, while informing the delivery of existing flood programmes
- work in partnership to explore, share knowledge and learn from one another to determine the most effective wider resilience measures – these include nature based solutions, property flood resilience and sustainable drainage systems
- plan and adapt to a changing climate by developing longer term, adaptive approaches

In many cases the measures (actions) in the South West FRMP contribute to wider benefits for local places including planning for climate mitigation and adaptation, nature recovery as well as integrated water management.

We’ve also developed the Flood Plan Explorer to support these plans and communicate their content via an online portal. This means we can stimulate even more opportunities for collaboration and co-operation across all we do.

We’ve listened to what you told us during the consultation on the draft FRMP which we carried out in October 2021 and we value what you value too. This included recognising the importance of partnerships to deliver actions, the need to strengthen a catchment approach so we work with and value our land and environment better, and rising to the challenge of making infrastructure resilient to flooding while reducing carbon use.

The Environment Agency knows the next 5 years will be both exciting and challenging. We need to innovate and adapt, making sure our thinking and actions change faster than our

climate. The Flood and Coastal Erosion Risk Management Strategy Roadmap to 2026 (Strategy Roadmap) will help us do that by providing practical ways in which flood and coastal investments can contribute to wider priorities including local nature recovery, carbon reduction and more integrated water solutions that also help with drought resilience. I'm pleased we have this opportunity to share the final South West FRMP, an important milestone but not the end.

We cannot do any of this alone and you've told us you want to get involved – please do.

We must continue to work in partnership and keep putting communities at the centre of what we do so they can adapt and thrive.

Phil Lodge, Director of Operations for South and South West England, Environment Agency

# Contents

# Introduction to the FRMP

You can find all the FRMP documents for the South West River Basin District on GOV.UK. The plan is supported by the:

- South West River Basin District Second Cycle Flood Risk Management Plan Habitats Regulations Assessment – a report on the findings of the habitats regulations assessment (HRA)
- South West River Basin District Second Cycle Flood Risk Management Plan Habitats Regulations Assessment non-technical summary – a summary of the findings in the full HRA report
- South West River Basin District Statement of Environmental Particulars (SOEP) – a report on the potential impacts on people and the environment when implementing the measures in the FRMP
- Annex 1 spreadsheet – a list containing the implementation status of each measure published in the first FRMP cycle

You can use Flood Plan Explorer, a new, interactive mapping tool that displays information about the measures included within this plan.

## Approach to the FRMP

The second cycle Flood Risk Management Plan (FRMP) is a plan to manage significant flood risks in the Flood Risk Areas (FRAs) identified within the South West River Basin District (RBD). Producing the FRMP for these areas is a requirement of the 'Flood Risk Regulations (2009)'. There are 19 FRAs in the South West RBD. These are shown in:

- FRAs for main rivers and the sea - under the heading: 'Environment Agency Flood Risk Areas for main rivers and the sea' and in Figure 1
- FRAs for surface water – Table 1 and Figure 2

The approach to identifying FRAs is outlined in 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

It's recognised that there are areas at risk of flooding outside of these FRAs. Therefore, the Environment Agency and other Risk Management Authorities (RMAs) will continue to plan for and manage the risk of flooding to all communities. This is regardless of whether they're in an FRA or not. For example, RMAs carry out flood risk management interventions, such as:

- warning and informing
- capital investment
- maintenance programmes

Therefore, the second cycle FRMP has been expanded to also show what is happening in other areas in the RBD that are outside of FRAs. This is similar to how the first cycle of FRMPs covering the period of 2015 to 2021 were developed. The FRMP also signposts to

other local plans and strategies that are likely to provide information on local actions for areas at risk of flooding.

The Environment Agency and other RMAs, in particular Lead Local Flood Authorities (LLFAs), worked together to develop the first cycle FRMP. This was to create a plan to manage the risk from all sources of flooding.

The second cycle FRMP builds on this approach. The ambition is that the FRMP is a strategic, place-based plan that shows what's happening in flood risk management across the RBD. It's closely aligned with the:

- government's 25 Year Environment Plan
- National Flood and Coastal Erosion Risk Management Strategy for England (FCERM strategy)

It's also aligned with the Environment Agency's 'FCERM Asset Management Strategy 2017 to 2022'. This is currently under review for republishing to cover 2021 to 2025, and beyond. This document reflects the Environment Agency's ambition and priority objectives in managing our assets to ensure that they remain resilient and reliable when needed.

The second cycle FRMP encourages closer ways of working between RMAs that'll help to achieve its revised objectives and measures. These revised objectives and measures align with the ambitions of the FCERM strategy. They also support achieving the wider environmental and growth ambitions of society. The second cycle FRMP is also aligned with the River Basin Management Plan 2022 for the South West RBD. Together, these plans set the strategic goals and approaches to managing water and flood risk within the RBD. More information on the background to FRMPs, the Flood Risk Regulations and how FRAs were identified is in the 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

## Contributors to the FRMP

The Environment Agency has worked with Lead Local Flood Authorities (LLFAs) and other Risk Management Authorities (RMAs) to develop this second cycle Flood Risk Management Plan (FRMP).

The Environment Agency and those LLFAs with a surface water Flood Risk Area (FRA) within their administrative area must produce a FRMP and are listed in Table 1.

RMAs without FRAs have also contributed to the FRMP. This is to show what's happening to manage the risk of flooding across the South West River Basin District (RBD).

These include:

- Bournemouth, Christchurch and Poole Council
- Cornwall Council
- Council of the Isles of Scilly
- Devon County Council

- East Devon District Council
- Environment Agency
- Exeter City Council
- Mid Devon District Council
- North Devon District Council
- North Somerset Council
- Plymouth City Council
- Somerset County Council
- South Hams District Council
- South West Water
- Teignbridge District Council
- Torbay Council
- Torridge District Council
- Wessex Water

The second cycle FRMP measures for the South West RBD cover all sources of flood risk and has been developed with contributions from other RMAs as listed above. Whilst the ambition of the plan is to be a strategic place-based plan that covers all sources of flood risk, there may be places and flood risk management activities that are not included. This is due to the strategic nature of the second cycle FRMP and does not change anything planned for those places. All RMAs across the South West RBD will continue to plan for and manage the risk of flooding as appropriate. Please review your LLFAs 'Local Flood Risk Management Strategy' for further information on its action plan.

Our ambition for the period 2021 to 2027 is to continue to drive catchment-based delivery in the South West RBD that offers multiple benefits to communities and the environment. This catchment-based approach is a key part of the Environment Agency's ambition to meet net carbon zero, along with low carbon innovation and carbon offsetting. It's also integral to achieving the Environment Agency's biodiversity net gain targets, which support the ambitions of the government's 25 Year Environment Plan. Working in partnership is the most effective way to address flooding and other climate change impacts and provides opportunities to deliver multiple benefits. During the period 2021 to 2027, the Environment Agency and RMA partners will continue to work together to produce and update strategic plans, such as the:

- evolving drainage and wastewater management plans - led by water companies
- review of the local flood risk management strategies - led by LLFAs
- review of the Shoreline Management Plans - led by the relevant Coastal Groups

Further information on partnership working can be found in the 'Managing flood risks in rural areas' and 'Managing flood risk in urban areas' sections.

The Environment Agency and many other RMAs work with partners in the River Basin District including:

- Catchment partnerships
- Landscape partnerships

- Catchment-based groups
- Non-government organisations
- Flood Action Groups
- Coastal Groups
- Other active community organisations

We value the contribution these partners make, including in:

- linking people and groups
- bringing in local knowledge, data and expertise
- developing and delivering projects

We intend to continue to develop and strengthen working in partnership to collaboratively identify, develop and deliver solutions to increase resilience to flooding and climate change and aid nature recovery in the River Basin District. The FRMPS are not intended to cover the detail of this partnership working.

## Environment Agency FRAs for main rivers and the sea

There are 17 FRAs identified as being at significant risk of flooding from main rivers and the sea that are in, or cross into, the South West RBD. These are:

- Barnstaple
- Bridgwater
- Burnham-on-Sea
- Cullompton
- Dawlish
- Exeter
- Exmouth
- Ilfracombe
- Minehead
- Mounts Bay
- Newton Abbot
- Plymouth
- Portreath
- St Blazey and Par
- Taunton
- Tiverton
- Weston-Super-Mare

The Weston-Super-Mare FRA for river and sea flooding spans both the South West and Severn RBDs. It’s described solely within the second cycle South West Flood Risk Management Plan.

## LLFAs with significant surface water flooding within their administrative boundary

There are 2 FRAs identified as being at significant risk of flooding from surface water that are in, or cross into, the South West RBD. These are shown in Table 1.

**Table 1: a list of the FRAs at risk of flooding from surface water and their LLFAs**

| Flood risk area name | LLFA name(s) |
|---|---|
| Exeter | Devon County Council |
| Plymouth | Plymouth City Council |

# Developing the FRMP

In preparing the Flood Risk Management Plan (FRMP), Risk Management Authorities (RMAs) reviewed the first cycle FRMP objectives and measures together with existing and evolving national and local plans and strategies.

Developing the FRMP has been impacted by the extraordinary events of the past few years. Despite these challenges, the Environment Agency and RMA partners have set out measures for FRAs, ensuring that the requirements of the 'Flood Risk Regulations 2009' are met. We have also taken a place-based approach to develop measures outside of FRAs.

For this FRMP, relevant plans and strategies include the:

- National Flood and Coastal Erosion Risk Management Strategy for England (FCERM Strategy)
- South West River Basin Management Plan (RBMP): updated December 2022
- Catchment Flood Management Plans (CFMPs)
- Bournemouth Local Flood Risk Management Strategy
- Dorset Local Flood Risk Management Strategy
- North Somerset Council Local Flood Risk Management Strategy
- Somerset's Local Flood Risk Management Strategy
- Devon County Council's Local Flood Risk Management Strategy
- Torbay Council's Local Flood Risk Management Strategy
- The Council of Isles of Scilly's Local Flood Risk Management Strategy
- Cornwall Council's Local Flood Risk Management Strategy
- Plymouth City Council's Local Flood Risk Management Strategy
- Plymouth and South West Devon Joint Local Plan
- Cornwall's draft Local Nature Recovery Strategy
- South West Water's evolving Drainage and Wastewater Management Plan
- Wessex Water's evolving Drainage and Wastewater Management Plan

- Hurst Spit to Durlston Head (Poole & Christchurch Bays) Shoreline Management Plan
- Hartland Point to Anchor Head Shoreline Management Plan
- Rame Head to Hartland Point Shoreline Management Plan
- Durlston Head to Rame Head Shoreline Management Plan

Many of the Local Flood Risk Management Strategies are likely to be reviewed and updated in the period 2021-2027.

Shoreline Management Plans are also undergoing a refresh in the period of 2021 – 2027.

## Approach to Objectives and Measures

For the second cycle of FRMPs, there's nationally consistent objectives which are closely linked to the:

- Flood Risk Regulations 2009
- National Flood and Coastal Erosion Risk Management Strategy (FCERM Strategy) and FCERM Strategy Roadmap to 2026
- Government's 25 Year Environment Plan

The full list of these objectives is in the 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

In drawing the objectives and measures together, RMAs have:

- revisited the priorities
- ensured there is a shared understanding of the main flood risks and how best to manage them

This second cycle FRMP for the South West RBD includes objectives and measures for:

- FRAs in the RBD
- Strategic Areas within the RBD
- areas that fall within management catchments (management catchment level)
- areas that span across or cover more than one management catchment (RBD level)

Strategic Areas (SA) are areas with a similar geography or strategic ambition where it's important to consider flood risk management across administrative boundaries and river catchments. There is one SA within the South West FRMP which is the Somerset Levels and Moors.

The management catchments are based on Water Framework Directive management catchments. Including these in this second cycle FRMP is consistent with how we presented objectives and measures in the first cycle FRMP. Our mapping of measures in management catchments will help the Environment Agency and RMA partners to identify opportunities where we can work together, and with others, to provide multiple benefits and to take a catchment-based approach.

There are 9 management catchments within the South West FRMP which are:

- South and West Somerset
- Avon Hampshire
- Dorset
- North Devon
- East Devon
- South Devon
- Tamar
- North Cornwall, Seaton, Looe and Fowey
- West Cornwall and the Fal

There are several areas in the RBD where FRAs have not been identified. This includes both Dorset and Wiltshire. Therefore, the measures for these areas are captured at a management catchment level. Information on how FRAs were identified can be found in 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

You can find more information about the second cycle objectives and measures within the section: 'Second cycle objectives and measures'.

The first cycle FRMP contained many measures which reflected the day-to-day activities carried out by RMAs. Day-to-day activities have not been included as measures in this second cycle FRMP. However, these activities will be continuing in the period 2021 to 2027. They're now captured in the national level measures the Environment Agency and LLFAs carry out as part of their routine, day-to-day work that are relevant to all FRMPs. You can find information about these national level measures in the interactive mapping tool - 'Flood Plan Explorer'.

# The South West RBD

## Overview of the South West RBD

The South West River Basin District (RBD) covers over 21,000 km$^2$. It includes Cornwall, Devon, Dorset and parts of Somerset, Hampshire and Wiltshire. It also includes the Isles of Scilly, a group of islands 25 miles southwest of Cornwall, and Lundy Island. The district has approximately 1,000km of coastline. Low pressure systems build significant weather fronts as they pass over the Atlantic Ocean. The South West is the first place these fronts hit land, increasing average rainfall, with the potential for short duration intense rainfall. This can cause extreme flooding in the steep, small catchments of Devon, Cornwall and Dorset.

The South West RBD is made up of 9 management catchments. These management catchments are set out in the Management Catchment Section in the 'Introduction to the FRMP'.

In total over 5.3 million people live and work in the South West, with its resident population fluctuating due to seasonal tourism. More people live outside major towns and cities compared to other parts of the country. These dispersed communities tend to experience localised flooding. This can often lead to economic challenges when trying to justify government funding for projects to increase levels of resilience.

Within the South West there are several urban centres. Approximately 6% of land in the South West RBD is built-up, significantly lower than the UK average. Communities such as Plymouth, Exeter, Taunton, Bridgwater, and Poole have high densities of properties at risk from multiple sources of flooding. To increase flood resilience in these locations, RMAs work together to ensure that holistic solutions address the risks of flooding from rivers, the sea, surface water, groundwater, and sewers.

The South West RBD faces several environmental challenges and opportunities. Many towns are experiencing growth and need to adapt to accommodate for the potential impact of a changing climate. Along the coast and in estuaries, flood defences can have an impact on wetland and coastal environments and their conservation interests. This, combined with sea level rise, can squeeze and erode intertidal habitat in front of coastal defences. Coastal waters are also very environmentally important and the RBD has over half of the country's designated bathing waters.

Freshwater habitats within the RBD are crucial for supporting wintering wildfowl, whilst reservoirs, rivers, estuaries and coastal water bodies support fisheries and shellfish waters. Although under less pressure than more densely populated RBDs, many heavily modified water bodies are not at their ecological potential. Physical modifications such as structures built to divert, transport and store water are identified as a key pressure in some areas.

Rivers, floodplains and coastlines are intimately associated with the South West landscape, including dramatic uplands, rugged coastlines, estuaries, marshes and lowlands. Whilst these varied landscapes are highly valued, they are also profoundly influenced by mining, industry and development, and farming accounts for around 80% of land use.

Although under less pressure than more densely populated RBDs, the majority of heavily modified water bodies are not at their ecological potential. Physical modifications are identified as a key pressure in some areas.

A combination of land and water-based cultural heritage and archaeological sites are of great significance in the RBD. These include 3 World Heritage Sites in the South West RBD which are stated below:

1. Stonehenge in Wiltshire
2. the Mining Landscape of Cornwall and Devon
3. the Jurassic Coast in Devon and Dorset

60% of the UK's Heritage Coast is within the South West RBD.

Numerous heritage assets are associated with the water environment, including water meadow systems, structures such as mills, bridges and canals, military maritime defences and historic boatyards. Settlements map historic links to rivers, estuaries and the sea through fishing and maritime trading or reflect the distinctive characteristics of the classic English seaside resort. Consequently, many historic settlements and numerous listed buildings are vulnerable to river and tidal flooding as well as coastal change. On the Somerset Levels and the uplands of Dartmoor, Exmoor and Bodmin Moor, peat has preserved organic material, which has disappeared from drier parts.

The popularity of the district as a holiday destination means tourism makes a significant seasonal contribution to the local economy. The South West supports a wide range of water based recreational activities on its rivers, lakes, estuaries, coasts and canals. With the RBD's vast coastline, much of the extensive public rights of way network is located along rivers, canals and the coast. The South West coast path is a nationally recognised public right of way and draws tourists to the area. Other notable tourist features include the World Heritage Sites and classic English seaside resorts and traditional fishing villages.

Within the South West RBD there are:

1. 17 FRAs for significant risk of flooding from main rivers and the sea
2. 2 FRAs for significant risk of flooding from surface water

Each of these defined areas are discussed in more detail in the 'Flood Risk Area level measures' Sections.

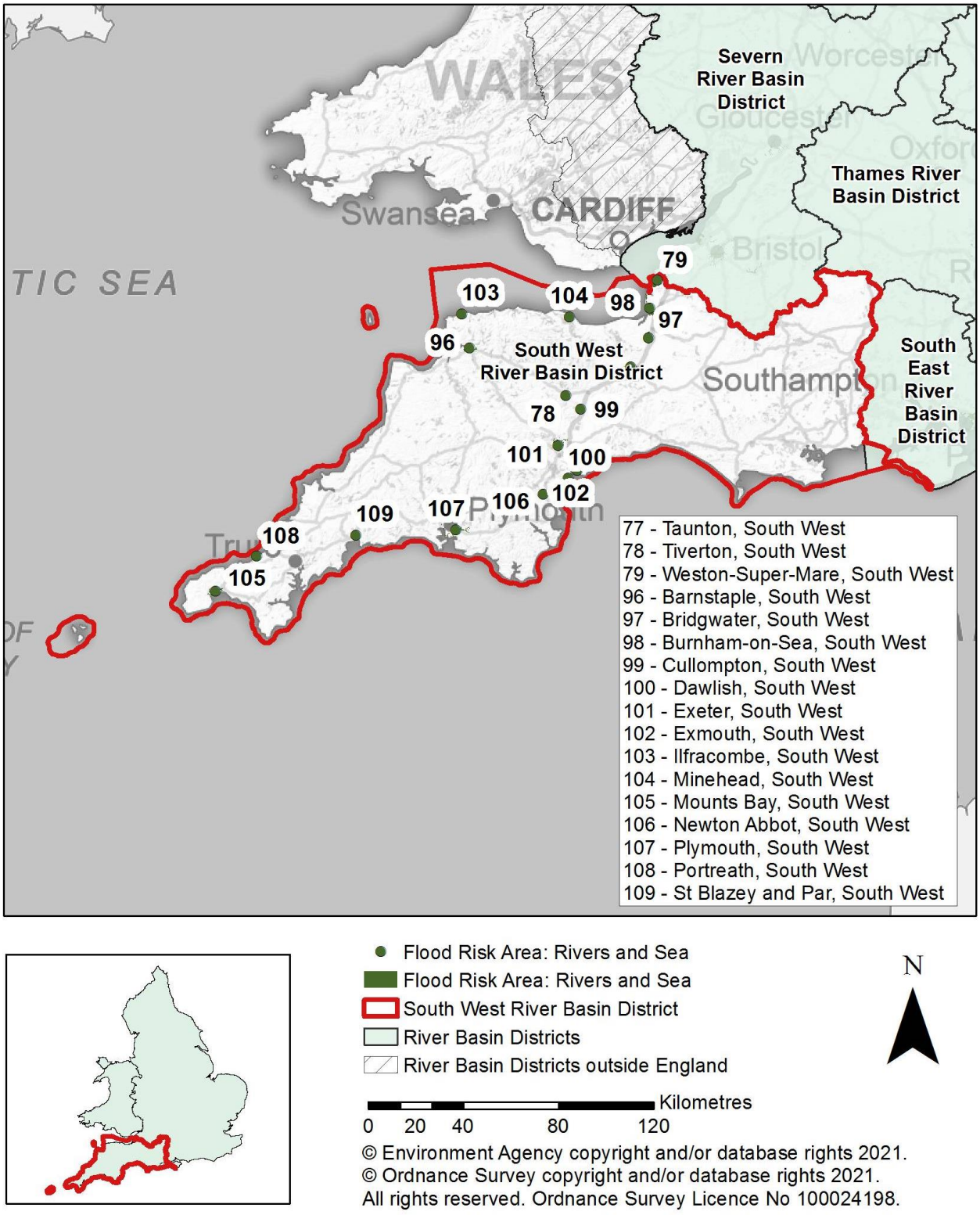



**Figure 1: Rivers and Sea FRAs in the South West RBD**

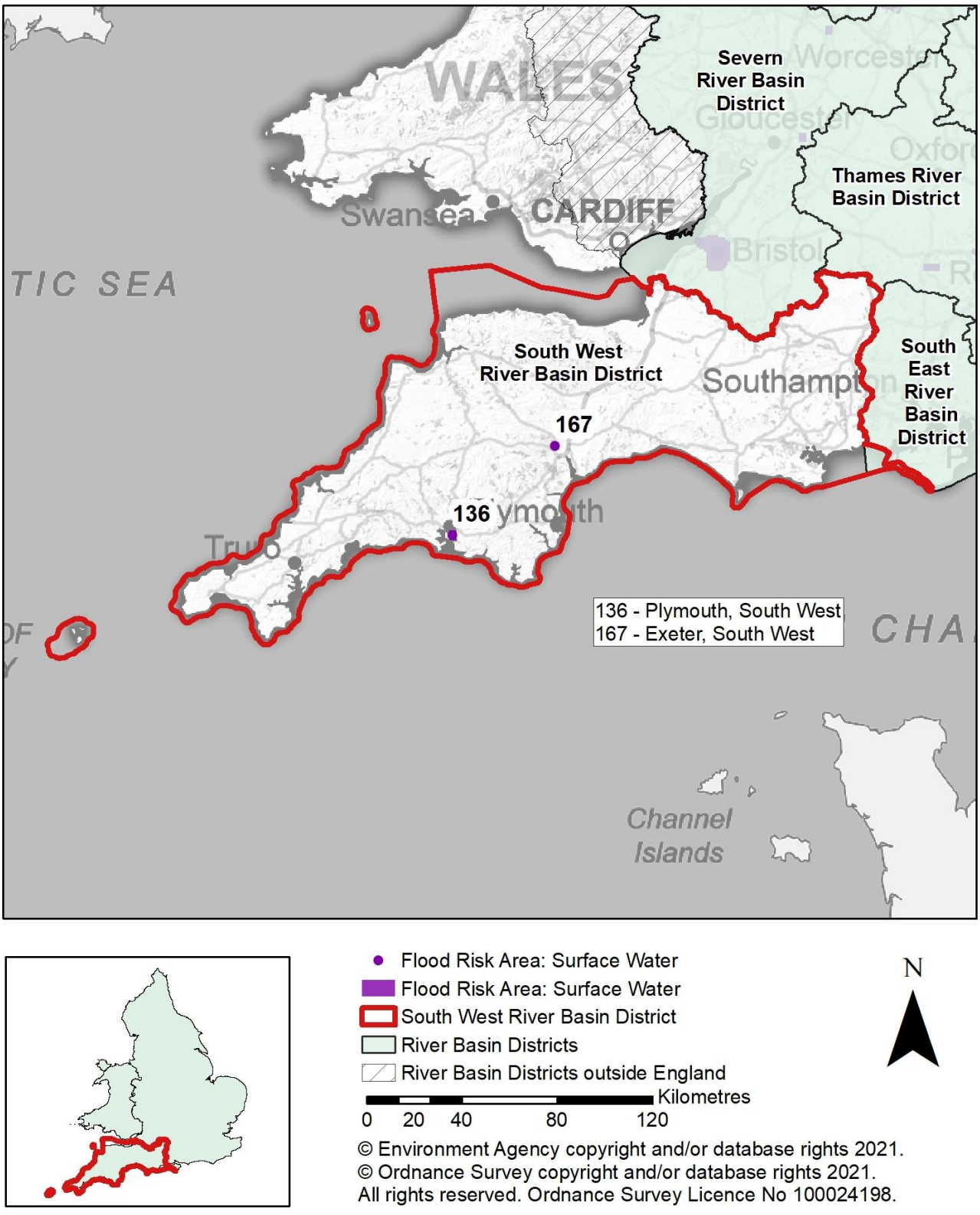



**Figure 2: Surface Water FRAs in the South West RBD**

For further information about the South West RBD, please read the accompanying South West River Basin District Second Cycle Flood Risk Management Plan – Strategic Environmental Assessment: environmental report. This includes information on topics such as the landscape, geology and cultural heritage of the South West RBD.

# The main flood risk issues and changes in the South West RBD

## River (fluvial) flood risk

River channels are sufficient to take varying flows of water for most of the year. River flooding occurs when the amount of water in a river channel exceeds its capacity. This can happen, for example, when heavy rain falls on an already waterlogged catchment or where blockages within the channel cause water to back-up. The water level rises above the river banks and spills into the river's floodplain, where historically properties, businesses, heritage assets and infrastructure have been built, and land farmed. Flooding can either develop gradually or rapidly according to how steeply the ground rises in the catchment and how fast water runs off into surface watercourses.

River flood risk in the South West River Basin District (RBD) is extremely diverse. Somerset has large areas of floodplain with wide rivers that take a long time to respond to rainfall. In some lowland areas, such as the Somerset Levels and Moors, land is at or near sea level and is at risk of tidal flooding and river tide locking. These areas depend on raised defences to reduce risk of inundation of flood water, and rely on artificial drainage systems, including channels and pumping stations for drainage. Flooding in these areas can be significant and last for prolonged periods.

Rivers in the Avon Hampshire management catchment receive large flows from chalk aquifers. These rivers react relatively slowly to rainfall but long periods of wet weather can result in prolonged flooding. On the other hand, Devon, Cornwall and West Dorset have smaller, steep catchments with fast-flowing rivers that respond rapidly. River levels can rise very quickly during intense rainfall, such as that seen at Boscastle in 2004.

There are 105 Rapid Response Catchments in the South West RBD that could be susceptible to extreme flash flooding. In these catchments, a river or stream can react very rapidly to rainfall and generate large flood depths or velocities of water that pose an extreme threat to life. There is often little or no time to warn of the impending danger, and so it's important that communities and partners can recognise the risk and respond effectively. As a result, Rapid Response Catchment Action Plans have been put in place for these areas. Examples of Rapid Response Catchments in the South West RBD include Weymouth, Porlock, Cheddar Yeo, Mevagissey and Shepton Mallet.

In some of these locations where there are small or dispersed communities, it also proves challenging economically to promote significant investment to increase levels of

community resilience to flooding. Working in partnership can solve these economic challenges whilst also providing opportunity for multiple benefits.

Diverse, multiple sources of flood risk, as described above, lead to community specific solutions to increase flood resilience. The South West RBD is made up of small river systems which drain directly into the sea. Therefore, each catchment can have flood risk managed without impact on, or influence from, neighbouring catchments.

A summary of the risk of flooding from rivers and sea in the RBD is shown in the section: Second cycle summary of flood risk for the South West RBD.

The Risk of Flooding from Rivers and the Sea map shows the chance of flooding from rivers and the sea. This is presented in categories that take account of flood defences and the condition that they are in.

## Coastal and tidal flood risk

The South West RBD is a peninsula with almost 1,000km of exposed coastline. The long coastline and sheltered harbour settings, such as estuaries and small harbour communities, have historically attracted development for economic reasons. Development in these locations are vulnerable to storms and coastal flooding.

These flood risks have been clearly demonstrated over the years. High energy waves and storms from the Atlantic can cause extensive physical damage to defences, property, businesses and critical infrastructure. An example of this includes the 2014 storms which damaged 172 properties and strategic rail and road infrastructure across the South West.

The South West's small coastal communities are posed with a significant coastal and tidal flood risk. This includes the low-lying Isles of Scilly, situated approximately 45 km offshore from Cornwall's far western tip. Residential properties, businesses, drinking water sources and environmentally sensitive areas are all low-lying meaning they are at high risk from coastal flooding alongside other coastal communities located on the mainland.

The exposure of the coast to the wind and wave direction tends to limit the flooding to those communities with a particular aspect to any given storm event. Therefore, while sea level rise will affect all communities, during a specific storm event coastal flood risk is not likely to affect all sections of the coast simultaneously.

Coastal and tidal flooding can occur when high tides coincide with strong winds, waves and/or low atmospheric pressure. These factors can interact with high river levels and significantly high rainfall to reduce the ability of river water to discharge to the sea. In the South West River Basin District (RBD), this interacts with tide locking effect and increases the flood risk to communities whose catchments drain into the sea. This type of flooding can cause significant impacts to low lying coastal and estuarine areas.

A summary of the risk of flooding from rivers and sea in the RBD is shown in the section: Second cycle summary of flood risk for the South West RBD.

Further information on tidal flood risk and management of tidal flooding can be found in the Risk of Flooding from Rivers and Sea map. This shows the chance of flooding from rivers and the sea. This is presented in categories that take account of flood defences and the condition that they are in.

Shoreline Management Plans (SMPs) are non-statutory, high level planning documents. They are large scale assessments of the risk associated with coastal processes, and a policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner.

The following SMPs identify the most sustainable approaches to managing the South West RBD's coastal erosion and flooding risks in the short, medium and long term:

- Hurst Spit to Durlston Head (Poole & Christchurch Bays)
- Hartland Point to Anchor Head
- Rame Head to Hartland Point
- Durlston Head to Rame Head

At the time of writing the FRMP, the SMPs are being refreshed to incorporate any new information such as:

- legislation
- climate change predictions
- planning guidance

The Environment Agency has a responsibility to create important coastal habitats that have been lost as a result of the presence of flood and coastal defences. Over the past 10 years new coastal habitats such as Steart Marshes in Somerset and Calstock intertidal habitat in Cornwall have been created as part of our ongoing habitat creation programme.

## Coastal erosion

Coastal erosion is managed by a range of partners. The Environment Agency has the coastal strategic overview in England. The coastal overview joins up coastal management activities to ensure flooding and erosion risk is managed effectively. The overview encourages authorities to work together in partnership to achieve effective management of coastal flooding and erosion risks.

Work to tackle coastal erosion is the responsibility of the Coastal Protection Authority – these are the unitary councils or in two tier authorities, the District Authority. Coastal Protection Authorities have operational powers relating to managing coastal erosion under the Coast Protection Act 1949 and the Flood and Water Management Act 2010.

Coastal erosion is a natural process and while management of coastal erosion is not a primary focus of the FRMP, in many coastal communities, erosion is linked to flood risk and are best considered together.

As set out above, the Shoreline Management Plans are the principal strategic planning documents on the coast. These contain the detailed information and assess the impact of erosion on communities and coastal frontages. The FRMP draws on this information to understand and demonstrate where erosion and the processes of coastal change influences flood risk and where appropriate flood risk measures need to be identified.

The geology of the north coast of Devon, Cornwall and the Isles of Scilly, consists mainly of ancient, hard rock. This coast experiences the highest energy wave climates in England, its west facing shorelines exposed to Atlantic storms.

In broad terms the South West has formed as a drowned landscape. Downward movement of the South West peninsula at the end of the last ice-age sank river valleys below sea level. Glacial melt-water streams and the onshore transport of eroded glacial material supplied sediment to the coasts. Rising and falling sea levels also played a role in shaping the present-day coast.

It's mainly as a result of these elements – hard rock, high energy waves, a large input of sediment and submerged river valleys – that the shape of the coastline is characterised by hard, craggy cliffs; resistant headlands; bays containing sandy beaches; rocky coves with small pocket beaches; relic and mobile dunes; and drowned river valleys, such as the Fal River and the Camel Estuary.

Historically human development at the coast has been focussed on access to the sea. Coastal communities have been almost exclusively developed not on the high cliffs and hard rock, but in the valley bottoms, around the sandy bays or in the drowned valley estuaries.

The direct result of the settlement of the coast is that many of the communities that are at risk of flooding, are also at risk of coastal erosion. The erosion and flood risks have always been present and we have been managing these risks by building seawalls, breakwaters, groynes and piers for hundreds of years. However, around the coast, erosion is still occurring, often adjacent to defences built to defend against the erosion.

Key areas in the South West RBD where coastal erosion and flood risk need to be managed together include Isles of Scilly, Mounts Bay, Par and St Blazey, Exe Estuary, Torridge and Taw, Teign, Dart, Erme, Poole Harbour and Westwood Ho!

There are many coastal fishing communities in the South West built onto the sediment that has accumulated in the drowned valleys, including Portreath, Mevagissey and Looe. In these communities the harbour breakwater structures not only provide functioning quays, and reduce wave action, but also prevent erosion of the coast.

As well as these key areas there are a number of smaller communities where dune systems provide coastal protection. Managing the erosion and recognising future changes to these dune systems will be key to increase communities resilience to flooding. This issue of erosion and function of dunes and how these will change over time is being

explored through Cornwall Council's Making Space for Sand project through the Flood and Coastal Erosion Innovation Programme.

Erosion can therefore threaten the stability of flood defences along the South West coastline. Monitoring carried out through the South West Regional Coastal Monitoring Programme and by local groups provides information on erosion. Additionally, the Environment Agency and local authorities visually inspect flood defences, especially after storms. The risk to the defences from erosion is reviewed and issues are monitored. Action is taken where erosion threatens the stability of a flood defence and the public investment can be justified.

Coastlines in the South West are subsequently experiencing 'coastal squeeze' because of a combination of coastal erosion and sea level rise. This is not only increasing the risk to property and infrastructure but also causing a loss of natural habitat and deteriorating their quality.

## Surface water flood risk

Over 25,000 people are at high risk of surface water flooding. Surface water flooding occurs from water running directly off land or when drainage systems become overloaded with high volumes of rainfall.

Surface water flooding is difficult to forecast and manage, due to its potentially rapid onset (flash flooding) and can be very localised to sub-areas of a town dependent on the local infrastructure and drainage network. Surface water is an obvious threat in dense urban areas where large numbers of properties can be affected and where there are hazards to public safety, such as people living in basement properties, underground car parking and pedestrian and vehicular underpasses. Many of our towns have grown around rivers and the sea as historic settlements, since then the drainage networks have grown with the town, however many of them are ageing and unable to cope with the heavy rainfall experienced today. Sustainable Urban Drainage Systems (SuDS) can alleviate surface water issues, as can separating surface water from combined sewer pipes to better utilise the capacity of drainage networks.

Towns such as Plymouth, Exeter, Taunton, Bridgwater and Poole have large numbers of properties at risk from multiple sources of flooding. In these areas, RMAs need to work together to find solutions to deal with the risks of flooding from rivers, the sea, surface water and sewers.

Surface water is the key risk in many rural areas where there are fewer properties, but where the ground may slope more steeply. Local Flood Risk Management Strategies produced by LLFAs provide details of locations, the nature of their risk, past history and any associated actions planned. Natural Flood Management projects and sensitive land management techniques upstream of these locations can help reduce the impact of rural surface water flooding. Further information on this approach is highlighted in the section: Land management and flooding.

Climate change is likely to increase surface water flood risk due to higher extreme rainfall intensities, population increase and the growth of towns as well as the trend for paving of driveways and similar will further compound this increased flood risk.

A summary of the risk of flooding from surface water in the RBD is shown in the section: Second cycle summary of flood risk for the South West RBD.

There were no surface water flood risk areas (FRAs) identified in the first cycle flood risk management plan. However, the second cycle flood risk management plan has identified 2 FRAs in the South West RBD that are nationally significant. These are:

- Exeter
- Plymouth

Further information on the risk and management of surface water flooding can be found in the Local Flood Risk Management Strategies listed in the Section: Developing the FRMP.

## Groundwater flood risk

Flooding from groundwater can occur when the level of water within the rock or soil that makes up the land surface (known as the water table) rises. The level of the water table changes with the seasons due to variations in long term rainfall and water abstraction. When the water table rises and reaches ground level, water starts to emerge on the surface and flooding can occur. Flooding from groundwater is most common in areas where the underlying bed rock is chalk, but it can also happen in locations with sand and gravel in the river valleys and other permeable geology.

Across most of the South West River Basin District, groundwater flooding is not a significant issue. The exception is in catchments in parts of West Dorset, on Cranborne Chase and Salisbury Plain which have a significant amount of groundwater influence arising from the underlying chalk. In these areas over 300 communities are known to be at risk (over 500 properties were affected in the winter of 2013/14). A Groundwater Flood Warning service exists in these areas, with work continuing to further develop forecast models and roll out to un-serviced communities.

Elsewhere, localised groundwater impacts have also been noticed on the Shutterton Brook at Dawlish and the Rydon Stream at Kingsteignton in Devon. In these locations it's important to work with other authorities to investigate combined groundwater and fluvial flood risk and actions. As groundwater flooding is a major contributor to flood risk in these catchments, there is a need to improve the groundwater flood warning service. Groundwater flood risk is managed via the Local Flood Risk Management Strategy. LLFAs have powers to carry out risk management activities associated with flooding from groundwater. Further information on the risk and management of groundwater flooding can be found in the Local Flood Risk Management Strategies listed in the section: Developing the FRMP.

## Sewer flood risk

Sewers that remove wastewater from properties can lead to 2 primary causes of flooding:

1. The overloading of a combined sewer and surface water drainage system which reduces the capacity for sewer flows during intense rainfall.
2. The disposal of household waste such as fat or non-flushable items like wet wipes down drains which results in blockages.

Many properties across the South West are at risk of sewer flooding due to these causes.

Responsibility for managing sewer flooding depends on the status of the sewer pipe. Public sewers are managed by the Water Companies, but private drainage within property boundaries is the responsibility of the property owner or Management Company.

Better outcomes and cost savings can be gained by considering flood risk from sewers and other sources together and then managing actions in an integrated manner across organisations. Water Companies across England are currently developing Drainage and Wastewater Management Plans (DWMPs) to plan their response to network pressures and sewer flooding issues, however these are not due to be completed until 2022/23.

Currently, across the South West, priorities are aligned for the RMAs both at a strategic level through the RFCC, and as measures are investigated at a community level. This is not a mandatory requirement of FRMPs but committing to this approach allows holistic solutions to be developed. Therefore, measures have been included that require this approach to be followed and expect that future iterations of the FRMP will include measures to reduce flood risk from multiple sources for specific communities. Addressing the flood risk can have wider benefits of improving water quality and freeing up capacity within existing sewer systems.

Further information on the risk and management of sewer flooding can be found in the Local Flood Risk Management Strategies and in the water company plans shown in the section: Developing the FRMP.

## Canal flood risk

Significant canals within the South West RBD include:

- Grand Western Canal at Tiverton
- Bridgwater and Taunton Canal

These structures were originally built for navigation and transportation purposes prior to the arrival of rail travel. As such, many of the associated assets are historically significant.

Canals are fed by reservoirs, or the wider catchment along them, to compensate for minor water losses due to leakage and evaporation and the water used as boats descend and ascend canal locks. Surface water run-off from areas near to canals also drains into them. Overflow weirs at intervals along canal banks help to maintain the water level within a

normal operating range or zone and these structures pass surplus water into watercourses passing nearby or underneath. Canals can alleviate flood risk due to the large storage volume represented by a small level increase along several kilometres of waterbody. They can also move water artificially within or between a catchment and delay the timing of flood peaks. However, canals constitute linear impoundments of significant bodies of water between locks and potential temporary closure points.

Flood risk can arise if an embankment breaches where a canal is on ground above the level of nearby property, or a culvert beneath the canal collapses, such as the embankment failure that happened on the Grand Western Canal in 2012 near Halberton which resulted in local property evacuations. The nature of this type of flooding, although very rare, means that it can be serious and happen without warning.

The Canal and River Trust are not a designated Risk Management Authority within the Flood and Water Management Act, 2010 but do have responsibilities for managing their infrastructure to minimise risk to others, including during incidents.

## Reservoir flood risk

The chances of a reservoir failing and causing flooding are very low; however, the extent of flooding from a reservoir can be many miles from its source. This is because the local geography, such as valleys, can channel flood water long distances. Under the Reservoirs Act 1975 the Environment Agency regulate all large, raised reservoirs and stringent requirements for inspection and improvement works are placed on any reservoir owner by authorised reservoir specialist engineers. This ensures that the reservoirs are properly maintained and regulated to minimise the risk of breach or failures. Under the Reservoirs Act 1975, it's a legal requirement for all undertakers to prepare a reservoir flood plan and flood map. There has been no reservoir flooding in England resulting in a loss of life since 1870, when a reservoir at Rishton, Lancashire failed.

Mapping indicates that, in a worse-case scenario, approximately 66,250 people in the South West River Basin District (RBD) live in areas at risk of reservoir flooding.

Also in areas at risk of flooding from reservoirs are:

- 14,880 non-residential properties
- 250 key services
- 3,350 hectares of Special Area of Conservation
- 1,790 listed buildings

The mapping has assumed reservoirs are full at the time of breach, that there are no emergency reservoir operating measures and that lots of different reservoirs fail at the same time. Numbers are therefore precautionary.

The Environment Agency did not identify any significant FRAs for reservoirs. The reasons for this are included in the Preliminary Flood Risk Assessment for main rivers, the sea and reservoirs in England published for the second cycle in 2018.

The flood risk from reservoirs map on GOV.UK shows the maximum extent of flooding, depth and speed of flow in the unlikely event that a reservoir fails. More information on how reservoirs are managed can be found in the Preliminary Flood Risk Assessment for England.

## Land management and flooding

As a rural English River Basin District (RBD), agriculture and habitat management activities play a major role in maintaining the South West's distinctive and varied landscape. Grassland and dairy farming dominate in the wetter western parts. Arable based farming takes place in the drier east, and upland farming practices take place on the uplands of Bodmin Moor, Dartmoor and Exmoor.

Soil types and geology will determine how fast or slow a river catchment could respond to flooding. Activities such as historic deforestation and legacy problems from previous agricultural practices such as over-wintering of stock on freely draining soils can reduce the potential for infiltration of rainfall, resulting in an increased risk of flooding. This is often felt in the smaller steep catchments across the South West and can contribute to locally significant flood risk. However, learning from research evidence and listening to the experiences of those who manage the land is providing the opportunity to work in partnership to deliver beneficial outcomes in key communities.

Local studies from Natural Flood Management Pilot projects have shown that poor soil husbandry practices can result in soils that should be capable of absorbing high levels of rainfall are creating over three times as much runoff. This results in a heighted flood risk for downstream communities. Efforts to restore soils in many catchments across the South West are underway through local projects and initiatives such as the Devon and Cornwall Soils Alliance.

Recognising the importance of good soil husbandry practices and land management not only reduces flood risk to communities downstream, but also provides multiple benefits to the catchment. This includes increasing drought tolerance, improving water quality, and creating healthy habitats for wildlife. More information on how we are managing drought risk in the South West can be found in the River Basin Management Plan 2022.

Upland soils in locations such as Dartmoor, Exmoor and Bodmin Moor are often peaty and have been subject to restoration initiatives through the South West Peatland Partnership since the early 2000s. This approach results in up to 30% lower flows coming from the uplands, whilst also enhancing biodiversity, restoring critical habitats and reducing carbon emissions from eroded peat which contribute significantly to the climate crisis.

There are approximately 240,000ha of woodland and forests in the South West RBD, a figure which is increasing, with upper catchments being restored to help reduce catchment response to rainfall, link up ancient woodland habitats, provide new ecosystems for wildlife and absorb carbon dioxide.

There is evidence that woodland measures can reduce flood flows, enhance critical habitats which have been removed through deforestation and absorb carbon dioxide. Particularly, woodland planting in the wider catchment can help reduce flood risk within smaller catchments. Its benefits will also be seen in larger catchments, however, to have a notable difference the scale of woodland creation has to increase accordingly.

Trees help reduce flood risk by intercepting rainfall before it hits the ground, and through root networks aerating soils and promoting infiltration of rainwater, both of which increase the length of time flood water will take to pass through a river catchment. Soils under woodland are generally protected from erosion risk, reducing delivery of sediment to watercourses.

As well as intercepting runoff upstream, 'woodland measures' for flood risk reduction can involve slowing the passage of water through the river valley. This can be done by targeted woodland creation on floodplains, in riparian zones next to rivers, or management such as the installation of features such as leaky dams to store small quantities of water across many smaller structures within the woodland flow pathways. Wet woodland creation in valley bottoms can deliver a wide range of environmental benefits and habitat restoration. This can enable continued reintroduction of native European Beavers to help manage and enhance the value of these areas.

Other techniques have included influencing 'swaling' or the burning of scrub habitat on the uplands which prevents the natural regeneration of woodland, requesting livestock levels are reduced in particularly sensitive locations, and blocking of old mining gulleys to store water in the headwaters of river catchments.

In the lowlands, much of the land is historically reclaimed, lying at or near sea level. Its use is heavily reliant on established manmade drainage systems, such as enlarged, perched channels, pumping stations and land drainage. Long term investment in maintenance, such as clearing vegetation and dredging, are required to sustain the current land use.

This area of flood risk management activity is developing to enable it to be used alongside more traditional solutions such a flood defences. Several local projects have been running since the first cycle FRMP to learn how to use these features, and some of these are listed below:

- Dartmoor Headwaters Natural Flood Management Pilot
- Ottery St Mary Natural Flood Management Pilot
- Kenwith Natural Flood Management Pilot
- Taw Torridge Estuary Natural Flood Management Pilot
- Culm Grassland Natural Flood Management project
- South West Peat Partnership
- Connecting the Culm
- Cory & Coly Natural Flood Management project
- River Otter Beaver Trial
- Boldventure Beaver Project
- Cornwall Beaver Project

- South West Water's Upstream Thinking Programme
- Poole Harbour Natural Capital Auction
- Hills to Levels Multiple Benefits Project
- River Hooke Natural Flood Management Project
- Holt Heath Natural Flood Management Project

## Managing flood risk in rural areas

The South West River Basin District (RBD) is a largely rural area, with many people living outside the major towns and cities. The South West's rural catchments have varying characteristics; Somerset has large areas of floodplain, such as the Somerset Levels and Moors. The land here is at or near sea level and is at risk of tidal flooding and river tide locking. On the other hand, Devon, Cornwall and West Dorset have smaller, steep catchments with fast-flowing rivers that respond very rapidly to often intense rain storms which typically arrive from the Atlantic Ocean. This can put lives at risk in these remote communities that experience rapid response flooding due to reduced response times and often fewer formal flood defences being present within communities. In addition, the Isles of Scilly form a unique island community off the South West peninsula of Cornwall, whose remoteness contributes to their identity. Maintaining year-round infrastructure links and coastal flood risk protection is a specific challenge.

Unlike other RBDs with large urban areas, in some places there is limited potential for high-cost flood defence schemes which benefit larger areas and high numbers of people. Protecting these remote communities and rural public transport infrastructure is challenging. When these receptors are affected by flooding, this can subsequently impact residents, visitors and the local economy including the agricultural sector. Improving community preparedness and flood warning services is a vital part of the solution where additional levels of protection are not achievable.

The agricultural nature of the South West has a major influence on the water environment. The agricultural industry is economically significant in the South West and its land uses are vulnerable to extreme weather and climate change. Significant flooding and dry periods can have potential to affect food production. Learning from those who own and manage the land provides opportunities to work in partnership to deliver benefits to key communities and nature. The Environment Agency is working closely with Natural England, Forestry England and Environmental Non-Governmental Organisations across the South West RBD to do just this through the implementation of Natural Flood Management solutions, Catchment Sensitive Farming initiatives and through the provision of advice to landowners and managers. This work aims to deliver wider environmental benefits beyond flood risk reduction, such as reducing water pollution, thriving wildlife biodiversity, and lowering flood risk to communities. Significant challenges remain around funding ongoing maintenance of the solutions installed as part of these schemes until the new agricultural payments system, the Environmental Land Management Scheme, comes into place, which is expected during the period of time this FRMP covers.

Work is required to further understand the tricky problems faced by farmers to balance food production versus the needs of the climate and biodiversity crisis and ongoing issues with revenue funding for maintenance of flood defences in rural areas which could be removed without increasing risk to communities. It is intended to build upon recent learning of Natural Flood Management projects in the South West and nationally to inform discussions with landowners and key partners, such as the National Farmers Union, as to how to achieve a balance that doesn't detrimentally impact farming whilst delivering flood resilience improvements.

Many of the issues with tackling flood and coastal risk issues in disparate rural communities are the result of central government policy on funding for schemes being prioritised to areas where the greatest number of properties can be at reduced risk of flooding. Currently this poses problems for delivery of improvements to existing flood defences and creation of new ones across South West England. However multiple benefit schemes which deliver environmental improvements and other societal benefits can often attract more funding but may result in lower overall increases in community flood resilience than engineered schemes at present.

In Devon, a Flood and Coastal Resilience Innovation Programme project is running until 2027 to investigate opportunities to increase levels of resilience to flooding in small communities. The findings from this project, and the others in the programme, will be fed back to policy makers to influence decision making for future investment periods beyond 2027.

## Managing flood risk in urban areas

Approximately 6% of land in the South West River Basin District is built-up and this is significantly lower than the UK average. More people live outside major towns and cities compared to other parts of the country. The dispersed communities tend to experience more localised flooding.

The South West RBD has relatively small urban areas but these suffer from flooding from smaller rivers, brooks and have urban drainage issues and surface water flooding. Within the South West there are a number of urban centres. Communities such as Plymouth, Exeter, Taunton, Bridgwater and Poole have high densities of properties at risk from multiple sources of flooding. In these locations the future control of flood risk will require RMAs to work together to ensure that holistic solutions are delivered that address the risks of flooding from rivers, the sea, surface water and sewers.

Due to the generally rural nature of the South West RBD, it is often difficult to justify large scale flood defence schemes to significantly increase the levels of resilience to flooding and coastal change. This, coupled with potentially significant increases in peak river flows and sea levels due to climate change may result in certain areas of communities becoming unsustainable. Careful consultation will need to be given to this issue in partnership with the community, Local Planning Authorities and many other partners to identify, plan and fund solutions to adapt to the impacts of climate change.

# History of flooding

This section of the Flood Risk Management Plan (FRMP) provides a summary of significant flood events and their consequences since the first cycle FRMP in 2015. It covers the period 2015 - February 2021. Significant is defined as an event which affected more than 20 residential properties. The first cycle FRMP for the South West River Basin District (RBD) contains information on historic flood events and their consequences before 2015. More detailed information on why flood records and evidence are important and how they are used is in the Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans.

The South West RBD has a long history of flooding. For the Somerset Levels and Moors, flood records date back to 1600s whilst some of the more significant events over the last 100 years occurred in 2013/4, 2012, 2000, 1997, 1960 and 1929. The 2013/14 flooding event mainly impacted the Parrett and Tone river catchments. During the 2013/14 event, the Environment Agency's defences across the area protected over 200 km2 of land and over 3,500 properties. However large areas of land and communities were still flooded for many weeks, including 172 properties. Strategic infrastructure, such as main roads and the rail network, was significantly affected and some small communities were cut off for several months.

Dorset, Wiltshire and Hampshire have also experienced major disruption due to flooding. An example includes autumn 2000 where a succession of weather systems brought prolonged rainfall which was exceptional in many communities within these counties. The impacts included major disruption to roads for several weeks. In addition, Fordingbridge and Ringwood were seriously affected with many properties inundated with flood water for several weeks. In Somerset, flooding occurred in Williton when 50 properties were affected by surface water and river flooding after periods of heavy rainfall. Between 2012 – 2014, over 500 properties were affected by groundwater flooding in Dorset and Wiltshire.

In Devon, Cornwall and the Isles of Scilly, Atlantic storms coinciding with high tides associated with significant wave action and tidal surge has resulted in devastating flood events through the years. Notable events include the February 2014 storms where approximately 100 properties experienced tidal flooding in Devon and approximately 200 properties flooded in Cornwall. Extensive damage occurred to coastal defences and infrastructure.

Since the first cycle FRMP, the dominant flood risk in the South West RBD has come from rainfall fronts approaching from the Atlantic. This has resulted in Cornwall and Devon being hardest hit in the South West by rainfall and storms.

A list of the historical flood events from all sources of flooding between January 2015 and December 2020 is shown in Table 2. Flood events were defined when 20 or more properties internally flooded.

**Table 2: historical flood events from all sources 2015 – December 2020. Number of properties rounded to the nearest 10**

| Date of flood | Location and approximate number of properties affected shown in brackets | Source of flood water |
|---|---|---|
| December 2020 | Notter Bridge (30)<br>Cornwall (30) | Fluvial, surface water |
| August 2020 | Torbay (40)<br>Plymouth (30)<br>Cornwall (30)<br>Barnstaple (160) | Surface water |
| February 2020 | Looe (20) | Surface water |
| December 2019 | Hayle (40) | Tidal, surface water |
| November 2019 | Cornwall (50) | Tidal, fluvial, surface water |
| October 2019 | Cornwall (20) | Fluvial, surface water |
| July 2017 | Coverack (60) | Surface water |
| November 2016 | Devon (90)<br>North Somerset (20) | Fluvial, surface water |
| September 2016 | Bournemouth/Poole (30)<br>Redruth (20) | Surface water |
| June 2016 | Devon (20) | Surface water and fluvial |

# Climate change and the South West RBD

This section sets out what we know are likely to be the implications of climate change in the South West RBD. We use allowances for different climate scenarios over different epochs or periods of time, over the coming century.

A percentile describes the proportion of possible scenarios that fall below an allowance level. The:

- central allowance is based on the 50th percentile
- higher central allowance is based on the 70th percentile
- upper end allowance is based on the 95th percentile

An allowance based on the 50th percentile is exceeded by 50% of the projections in the range. At the 70th percentile it's exceeded by 30%. At the 95th percentile it's exceeded by 5%. The 'H++' allowance is an extreme climate change scenario which applies up to the year 2100 for sea level rise.

As the data that is used to predict the impact of climate change is constantly changing the most up to date information has been used at the time of publishing, over the next 6 years as this changes the most up-to date information should be used.

## Coastal flood risk

As sea levels rise, it means coastal flooding will become more frequent. This is because higher water levels will be seen more often. Predicting coastal flooding is complicated because it's a combination of:

- a still water level
- a surge component
- wave conditions

Future changes in sea levels are primarily accounted for by increases to the mean sea level. Changes in storminess and wave conditions are not as well understood or are not likely to change significantly. Future changes in wave conditions are thought to be heavily variable by geographical area and are an area of further research. Table 3 sets out how we expect mean sea levels to rise along the coastline by 2125.

**Table 3: cumulative mean sea level rises between 2000 and 2125 (metres)***

| Allowance | Sea level rise |
|---|---|
| Extreme (H++) | 1.90m** |
| Upper end | 1.62m |
| Higher central | 1.21m |

* Data source: flood risk assessments: climate change allowances

** This applies up to the year 2100.

## Fluvial (river) flood risk

Rainfall intensity is expected to increase in the future, which will cause river flows to increase. Flood risk assessments: climate change allowances sets out how much we expect peak river flows might increase by 2125 for management catchments. A 'Management Catchment' is a designated river catchment designated under the Water Framework Directive (The Water Environment (Water Framework Directive) Regulations 2017); this subdivides river catchment areas for easier management within the River Basin District.

As river flows increase, it means that fluvial flooding will become more frequent. This is because higher river flows will be seen more often.

RBDs cover large areas. We know that some areas will be more affected by climate change than others. The range of increases for the South West RBD for the upper end scenario for 2080s epoch (2070-2125) is from 74% to 105%. This range reflects a difference in anticipated change across management catchments within the RBD.

## Surface water flood risk

In winter, more rainfall and 'wet days' are projected. In summer less rainfall and fewer 'wet days' are projected. For all seasons, rainfall intensity is projected to increase.

Intense rainfall can cause surface water flooding, particularly when the ground is already wet or following a prolonged dry spell. This is when clay soils can form an impermeable crust. As rainfall intensity increases, it means that surface water flooding will become more frequent, because higher rainfall totals will be seen more often. This is likely to have a particular impact on areas affected by high groundwater levels as well as in low lying areas with limited capacity to remove flood water, such as the Somerset Levels and Moors.

Flood risk assessments: climate change allowances set out how much we expect rainfall intensity might increase by 2125 for management catchments in the South West RBD. The range of increases for the South West RBD for the upper end scenario for the 2070s epoch (2061-2125) is from 45% to 50%.

## How our understanding of the impact of climate change on flood risk might change

Our understanding of the impact of climate change on flood risk will evolve as more climate modelling and research is undertaken. The climate change allowances provided are based on the latest UK climate change projections in UKCP18 and UKCP Local (2.2km). We will review, and where needed update, the climate change allowances as new climate change projections and research is published, working with the Met Office and other experts such as at universities.

Our climate changes naturally over time, alongside human influence since the industrial revolution, due to the emission of greenhouse gases. As well as climate change, there are other factors that can affect how severe a flood is. This includes how wet the ground already is when heavy rain starts to fall. This means that it's difficult to be sure about how much more likely a certain size of flood will be in the future.

Traditional methods used to estimate the likelihood and size of floods assume 'stationarity' of extreme events. This means that flooding in the past is assumed to represent the behaviour of future flooding. Due to recent large-scale flood events on our rivers and coasts, many hydrologists are now considering 'non-stationarity'. This recognises statistically significant changes over time.

We're working with universities to actively research what this might mean for future increases in flood risk. This means that our understanding of how likely extreme floods will be in the future, and what contributes to this, is likely to change.

More information on climate change considerations in the FRMPs is in 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans'.

# Progress review of implementing the first cycle FRMP

This section assesses the achievements and what has happened across the South West RBD since the first cycle FRMP was produced in 2015. It describes how the first cycle FRMP was reviewed.

It reports on the status of the measures and a summary of progress made towards achieving the objectives in the first cycle FRMP. It gives reasons if progress has not been made.

## How we assessed progress

The Flood Risk Regulations 2009 (FRR) require that the Environment Agency and LLFAs review the first cycle FRMP. The FRRs state that this review must:

- include an assessment of the progress made towards implementing the measures
- include a statement of the reasons why any measures proposed in the previous FRMP have not been implemented

The Environment Agency and LLFAs followed these steps to complete the review within the South West RBD:

1. The status of each measure was reviewed and assigned an estimated implementation status as of 31 March 2021.
2. For measures assigned an implementation status of 'not started' or 'superseded' reasons were given why they have not been progressed.
3. Additional measures were identified that have implemented since 2015 which have made a material difference to achieving the first cycle FRMP objectives.
4. An assessment of how well the measures have contributed towards achieving the first cycle FRMP objectives.

The review of first cycle FRMPs is presented in this section by:

- summary statistics to show an overview of measure implementation
- a selection of case studies to demonstrate what has been achieved since 2015
- a summary of additional measures implemented since 2015
- an overview of how well first cycle FRMP objectives have been met

## Summary of progress of implementing the measures since 2015

Table 4 shows a summary of the estimated implementation status since 2015 of all the measures in the South West RBD, as of 31 March 2021. Chart 1 also shows this in more detail.

**Table 4: implementation status of measures for the South West RBD**

| Progress | Number of measures |
|---|---|
| Ongoing | 256 |
| Ongoing construction | 12 |
| Completed | 134 |
| Superseded | 173 |
| Not started - proposed | 27 |
| Not started - agreed | 37 |

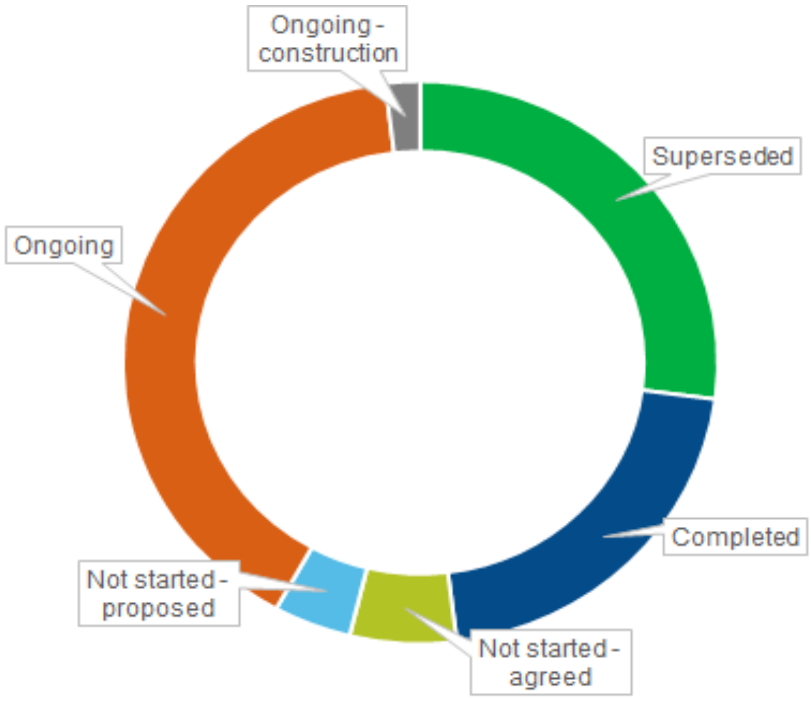



**Chart 1: implementation status of measures for the South West RBD**

21% of the measures published in the first cycle FRMP have been completed. 2% of the measures are ongoing in construction. 40% of the measures are ongoing.

Of these ongoing measures, 46% are day to day activities which have been carried out by risk management authorities in 2015-2021. These activities will be continuing in the period 2021-2027 and have been transitioned into the national level measures. These national level measures can be found in Flood Plan Explorer - the interactive mapping tool.

44% of the ongoing measures are outside of day-to-day activities. Examples of this include the Dartmoor Headwaters Natural Flood Management Pilot in Devon and the Moors at Arne project in Dorset (see case studies below).

10% of the measures proposed in the first cycle FRMP have not been implemented. The reasons for this are:

- further work showed it was not viable
- it has been postponed
- it has been included in another piece of work
- it has been replaced by another measure
- it does not yet have funding

Each measure included in the published first cycle FRMP and its implementation status at the end of March 2021 can be found in Annex 1. Annex 1 also provides information on which measures from the first cycle FRMP have been transitioned to this second cycle FRMP.

Examples of projects achieved during the first cycle FRMP are included in case studies in this section.

## Case Study: Dartmoor Headwaters Natural Flood Management Pilot

Between 2018 and 2021, the Environment Agency and Dartmoor National Park Authority has been working in partnership with:

- Devon County Council
- Westcountry Rivers Trust
- Devon Wildlife Trust
- Plymouth University
- National Highways
- Natural England
- the Woodland Trust

Partners are working to implement natural flood management interventions across Dartmoor to reduce the flood risk to residential properties in the lowlands of the catchment as part of a £15 million national programme. These natural flood management interventions also provide other benefits including water quality and biodiversity improvements.

The pilot focussed on 5 priority catchments: the River Mardle and Dean Burn (upstream of Buckfastleigh), Hanger Down (upstream of Ivybridge), the Colley Brook (upstream of Peter Tavy) and the Black Brook (upstream of Walkhampton). A project officer was recruited and engagement with landowners was conducted prior to delivery of solutions.

The partnership has collated £834,000 of funding across several different funding streams and complimentary projects to deliver a range of natural flood management interventions. Examples include:

- The installation of approximately 350 timber, stone and willow leaky dams
- Planting 6,000 trees to increase infiltration and reduce surface water runoff
- Funded 75 hectares of peatland restoration in addition to river restoration and floodplain reconnection
- Working with partners to influence activities such as livestock grazing to improve soil health and reduce soil compaction
- Completion of a PhD with Plymouth University which looked at the hydrology of woodlands in Dartmoor and how this can help planning proposals

**Figure 3: Dartmoor Commoners installing leaky dams in gulleys above Buckfastleigh, Devon**

## Case Study: The Moors at Arne

The Environment Agency, RSPB and Natural England are working together to adapt approximately 150 hectares of the Moors at Arne into a diverse wetland habitat.

The scheme will involve the construction of new tidal embankments further inland than the existing ones. Once in place, the land in front of the new embankments will be opened to the action of the tides and with this new salt marsh habitats will be created. These new tidal embankments will give greater flood resilience for local people and property.

The project has developed outline proposals since its public launch in October 2018. Detailed surveys and assessments are underway to support detailed design and a planning application in 2021.

**Figure 4: an aerial view of The Moors at Arne**

## How these measures were implemented and the main outcomes achieved

The Flood Risk Regulations (FRR) state that the FRMP must include measures relating to: the prevention of flooding; the protection of individuals, communities, and the environment against the consequences of flooding, and arrangements for forecasting and warning. In order to meet the requirements of the FRR, measures included in the first cycle FRMP were grouped into themed approaches: preventing flooding, protecting against flooding, preparing for flooding, and recovery and review following flooding.

### Measures that have contributed to preventing flooding

11% of completed measures have contributed to the prevention of flooding. For example, the Environment Agency worked with North Somerset Council to develop the Weston Bay Beach and Dune Management Plan. The Plan provides guidance to ensure that the beach and dunes at Weston Bay provide effective flood protection into the future.

## Measures that have contributed to protecting places from flooding

63% of completed measures have helped to protect individuals, communities, and the environment against the consequences of flooding. These measures informed the 2015 - 2021 capital programme. Approximately £190 million was invested in Environment Agency and other RMA projects between 2015 and 2021 in the Devon, Cornwall and Isles of Scilly area. Approximately £180 million was invested in the Environment Agency's Wessex area, which spans both the Severn and South West River Basin Districts.

These projects have significantly increased protection to almost 11,000 homes in the Devon, Cornwall and Isles of Scilly area and 15,468 homes in the Environment Agency's Wessex area, which spans both the Severn and South West River Basin Districts, between 2015-2021. The refurbishment of Padstow tidal defence scheme is an example of this.

### Case Study: Padstow Tidal Defences

The Padstow tidal defences were built over the two winters of 1987 and 1988 to protect the seaside town from a combination of tidal and sewerage flooding.

The gate is operated on behalf of the Environment Agency by Padstow Harbour Commission. It's closed during severe storms, high seas and tidal surges. It's also closed during low tides to maintain the water in the harbour and the walkway across the North and South Piers, providing valuable amenities in Padstow.

The tidal defences have been operating since 1989 and has successfully continued to reduce Padstow from flood risk many times.

During the 2017/18 winter the Environment Agency completed a £850,000 refurbishment project to extend the life of the tidal gate for a further 25 years. The project was funded by the Department for Environment, Food and Rural Affairs (Defra) and the refurbishment was supported by Padstow Harbour Commission.

The project was technically challenging, requiring the gate to be removed for refurbishment. The solution was to float the gate to a suitable location for lifting, with support from specialist diving contractors during the repositioning work.

This project has reduced the flood risk to 28 households and has extended the life of the flood defence scheme by 25 years.

**Figure 5: an image of the Padstow tide gate in operation and contractors during refurbishment project**

In addition, projects have also contributed to the enhancement of 349ha and 221km of waterbody and creation of 531ha and enhancement 900ha of habitat in the Environment Agency Devon, Cornwall and Isles of Scilly area.

## Measures that have supported people to prepare for flooding

22% of completed measures have helped to prepare people for flooding. RMAs have worked in partnership and with communities to ensure that they are more resilient and able to adapt to future flooding. An example of this includes the development of a community flood action plan to increase the Kingsbridge community's resilience to flooding in Devon.

### Case Study: Community Resilience in Kingsbridge, Devon

In response to the flooding in Kingsbridge during the 2012 storms, the community was included in the Defra funded Devon Community Resilience Pathfinder project in 2019. The project comprised of the following partners:

- Devon County Council
- Torbay Council

- Plymouth City Council
- Environment Agency

The project includes the development of a Community Emergency Plan and engagement with the community. This work was supported by Kingsbridge Town Council, South Hams District Council, South West Water, the Environment Agency and the local community. The outcome of the project included:

- Funded community resilience equipment, for example PPE, road signs, sandbags, electronic signage and radios
- Flood Warden Training
- Development of a private flood warning system

The Community Emergency Response Plan was put into practise during the 2014 coastal storms. This ensures the community works closely with emergency responders to effectively manage their own flood risk. The community were also able to improve their coastal flooding forecasting techniques.

## Measures that have supported communities to recover from flooding

2% of the completed measures have helped to support communities to recover from flooding. For example, information collected following the flooding in 2013-14 in Somerset provided evidence to inform Somerset's 20 Year Flood Action Plan and its subsequent reviews (see Section: Somerset Levels & Moors Strategic Area for further information).

## Ongoing measures

In addition to the completed measures, the first cycle FRMP also included ongoing measures that reflect the day to day activities undertaken by RMAs which contribute to managing flood risk. These measures have continued throughout the period 2015-21. For example, RMAs operate and maintain flood risk assets to help protect individuals, communities, and the environment from flooding. Environment Agency flood defences alone reduce the risk to 206,990 properties in Devon, Cornwall and Wessex.

The Environment Agency has continued to issue 4,760 flood alerts and 1,290 warnings and has warned and informed the public of the risk of flooding so that there is time to prepare. The Environment Agency also continues to fulfil its permitting duties and the South West has issued a total of 1,272 permits between 2016 and 2021 (data was unavailable for 2015). In addition to the above, other ongoing measures also include:

- activities that support integrated catchment-based water management
- carrying out our roles as statutory consultee in the planning process
- continuing our modelling programme
- publishing of updates to our flood risk mapping
- monitoring of the coast via the South West Regional Coastal Monitoring Programme

- reservoir management and regulation
- working with and training of flood wardens
- engagement during and after flooding

These activities will continue to be carried out during the second cycle period from 2021-2027.

## Additional measures implemented since 2015

Measures have been implemented which have emerged since the publication of the first cycle FRMP. These include approximately 23 projects in Devon, Cornwall and the Isles of Scilly and 17 projects in Wessex completed by RMAs as part of the six-year capital investment programme.

These projects include a mixture of engineered flood risk management schemes, property flood resilience measures, flood risk management asset capital maintenance and refurbishment.

These projects have significantly reduced flood risk to 3,921 residential properties across the RBD.

An example of these projects is the repair works which were undertaken to Portreath Harbour Wall in 2019. The works cost approximately £840,000. A 23m section of the sea wall was rebuilt after it was damaged during Storm Eleanor in January 2018. This project reduced the flood risk to approximately 54 properties.

## How well these measures have achieved the first cycle FRMP objectives

The FRR require the FRMP to include details of objectives for the purpose of managing flood risk. Measures are used to set out how the objectives will be achieved. First cycle FRMP objectives were grouped into categories:

- social
- economic
- environmental

Information on these objectives can be found in Part B of the first cycle FRMP. Overall, the measures included in the first cycle FRMP have successfully achieved the objectives set out across all categories. This has delivered a great improvement to the social, economic and environmental well-being of the South West River Basin district.

The first cycle FRMP showed which objective category/ies each measure would help to deliver. The following describes measures under the objective category (social, economic and environmental) that they primarily benefit. 5% of the completed measures have contributed to achieving more than one of the objective categories. Due to this, the total of the percentages shown below totals greater than 100%.

## Completed measures contributing towards achieving social objectives

89% of completed measures contributed to achieving social objectives by helping to enhance community preparedness and resilience to flooding. Some of the measures have contributed to working with Local Planning Authorities to ensure that new development does not increase the risk of flooding, and continuing to maintain assets and watercourses to minimise the risk of flooding to people and property.

An example includes the Helston Flood Alleviation Scheme. Engagement with the local community commenced in 2016 and the project was completed in 2021. The project consisted of the construction of new flood walls within Helston Town to manage flood risk from the River Cober and work to the outfall tunnel and flood relief culvert at Loe Bar to manage water levels within Loe Pool. This project reduced flood risk to 47 homes.

## Completed measures contributing towards achieving economic objectives

9% of completed measures contributed to achieving economic objectives by helping to minimise the risk of flooding to transport services, considering the risk of flooding to agricultural land, and ensuring that flood risk management activities do not adversely affect the tourism industry.

An example includes the £1.4 million rock armour protection works carried out by Torbay Council to the cliff at Hollicombe Beach in 2017. By undertaking this work, Torbay Council were able to protect critical infrastructure, including the railway line which links Paignton to the main line to London, and a sewer pipe serving a large area of Torbay.

## Completed measures contributing towards achieving environmental objectives

8% of completed measures contributed to achieving environmental objectives by minimising the negative impacts of flooding to designated nature conservation sites and designated heritage sites. These measures also contributed to achieving Water Framework Directive objectives.

An example of this includes the Environment Agency working in partnership to investigate options to reduce flood risk in Calstock from the Tamar Estuary, whilst also creating new intertidal habitat. The investigation commenced in 2017. Construction is now nearing completion. The Environment Agency has created a habitat area with pools and creeks, which will support biodiversity, absorb carbon, off-set some of the impacts of sea level rise and provide a new amenity asset for the community.

## Case study: Achieving Environmental Objectives: Cannington Flood Defence Scheme

Cannington village in Somerset has experienced a long history of flooding from the Cannington Brook. In November 2012, over 40 properties were flooded twice within a matter of days. In 2017, a £4.5 million partnership project delivered a new flood alleviation channel after the old brook, built in 1984, was deemed unfit to cope with present and future flood flows. The project:

- reduced the overall flood risk to approximately 200 properties in Cannington
- improved the standard of protection to 77 homes and 10 businesses, to protect against a flood that has a 1% chance of occurring in any given year
- significantly reduced the risk of flooding to the A39 (a nationally important road, which serves Hinkley Nuclear New Build)
- decreased the likelihood of sewer flooding in the village centre, leading to health and environmental benefits
- the scheme won a Green Apple award for environmental best practice

In addition to the completed measures, ongoing measures that reflect day to day activities undertaken by RMAs in the period 2015-2021 have contributed to achieving the first cycle FRMP objectives. An example of this includes the expansion of the flood warning service across the South West RBD (see case study below).

## Case Study: Flood Warning Expansion Project (FWEP)

The Flood Warning Expansion Project (FWEP) is a Treasury funded project through Defra, which commenced in April 2019, using £5.15 million to provide a flood warning to all properties at high risk of flooding, by March 2022.

In the South West RBD there are a significant number of properties at high risk of flooding. Devon and Cornwall combined have the highest proportion of high-risk properties in England.

Currently, not all at risk properties can receive a flooding warning. For example, 68% of properties in Devon, Cornwall and the Isles of Scilly receive a flood warning at present. The ambition of FWEP is to deliver flood warnings to all properties at high risk of river and coastal flooding (that currently do not receive any flood warning service).

The Environment Agency is working hard to achieve this through a range of methods. These include:

- Developing innovative monitoring and forecasting techniques that, if sufficiently accurate, could be used to provide communities with timely flood warnings in order to take action prior to a flood. Communities in Wessex include Preston, Larkhall and Cheddar amongst others.
- Expanding the geographical areas which currently receive a flood warning such as Mevagissey in Cornwall and Dawlish located in Devon.

- Identifying and providing the opportunity for other communities to receive flood warnings. This includes remote properties and small, Rapid Response Catchments.
- Increasing flood warning knowledge, data and evidence by installing new monitoring sites across the South West RBD and developing new forecasting models. The equipment will also be more ‘mobile’ so there will be the option of deploying in different locations if the initial installation location proves not to be optimal. At present, new monitoring sites have been installed across the RBD. Examples include Bovey Tracey, Axminster, Rockbeare, Kingsbridge, and Buckfastleigh.

The FWEP is a fantastic foundation to increase the Environment Agency‘s current flood warning service coverage across the South West RBD.

# Second cycle summary of flood risk for the South West RBD

The South West River Basin District (RBD) is composed of a variety of sized communities spread out across river catchments and the coastline, many of which are vulnerable to flooding and coastal change. Both risks to communities are very complex and wide-ranging in their potential impacts which can be felt not only on residential properties, but commercial businesses, public structures and services such as village halls or GP surgeries, transport infrastructure like railway lines and roads, and utility infrastructure such as sewage treatment works.

Across the whole RBD many of these 'assets' fall within the floodplain, and the summary of this information is provided below. However, many of the assets within a floodplain could impact the wider RBD population, such as an electricity substation which serves a whole community, including areas not vulnerable to flooding. There is work being undertaken experimentally within the RBD during the lifetime of this FRMP to try and understand these indirect impacts of a flood which may inform future decision making on delivery of resilience and adaptation to communities across the South West.

Both direct and indirect impacts of flooding and coastal change can also be felt by a community due to damage or loss of sensitive environmental features, designations, or heritage structures. The scale of these assets being at risk is summarised below, however indirect impacts here are also not currently able to be shown due to the lack of data demonstrating the linkages between these issues. The impact of flooding and coastal change on these sites isn't just solely a loss of habitat or footprint of heritage features, many of which are relied upon for the tourist appeal of the South West region, and significantly underpin the local economy.

This section shows a summary of flood risk in the South West RBD in England from:

- rivers and sea
- surface water

The data in Tables 5 to 10 is from the updated flood hazard and risks maps published in December 2019. This data considers the presence and condition of defences. The risk is presented in flood risk likelihood categories. These indicate the chance of flooding in any given year:

- high risk means that each year an area has a chance of flooding of greater than 3.3%
- medium risk means that each year an area has a chance of flooding between 1% and 3.3%
- low risk means that each year an area has a chance of flooding of between 0.1% and 1%
- very low risk means that each year an area has a chance of flooding of less than 0.1%

**Table 5: summary of river and sea flood risk to people in the South West RBD**

| Risk to people | Total in RBD | High risk | Medium risk | Low risk | Very low risk |
|---|---|---|---|---|---|
| Number of people in RBD | 3,675,076 | 31,708 | 86,593 | 165,049 | 9,852 |
| Number of services | 24,768 | 548 | 866 | 1,165 | 80 |

There are 3,675,076 people in the RBD. Of these:

- 7.98% are in areas at risk of flooding from rivers and the sea
- 0.86% are in areas at high risk of flooding

There are 24,768 services in the RBD. Of these:

- 10.73% are in areas at risk of flooding from rivers and the sea
- 2.2% are in areas at high risk

**Table 6: summary of river and sea flood risk to economic activity in the South West RBD**

| Risk to economic activity | Total in RBD | High risk | Medium risk | Low risk | Very low risk |
|---|---|---|---|---|---|
| Number of non-residential properties | 168,330 | 5,281 | 8,686 | 11,087 | 789 |
| Number of airports | 5 | 2 | 0 | 0 | 0 |
| Length of trunk road (kilometres (km)) | 1,831 | 34 | 44 | 39 | 2 |
| Length of railway (km) | 1,049 | 96 | 41 | 71 | 6 |
| Agricultural land (hectares (ha)) | 1,151,764 | 23,838 | 25,465 | 17,551 | 798 |

There are 168,330 non-residential properties in the RBD. Of these:

- 15.35% are in areas at risk of flooding from rivers and the sea
- 3.14% are in areas at high risk of flooding

There are 5 airports in the RBD. Of these:

- 40% are in areas at risk of flooding from rivers and the sea
- 40% are in areas at high risk of flooding

There are 1,831 km of trunk roads in the RBD. Of these:

- 6.5% are in areas at risk of flooding from rivers and the sea
- 1.86% are in areas at high risk of flooding

There are 1,049 km of railways in the RBD. Of these:

- 20.4% are in areas at risk of flooding from rivers and the sea
- 9.15% are in areas at high risk of flooding

There are 1,074,100 hectares of agricultural land in the RBD. Of these:

- 5.87% are in areas at risk of flooding from rivers and the sea
- 2.07% are in areas at high risk of flooding

**Table 7: summary of river and sea flood risk to the natural and historic environment in the South West RBD**

| Risk to the natural and historic environment | Total in RBD | High risk | Medium risk | Low risk | Very low risk |
|---|---|---|---|---|---|
| Number of EU designated bathing waters within 50 metres (m) | 74 | 71 | 0 | 1 | 0 |
| Number of Environmental Permitting Regulations (EPR) installations within 50m | 233 | 18 | 10 | 11 | 1 |
| Area of Special Area of Conservation (SAC) within area (ha) | 224,273 | 3,291 | 964 | 329 | 14 |
| Area of Special Protection Area (SPA) within area (ha) | 78,130 | 6,898 | 3,288 | 1,389 | 46 |
| Area of Ramsar site within area (ha) | 33,492 | 6,663 | 3,260 | 1,411 | 43 |
| Area of World Heritage Site within area (ha) | 24,791 | 594 | 506 | 159 | 9 |
| Area of Site of Special Scientific Interest (SSSI) within area (ha) | 156,345 | 10,726 | 5,411 | 1,874 | 62 |
| Area of parks and gardens within area (ha) | 20,182 | 679 | 433 | 66 | 1 |

| Risk to the natural and historic environment | Total in RBD | High risk | Medium risk | Low risk | Very low risk |
|---|---|---|---|---|---|
| Area of scheduled ancient monument within area (ha) | 224,273 | 3,291 | 964 | 329 | 14 |
| Number of listed buildings within area | 58,756 | 2117 | 2551 | 1652 | 168 |
| Number of licensed water abstractions within the area | 3554 | 603 | 190 | 52 | 2 |

There are 74 EU designated bathing waters in this RBD. Of these:

- 97.3% are in areas at risk of river and sea flooding
- 97.95% are in areas at high risk of flooding

There are 233 Environmental Permitting Regulations (EPR) installations in the RBD. Of these:

- 21% are in areas at risk of river and sea flooding
- 7.8% are in areas at high risk of flooding

There are 224,273 hectares of Special Area of Conservation (SAC) in the RBD. Of these:

- 2.05% are in areas at risk of flooding from rivers and the sea
- 1.47% are in areas at high risk of flooding

There are 78,130 hectares of Special Protection Area (SPA) in the RBD. Of these:

- 14.9% are in areas at risk of flooding from rivers and the sea
- 8.83% are in areas at high risk of flooding

There are 33,492 hectares of Ramsar sites in the RBD. Of these:

- 33.97% are in areas at risk of flooding from rivers and the sea
- 19.89% are in areas at high risk of flooding

There are 24,791 hectares of World Heritage Site in the RBD. Of these:

- 5.11% are in areas at risk of flooding from rivers and the sea
- 2.4% are in areas at high risk of flooding

There are 156,345 hectares of Site of Special Scientific Interest (SSSI) in the RBD. Of these:

- 11.56% are in areas at risk of flooding from rivers and the sea
- 6.86% are in areas at high risk of flooding

There are 20,182 hectares of parks and gardens in the RBD. Of these:

- 5.84% are in areas at risk of flooding from rivers and the sea
- 3.36% are in areas at high risk of flooding

There are 224,273 hectares of scheduled ancient monument in the RBD. Of these:

- 2.05% are in areas at risk of flooding from rivers and the sea
- 1.46% are in areas at high risk of flooding

There are 58,756 listed buildings in the RBD. Of these:

- 11.04% are in areas at risk of flooding from rivers and the sea
- 3.6% are in areas at high risk of flooding

There are 3554 licensed water abstractions in the RBD. Of these:

- 23.8% are in areas at risk of flooding from rivers and the sea
- 16.97% are in areas at high risk of flooding

**Table 8: summary of surface water flood risk to people in the South West RBD**

| Risk to people | Total in RBD | High risk | Medium risk | Low risk |
|---|---|---|---|---|
| Number of people in RBD | 3,675,076 | 26,736 | 42,978 | 199,180 |
| Number of services | 24,768 | 158 | 215 | 942 |

Of the 3,675,076 people in the RBD:

- 7.32% are in areas at risk of flooding from surface water
- 0.73% are in areas at high risk of flooding

Of the 24,768 services in the RBD:

- 5.3% are in areas at risk of flooding from surface water
- 6.38% are in areas at high risk

**Table 9: summary of surface water flood risk to economic activity in the South West RBD**

| Risk to economic activity | Total in RBD | High risk | Medium risk | Low risk |
|---|---|---|---|---|
| Number of non-residential properties | 168,330 | 3,121 | 3,624 | 14,003 |
| Number of airports | 5 | 4 | 0 | 1 |
| Length of trunk road (kilometres (km)) | 1,831 | 49 | 52 | 185 |

| Risk to economic activity | Total in RBD | High risk | Medium risk | Low risk |
|---|---|---|---|---|
| Length of railway (km) | 1,049 | 43 | 36 | 109 |
| Agricultural land (hectares (ha)) | 1,151,764 | 12,441 | 8,042 | 33,392 |

Of the 178,855 non-residential properties in the RBD:

- 12.33% are in areas at risk of flooding from surface water
- 1.85% are in areas at high risk of flooding

Of the 5 airports in the RBD:

- 100% are in areas at risk of flooding from surface water
- 80% are in areas at high risk of flooding

Of the 1,831 km of trunk roads in the RBD:

- 15.6% are in areas at risk of flooding from surface water
- 2.67% are in areas at high risk of flooding

Of the 1,049 km of railways in the RBD:

- 17.9% are in areas at risk of flooding from surface water
- 4.09% are in areas at high risk of flooding

Of the 1,151,764 hectares of agricultural land in the RBD:

- 4.68% are in areas at risk of flooding from surface water
- 1.08% are in areas at high risk of flooding

**Table 10: summary of surface water flood risk to the natural and historic environment in the South West RBD**

| Risk to the natural and historic environment | Total in RBD | High risk | Medium risk | Low risk |
|---|---|---|---|---|
| Number of EU designated bathing waters within 50 metres (m) | 74 | 22 | 10 | 12 |
| Number of Environmental Permitting Regulations (EPR) installations within 50m | 233 | 82 | 34 | 53 |
| Area of Special Area of Conservation (SAC) within area (ha) | 224,273 | 1,437 | 826 | 3,418 |

| Risk to the natural and historic environment | Total in RBD | High risk | Medium risk | Low risk |
|---|---|---|---|---|
| Area of Special Protection Area (SPA) within area (ha) | 78,130 | 444 | 384 | 1,964 |
| Area of Ramsar site within area (ha) | 33,492 | 418 | 340 | 1,689 |
| Area of World Heritage Site within area (ha) | 24,791 | 238 | 161 | 536 |
| Area of Site of Special Scientific Interest (SSSI) within area (ha) | 156,345 | 2,324 | 1,437 | 5,795 |
| Area of parks and gardens within area (ha) | 20,182 | 362 | 185 | 683 |
| Area of scheduled ancient monument within area (ha) | 224,273 | 1,437 | 826 | 3,418 |
| Number of listed buildings within area | 58,756 | 983 | 495 | 1,854 |
| Number of licensed water abstractions within the area | 3554 | 297 | 96 | 465 |

Of the 74 EU designated bathing waters in this RBD:

- 59.46% are in areas at risk of surface water flooding
- 29.73% are in areas at high risk of flooding

Of the 233 Environmental Permitting Regulations (EPR) installations in the RBD:

- 72.53% are in areas at risk of surface water flooding
- 35.19% are in areas at high risk of flooding

Of the 224,273 hectares of Special Area of Conservation (SAC) in the RBD:

- 2.33% are in areas at risk of flooding from surface water
- 0.5% are in areas at high risk of flooding

Of the 78,130 hectares of Special Protection Area (SPA) in the RBD:

- 3.57% are in areas at risk of flooding from surface water
- 0.57% are in areas at high risk of flooding

Of the 33,492 hectares of Ramsar sites in the RBD:

- 7.3% are in areas at risk of flooding from surface water
- 1.25% are in areas at high risk of flooding

Of the 24,791 hectares of World Heritage Site in the RBD:

- 3.77% are in areas at risk of flooding from surface water
- 0.96% are in areas at high risk of flooding

Of the 156,345 hectares of Site of Special Scientific Interest (SSSI) in the RBD:

- 6.11% are in areas at risk of flooding from surface water
- 1.49% are in areas at high risk of flooding

Of the 20,182 hectares of parks and gardens in the RBD:

- 6.09% are in areas at risk of flooding from surface water
- 1.79% are in areas at high risk of flooding

Of the 224,273 hectares of scheduled ancient monument in the RBD:

- 2.5% are in areas at risk of flooding from surface water
- 0.64% are in areas at high risk of flooding

Of the 58,756 listed buildings in the RBD:

- 5.67% are in areas at risk of flooding from surface water
- 1.67% are in areas at high risk of flooding

Of the 3,554 licensed water abstractions in the RBD:

- 24.1% are in areas at risk of flooding from surface water
- 8.36% are in areas at high risk of flooding

It should be noted that some of the environmentally designated sites at risk within the RBD are reliant to some degree on flooding. It's needed to maintain their interest features.

# Second cycle objectives and measures

A full list of the objectives are in the Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans.

In developing the FRMP, the RMAs have:

- drawn **conclusions** from the hazard and risk maps and other sources of information - this helps us all to understand the risks or opportunities
- **taken account** of the likely impact of climate change on the occurrence of floods
- selected appropriate **objectives** from the national list to reduce the adverse consequences of flooding for human health, economic activity and the environment (including cultural heritage), and reduce the likelihood of flooding
- identified the likely approach (the measures) to achieve these objectives using the categories: **preparing, preventing, protecting** and **recovery and review**

In determining the proposed measures for the FRMP, the RMAs considered several different factors. The main ones are outlined in the Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans.

## Finding the second cycle measures

For this second cycle of flood risk management planning, the Environment Agency has developed a new interactive mapping tool called Flood Plan Explorer. You can use Flood Plan Explorer to discover information about all the measures proposed as part of this plan. This information mainly includes:

- where the measure is
- a description of the measure and what it's aiming to achieve
- which objectives the measure will help to achieve
- who is responsible for implementing the measure
- when the measure is planned to be implemented

## National level objectives and measures

There are a number of measures which are applicable to every FRA in England. The Environment Agency will seek to implement these national-level measures as part of its routine day-to-day work as a risk management authority. The Environment Agency is responsible for the national level measures that apply to every FRA for main rivers and the sea.

LLFAs are responsible for the national level measures that apply to every FRA for surface water. Some of these measures are statutory (the work is required by law), and others are optional. LLFAs implement their day-to-day work in different ways depending on local priorities and resources. You should look at LLFA websites and their local flood risk management strategies for more information on how they carry out their day-to-day work.

You can find information about each of these measures in the interactive mapping tool - Flood Plan Explorer.

## The South West RBD level objectives and measures

92 measures have been developed which apply specifically to:

- The whole South West RBD
- Large inland or coastal areas of the South West RBD

This is 23% of the total number of measures in the second cycle Flood Risk Management Plan. These measures have been developed in addition to measures which cover other spatial scales.

You can find information about each of these measures in the interactive mapping tool - Flood Plan Explorer.

## The South West RBD management catchment level objectives and measures

As described in the section: Introduction to the FRMP, measures have been developed that apply specifically to places within the 9 management catchments in the South West River Basin District (RBD).

168 measures have been developed which apply specifically to places within each of the management catchments in the South West RBD or the whole of a management catchment within the South West RBD. This is equivalent to 42% of the FRMP measures. These management catchments are:

- South and West Somerset
- Avon Hampshire
- Dorset
- North Devon
- East Devon
- South Devon
- Tamar
- North Cornwall, Seaton, Looe and Fowey
- West Cornwall and the Fal – including the Isles of Scilly

These measures have been developed in addition to measures which cover other spatial scales. You can view the locations of these management catchments and all the measures in the South West RBD in the Flood Plan Explorer, an interactive mapping tool.

## Flood Risk Area measures

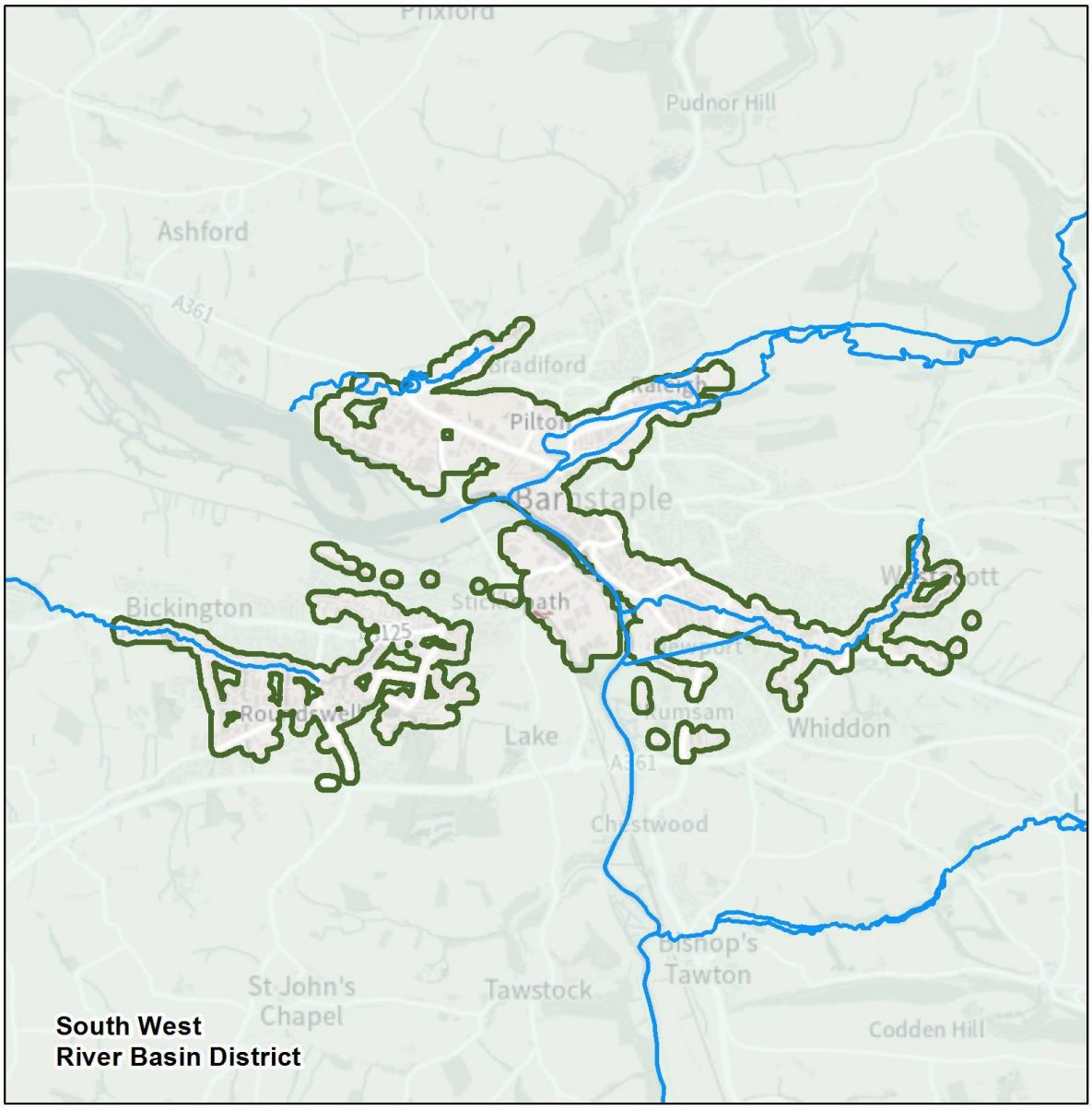
There are 134 measures applicable to managing flood risk in the nationally identified Flood Risk Areas (FRAs) in the South West River Basin District (RBD). This is 34% of the total number of measures in this Flood Risk Management Plan (FRMP). The full list of FRAs in the South West RBD can be found in the introduction of this plan. More information on how FRAs were identified can be found in the Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans. The FRAs are described below.

In addition to the measures developed for the FRAs, measures have also been produced for:

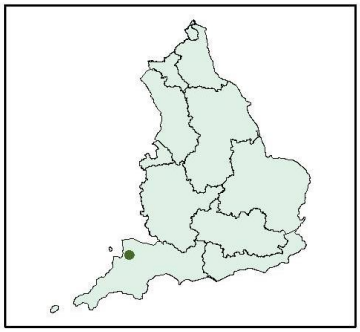
- Strategic Areas within the RBD (see Section: Somerset Levels and Moors Strategic Area)
- areas that fall wholly within Management Catchments (see section: The South West RBD management catchment level objectives and measures)

- areas that span across or cover more than one Management Catchment (see Section: The South West RBD level objectives and measures)
- As described in the Section: Contributors to the FRMP, in Dorset and Wiltshire, there were no FRAs identified. Therefore, the measures for these areas are captured at a Management Catchment level. Information on how FRAs were identified can be found in Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans

# The Barnstaple Rivers and Sea Flood Risk Area




Flood Risk Area: Barnstaple, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

Kilometres
0 1 2 3



**Figure 6: a map showing the boundary of the Barnstaple Flood Risk Area**

## Introduction to the Barnstaple Flood Risk Area

The Barnstaple Flood Risk Area (FRA) is located on the northern coast of Devon. The River Taw and its tributaries conveys water from parts of the North Devon Catchment through the Barnstaple FRA to the Taw Estuary and directly out to sea.

The FRA comprises of several urban communities, including:

- Barnstaple
- Bradiford
- Roundswell
- Bickington

The Barnstaple FRA is a mixture of residential and commercial properties. Much of the town is on the east side of the estuary, connected to the western side by the ancient Barnstaple Long Bridge.

The Barnstaple FRA is surrounded by green space of mainly farmland and the intertidal habitat of the River Taw Estuary.

The Barnstaple FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and implementation of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority, whose remit includes flood risk from surface water and ordinary watercourses.

South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. North Devon District Council are the Local Planning Authority, whose remit includes ordinary watercourses, planning and the Coastal Protection Authority.

## Hydrology and geology of the catchment

The River Taw catchment extends from North Tawton in the south to Barnstaple and Braunton in the north and includes major tributaries, such as the rivers Mole and Bray. The rivers Yeo (Barnstaple) and Caen also form part of the Taw catchment and drain directly to the Taw estuary. Other watercourses drain smaller more local areas to the north and south of the River Taw into the FRA. These are:

- Bradiford Water
- Coney Gut
- Lake and Rumsum

The River Taw catchment is characterised by carboniferous and Devonian rocks which are of low permeability and porosity. The impermeable geology of the River Taw’s headwaters

on Dartmoor, and the low permeability of the Devonian and carboniferous rocks means that much of the catchment will respond rapidly to any rainfall.

In the River Taw catchment, the soil structure and land use mean that the potential for transporting sediment is moderate to high. Both the middle and upper reaches of the Taw catchment display areas where the river channel is buffered by agricultural land without any riverside vegetation. This means there is a high chance of bank erosion and subsequent transportation of sediment. The Taw estuary forms one of the major sediment sinks of the North Devon catchment.

## Environmental designations

Environmental designations located within the Barnstaple FRA include:

- Fremington Claypit Site of Special Scientific Interest (SSSI)
- Fremington Quay Cliffs SSSI
- Bradiford Valley SSSI

The Taw-Torridge Estuary SSSI are located within 1km of the Barnstaple FRA. The Barnstaple FRA is also located within the buffer zone of the North Devon Biosphere Reserve.

Numerous listed buildings are located within the Barnstaple FRA including:

- Long Bridge
- Castle Quay
- Queen Annes Walk
- Castle Chambers

A Scheduled Ancient Monument, Barnstaple Castle, falls within the Barnstaple FRA. There are also Conservation Areas within the Barnstaple FRA.

## Flood risk sources

Fluvial and tidal, from the tidal stretches of the larger rivers, are the greatest sources of flood risk to the Barnstaple FRA. Much of the infrastructure within the FRA is located immediately behind defences, with both residential and commercial properties extending landwards beyond the tidal strip, with some properties built below tide levels. Therefore, periods of high tide coinciding with heavy rainfall and high fluvial flows on the Rivers Yeo and Taw can result in river flows backing up (known as tide locking) and surface water flooding. The tidal limit on the River Taw is at Newbridge Causeway which is approximately 3.5km, upstream of Barnstaple town centre. The risk of flooding on all watercourses within the FRA can be affected by high tides. Climate change and sea level rise will result in more frequent and rapid onset of flooding in the future but will not significantly increase areas of Barnstaple at risk due to local geography.

The Barnstaple FRA is also susceptible to flooding from surface water and sewers during high rainfall events. This is due to the heavily urbanised nature of the area and ageing

drainage infrastructure. Additional surface water inputs to combined sewers, as well as becoming tide locked in frequent tidal conditions, result in increased levels of risk to some areas of the community, as seen in the recent flooding which occurred in 2020.

Flood risk from new development pressures within the Barnstaple FRA is managed through the designation of the two Critical Drainage Areas (CDA). A CDA is an area that has critical drainage problems, and which has been notified to the local planning authority as such by the Environment Agency in line with the National Planning Policy Framework (NPPF). In these locations, there is a need for surface water to be managed to a higher standard than normal to ensure any new development will contribute to a reduction in flooding risks in line with NPPF. These higher standards are determined by the Environment Agency.

## Current flood risk

The Barnstaple Flood Risk Area (FRA) has a long history of flooding with notable events in the:

- the 1960s
- the 1980s
- 1996
- 2000
- 2012
- the winter of 2013/2014

Since the production of the first cycle Flood Risk Management Plans in 2015, there have been 2 recorded flood events in key locations caused by a combination of sources in the in the Barnstaple FRA.

In November 2016, properties in the Signal Terrace, Clifton Terrace and the Sherratts Oak area flooded. The River Yeo is thought to be the source of this event.

In August 2020 the Barnstaple FRA was also affected by flash flooding, where roads and 165 properties were flooded. This flood event was caused because of high intensity rainfall that was localised over the town of Barnstaple. This created significant volumes of surface water that overwhelmed the drainage systems to the extent that they were unable to function effectively.

The flood hazard and risk maps show that in the Barnstaple FRA, 6,202 people live in areas at risk of flooding from rivers and the sea. Of these people, 7.3% live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 791 non-residential properties - including hospitals, schools and colleges and public utilities (such as Barnstaple’s electricity substation and telecommunication exchange)
- 0.24km of roads

- 0.53km of railway
- 4.1ha of agricultural land
- areas of designated environmental sites
- 140 listed buildings
- scheduled ancient monuments
- licensed water abstraction and discharge points

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Barnstaple FRA.

Given the scale and significance of flood risk in the Barnstaple FRA, measures are being taken to increase community resilience to flooding and coastal change.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. For example:

- Devon County Council
- South West Water
- North Devon District Council
- the North Devon Catchment Partnership

The Devon Flood and Water Management Group which comprises of all the local RMAs and key partners meet regularly to discuss:

- work programmes
- topical flood resilience matters
- resolve any operational issues across Devon

Barnstaple Town Council meet to discuss emergency planning and are currently developing their Community Emergency Plan in collaboration with Devon Communities Together and Devon Community Resilience Forum.

## Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service
- raising public awareness with associated campaigns

Increasing flood resilience where possible is important as building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them

with a flood warning service allows us to reduce the risk to life and property even if defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Barnstaple Flood Risk Area (FRA) that monitor:

- tide levels
- river levels
- river flow
- rainfall

The tide levels are forecast from Ilfracombe and estuary levels are also monitored at Castle Quay within Barnstaple. River levels are monitored upstream of the FRA at three key locations to provide forecasts of flood risk in the catchments. River levels are also monitored at three trash screens in the FRA, Coney Gut. River flow is monitored at Collard's Bridge on the Yeo. Rainfall is monitored by four telemetered rain gauges in the catchment, the nearest to Barnstaple being Wistlandpound which is approximately 13km from the FRA. There are also seventeen manually read daily gauges in the catchment that can be used to validate forecasts and identify longer term rainfall trends.

The information collected from these monitoring sites are used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents. Our Flood Warning service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea. There is one coastal flood alert area and two coastal flood warning areas that cover the Barnstaple FRA. There are 2 fluvial flood alert areas and three fluvial flood warning areas that cover the Barnstaple FRA.

As part of the Flood Warning Expansion Project a new warning service is being developed for the Coney Gut. Further engagement is planned to start during 2021/22 to:

- raise flood awareness and understanding
- support community resilience efforts at Barnstaple
- promote the launch of this new Flood Warning Service

The aim is to ensure the community knows how to:

- respond to flood warnings
- stay safe
- minimise damage

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic and forecast modelling. Hydraulic models are used to assess:

- current flood risk

- impacts of climate change
- how future levels of flood risk could be managed

In 2010, the Barnstaple 2D Modelling and Mapping study was undertaken to model the Taw Estuary and its tributaries in the Barnstaple area to gain a better understanding of the flood mechanisms and flood risk.

In 2015, the Barnstaple 2D Modelling and Mapping study was updated and used to inform the Barnstaple Flood Defence Improvements Strategy.

In 2020, the Taw-Torridge mapping and modelling study was commissioned to update the existing models within the Taw and Torridge estuaries and coastline to bring them in line with current climate change projections and forecasting standards. The 2015 Barnstaple hydraulic model is one of the models to be updated. Once this study has been completed, the outputs from the model will be used to identify climate change impacts in the Barnstaple FRA and test potential options for future development and flood risk management activities.

There are two forecasting models in the Barnstaple FRA, these cover the River Yeo and River Taw. These forecasting models will also be updated as part of the Taw-Torridge mapping and modelling study. Forecasting models are used to determine potential impacts from heavy rainfall or high tide events and inform the incident response activities of RMAs and professional partner organisations to reduce risk to communities.

Flood risk maps are published based on the outputs from the hydraulic modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

## Flood Alleviation Schemes

In 1984, the Barnstaple Flood Defence Scheme was built. This scheme comprises embankments, revetments and masonry walls along the River Taw and Yeo.

The Coney Gut flood scheme was also built in the 80s/90s to deal with fluvial flooding and tidal locking in the Portmarsh area.

Flooding in the 1990s led to the construction of the Bradiford Water flood defence scheme. This includes debris screen and a bypass channel which reduce the risk of blockages under structures in the village, and direct high flows out to the Taw Estuary through a lower risk route respectively.

The first phase of the Anchorwood and Severn Brethren flood defence scheme has been upgraded to facilitate redevelopment; it included the raising of land to enable development of new housing and retail outlets and a supermarket, and the improvement of existing flood defences to a higher standard along the tidal River Taw. The second phase is in

development at present and will continue the defences around the remainder of the commercial area and sports centre to tie defences back into higher ground adjacent to the railway line. This approach has left a legacy of flood risk assets of variable effectiveness and residual life, however there is a short to medium term plan that will remedy these issues once phase 2 has been implemented.

In 2005, improvement works were undertaken to the raised walls along the Barnstaple Yeo. In 2006, a refurbishment of the Coney Gut Outfall was completed to improve operational conditions.

In 2015, the Environment Agency worked in partnership with Devon County Council and North Devon District Council to publish the Barnstaple Flood Defence Improvements Study. This study looked to assess current flood risk, impacts of climate change, the condition and performance of existing flood risk management assets and how future levels of flood risk could be managed. It has been recognised that a long-term flood defence improvement strategy is required to help facilitate housing and employment growth and mitigate climate change within the Barnstaple Flood Risk Area. Options for flood risk management in Barnstaple are currently being assessed as part of the Environment Agency's 6-year investment programme in partnership with North Devon District Council. This will ensure that growth and regeneration opportunities in Barnstaple are aligned with delivering flood risk management activities.

A strategy for long-term shoreline management is in development by Devon County Council and the Environment Agency. Upon completion this will be adopted to increase resilience of vulnerable areas and infrastructure from flooding and erosion while enabling regeneration and growth, and where required promote adaptation of development away from unsustainable locations.

Devon County Council are currently investigating potential opportunities to reduce risk to surface water flood risk.

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Barnstaple Flood Risk Area (FRA). Rainfall intensity is expected to increase in the future and cause higher river flows and levels. Sea levels are also expected to rise. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often. This means that flooding from rivers and the sea will become more frequent.

Sea level rise and increased wave heights will likely lead to overtopping of existing defences and subsequent coastal flooding to occur more frequently. Annual tidal flooding on the Taw and Yeo is expected by 2050, particularly at Pilton and the Portmarsh area. The current approach to managing tidal flood risk in the Barnstaple FRA is to maintain the existing defences through repairs to prolong their life until the 2040s, and to then investigate the need for further improvements prior to 2050. Predicted increase in estuary

levels will result in a loss of inter-tidal habitat meaning any future improvements may have a requirement to create habitat to offset these losses.

Climate Change predictions indicate that rainfall intensity is expected to increase in future causing higher river flows and levels. This means that flooding from rivers will become more frequent. Tide locking impacts from the River Yeo are expected by 2050. Tidal locking is expected to occur more frequently on the River Yeo. When high tides coincide with high river flow events, it's anticipated that overtopping will occur at Pilton Park. This will subsequently increase the frequency of travel disruptions on Braunton Road, and flooding of the Newport area. The Bradiford Water and Coney Gut are heavily modified watercourses. Currently, there are no options to increase the capacity of these watercourses. Therefore, increased localised flooding impacts are expected in these areas.

Climate change predictions anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Due to the low lying and heavily urbanised nature of the Barnstaple FRA, increased rainfall is expected to frequently overload the ageing drainage infrastructure. Furthermore, high rainfall events coinciding with high tides will cause more frequent tide locking around the Town Square, Mill Road, Newport areas. This will impact transport links between South Barnstaple and North Barnstaple by the Long Bridge. To support in the management of this increased risk from surface water, new development within the Barnstaple FRA is managed through the designation of a Critical Drainage Area (CDA).

Devon County Council plan to review the surface water risks and are planning to carry out improvements between 2021 and 2027, and South West Water have reviewed their assets within the FRA and associated risks to determine what actions will be required address climate change. North Devon District Council is working in partnership with the Environment Agency to ensure any new development in the flood zone is compatible with the increased risk from climate change.

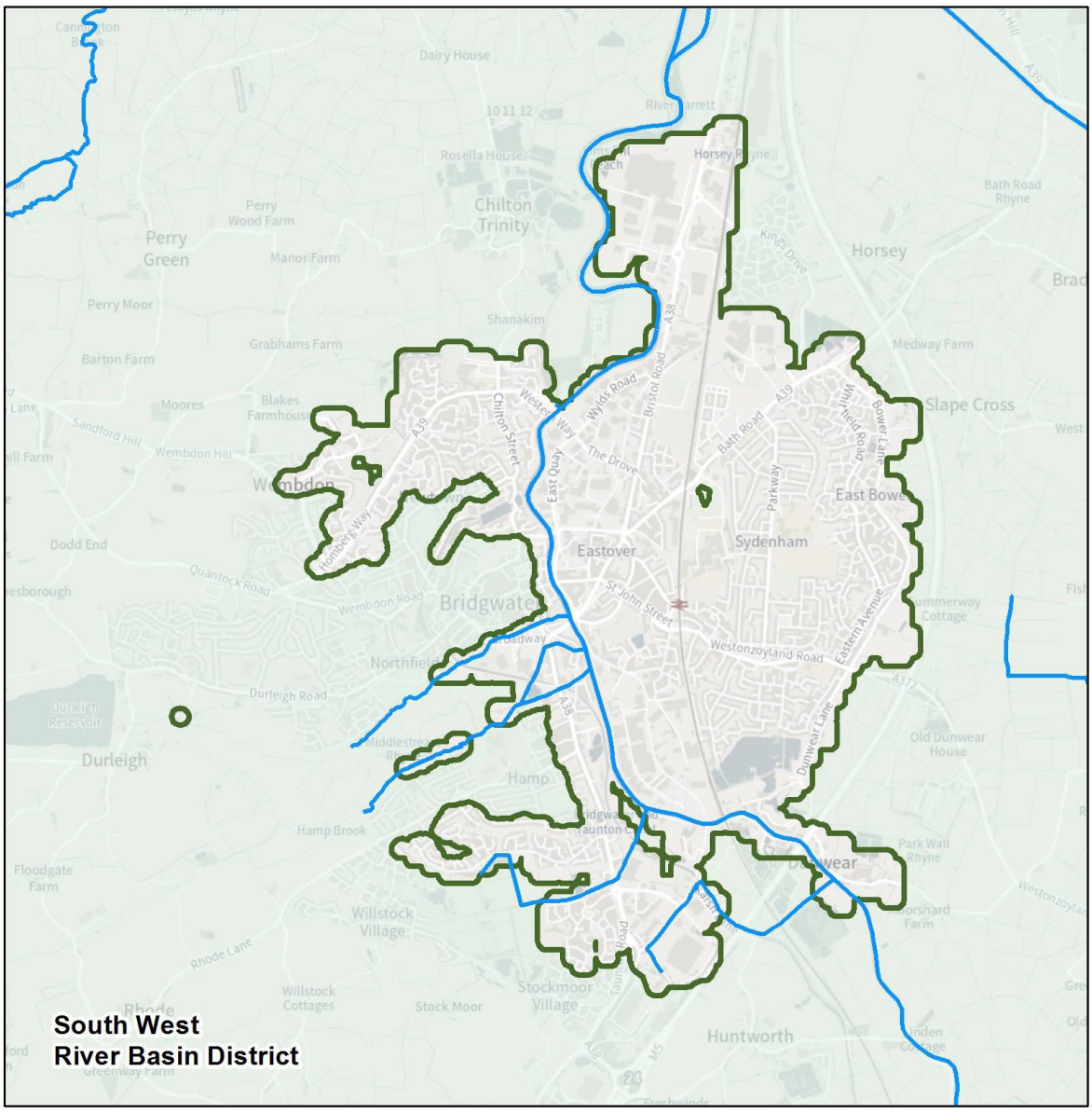
Please refer to the Climate change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South-West River Basin District.

## Objectives and measures for the Barnstaple Flood Risk Area

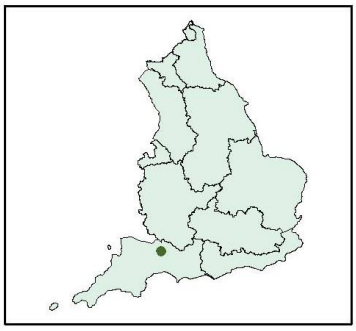
Measures have been developed that apply specifically to the Barnstaple FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Barnstaple FRA.

You can find information about all the measures that apply to the Barnstaple FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Bridgwater Rivers and Sea Flood Risk Area




Flood Risk Area: Bridgwater, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

0 1 2 3 Kilometres



**Figure 7: a map showing the boundary of the Bridgwater Flood Risk Area**

## Introduction to the Bridgwater Flood Risk Area

The Bridgwater Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Somerset County Council is the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Sedgemoor District Council hold the role of Coast Protection Authority (CPA). The council is responsible for the coastal frontage, as well as being a Risk Management Authority (RMA) for ordinary watercourses in support of the LLFA. Sedgemoor District Council is also the Local Planning Authority.

Somerset Drainage Boards Consortium is the Internal Drainage Board (IDB) responsible for land drainage and flood defence works on the local rhyne network. The IDB lead on ordinary watercourse matters within a LLFA area.

Wessex Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

Bridgwater is a large industrial town on the estuary of the River Parrett, situated below high tide level. The River Parrett runs through Bridgwater draining the extensive lowland area of the Somerset Levels and Moors. The river is tidally influenced and protected by raised flood defences.

Several smaller fluvial watercourses drain into the River Parrett at Bridgwater. This includes the:

- River Hamp
- Durleigh River
- Huntworth Business Park Rhyne
- Reedmoor Rhyne
- Stockmoor Rhyne

The Bridgwater & Taunton Canal (24.6km) flows from the River Tone at Firepool Lock in Taunton, into Bridgwater where a weir allows excess water to run into the tidal River Parrett. This canal ends at Bridgwater Docks.

The King Sedgemoor Drain lies just to the north of the FRA, which also drains the Somerset Levels and Moors into the River Parrett at Dunball.

Located north of the Bridgwater FRA are the Bridgwater Bay and Severn Estuary Special Scientific Interest (SSSI), along with the Severn Estuary Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar Site.

## Current flood risk

In November 2011, a section of wall collapsed at West Quay in Bridgwater without warning. This left part of the town was vulnerable to tidal flooding until the wall reconstruction was completed in June 2013.

Areas to the south-west of the FRA area were affected by the Somerset Levels and Moors flooding in 2013 to 2014. Within Bridgwater, a very high water level was recorded on 3 January 2014. This happened when a tidal surge event resulted in water levels within 200mm of the crest level of the flood defences.

The FRA is susceptible to flooding from the sea during times of high spring tides. A tidal surge barrier is currently proposed within Bridgwater to provide flood protection to the FRA. Please see further information in section below.

The flood hazard and risk maps show that in the Bridgwater FRA, 29,258 people live in areas at risk of flooding from rivers and the sea. Of these people, 0.2% live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 1,352 non-residential properties - including hospitals, schools and colleges and public utilities
- 0.35km of roads - including parts of the trunk road network
- 4km of railway
- 66 listed buildings
- 255.57ha of agricultural land
- 2 environmental permitting regulatory sites
- 1 licensed water abstraction site

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Bridgwater FRA.

Based on this information, Risk Management Authorities have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other RMAs and other stakeholders. This includes:

- Somerset County Council (LLFA)
- Sedgemoor District Council (CPA)
- Somerset Drainage Boards Consortium (IDB)
- Somerset Rivers Authority
- Wessex Water

The Somerset Rivers Authority (SRA) was set up in 2015 following the flooding of the Somerset Levels and Moors in 2013/14 as a partnership of the local flood RMAs. The SRA oversees the 'Somerset Levels and Moors 20 Year Flood Action Plan'. This includes additional flood risk mitigation works for Somerset that cannot be delivered under the remits of other RMAs.

Somerset County Council co-ordinates regular Operational Flood Group and Strategic Flood Management Board meetings for RMAs to:

- resolve operational issues
- discuss work programmes
- identify opportunities to work in partnership

The Environment Agency monitors river and rainfall conditions at 7 sites in and immediately adjacent to the FRA. We collect data on:

- river levels
- river flows
- rainfall

This information is used to inform activities related to 6 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur.

The water level and flow information are also used to inform and calibrate mathematical modelling of the river network. The tributaries that drain into the River Parrett within Bridgwater have all been modelled to assess their fluvial impacts.

Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and businesses of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

Throughout the FRA, the Environment Agency maintain flood risk management assets, such as:

- river channels
- flood defence walls
- embankments

Similarly, Somerset County Council, Sedgemoor District Council, the IDB and Wessex Water maintain assets that perform a flood risk management function on the drainage network.

## The impact of climate change and future flood risk

Rainfall intensity is expected to increase in the future, causing higher river flows and levels. Sea levels are also expected to rise. This means that flooding from rivers and the sea will become more frequent.

One of the projects within the Bridgwater FRA is the 'Bridgwater Tidal Barrier' scheme. It's a partnership project with Sedgemoor District Council to reduce tidal flood risk from the River Parrett to 11,300 homes, 1,500 businesses and critical, local infrastructure.

The scheme comprises of a tidal surge barrier located at Express Park across the River Parrett and associated downstream defence improvements. 12 fish passes within the local area are also being improved as part of the project. The detailed design phase for the scheme is due to commence in 2021.

The 'Bridgwater Tidal Barrier' scheme is a key element of current RMA plans and policies, including the:

- 'Parrett Estuary Flood Risk Management Strategy' (2010)
- 'Somerset Levels and Moors Flood Action Plan' (2014)
- 'Sedgemoor District Council's Local Plan' (2011-2032)

Please refer to section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the Bridgwater FRA

Measures have been developed that apply specifically to the Bridgwater FRA. These measures have been developed in addition to those covering a wider geographic area, which also apply to the FRA.

You can find information about all the measures that apply to the Bridgwater FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Burnham-on-Sea Rivers and Sea Flood Risk Area

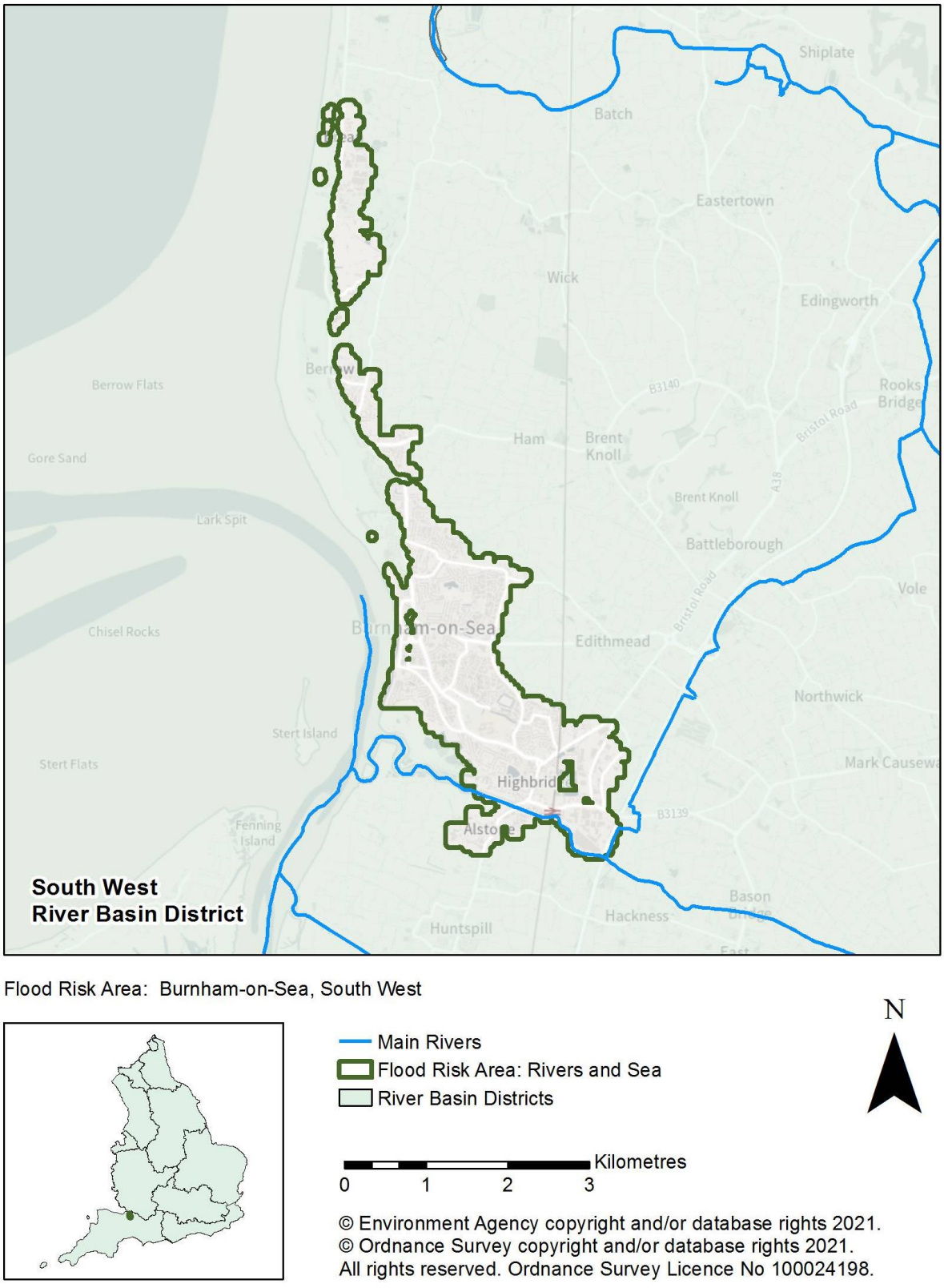



**Figure 8: a map showing the boundary of the Burnham-on-Sea Flood Risk Area**

## Introduction to the Burnham-on-Sea Flood Risk Area

The Burnham-on-Sea Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Somerset County Council is the Lead Local Flood Authority (LLFA) whose remit includes flood risk from:

- surface water
- groundwater
- ordinary watercourses

Sedgemoor District Council is the Coastal Protection Authority whose remit includes coastal erosion and protection. They're also the Local Planning Authority for this FRA.

Somerset Drainage Boards Consortium is the Internal Drainage Board (IDB) who are responsible for land drainage and flood defence works on the local rhyne network. The IDB lead on ordinary watercourse matters within an LLFA area.

Wessex Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

Burnham-on-Sea is a seaside town lying within Bridgwater Bay, Somerset, along the Severn Estuary. It's a popular recreation and tourist destination, attracting visitors for a range of activities, such as dog walking and horse riding. Behind the beach front, there are 5 large caravan sites at:

- Brean
- Berrow
- Burnham-on-Sea

Located within the Burnham-on-Sea FRA are the Bridgwater Bay and Berrow Dunes Sites of Special Scientific Interest (SSSI) and the Severn Estuary Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar Site.

Several Local Wildlife Sites are also located in the FRA, including:

- Apex Gardens
- St Christophers Playing Field
- River Brue and Highbridge Pits
- Brean Dunes

The FRA is susceptible to flooding from the sea during times of high spring tides.

## Current flood risk

Burnham-on-Sea, Berrow and Brean are protected by a mixture of engineered sea defences and natural, coastal sand dunes. These communities rely on seasonal tourism and many of the caravan and camping sites are located on low-lying land, behind the tidal flood defences.

The coastal risks in the area are varied. Some locations are susceptible to waves, and other parts of the coast are at risk of high tides. These tides wash over the banks and increase the chances of a breach of the defences. The extensive dune area is subject to erosion from storm damage, as experienced by the very high tides of March 2020.

The River Brue runs through Highbridge and outfalls at Highbridge Clyse (sluice) to the River Parrett, which discharges into the sea. The Brue catchment is mostly lowland, wet grassland and forms part of the unique landscape of the Somerset Levels and Moors. The River Brue is a man-made wide, deep channel at Highbridge.

The Highbridge Clyse provides tidal protection to the community. However, the watercourse can become tide locked, especially when high flows move down the catchment from the extensive watercourse network on the Somerset Levels and Moors. The lower reaches of the Parrett are tidal for some 30km. The twice daily tide carries large quantities of silt up the tidal reaches of the Parrett, which can impact the channel management.

The coastal storm of December 1981 impacted much of the Bristol Channel and Severn Estuary, and the coastline between Pawlett and the Axe Banks was greatly affected. Following the storm, several schemes were improved. The Environment Agency is now investigating how sea level rise and increased storminess will impact on the flood defences and natural dunes in the area.

The flood hazard and risk maps show that in the Burnham-on-Sea FRA, 22,117 people live in areas at risk of flooding from rivers and the sea. Of these people, 0.5% live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 600 non-residential properties - including hospitals, schools and colleges and public utilities
- 0.36km of roads - including parts of the trunk road network
- 1.36km of railway
- 292.33ha of agricultural land
- 18 listed buildings and 0.78ha of Scheduled Ancient Monuments
- 1 designated bathing water
- areas of designated environmental sites - including 2.98ha of the Severn Estuary SAC and 3.19ha of the Severn Estuary SPA, Ramsar Site and SSSI

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Burnham-on-Sea FRA.

Based on this information, Risk Management Authorities have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. These include:

- Somerset County Council (LLFA)
- Sedgemoor District Council (Coastal Protection Authority)
- Somerset Drainage Boards Consortium (IDB)
- Somerset Rivers Authority (SRA)
- Wessex Water

Somerset County Council co-ordinate regular Operational Flood Group and Strategic Flood Management Board meetings for RMAs to:

- resolve operational issues
- discuss work programmes
- identify opportunities to work in partnership

The Somerset Rivers Authority (SRA) was set up in 2015 following the flooding of the Somerset Levels and Moors in 2013 to 2014. This was in partnership with the local flood RMAs. The SRA oversees the 'Somerset Levels and Moors 20 Year Flood Action Plan' and additional flood risk mitigation works for Somerset, which cannot be delivered under the remits of other RMAs.

There were 8 schemes delivered in this area following the 1981 storm. The tidal defences between Burnham-on-Sea and Brean Down are currently a mixture of:

- an engineered sea wall
- sand dunes
- rock armour
- various private defences

To date, these schemes have managed the risks well with subsequent storms posing limited spray overtopping issues or episodic erosional impacts.

The Environment Agency is now embarking on a partnership with Sedgemoor District Council to review, remodel and plan future adaption flood and erosion risk projects to meet the future challenges.

Funding for Flood and Coastal Erosion Risk Management (FCERM) capital projects follows the Department for Environment Food and Rural Affairs' 'Partnership Funding policy'. This policy relies on organisations working together to fund and develop FCERM projects in England. Projects progress by building partnerships that support sound

investment choices and secure related funding agreements. These projects are funded in part by government with financial contributions from FCERM Grant in Aid. They offer organisations and communities greater opportunities and incentives to have a financial share in managing risks and a greater say in protecting their local area.

The Environment Agency are developing partnership projects based on the 'North Devon & Somerset Shoreline Management Plan' (SMP). This plan sets out the overarching polices for coastal management, which 'Hold the Line' and 'Managed Realignment' policies dominate. The 'Draft Severn Estuary Flood Risk Management Strategy' (2013) also provides additional information to help us look at the policies from the SMP in more detail, paying particular attention to:

- potential high level scheme options
- funding and benefits
- habitat requirements

The next challenge is to plan for the future. We need to understand how we can work with other RMAs and the wider community to adapt to climate change in a timely manner. This means we need to think big and start our partnerships early. Preliminary discussions between the Environment Agency and Sedgemoor District Council are underway and we are scoping a flood and erosion risk study in partnership to investigate the risks of the future.

The Environment Agency monitors river and rainfall conditions within the FRA. We monitor sea levels from the Hinkley tidal gauge that's within the FRA. This information is used to inform activities related to 4 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur.

This information is also used to inform and calibrate mathematical modelling of the river network. Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and businesses of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

## The impact of climate change and future flood risk

Rainfall intensity is expected to increase in the future, causing higher river flows and levels. Sea levels are also expected to rise. This means that flooding from rivers and the sea will become more frequent.

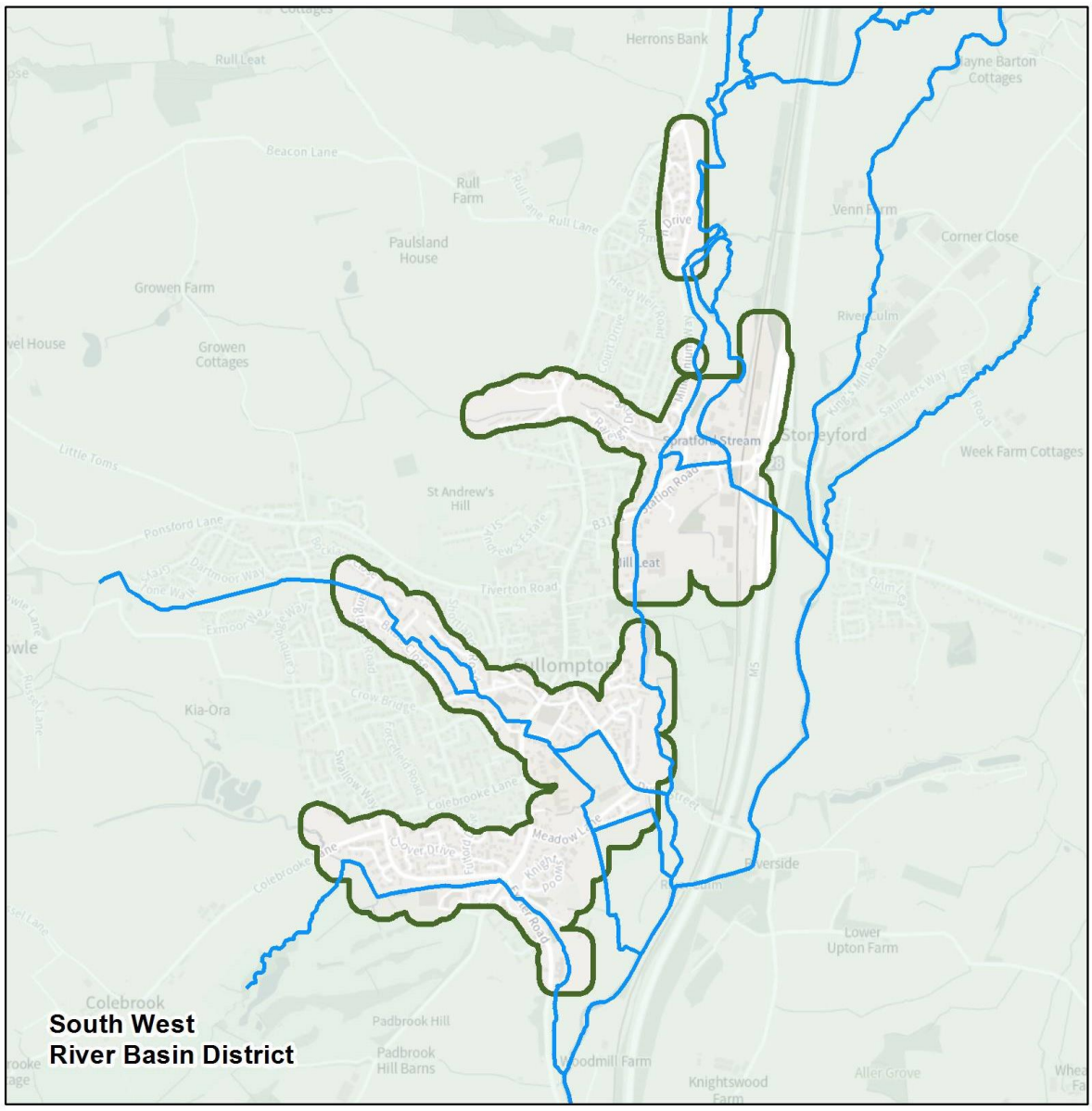
Please refer to the Climate change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the Burnham-on-Sea FRA

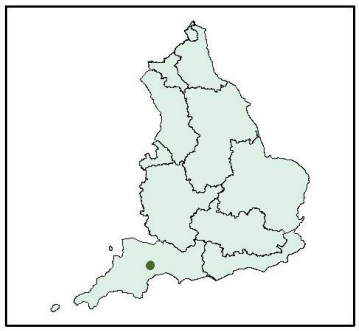
Measures have been developed that apply specifically to the Burnham-on-Sea FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the FRA.

You can find information about all the measures that apply to the Burnham-on-Sea FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Cullompton Rivers and Sea Flood Risk Area




Flood Risk Area: Cullompton, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

0 0.5 1 1.5 Kilometres



**Figure 9: a map showing the boundary of the Cullompton Flood Risk Area**

## Introduction to the Cullompton Flood Risk Area

The Cullompton Flood Risk Area (FRA) is in Mid Devon. It covers many of the urban districts of Cullompton which includes:

- residential properties
- businesses
- amenity areas

It's also surrounded by a gently undulating landscape of green space, mainly used for farming. Cullompton is located on the River Culm and is famous for its working textile and paper mills.

The Cullompton FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority whose remit includes flood risk from surface water and ordinary watercourses and are also the Highway Authority. South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. Mid Devon District Council are both a Risk Management Authority and the Local Planning Authority whose remit includes management of ordinary watercourse flood risks and planning.

## Hydrology and geology of the catchment

Cullompton lies at the confluence of the River Culm and Spratford Stream, both of which drain predominantly poorly draining rural land. Four small fast responding catchments drain waters from the West. These include:

- Fulford Water
- St Georges Well Stream
- Crow Green Stream
- Cole Brook

The River Ken, a highly braided river, drains a mainly rural catchment and discharges into the River Culm from the East. The presence of the M5 and Bristol Exeter mainline railway, both on embankments, play a significant role in how flood flows are distributed East and West of these features. All the bridges that convey the main Bristol Exeter railway line over watercourses are a constriction to flow as are to a lesser degree those of the M5. The wide floodplains of the lower reaches of the Culm provide considerable floodwater storage, attenuating and reducing peak flows.

Underlying geology found in the middle and eastern parts of the Exe and Culm catchment is Permo-Triassic sandstones, mudstones and breccias. The varying permeability of the bedrock contributes to the different rainfall response times. Soil types affect the response of rivers and surface water to rainfall, and therefore have implications for flood risk. The

Culm valley is characterised with silty, clayey soils which have a small particle size which are also low in permeability. The nature of the geology and soils of the catchment lead to a slower response from rivers in the Culm catchment.

## Environmental designations

There are no significant environmental designations included in the Cullompton FRA. There are listed buildings located within and around the Cullompton FRA. There is also a Conservation Area that spans across the Cullompton FRA.

## Flood risk sources

The greatest source of flood risk to the Cullompton Flood Risk Area is from the River Culm. Other watercourses drain smaller more local areas of the Cullompton FRA. Cullompton has a very complex flood risk with these five watercourses converging on the town all with different response times. These are the:

- Spratford Stream
- Crow Green Stream
- Cole Brook
- Halberton Stream

The Cullompton Leat runs parallel to the main high street from Head Weir North of Cullompton and takes its water from the Spratford Stream. It flows past three former watermills (Upper, Middle and Lower Mill) and then empties into the Culm near First Bridge.

The Cullompton FRA is also susceptible to flooding from surface water and sewers during high rainfall events due to the heavily urbanised nature of the FRA and ageing drainage infrastructure. Additional surface water inputs to combined sewers, as well as ageing drainage infrastructure, result in increased levels of risk to some areas of the community. Large areas of farmland around Cullompton have been allocated for development. The most significant of this development and just West of the FRA is the Culm Garden Village where up to 5000 new homes and associated infrastructure will be built.

Flood risk from new development pressures within and around the Cullompton FRA is managed through the designation of a Critical Drainage Area (CDA). A CDA is an area that has critical drainage problems, and which has been notified to the local planning authority as such by the Environment Agency in line with the National Planning Policy Framework (NPPF). In these locations, there is a need for surface water to be managed to a higher standard than normal to ensure any new development will contribute to a reduction in flooding risks in line with NPPF. These higher standards are determined by the Environment Agency.

## Current flood risk

The Cullompton Flood Risk Area (FRA) has a long history of flooding with notable events in:

- the 1960s
- the 1980s
- 1997
- 2000
- 2002
- 2008
- 2012

Since the production of the first cycle Flood Risk Management Plans in 2015, there have been 2 recorded flood events in key locations caused by a combination of sources in the in the Cullompton FRA.

In November 2016, two properties were flooded on Exeter Road in Cullompton. Surface water flows came down through Swallow Way, Clover Drive and Fulford Drive.

The flood hazard and risk maps show that in the Cullompton FRA, 1,164 people live in areas at risk of flooding from rivers. Of these people, 17.3% live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 75 non-residential properties
- 0.42km of railway
- 11.6ha of agricultural land
- 2 listed buildings

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Cullompton FRA.

Given the scale and significance of flood risk in the Cullompton FRA, measures are planned to increase community resilience to flooding.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. For example:

- Devon County Council
- South West Water
- Mid Devon District Council
- the East Devon Catchment Partnership

The Devon Flood and Water Management Group, which comprises of all the local RMAs and key partners meet regularly to discuss:

- work programmes
- topical flood resilience matters
- resolving any operational issues across Devon

Cullompton Town Council meet to discuss emergency planning and have a Community Emergency Plan, which includes Flood Wardens who operate temporary barriers.

## Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service
- raising public awareness with associated campaigns

Increasing flood resilience where possible is important, as building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them with a flood warning service, allows us to reduce the risk to life and property. This is even if defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Cullompton FRA that monitor:

- river levels
- river flow
- rainfall

River flows are monitored downstream of the FRA at Woodmill and is used for flood warning. River levels are monitored upstream of the flood risk area at Culmstock and is used for flood warning. Rainfall is monitored at three rain gauges outside of the FRA.

The information collected from these monitoring sites are used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents. Our Flood Warning service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea. There is one fluvial flood alert areas and two fluvial flood warning areas that cover the Cullompton FRA.

As part of the Flood Warning Expansion Project new warning services are being developed for the Cole Brook and Crow Green Stream. Further engagement is planned to start during 2021/22 to:

- raise flood awareness and understanding
- support community resilience efforts in Cullompton
- promote the launch of this new Flood Warning Service

The aim is to ensure the community knows how to respond to flood warnings, to stay safe and minimise damage.

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic modelling. Currently there are no Environment Agency detailed models covering the Cullompton FRA. However, the entire catchment has been modelled by a partnership project promoting co-adaption to flood risk named 'Connecting the Culm' led by the Blackdown Hills Area of Outstanding Natural Beauty.

## Flood Alleviation Schemes

The Environment Agency maintains flood risk management assets on Main Rivers for example river channels, flood defence walls, embankments or engineered channels, throughout the Flood Risk Area. Devon County Council, Exeter City Council and South West Water similarly maintains assets that perform a flood risk management function on surface water, Ordinary Watercourses and the drainage network respectively.

In 1968, a flood alleviation channel was constructed adjacent to the M5 at Cullompton to compensate for the area of flood plain lost when the M5 (then Cullompton Bypass) was constructed. As part of the land purchase agreement, it became the responsibility of the now Highways Agency to maintain the channel. The channel has been subjected to periods of flooding since its construction, leading to large amounts of silt being deposited within it. This reduced the capacity of the channel and increased the risk of flooding in the surrounding area. In 2010, it was agreed that 6,500m3 of silt would be removed to return the channel to its original design.

In the 1980s, a flood defence scheme was constructed by predecessors of the Environment Agency which included lowered flood berms earth embankments and a flood flow control sluice structure on the leat. This scheme helps reduce the risk of flooding to the Alexandria Industrial Estate, Showman's sites, Station Road, nearby properties and the northern parts of Community Fields.

In 2015, an embankment was constructed as part of the Rivermead Flood Defence Scheme to reduce flood risk to homes that had no previous protection. The demountable flood barriers across the highway are operated by local voluntary Flood Wardens.

There is a South West Water pumping station on Chestnut Avenue that pumps surface water from the road drainage to an outfall on the Spratford Stream.

Many assets along watercourses within the FRA are in private ownership by riparian owners for both residential and commercial properties that sit along watercourses or over culverts. The Environment Agency maintain key flood risk management assets for example flood defence walls or embankments, throughout the FRA.

The Connecting the Culm project is looking at catchment-based solutions to provide increased community resilience to climate change driven pressures such as flood risk across the entire River Culm catchment. The project will initially focus on priority areas around Culm Garden Village, Killerton Estate and the headwaters of the catchment on the Blackdown Hills, but will expand to address issues on watercourses such as the Cole Brook and Crow Green Stream. Options for the areas of the catchment within the FRA have not yet started up, but others outside of it are currently in development and will influence successive phases of work. Solutions could include:

- attenuation of water in the upper catchment
- improving the capacity of existing assets
- creating new natural flood defences

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Cullompton Flood Risk Area (FRA). Rainfall intensity is expected to increase in the future and cause higher river flows and levels. This means that flooding from rivers will become more frequent.

The greatest source of flood risk to the Cullompton FRA is from the River Culm. The latest climate change peak river forecasts predict an increase in the potential maximum river flow through of Cullompton leading to higher depths and frequency of flooding. It’s anticipated that there will be an increase in overtopping and subsequent flooding to the Alexandria Industrial Estate, and both residential and commercial property off Station Road, as a result of climate change. Other particularly vulnerable areas include the route of the town centre relief road, the railway line, the M5 motorway and Station Road.

The Cole Brook and Crow Green Stream will also be impacted by climate change with a predicted increase in river levels and flow as a result of increased rainfall. There are limited options available to increase the capacity of both the Cole Brook and Crow Green Stream, therefore alternative solutions will include Natural Flood Management techniques within existing undeveloped areas of floodplain, and the broader catchments upstream.

To manage the impacts of climate change on the Cullompton FRA, a catchment-based solutions project called Connecting the Culm is being undertaken to determine and develop solutions that enable co-adaptation to climate change risks with local residents and landowners. This project aims to increased community resilience to climate change driven pressures such as flood risk across the entire River Culm catchment. The project will initially focus on priority areas around Culm Garden Village, Killerton Estate and the headwaters of the catchment on the Blackdown Hills, but will expand to address issues on watercourses such as the Cole Brook and Crow Green Stream

Climate change predictions anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Due to the heavily urbanised and low-lying nature of the Cullompton FRA, increased rainfall is expected to frequently overload the ageing drainage infrastructure. Property at Pound Square, Brook Road, and Duke Street may thus need Property Flood Resilience measures fitted, or any existing measures replaced or upgraded.

To support in the management of this increased risk from surface water, new development within the Cullompton Flood Risk Area is managed through the designation of a Critical Drainage Area (CDA).

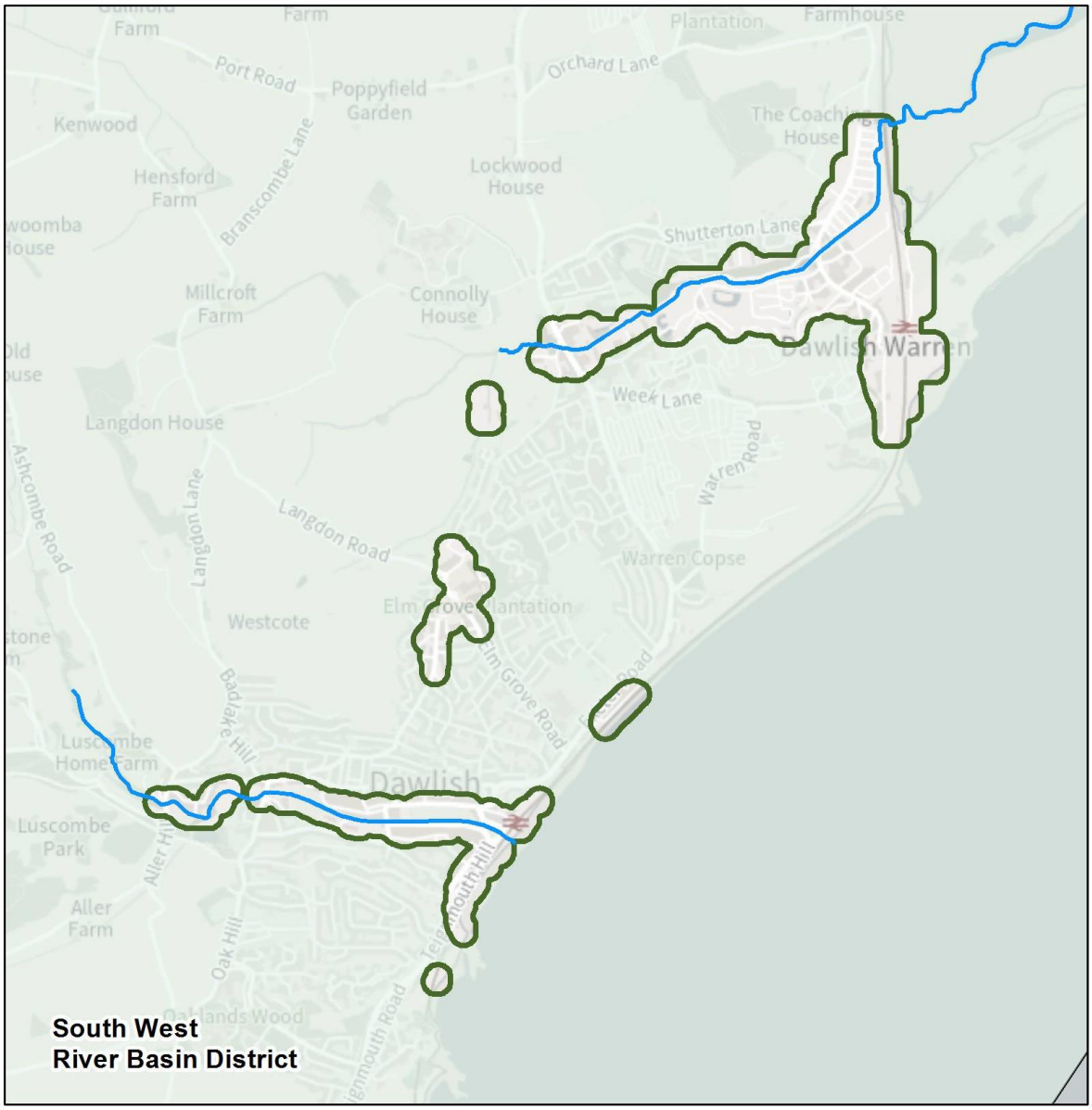
Please refer to the Climate change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South West River Basin District (RBD).

## Objectives and measures for the Cullompton FRA

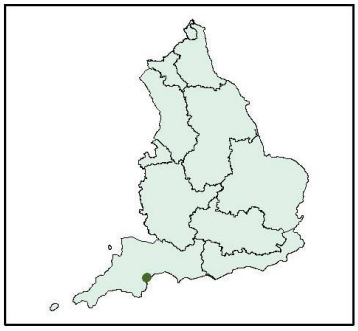
Measures have been developed that apply specifically to the Cullompton Flood Risk Area (FRA). These measures have been developed in addition to those covering a wider geographic area, but also apply to the Cullompton FRA.

You can find information about all the measures that apply to the Cullompton FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Dawlish Rivers and the Sea Flood Risk Area




Flood Risk Area: Dawlish, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

Kilometres
0 0.5 1 1.5



**Figure 10: a map showing the boundary of the Dawlish Flood Risk Area**

## Introduction to the Dawlish Flood Risk Area

The Dawlish Flood Risk Area (FRA) is located on the southern coast of Devon. The FRA comprises of several urban communities, including:

- Dawlish
- Dawlish Business Park
- Dawlish Warren

The Dawlish FRA is a mixture of residential and commercial properties. It has been identified as an FRA because the risk of flooding from rivers and sea is significant nationally for people, the economy or the environment (including cultural heritage).

The coastal town of Dawlish is the third largest town in the Teignbridge district. It has grown from an 18th century small fishing port into a well-known seaside resort. Dawlish Warren is a small seaside resort located on the south Devon coast, east of Dawlish on the mouth of Exe Estuary. The Environment Agency take the lead on the development and implementation of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority (LLFA), whose remit includes flood risk from surface water and ordinary watercourses.

South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. Teignbridge District Council are both a Risk Management Authority (RMA) and the Local Planning Authority, whose remit includes managing flood risks from Ordinary Watercourses, planning and acting as the Coastal Protection Authority.

## Hydrology and geology of the catchment

Within the Dawlish FRA there are two discrete river catchments and areas of coastal risk.

The town of Dawlish is on the south Devon coast and within the catchment of the Dawlish Water stream. This watercourse drains a steeply rising 20km2 catchment on its journey from Haldon Hill and through the Ashcombe valley into Dawlish Town. Once within the town, the watercourse drops over numerous weirs and under bridges, passing through the Manor Gardens and The Lawn. It then passes beneath the A379 main road and the railway line, eventually discharging to the sea. The lower reach of the watercourse is heavily modified with 20 weirs and sluices along its length.

Dawlish Warren is on the south Devon coast, which is on the western side of the mouth of the Exe Estuary. It’s at risk of flooding from both the estuary and coast, but also from the Shutterton Brook. In the 1800s, Isambard Kingdom Brunel constructed the South Devon Railway from Exeter to Plymouth. This railway, part of the main line to London, passes though Dawlish Warren and was constructed at the time on an offshore embankment. This established the line across the mouth of Shutterton Lake, re-diverting the brook to enter the estuary under arches at Eales Dock. Over time, this area behind the embankment was dried out to be used as farmland, being converted more recently into holiday parks. Areas

immediately adjacent to the watercourse do not feature brick and mortar residential homes, but multiple holiday parks with several hundred caravans, many of which are occupied throughout the year, resulting in large seasonal fluctuations to the numbers of residents at risk of flooding within the Dawlish FRA.

## Environmental Designations

Environmental designations located within the Dawlish FRA are the:

- Dawlish Cliffs Site of Special Scientific Interest (SSSI)
- Exe Estuary SSSI
- Dawlish Warren SSSI
- Exe Estuary Special Protection Area (SPA)
- Dawlish Warren SPA
- Dawlish Warren Local Nature Reserve (LNR)

The FRA also includes three designated Bathing Water Areas including:

- Dawlish Coryton Cove
- Dawlish Town
- Dawlish Warren

Exe Estuary Ramsar Site is located near to the Dawlish FRA.

Numerous listed buildings are located within the Dawlish FRA including:

- Jubilee Bridge
- Properties on Brunswick Place
- Dawlish Railway Station

The Dawlish FRA also has a Conservation Area located within it.

## Flood risk sources

The greatest sources of flood risk to the Dawlish FRA are tidal and fluvial. High tide levels occurring at the same time as high river levels in the Dawlish Water stream may cause combined flooding. The railway line is also affected by coastal flooding due to wave overtopping. However, the impact of this risk has been reduced following Network Rail's construction of a new seawall along Marine Parade and adjacent to the railway station in 2020/21. Flooding can also result from inadequacies of the surface water system and surface water flows down Teignmouth Hill.

Further flooding is possible within the Dawlish Warren area from the Shutterton Brook, which can result in the rapid onset of flooding to vulnerable properties. This includes the caravans within the holiday park areas. Furthermore, where the Shutterton Brook meets the sea at Dawlish Warren, river levels can be elevated at high tide by 'tide-locking'. This is when the river is unable to drain to the sea, which heightens the risks further.

The Dawlish FRA is designated as a Rapid Response Catchment, meaning that the onset of flooding can be fast. This is due to the steep and heavily developed nature of the catchment.

Due to the rapid response nature of the catchment and the vulnerability of the community to flash flooding, the Environment Agency are committed to:

- notifying residents and businesses about their flash flood risk
- offering community representatives assistance with developing the Dawlish Community Emergency Plan every three years

Parts of the Shutterton Brook catchment are believed to be susceptible to groundwater flooding due to the permeable nature of its geology. This form of flooding is caused by rising water tables below ground meeting the surface, as the porosity of the underlying rock is filled. This results in flooding that:

- is very hard to plan for
- is often unknown as to where it will emerge first
- can last for a prolonged period if the aquifer is saturated by subsequent rainfall events

The Dawlish FRA is also susceptible to flooding from surface water and sewers during high rainfall events. This is due to the heavily urbanised nature of the FRA and ageing drainage infrastructure. Additional surface water inputs to combined sewers, as well as becoming tide-locked in frequent tidal conditions, result in increased levels of risk to some areas of the community. This was seen in the recent flooding that occurred in 2020.

Flood risk from new development pressures within the Dawlish FRA is managed through the designation of a Critical Drainage Area (CDA). A CDA is an area that has critical drainage problems that has been notified to the local planning authority by the Environment Agency in line with the National Planning Policy Framework (NPPF). In these locations, there a need for surface water to be managed to a higher standard than normal to ensure any new development will contribute to a reduction in flooding risks in line with NPPF. These higher standards are determined by the Environment Agency.

## Current flood risk

The Dawlish FRA has a long history of flooding with notable events in:

- the 1960s
- the 1980s
- 1999
- 2002
- 2004
- 2006
- 2008
- 2012
- 2014

Since the production of first cycle Flood Risk Management Plans in 2015, there have been two recorded flood events in key locations caused by a combination of sources in the Dawlish FRA.

The flood hazard and risk maps show that in the Dawlish FRA, 962 people live in areas of flood risk from rivers and the sea. Of these people, 36% live in high risk areas.

Also shown to be at risk of flooding from rivers and the sea are:

- 127 non-residential properties at risk
- 0.18km of railway at risk
- 4.72ha of agricultural land
- areas of designated environmental sites, bathing waters and 13 listed buildings
- 3 large caravan parks with a mixture of residential and holiday units

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Dawlish FRA.

Given the scale of both fluvial and coastal flood risk and coastal erosion risks in Dawlish, measures are being taken to increase community resilience to flooding and coastal change. The significance of fluvial and tidal flood risk in Dawlish Warren to vulnerable receptors such as the holiday parks is also a factor.

## How the risk is currently managed

The management of flood risk from Main Rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders leading on other sources of flood risk and coastal erosion. This includes:

- Devon County Council
- South West Water
- Teignbridge District Council
- the South Devon Catchment Partnership

The Devon Flood and Water Management Group, which comprises of all the local RMAs and key partners, meet regularly to:

- discuss work programmes
- discuss topical flood resilience matters
- resolve any operational issues

Furthermore, Dawlish Town Council also meet to discuss emergency planning. They currently have a Community Emergency Plan, which includes the role of their flood wardens.

## Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service
- raising public awareness with associated campaigns

Increasing flood resilience, where possible, is important as building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them with a flood warning service, allows us to reduce the risks to life and properties. This includes whether defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Dawlish FRA that monitor:

- tide levels
- river levels
- river flow
- rainfall

The tide levels are monitored at the tide gauge at:

- Exmouth Dock
- Teignmouth
- Devonport

Estuary levels are monitored at Topsham. The wave buoy at Dawlish is managed by the Plymouth Coastal Observatory and provides data during incidents and calibrates other sources of data.

Within the Dawlish FRA, river flow is monitored on the Dawlish Water. Rainfall is monitored by the rain gauge within the upper Dawlish Water catchment at Ashcombe. Currently, there is no river flow or level monitoring on the Shutterton Brook. The Flood Warning Expansion Project is looking to install a river level gauge and rain gauge for the Shutterton Brook catchment.

The information collected from these monitoring sites is used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents. Our Flood Warning Service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea.

There are 2 coastal flood alert areas that cover the Dawlish FRA. Additionally, there are 3 coastal flood warning areas that cover the Dawlish FRA. There's also one fluvial flood alert area that covers the Dawlish FRA. Currently there is no fluvial flood warning service that covers the Dawlish FRA. However, it's anticipated that these properties will receive a flood warning service as part of the Flood Warning Expansion Project by 2022. Further engagement is planned to start during 2021/22 to:

- raise flood awareness and understanding
- support community resilience efforts at Dawlish
- promote the launch of this new Flood Warning Service

The aim is to ensure the community knows how to:

- respond to flood warnings
- stay safe and
- minimise damage

This engagement will involve the community flood group to support them in refreshing their existing Community Emergency Plan. It should be noted that it's difficult to provide direct warning messages to transient communities, such as residents of holiday parks, during a flooding incident. Therefore, a significant risk to resilience remains for the holiday parks at Dawlish Warren, which comprise of a large percentage of the properties within this flood risk area.

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic and forecast modelling. Hydraulic models are used to assess:

- current flood risk
- impacts of climate change
- how future levels of flood risk could be managed

In 2012, the Exe Estuary 2D Modelling and Mapping study was undertaken to model the Exe Estuary and its tributaries. This model included the Shutterton Brook in the Dawlish FRA.

The hydrodynamic 1D/2D model was developed to assess flood risk and hazards. This model has received updates in the last few years as part of the planning process to test development proposals on the Shutterton Brook.

The Shutterton Brook is currently being re-modelled to:

- inform future flood map improvements
- understand the changing flood risk in the future due to sea level rise
- evaluate the potential for various improvements to community flood resilience

Dawlish Water was modelled in 2014 by Teignbridge District Council. However, this model is currently being updated to inform future flood map improvements and evaluate the potential for various improvements to community flood resilience.

Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

## Flood Alleviation Schemes

### Dawlish

The Dawlish Water stream drains a steeply rising 20km$^2$ catchment with numerous modifications to the watercourse through the town. The Dawlish Water stream starts its journey at Haldon Hill, then flows down through the Ashcombe valley and into Dawlish Town. Once within the town, the watercourse drops over numerous weirs and under bridges, passing through Manor Gardens and The Lawn. The watercourse then flows beneath the A379 main road and Brunel's railway viaduct, eventually discharging to the sea.

Desilting the Dawlish Water within the town is undertaken as required by Teignbridge District Council. However, modelling has shown that this work has a limited effect on reducing flood risk to the town. The mapping and modelling study that is currently being undertaken will inform any future options to improve community resilience to the community of Dawlish, such as:

- provision of linear flood defences
- property flood resilience measures
- adaptation to climate change risks

The town of Dawlish is also susceptible to coastal flooding, especially the railway which runs along the shoreline. Since the opening of the South Devon Railway in 1846, the sea wall has often been damaged by marine erosion and overtopping. In February 2014, 30 properties were affected and the railway line suffered significant damage, closing for 2 months. As a result of the disruption, Network Rail was asked by the Government to report on options to maintain a resilient rail service to the South West Peninsula. Following this, Network Rail are carrying out Coastal Resilience Works to the Railway Infrastructure to protect the railway by improving the existing sea defences. Improvement works were carried out to the seawall at Marine Parade and adjacent to the railway station. This was to reduce the impact of coastal flood and erosion events on rail services in 2020/21.

The Shoreline Management Plan covering the Dawlish FRA is currently under review. This is led by the South Devon and Dorset Coastal Advisory Group and Teignbridge District Council. This plan will develop policy for coastal management to address both coastal flooding and erosion risks. It'll also inform associated action plans to deliver sustainable

coastal management and adaptation to climate change risks for short, medium and long-term timeframes.

A project is underway to investigate the opportunities to increase resilience to flooding, coastal change and climate risks from the Dawlish Water. This is currently in early stages and is awaiting results from a modelling study to inform potential courses of action for the future.

**Dawlish Warren**

Dawlish Warren is affected by both tidal flooding and fluvial flooding from the Shutterton Brook. Due to modifications to the landscape from the railway, much of the settlement of Dawlish Warren is on drained, low-lying, intertidal land. Although this land has been drained it's low-lying, compared to the estuary, and as such is vulnerable to being tide-locked. This greatly increases the risk of fluvial flooding.

Holiday parks comprising of static caravans and holiday chalets have been on this land, adjacent to the watercourse. In December 2000, the Hazelwood Park caravan site flooded from the Shutterton Brook with 100 people being evacuated. The watercourse is classified as a Rapid Response Catchment, and has been listed as the highest priority RRC in the South West due to the risks associated with such a significant number of caravans within the floodplain, many of which are occupied throughout the year, meaning the population at risk of flooding in the Dawlish Flood Risk Area can fluctuate seasonally.

The lower reaches of the Shutterton Brook are lined by flood walls constructed in 1991, which extend upstream from the tidal flaps at Eales Dock to Dawlish Warren Road. There's a small pumping station operated by South West Water to pump water past the constriction caused by the road bridge. No substantial hard defences exist upstream of this point.

Due to the low level of the outfalls at Eales Dock, the Shutterton Brook is often tide-locked and the area upstream of the outfalls acts as a de facto flood storage area. This is if the capacity is overwhelmed before tide levels fall, overtopping will occur. With increased tide levels due to climate change the frequency of tide-locking is expected to increase.

A project is underway to investigate the opportunities to increase resilience to flooding, coastal change and climate risks from the Shutterton Brook. This is currently in early stages and is awaiting results from a modelling study to inform potential courses of action for the future.

Although not located within the FRA extent, the Dawlish Warren Beach Management Scheme was completed in 2017. The scheme reduces the impacts of coastal erosion and wave heights to benefit communities around the Exe Estuary. This scheme included:

- the installation of a new coastal revetment
- groynes improvements
- dredged marine sediment being used to form a 'geotube' defence and to recharge the beach

Since completion further works have become necessary to stabilise the geotube and to ensure the life of Dawlish Warren spit can be prolonged for as long as possible to provide benefits to the local community and the Exe Estuary.

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Dawlish FRA. Rainfall intensity is expected to increase in the future and cause higher river flows and levels. Sea levels are also expected to rise. As sea levels rise, coastal flooding will become more frequent as higher water levels and storms will be seen more often. This means that flooding from rivers and the sea will become more frequent. Dawlish is already at the forefront of adapting to the climate crisis due to Network Rail's investment to increase resilience of the railway line. However, areas of low-lying land at Dawlish Warren will need to adapt to rising sea levels and increased rainfall caused by climate change.

Sea level rise and increased storminess will result in the Dawlish and Dawlish Warren coastal frontage, development and critical transport infrastructure running parallel to it, becoming more susceptible to damage. This could subsequently reduce access to areas of Devon and Cornwall outside of the FRA that rely on these regional transport links.

Network Rail are carrying out coastal resilience works to the railway infrastructure to defend the railway by improving the existing sea defences. Improvement works were carried out to the seawall at Marine Parade and adjacent to the railway station to reduce the impact of coastal flood and erosion events on rail services in 2020/21.

Increased sea level rise will also impact the ability of rivers within the Dawlish FRA to drain out to sea especially in periods of:

- combined intense rainfall
- increased river levels
- high tides

This is known as tide locking. Numerous caravan parks along the Shutterton Brook are particularly susceptible to the increase in frequency and consequence of flooding from tide-locking. These tide-locking events can take up to 12 hours to drain from the area, this period of tide-locking will also increase with climate change.

The Dawlish Water and Shutterton Brook are both classified as Rapid Response Catchments. Meaning that the onset of flooding in the present day can be fast, this is due to the steep and heavily developed nature of the catchment. Climate Change predictions indicate that rainfall intensity is expected to increase in future, causing even higher river flows and levels. This means that flooding from rivers and surface water will become more frequent in already rapidly responding catchments, reducing the time of the community to respond further.

The Dawlish Water is a heavily modified watercourse with channel capacity constraints, with numerous weirs and bridges. A project is underway to investigate the opportunities to increase resilience to flooding, coastal change and climate risks from the Dawlish Water. This is currently in early stages and is awaiting results from a modelling study to inform potential courses of action for the future. However, it's anticipated that the structures across the channel will not be able to cope with increased flows resulting from climate change.

With increased rainfall and river levels, many of the caravan sites along the Shutterton Brook will be at increased risk of flooding. The Shutterton Brook will also be susceptible to increased sea level rise and subsequent tide-locking impacts from the Exe estuary. A project is underway to investigate the opportunities to increase resilience to flooding, coastal change and climate risks from the Shutterton Brook. This is currently in early stages and is awaiting results from a modelling study to inform potential courses of action for the future. This is to determine how to resolve the risks in this location, ranging from improvements of existing defences to relocation of vulnerable receptors, such as the caravan parks, out of the floodplain.

Climate change predictions anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Due to the steep-sided and heavily urbanised nature of both the Dawlish Water and Shutterton Brook catchments, increased rainfall is expected to frequently overload the ageing drainage infrastructure. To support in the management of this increased risk from surface water, new development within the Dawlish FRA is managed through the designation of a Critical Drainage Area (CDA).

Please refer to section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the South West RBD.

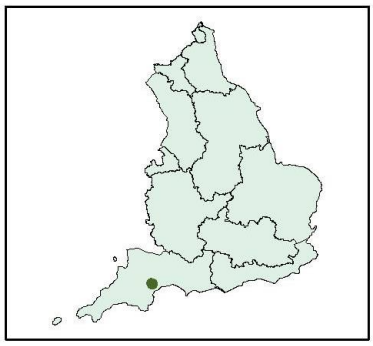
## Objectives and measures for the Dawlish FRA

Measures have been developed that apply specifically to the Dawlish FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Dawlish FRA.

You can find information about all the measures that apply to the Dawlish FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Exeter Rivers and Sea Flood Risk Area


Flood Risk Area: Exeter, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

Kilometres
0 1 2 3



**Figure 11: a map showing the boundary of the Exeter Flood Risk Area**

## Introduction to the Exeter Rivers and Sea Flood Risk Area

The Exeter Flood Risk Area (FRA) is on the south coast of Devon. The River Exe and its tributaries conveys water from parts of the Exe Catchment through the Exeter FRA to the Exe Estuary and directly out to sea. The FRA comprises of several urban communities, including:

- Heavitree
- Pinhoe
- Sowton
- Marsh Barton
- Exwick
- Alphington
- St Thomas

The Exeter FRA has a mixture of residential and commercial properties. The area is surrounded by green space of mainly farmland and the Exe Estuary.

The Exeter FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and implementation of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority, whose remit includes flood risk from surface water and ordinary watercourses.

South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. Exeter City Council are the Local Planning Authority, whose remit includes ordinary watercourses and planning.

## Hydrology and geology of the catchment

The Exe catchment is delineated by the hydrological sub-catchment boundaries of the rivers:

- Exe
- Barle
- Clyst
- Creedy
- Culm

The River Barle and headwaters of the River Exe are within Exmoor National Park. The Rivers Creedy and Culm join the River Exe just north of the Exeter FRA. However, the River Clyst flows directly into the Exe estuary downstream of the Exeter FRA at Topsham.

To the north, the catchment consists of the upland of Exmoor. The Barle and upper reaches of the Exe, flow through narrow valleys coming off the moor which at times

respond rapidly to rainfall with high velocities and depths. Below the confluence of the Barle and Exe, the valley opens out into wide flood plains meandering through valleys separated by low hills. The Creedy, Culm, Clyst and lower Exe are much flatter and slower flowing with a wider floodplain.

The geology within the Exe catchment spans approximately 400 million years from the Devonian period through to the present day. The headwaters of the Exe, Haddeo and Barle in the north of the catchment comprise of Devonian siltstones, sandstones and shales. These rocks are generally of low permeability and therefore produce more surface water runoff in the upper catchment.

The middle and eastern parts of the catchment are underlined by Permo Triassic sandstones, mudstones and breccias, with the Crediton trough running from east to west. These stones form the Aylesbeare Mudstone Group and because of their good porosity form the aquifers found within the catchment. The lower Exe comprises of sandstone breccias within the Permo Triassic strata. Groundwater is contained within the sandstone aquifers of the lower Exe, Culm and Clyst valleys. Recharging of these aquifers during wet periods will have some effect on reducing peak flows in the rivers Exe, Culm and Clyst. This is because some of the floodwater volume may be removed by storage into the underlying rock strata.

Soil types affect the response of rivers and surface water to rainfall, and therefore have implications for flood risk. The Exe catchment has a broad distribution of soil types, most soils in the catchment are freely draining. The upland areas of the catchment on Exmoor are characterised by peaty soils with low permeability. To the east of the catchment, silty, clayey soils in the Culm valley have much smaller particle sizes that are also low in permeability.

Overall, the nature of the geology and soils of the catchment will lead to:

- a fast response of flood flows to rainfall in the Barle and upper Exe catchments
- a slower response in the Clyst and Culm
- a tendency to localised surface water flooding
- little risk of groundwater flooding

## Environmental designations

Exeter contains a rich variety of wildlife habitats owing to a particular combination of geology and topography. Both the Exe Estuary and Bonhay Road Cutting Site of Special Scientific Interest (SSSI) are located within the Exeter FRA. The Stoke Woods SSSI is also within 1km of the Exeter FRA. South of Countess Weir, the Exe Estuary is a Ramsar site and a Special Protected Area recognised as a wetland site of international importance. The area supports many rare species and is famous for its Avocets and Lapwings, which are located within the Exeter FRA.

Scheduled Ancient Monuments within the Exeter FRA include:

- The medieval Exe Bridge

- St Edmund's Church
- St Katherine’s Priory

Numerous listed buildings and Conservation Areas are located within the Exeter FRA.

The St. Bartholomew’s Cemetery Park and Garden is also located within the Exeter FRA.

## Flood risk sources

The greatest source of flood risk to the Exeter FRA is fluvial. Significant flooding problems are associated with the River Exe and its tributaries, affecting:

- residential and commercial properties
- the local highway network
- the main railway line to London Paddington and the Barnstaple branch line - both of which forms a major strategic link between London and the South West

Other watercourses drain smaller more local areas to the north and south of the river Exe into the FRA. These are the:

- Alphin Brook
- Fordland Brook
- Mincinglake Stream
- Taddiforde Brook
- North Brook
- Higher Leat
- Exwick Leat
- Pinn Brook

Alphin and Matford brooks drain into the River Exe through complex structures. However, at the time of flood flows are diverted towards Exminster Marshes.

The Exeter St Thomas area of the Exeter FRA is designated as a Rapid Response Catchment, meaning that the onset of flooding can be fast. This is due to the steep and heavily developed nature of the catchment. Due to the rapid response nature of the catchment and the vulnerability of the community to flash flooding, the Environment Agency are committed to:

- notifying residents and businesses about their flash flood risk
- offering community representatives assistance with developing the Exeter St Thomas Community Emergency Plan every 3 years

The Exe Estuary's tidal limit extends up to Trew’s Weir in the southern part of the city. Upstream of Exeter, the wide floodplains of the Lower Exe and Culm provide considerable floodwater storage and attenuation. However, this can lead to flooding of the main railway line that lies within or across the floodplain.

Within Exeter, the river channel is wide and steep and is heavily modified from its natural state. There are several historic weirs, leats and road/rail bridges, as well as the Exeter Canal and the Exwick and Trews flood bypass channels and control structures. These structures form part of the post 1960 flood defences. The Exeter Ship Canal lies within the FRA and is owned and maintained by Exeter City Council.

The Exeter FRA is also susceptible to flooding from surface water and sewers during high rainfall events due to the heavily urbanised nature of the FRA and ageing drainage infrastructure. Additional surface water inputs to combined sewers, as well as ageing drainage infrastructure, result in increased levels of risk to some areas of the community. Please refer to The Exeter Surface Water Flood Risk Area in the section below for more information on the surface water risk and how its managed.

## Current flood risk

The Exeter FRA has a long history of flooding with records dating back to the 13th century. Notable events took place during:

- the 1960s
- 1972
- 1999
- 2000
- 2012

Since the production of the first cycle Flood Risk Management Plans in 2015, there have been increasingly high flood flows recorded on the River Exe through the Exeter FRA. This was particularly the case during Storm Angus in 2016 and Storm Dennis in 2020.

The flood hazard and risk maps show that in the Exeter FRA, 16,495 people live in areas at risk of flooding from rivers and the sea. Of these people, 4.9% are considered to live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 2,118 non-residential properties - including hospitals, schools/colleges and public utilities
- 5.38km of roads
- 7.51km of railway
- 66ha of agricultural land
- areas of designated environmental sites
- 58 listed buildings
- Scheduled Ancient Monuments
- water abstraction sites
- Environmental Permitting Regulatory Sites

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Exeter FRA.

Given the scale and significance of flood risk in the Exeter FRA, measures are being taken to increase community resilience to flooding and coastal change.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. For example:

- Devon County Council
- South West Water
- Exeter City Council

The East Devon Catchment Partnership also covers the River Exe catchment. They're increasingly considering more natural solutions to flood risk problems in and around Exeter as part of their work plan.

The Devon Flood and Water Management Group, which comprises of all the local RMAs and key partners meet regularly to discuss:

- work programmes
- topical flood resilience matters
- resolving any operational issues across Devon

Community volunteers in the Exeter St Thomas area have created a Community Emergency Plan that also includes flood wardens.

### Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service
- raising public awareness with associated campaigns

Increasing flood resilience where possible is important, as building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them with a flood warning service, allows us to reduce the risk to life and property. This is even if defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Exeter FRA that monitor:

- tide levels
- river levels
- river flow

- rainfall

River flow is monitored at Trews Weir on the River Exe. River levels are monitored at Exwick, which is within the FRA. However, this gauge is scheduled to be decommissioned. The catchments upstream of the Exeter FRA have a network of 3 river flow and 4 rivel level gauges that inform trigger levels at Trews Weir. They offer resilience to the largest fluvial risk area in the South West of England.

As part of the Flood Warning Expansion Project, 2 new river gauges are being considered for the Northbrook and the Alphinbrook rivers within the Exeter FRA. The tide levels are forecast from the Class A tide gauge at Exmouth Dock and estuary levels are also monitored at Topsham. Rainfall is monitored in the FRA by the telemetered rain gauge at the Met Office. However, there are 3 other telemetered rain gauges in the vicinity of the FRA that validate rainfall radar forecasts.

The information collected from these monitoring sites are used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents. Our Flood Warning Service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea. There is one coastal flood alert area and one coastal flood warning area that covers the Exeter FRA. There are 3 fluvial flood alert areas and 4 fluvial flood warning areas that cover the Exeter FRA.

As part of the Flood Warning Expansion Project new warning services are being developed for the Northbrook (Heavitree) and the Alphinbrook (Alphington). Further engagement is planned to start during 2021/22 to:

- raise flood awareness and understanding
- support community resilience efforts at Heavitree and Alphington
- promote the launch of this new Flood Warning Service

The aim is to ensure the community knows how to:

- respond to flood warnings
- stay safe
- minimise damage

This engagement will involve the community flood group to support them refresh their existing Community Emergency Plan.

Currently a Flash Flood Warning Service is being trialled in the St Thomas area. To date this warning has not been issued.

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic and forecast modelling. Hydraulic models are used to assess:

- current flood risk
- impacts of climate change
- how future levels of flood risk could be managed

Flood risk maps are published based on the outputs from the hydraulic modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

In 2000, a flood event occurred in Exeter that impacted the Quay and the railway line at Cowley Bridge. During this event the river flow was recorded at 525 cubic metres per second. This is the highest flow since the 1960 flood events. Following this event, hydrological and hydraulic modelling was undertaken to assess the standard of protection of the existing Exeter Flood Defence Scheme.

In 2005, a flood risk model was developed that covered the River Exe through Exeter and the downstream reach of the River Creedy, from New Bridge to its confluence with the Exe. Subsequently in 2006, this one dimensional model was used to test sluice gate operational procedures, blockage scenarios and bank raising options as part of the River Exe Flood Incident Management Plan.

In 2010, the Exeter previous model was developed further to represent the River Exe and its associated floodplain through Exeter. This mapping and modelling study was undertaken to gain a better understanding of flood hazard under a range of scenarios for Exeter.

In 2012, the railway near Cowley Bridge and the Quay area suffered from direct flooding, and localised surface water flooding was reported in Cowick Street and Frog Street. This led to the identification and need to upgrade the Exeter Flood Defence Scheme.

Subsequently, in 2013 additional investigations and adjustments were made to this model for use in designing the upgrade to the Exeter Flood Defence Scheme, which is currently in construction.

Following the completion of the Exeter Flood Defence Scheme, the Exeter model and flood map will be updated to reflect:

- current day standards
- mapping
- the improvements delivered by upgrading the flood defences

There are 2 forecasting models in the Exeter FRA, these cover the rivers:

- Northbrook

- Pinnbrook

Forecasting models are used to determine potential impacts from heavy rainfall or high tide events. They also inform the incident response activities of RMAs and professional partner organisations to reduce risk to communities.

## Flood Alleviation Schemes

The Environment Agency maintains flood risk management assets on main rivers throughout the FRA. This includes:

- river channels
- flood defence walls
- embankments or engineered channels

Devon County Council, Exeter City Council and South West Water similarly maintain assets that perform a flood risk management function on:

- surface water
- Ordinary Watercourses
- the drainage network

### River Exe

During the major floods in 1960, over 1,000 properties flooded. This event led to the design and construction of the original Exeter Flood Defence Scheme between 1962 and 1979. This was a large and ambitious project that re-engineered the whole river channel over 7km through the city. This flood defence scheme successfully reduced the flooding problems until it began to operate at near full capacity during the most significant flood events of recent years in:

- 1999
- 2000
- 2012

During the October and December 2000 flood events, our understanding of the local hydrology changed. This subsequently led to local modelling of the River Exe and subsequent upgrade of the Exeter Flood Defence Scheme.

In November and December 2012, the railway line at Cowley Bridge Junction was overtopped, resulting in significant rail damage and delays. Subsequently, Network Rail have constructed flood relief culverts underneath Cowley Bridge Junction to reduce flood risk to the railway. They also installed demountable defences to reduce risks of flood water, bypassing the Exeter Flood Defence Scheme.

In 2019, the partial collapse of St James Weir required emergency works to safeguard essential infrastructure. This identified the need for works being considered for the condition of Trews Weir.

Subsequently, between 2012 and 2021, the Environment Agency worked in partnership with Exeter City Council and Devon County Council to improve the flood defences. A comprehensive new scheme for the River Exe is currently being delivered. This is composed of improvements to Trews Flood Relief Channel that include new:

- flood walls
- embankment improvements
- flood gates
- demountable defences (Exeter Quay, St. David's Railway Station, Countess Weir and Cowley Bridge)

Engagement has continued throughout the Exeter Flood Defence Scheme construction. The final phase of engagement will provide Exeter quayside businesses with opportunities to understand:

- their local flood warning service
- residual flood risk
- how temporary flood barriers will operate on the quay

Exwick Radial Gate controls the split of flow during a flood down the River Exe and activates the Exwick flood relief channel.

**Ordinary Watercourses**

Historically, the Alphin Brook flooded Marsh Barton during the early 1960s. The worst recorded event was on 30 September 1960. Since then, a comprehensive flood defence scheme has alleviated risks associated with the Alphin Brook and provides a high standard of protection.

On 10 July 1972, there was a significant flood event along the length of the Pinn Brook. During the late 1970s and into the early 1980s, Exeter City Council implemented improvements at all the principal flooding locations south of the railway.

The North Brook routinely flooded Honiton Road and Sweetbrier Lane in Heavitree prior to the construction of the North Brook Flood Defence Scheme by Devon County Council in 2020/21. Since construction of the scheme, flooding has been confined to local surface water inadequacies.

Flooding has occurred at St David's where the Taddiforde Brook enters the River Exe floodplain and gradients quickly reduce. Flows in this catchment are significantly modified by a cascade of ornamental lakes and ponds within the university campus. These are privately built and maintained. These offer storage benefits and provide attenuation, but also present significant risks if they were to fail and release large quantities of water. Of particular concern is where the Taddiforde Brook passes under the B3183 in a small Victorian brick arch. Any failure of this structure could give rise to significant flood risks to all properties downstream. Exeter City Council have a project to alleviate flooding in this area currently under development.

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Exeter FRA. Climate change allowances are predictions of the anticipated change for:

- peak river flow
- peak rainfall intensity
- sea-level rise

Climate Change predictions indicate that rainfall intensity and duration is expected to increase. This in turn will increase the potential maximum river flow through the city. Areas that'll be impacted include the Quay, along the riverbanks and the railway line at Cowley Bridge.

Through the city of Exeter the River Exe channel is wide and steep in characteristic and is heavily modified from its natural state. There are several historic weirs, leats and road/rail bridges, as well as the Exeter Canal and the Exwick and Trews flood bypass channels and control structures. These structures form part of the post 1960 flood defences.

The Exeter Flood Defence Scheme raised the level of flood defences upon completion of works in 2021. It's not possible to increase defence levels further without increasing the level of the railway line and capacity of the bridge on which the railway crosses the River Exe. This means that with increased rainfall and river flow, overtopping of the River Exe defences will again become more likely. This is once the design life of the Flood Defence Scheme is reached.

Sea level rise will also impact the Exeter FRA. The tidal boundary of the River Exe will be held at Trews Weir, although an increase in inter-tidal habitat will be visible in the improved channel. This is due to increasing levels of salinity and frequency of inundation.

The impacts include:

- destabilisation of the riverbanks
- reduced outflow capacity of smaller watercourses
- increased likelihood of flooding to Marsh Barton and the Matford area

Low-lying residential properties in the Countess Wear area will be at increased flood risk due to sea level rise.

Many of the ordinary watercourses in the Exeter FRA will also be impacted by climate change. These include the:

- Taddiforde Brook
- Northbrook
- Pinn Brook
- Alphin Brook
- Matford Brook

With increased rainfall intensity and rapid runoff from the upper catchments, higher flows and consequently flood levels within these smaller watercourses will become more likely and frequent. Many of the watercourses mentioned also flow through heavily urbanised areas that will see an increase in flood frequency and impacts. To manage this increased flood risk, the Environment Agency will work with Devon County Council and Exeter City Council to investigate possible improvements to existing schemes on ordinary watercourses within the Exeter FRA.

The Exeter FRA is also susceptible to an increase in flooding from surface water as a result of climate change. Please refer to The Exeter Surface Water Flood Risk Area in the section below for more information on the climate change impacts.

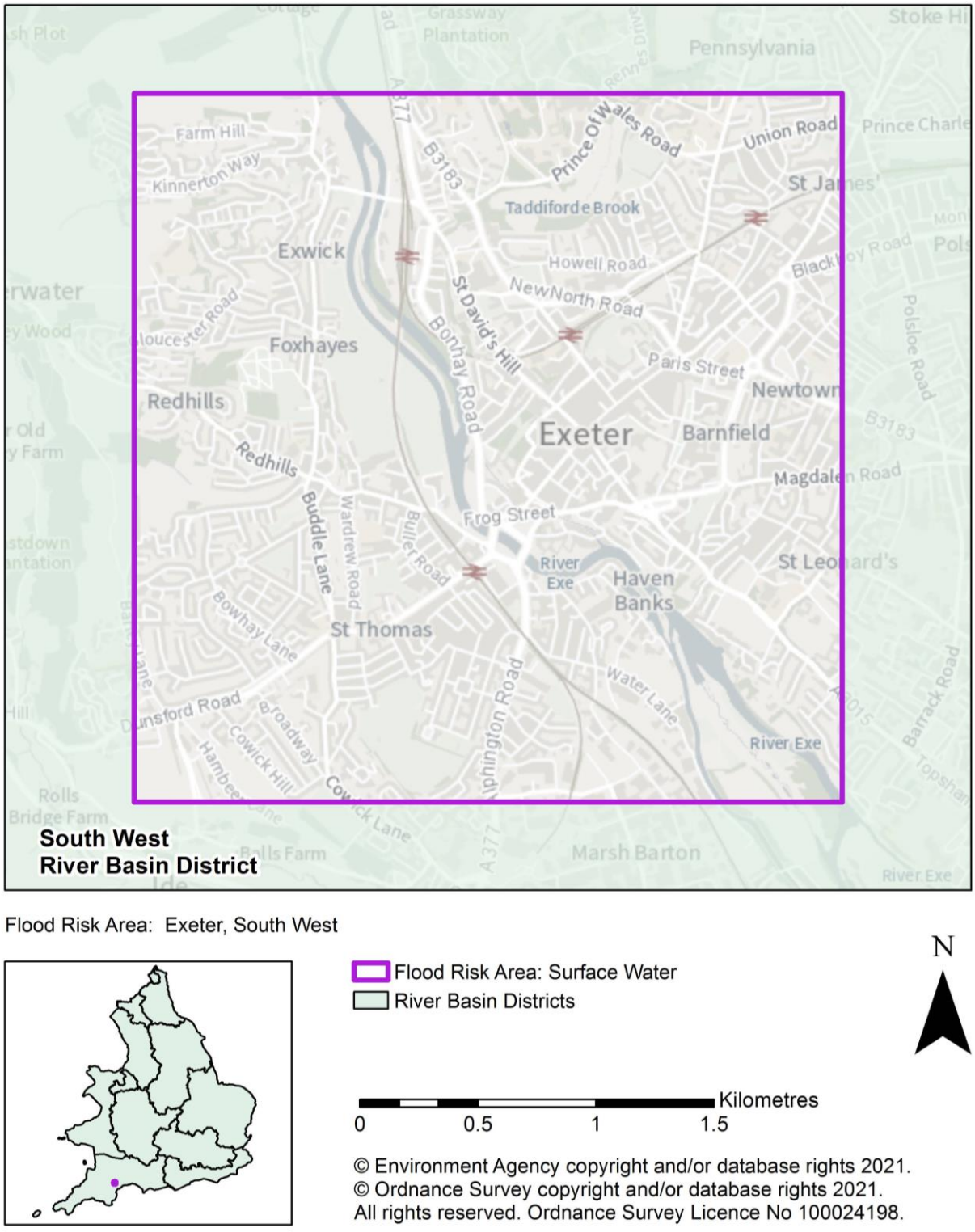
You can also refer to the section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the river basin district.

## Objectives and measures for the Exeter FRA

Measures have been developed that apply specifically to the Exeter FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Exeter FRA.

You can find information about all the measures that apply to the Exeter FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Exeter Surface Water Flood Risk Area




Flood Risk Area: Exeter, South West



Flood Risk Area: Surface Water
River Basin Districts

N

Kilometres
0 0.5 1 1.5



**Figure 12: a map showing the boundary of the Exeter Flood Risk Area**

## Introduction to the Exeter Surface Water Flood Risk Area

The Exeter Flood Risk Area (FRA) is on the south coast of Devon. The area comprises of several urban communities with a mixture of residential and commercial properties. These communities include parts of:

- Heavitree
- Marsh Barton
- Exwick
- St Thomas

The Exeter FRA is surrounded by green space of mainly farmland. It's been identified as an FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

Devon County Council take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. They are the Lead Local Flood Authority responsible for managing flood risk from:

- surface water
- groundwater
- ordinary watercourses

Whereas the Environment Agency's remit includes flood risk from rivers and the sea.

South West Water owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA. Exeter City Council are the Local Planning Authority, whose remit includes ordinary watercourses and planning.

## Hydrology and geology of the catchment

Please refer to The Exeter Rivers and Sea Flood Risk Area in the section for more information on the geology and soil characteristics of the River Exe catchment.

## Environmental designations

Exeter contains a rich variety of wildlife habitats owing to a particular combination of geology and topography. The Bonhay Road Cutting Site of Special Scientific Interest (SSSI) is located within the Exeter FRA.

Scheduled Ancient Monuments within the Exeter FRA include:

- the medieval Exe Bridge
- Rougemont Castle
- part of the Roman town of Exeter, beneath Cathedral Green

Numerous listed buildings and Conservation Areas are located within the Exeter FRA.

Registered Parks and Gardens located within the Exeter FRA include the St. Bartholomew's Cemetery and Northerhay and Rougemont Gardens.

## Flood risk sources

The Exeter FRA is susceptible to flooding from surface water during high rainfall events due to the heavily urbanised nature of the catchment. The city is characterised by relatively compact urban areas set within countryside. Much of the surface water flooding across Exeter is a result of the urbanised nature of the city with a high proportion of impermeable surfaces. These surfaces are exacerbated by the topography of the city, as well as aging drainage infrastructure that has been increasingly overloaded with additional surface water input. This is due to climate change and urban creep, as well as becoming tide-locked in frequent tidal conditions and when fluvial events occur.

The Exeter FRA is also susceptible to flooding from rivers and the sea. The Exeter St Thomas area of the FRA is designated as a Rapid Response Catchment. Please refer to The Exeter Rivers and Sea Flood Risk Area section for more information on the flood risk from rivers and sea and how its management.

The Exeter Ship Canal lies within the FRA and is owned and maintained by Exeter City Council.

## Current flood risk

The Exeter FRA has a long history of flooding with records dating back to the 13th century. The most recent significant flood event attributed to surface water happened in October 2014, where 64 properties were affected. Other flood events in areas such as Longbrook, have happened since 2014 but not to the same scale.

The flood hazard and risk maps show that in the Exeter FRA, 5,662 people live in areas at risk of flooding from surface water. Of these people, 9.5% live in areas of high risk.

Also shown to be at risk of flooding from surface water are:

- 460 non-residential properties - including hospitals, schools and colleges and public utilities
- 2.48km of roads
- 3.74km of railway
- 0.18ha of agricultural land
- areas of designated environmental sites
- 23 listed buildings
- scheduled ancient monuments
- water abstraction sites

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Exeter FRA.

Based on this information, Risk Management Areas (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the future and current impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from surface water is led by Devon County Council, who are the Lead Local Flood Authority in collaboration with other RMAs and other stakeholders. This includes:

- the Environment Agency
- South West Water
- Exeter City Council
- the East Devon Catchment Partnership

The Devon Flood and Water Management Group comprises of all the local RMAs and key partners. They meet regularly to:

- discuss work programmes
- topical flood resilience matters
- resolve any operational issues across Devon

Community volunteers in the Exeter St Thomas have created a Community Emergency Plan which includes flood wardens.

### Monitoring, forecasting, modelling and warning

Please refer to The Exeter Rivers and Sea Flood Risk Area in the section for more information on the hydrometric monitoring, modelling and flood warning capabilities in the River Exe catchment.

The Environment Agency provide a Flood Warning Service to people in areas that are at risk of flooding from rivers and the sea. In limited locations, where it's technically possible, the Environment Agency are also able to warn people of groundwater flooding. At present, the Environment Agency can only raise high level awareness of the potential for surface water flooding through our web based 5 day flood risk forecast. Currently, there is no detailed surface water warning system for the UK.

The modelling of surface water is undertaken nationally, and the Environment Agency is responsible for publishing surface water flood risk maps. These maps are developed to help with planning the response to surface water flooding issues and are not intended to be used at the individual property level. The Environment Agency work closely with Devon County Council, who are responsible for the modelling and mapping surface water flood risk areas in Devon. This is to make further detailed assessments of the risks and opportunities.

## Flood Alleviation Schemes

The Environment Agency maintains flood risk management assets on Main Rivers throughout the FRA. These include:

- river channels
- flood defence walls
- embankments or engineered channels

Similarly, Devon County Council, Exeter City Council and South West Water maintain assets that perform a flood risk management function on:

- surface water
- ordinary watercourses
- the drainage network (respectively)

Following the Exeter Surface Water Management Plan an investigation undertaken by Devon County Council in partnership with fellow RMAs, the Northbrook catchment was identified as a key area of investment. This is due to the number of properties at risk from surface water and out of bank fluvial flooding from the ordinary watercourse. Three phases of work were then proposed to combat the flooding in the catchment:

- phase 1 - took place at Guinevere Way
- phase 2 - took place at Georges Close
- phase 3 - took place in the Honiton Road area of the catchment

Recent flood risk improvements within the Exeter FRA were undertaken and completed by Devon County Council in 2019. They include the first phase of works to protect 55 properties at Guinevere Way/Round Table Meet, incorporating:

- the installation of a 300m long, low-level wall along the cycle path/footway - Beacon Lane to Bettys Mead playing fields to intercept an overland flow path
- significant highway drainage improvements – 3 grated channels passing over the road and diverting water into the Northbrook watercourse where there’s spare capacity
- the removal of downstream obstruction within the Northbrook watercourse

Phase 2 works to create a flood attenuation area within the public, open space at Georges Close to reduce surface runoff from putting properties at risk. These works were completed in December 2020, benefitting 25 properties locally.

Additional works under the Exeter Surface Water Project included the provision of Property Level Resilience at Old Tiverton Road for 15 properties. These were delivered and managed by Exeter City Council.

Phase 3 works are due to for further investigation and development in the 2021/22 financial year. The plan is to create an above ground attenuation feature that benefits the Honiton Road area of the catchment.

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Exeter FRA. Climate change allowances are predictions of the anticipated change for:

- peak river flow
- peak rainfall intensity
- sea-level rise

Climate change predictions anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Due to the heavily urbanised and low-lying nature of the River Exe catchment, increased rainfall is expected to frequently overload the ageing, combined drainage network. This will place an additional burden on sewer infrastructure to carry other forms of flood water.

Investigations to separate the combined sewer network will be required but may be costly and limited by the available space in the city. To support in the management of this increased risk from surface water, the Environment Agency is working with Devon County Council and Exeter City Council to ensure that new developments are compatible with the increased flood hazards.

The Exeter FRA is also susceptible to an increase in flooding from rivers and the sea as a result of climate change. Please refer to The Exeter Rivers and Sea Flood Risk Area in the section for more information on the climate change impacts on river and tidal flooding within the Exeter FRA.

You can also refer to the section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the river basin district.

## Objectives and measures for the Exeter FRA

Measures have been developed that apply specifically to the Exeter FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Exeter FRA.

You can find information about all the measures that apply to the Exeter FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Exmouth Rivers and Sea Flood Risk Area

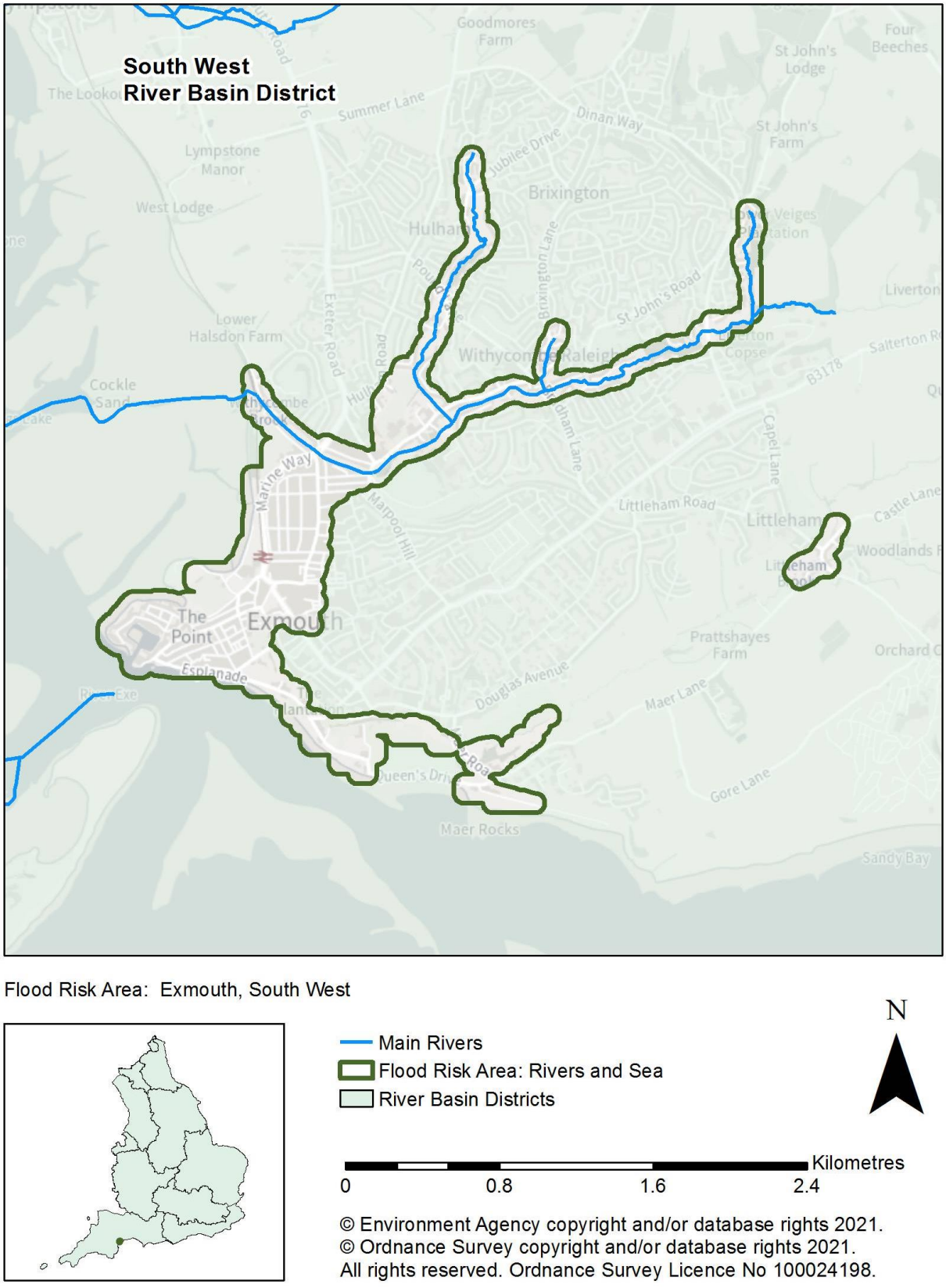



**Figure 13: a map showing the boundary of the Exmouth Flood Risk Area**

## Introduction to the Exmouth Flood Risk Area

The Exmouth Flood Risk Area (FRA) is on the southern coast of Devon, at the mouth of the Exe Estuary. The FRA comprises of several urban communities with a mixture of residential and commercial properties. This includes:

- Exmouth Harbour
- Littleham
- Withycombe Raleigh
- Exmouth Seafront
- Queen's Drive

The Exmouth FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

Exmouth draws in tourism and recreational activities that are vital to the income of the local community. Therefore, many parts of the frontage are heavily developed with a railway line running along the shoreline, which results in a reliance on hard coastal defences.

Much of the infrastructure within the FRA is located immediately behind raised defences, with both residential and commercial properties extending landward. As a result, many of the properties within the FRA are located below sea level, particularly in the Colony area. The coast between Sandy Bay and Exmouth comprises of a cliff area to the east, with the reclaimed spit of Exmouth having been heavily developed over the last 2 centuries. Waves generated in the English Channel are significant along this section of coast.

The Environment Agency take the lead on the development and implementation of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority, whose remit includes flood risk from surface water and ordinary watercourses.

South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. East Devon District Council are both a Risk Management Authority (RMA) and the Local Planning Authority, whose remit includes management of Ordinary Watercourse flood risks, planning and acting as the Coastal Protection Authority.

## Hydrology and geology of the catchment

Exmouth lies to the eastern side of the mouth of the Exe Estuary within the Exe catchment. The headwaters of the River Exe are within Exmoor National Park. The Rivers Creedy and Culm join the River Exe just north of Exeter, and the River Clyst flows directly into the Exe estuary downstream of the Exeter at Topsham.

The geology within the Exe catchment spans approximately 400 million years from the Devonian period through to the present day. The headwaters of the Exe, Haddeo and Barle in the north of the catchment comprise of:

- Devonian siltstones
- sandstones
- shales

These rocks are generally of low permeability and therefore produce more surface water runoff in the upper catchment.

The lower Exe comprises of sandstone breccias within the Permo Triassic strata. Groundwater is contained within the sandstone aquifers of the lower Exe, Culm and Clyst valleys. Recharging of these aquifers during wet periods will have some effect on reducing peak flows in the rivers:

- Exe
- Culm
- Clyst

This is because some of the floodwater volume may be removed by storage into the underlying rock strata.

Soil types affect the response of rivers and surface water to rainfall, and therefore have implications for flood risk. The Exe catchment has a broad distribution of soil types, most soils in the catchment are well drained.

## Environmental designations

Located within the Exmouth FRA is the Maer Local Nature reserve. The FRA borders the:

- Exe Estuary Special Protected Area
- Exe Estuary Ramsar
- Exe Estuary Site of Special Scientific Interest

Nearby are the East Devon Pebblebed Heaths Special Area of Conservation and Aylesbeare Common Royal Society for the Protection of Birds reserve. Exmouth seafront is also a designated bathing waters zone.

Numerous listed buildings and Conservation Areas are located within the Exmouth FRA.

## Flood risk sources

The predominant sources of flood risk to the Exmouth FRA are fluvial and tidal risks. Much of the built infrastructure within the FRA is protected by engineered defences.

Along the coastal frontage, an elevated flood defence wall provides protection from coastal flooding. However, in south-westerly storms, waves regularly break over the wave return wall causing localised flooding along the Esplanade. Recent upgrading of the coastal

defences aim to contain flood waters that have overtopped the defences and prevent flooding further inland. Nevertheless, properties within the Colony area and the town centre are vulnerable to flooding from wave overtopping due to the low-lying ‘dish-shaped’ topography behind the tidal defences.

The principal watercourses within the Exmouth FRA are the:

- Withycombe Brook (main river)
- Bapton Brook (main river)
- Littleham Brook (ordinary watercourse)

The Withycombe Brook and Bapton Brook both benefit from a historic flood defence scheme constructed in the 1960s. This gives rise to a heavily modified system, with limited biodiversity and amenity value. Within the scheme there are extensive lengths of straight concrete channel contained by high retaining walls, with a limited residual lifespan and requirement for future upgrading.

The Exmouth FRA is also susceptible to flooding from surface water and sewers during high rainfall events. This is due to the heavily urbanised nature of the FRA and ageing drainage infrastructure.

South West Water operates and manages a surface water pumping station to serve the Colony area. This is noted as having ground levels of 2m below extreme tidal levels at the lowest point. South West Water and Devon County Council have recently undertaken an integrated urban drainage study of the sewerage network to identify and address areas of concern.

## Current flood risk

The Exmouth Flood Risk Area (FRA) has a long history of flooding with notable events in:

- 1925
- 1938
- the 1960s
- 1972
- 2004
- 2005
- 2008
- 2012
- the winter of 2013/14

Since the production of the first cycle Flood Risk Management Plans in 2015, there have been three recorded flood events in the Exmouth FRA. All three events were coastal events causing flooding to the Esplanade.

The flood hazard and risk maps show that in the Exmouth FRA, 6,010 people live in areas of flood risk from rivers and the sea. Of these people, 76.5% live in high risk areas.

Also shown to be at risk of flooding from rivers and the sea are:

- 514 non-residential properties – including emergency service stations, health centres and schools
- 0.89km of roads
- 0.78km of railway
- 5.2ha of agricultural land
- areas of designated environmental sites
- 20 listed buildings

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Exmouth FRA.

Given the scale and significance of flood risk in the Exmouth FRA, measures are being taken to increase community resilience to flooding and coastal change.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. This includes:

- Devon County Council
- South West Water
- Exeter City Council

The East Devon Catchment Partnership also covers the River Exe catchment. They're increasingly considering more natural solutions to flood risk problems in and around East Devon as part of their work plan.

The Devon Flood and Water Management Group, which comprises of all the local RMAs and key partners, meet regularly to:

- discuss work programmes
- discuss topical flood resilience matters
- resolve any operational issues

Furthermore, Exmouth Town Council meet to discuss emergency planning, as well as having a well-developed Community Emergency Plan, which is supported by the community flood group.

### Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service

- raising public awareness with associated campaigns

Increasing flood resilience, where possible, is important as building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them with a flood warning service, allows us to reduce the risk to life and property. This is even if defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Exmouth FRA that monitor:

- tide levels
- river levels
- river flow
- rainfall

The tide levels are forecast from the Class A tide gauge at Exmouth Dock and estuary levels are also monitored at Topsham. The wave buoy at Dawlish is managed by the Plymouth Coastal Observatory and provides data during incidents and calibrates other sources of data. River flow on the Withycombe Brook is monitored at Phear Park. There is no fluvial monitoring on the Littleham Brook. Rainfall is monitored by the telemetered rain gauge at the Met Office in Exeter. There is also another rain gauge in the vicinity of the FRA at Maer Lane.

The information collected from these monitoring sites are used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents. Our Flood Warning Service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea. There are 2 coastal flood alert areas that cover the Exmouth FRA.

Additionally, there are 2 coastal flood warning areas that cover the Exmouth FRA. There’s one fluvial flood alert area that covers the Exmouth FRA. Currently there is no fluvial flood warning that covers the Exmouth FRA. However, a fluvial flood warning service is being developed as part of the Flood Warning Expansion Project. Currently there is no fluvial flood warning service on the Littleham Brook.

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic and forecast modelling. Hydraulic models are used to assess:

- current flood risk
- impacts of climate change
- how future levels of flood risk could be managed

In 2011, a Flood Risk Mapping Modelling study was undertaken to model the Exe Estuary and its tributaries to gain a better understanding of the flood mechanisms and flood risk. However, following the completion of the Exmouth Tidal Defence Scheme, this model will be required to be updated to a wave overtopping model. This is to ensure that the risk to Exmouth is portrayed and flood mapping can be updated to represent the benefits of the new tidal flood defences.

This model also includes the Withycombe Brook. However, the fluvial element of this model requires updating to better represent current understanding of flood risk and the Withycombe Brook Flood Defence Scheme.

A new flood forecasting model is being developed to implement the proposed fluvial Flood Warning Service as part of Flood Warning Expansion Project. Forecasting models are used to determine potential impacts from heavy rainfall or high tide events. These models inform the incident response activities of RMAs and professional partner organisations to reduce risk to communities.

Flood risk maps are published based on the outputs from the hydraulic modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

## Flood Alleviation Schemes

Exmouth has a long history of tidal flooding. The worst recorded flooding was in 1960 when Exmouth flooded twice, with nearly 1000 properties affected. The Environment Agency produced the Exe Estuary Flood and Coastal Erosion Risk Management Strategy, which identified the need to upgrade the tidal defence scheme.

The Environment Agency has been working in partnership with East Devon District Council and Devon County Council to deliver the scheme that will reduce the risk of tidal flooding to over 1,400 residential and 400 commercial properties. This scheme will deliver defences along the estuary between Withycombe Brook and Marine Parade, with key locations at:

- The Royal Avenue
- Camperdown Creek
- The Esplanade

As well as providing benefits to reduce flooding, the adopted design will also improve road safety.

Once the scheme is complete, East Devon District Council will have a future role of maintaining the defences built on council-owned land. Exmouth Town Council has worked in collaboration with Environment Agency and East Devon District Council to recruit an

additional team of flood wardens. This is for community operated assets that form part of Exmouth Tidal Defence Scheme.

The Environment Agency are also working with Hello Lamp Post to commission a 12 month digital engagement pilot initiative as part of the Exmouth Tidal Flood Defence Scheme. This is to:

- showcase the scheme
- showcase its community operated assets
- promote residual risk messages

Exmouth Town does not have any coastal erosion issues but there are beach lowering issues along the seafront. This has justified the requirement for the Beach Management Plan (BMP), which currently promotes beach recharging/re-profiling by 2030 along the Maer. This will be confirmed as part of BMP review starting 2021. The Shoreline Management Plan refresh indicates a 'hold the line' policy for the coastline frontage is now preferred at his location.

A strategy for long-term shoreline management is in development by Devon County Council and the Environment Agency. Upon completion, this will be adopted to increase the resilience of vulnerable areas and infrastructure from flooding and erosion, while enabling regeneration and growth. Where required, it'll promote the adaptation of development away from unsustainable locations.

Exmouth was subject to serious fluvial flooding from the Withycombe, Bapton and Littleham Brooks in 1960 following a local thunderstorm. This subsequently led to the construction of the current Withycombe Brook Flood Defence Scheme in 1963. The scheme is dual purpose, with the upper sections designed to convey flood water quickly out the system. The lower section is to prevent against tide locking where the watercourse discharges into the Exe Estuary.

The Bapton Brook drains into the Withycombe Brook and benefits from an engineered overflow channel/culvert to provide additional capacity during times of high flows. This scheme has successfully protected approximately 1000 properties from flooding, through providing a 1% Annual Exceedance Probability (AEP) standard of protection from fluvial flooding and catering for the 0.5% AEP tidal levels at the confluence with the Estuary. However, this flood defence scheme is coming to the end of its life. The build quality of many of the historic assets is noted as being poor, with visible signs of concrete spalling and failing base slabs. Review and investment will be required to maintain and future-proof the scheme.

Within Littleham village, Littleham Road has a history of flooding from the brook and surface water runoff from the south. Replacement of the road culvert has alleviated much of this flooding but there is still surface water nuisance flooding in Maer Lane that originates from Sandy Bay.

The Exmouth FRA is also susceptible to flooding from surface water and sewers during high rainfall events. This is due to the heavily urbanised nature of the FRA and ageing

drainage infrastructure. Additional surface water inputs to combined sewers, as well as ageing drainage infrastructure, result in increased levels of risk to some areas of the community. Tide locking also prevents discharge from some portions of the drainage network heightening risks during high tides.

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Exmouth FRA. Rainfall intensity is expected to increase in the future and cause higher river flows and levels. Sea levels are also expected to rise. As sea levels rise, coastal flooding will become more frequent, as higher water levels and storms will be seen more often. This means that flooding from rivers and the sea will become more frequent.

Sea level rise and increased storminess will result in the Exmouth coastal frontage, development and the critical transport infrastructure being more susceptible to damage from coastal flooding and overtopping. Some low-lying areas of the Exmouth FRA are particularly vulnerable to sea level rise, such as the Colony and the Maer. These areas will be affected by greater flood depths in an inundation event, up to first floor level for properties located in the Colony. The increase in sea level rise and coastal storms will also result in Dawlish Warren spit being breached.

Impacts within the Exe Estuary are likely to increase in the future as the spit transitions to a more naturally functioning system as identified within Exe Estuary Flood and Coastal Erosion Risk Management Strategy 2012. This also includes the post-scheme review 2021 which is ongoing). Under this scenario there will be increased wave heights of approx. 0.3 to 0.5m within the Exe Estuary. This will increase risk of spray and potentially wave overtopping of coastal defences and main line railway within lower estuary.

The Exmouth Tidal Defence Scheme was completed in 2021. This scheme is comprised of defences along the estuary between Withycombe Brook and Marine Parade, with flood gates at key locations at:

- The Royal Avenue
- Camperdown Creek
- The Esplanade

Sea level rise will begin to reduce the level of protection of the new defences in 2065, the defences have been built to be upgradable to protect against future sea level rise.

The Exmouth Docks area is undefended by the new Exmouth Tidal Defence Scheme but is currently protected from coastal flooding by the higher ground levels and some privately owned and maintained sea walls. However, anticipated it's that intervention will be required within the next 50 years to adapt to sea level rise in this area.

The Exmouth FRA is not impacted by coastal erosion, as hard engineering structures have fixed the coastline in place. However, there are beach lowering issues along the seafront.

This has justified the requirement for the Beach Management Plan (BMP), which currently promotes beach recharging/re-profiling by 2030 along the Maer. This has been confirmed as part of the BMP review at the start of 2021. The Shoreline Management Plan refresh indicates a 'hold the line' policy for the coastline frontage is now preferred at his location. Coastal squeeze will see a reduction in the available beach area.

Climate Change predictions indicate that rainfall intensity is expected to increase in future causing higher river flows and levels. This means that flooding from rivers will become more frequent.

The Withycombe Brook is a heavily modified watercourse with many sections being lined concrete channels crossed by road bridges which lead to channel capacity constraints. There are limited options available to increase the capacity of the Withycombe Brook due to the constrained urban nature of the watercourse. Flows will become increasingly constricted resulting in flooding. Significant investment will be required to maintain or increase resilience by replacing and improving existing defences. However, other options will have to be considered to ensure that this area has a sustainable future to the impacts of climate change and increased flooding.

Many of the ordinary watercourses in the Exmouth FRA will also be impacted by Climate Change, which include the Bapton Brook and Littleham Brook. With increased rainfall intensity and rapid runoff from the upper catchments, flows and levels within these smaller watercourses will become elevated. The middle parts of the Littleham Brook flow through an urban area which will see an increase in flood frequency and impacts. This is also partly due to the limited scope to increase the capacity of the structures that cross the Littleham Brook which may further constrict flow. Changes in the management of this watercourse will be required to improve its capacity. Tide locking of the outfall of the Littleham Brook into the sea will also occur more frequently due to sea level rise.

Climate change projections anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Due to the heavily urbanised and low-lying nature of land within the FRA, increased rainfall is expected to frequently overload the ageing sewerage network. This will place a greater reliance on pumped systems to disperse drainage. A knock-on impact of this will be an increased pollution risk to the designated Exe Estuary. Furthermore, there are areas of low-lying reclaimed porous land throughout the coastal fringe of the Exmouth FRA. With sea level rise, this will result in a raised water table and seepage of salt water into basements of properties and the drainage network. This will also reduce its capacity and affect the treatment of wastewater.

To support in the management of this increased risk from surface water, the Environment Agency is working with East Devon District Council, Devon County Council and South West Water to ensure that surface water flood risk is managed sustainably.

Please refer to the Climate change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the Exmouth FRA

Measures have been developed that apply specifically to the Exmouth FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Exmouth FRA.

You can find information about all the measures which apply to the Exmouth FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Ilfracombe Rivers and the Sea Flood Risk Area

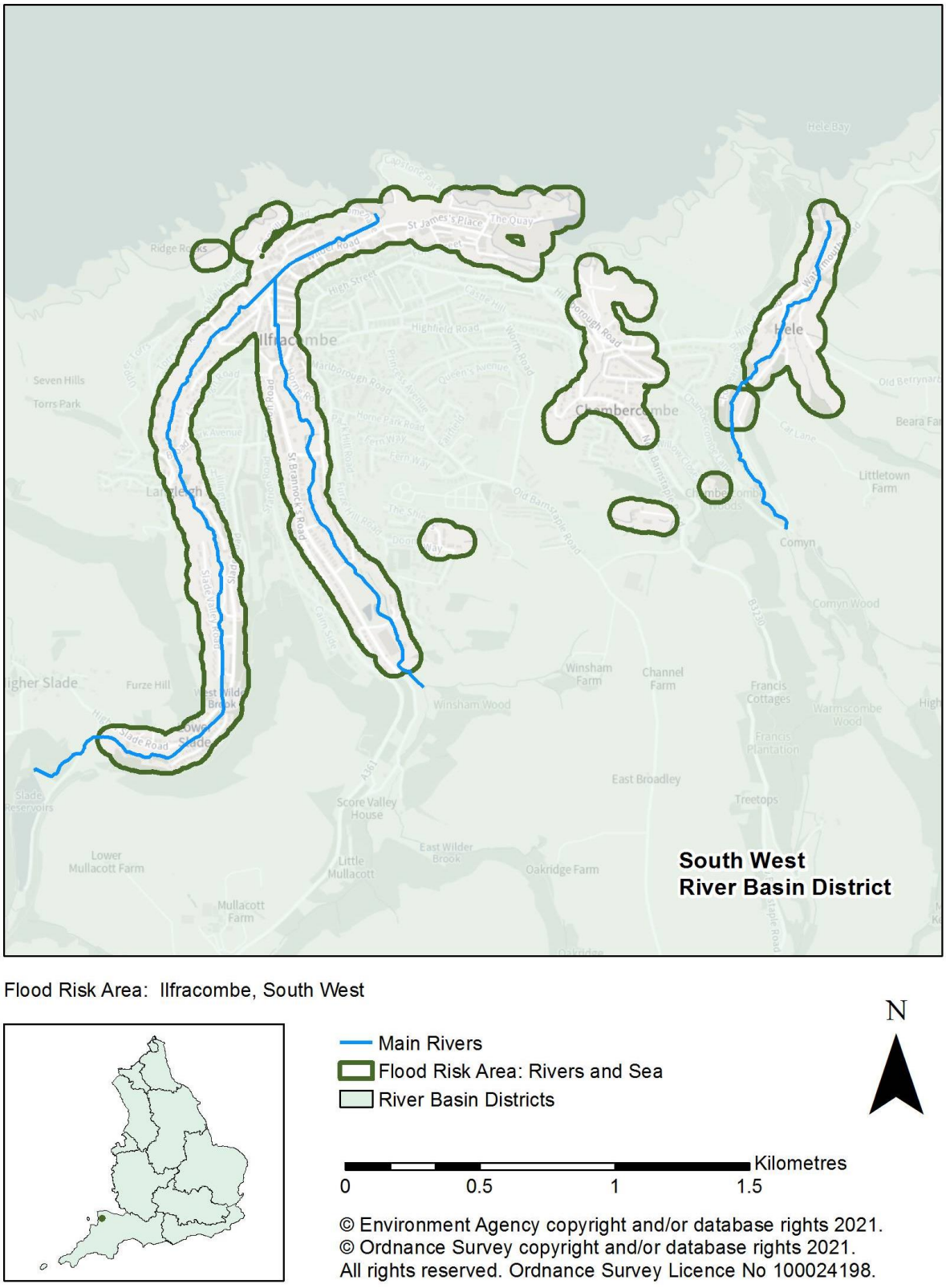



**Figure 14: a map showing the boundary of the Ilfracombe Flood Risk Area**

## Introduction to the Ilfracombe Flood Risk Area

The Ilfracombe Flood Risk Area (FRA) is on the northern coast of Devon. The FRA includes the 2 coastal communities of Ilfracombe and Hele.

Ilfracombe is the third largest settlement in northern Devon and is an important service centre providing a range of opportunities within:

- tourism
- retail
- education
- health and community facilities
- employment

The town has grown up the hillsides around the harbour and town beaches and along the two main river valleys, the East Wilder Brook and West Wilder Brook.

Hele is a small coastal village to the east of the town of Ilfracombe. The Hele Valley stream drains through Hele village and out to Hele Bay.

The Ilfracombe FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and implementation of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority, whose remit includes flood risk from surface water and ordinary watercourses.

South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. North Devon District Council are both a Risk Management Authority (RMA) and the Local Planning Authority, whose remit includes:

- the management of ordinary watercourse flood risks
- planning
- acting as the Coastal Protection Authority

## Hydrology and geology of the catchment

The catchment area is characterised by Devonian Ilfracombe slate to the west and Hangman sandstone to the east. The low permeability of the Devonian slate to the west means that much of the catchment will respond rapidly to any rainfall.

## Environmental designations

The Hele, Samson's and Combe Martin Bays Site of Special Scientific Interest are within 1km of the Ilfracombe FRA. Exmoor National Park is located within 5km Flood Risk Area.

Several Local Wildlife Sites exist on or are adjacent to the watercourses in the Flood Risk Area including Torrs Park, The Cairn and Old Railway, Winsham Farm and Beacon Point.

Numerous listed buildings are located withing the Ilfracombe FRA including:

- Harbour Master's Office
- Ilfracombe Yacht Club
- Ship and Pilot Inn
- Parish Church of Saint Philip and St James

The Ilfracombe FRA also includes a Conservation Area.

## Flood risk sources

The greatest sources of flood risk to the Ilfracombe FRA are fluvial and coastal. Through the town of Ilfracombe, the East and West Wilder Brooks flow in open channels from the southern area of the town. It then into culverted watercourses beneath the older Victorian part of the town, before merging and entering the sea at the Promenade.

The Ilfracombe FRA is also susceptible to flooding from the sea during times of high spring tides, during storms and when prevailing winds are blowing from the North. Areas impacted include:

- Wilder Beach
- Cheyne Beach
- the Harbour

The risk of flooding on all watercourses within the FRA can be affected by high tides when the ability for river flows to discharge to the sea is reduced.

The village of Hele Valley stream drains through a steep-sided valley and out to Hele Bay.

The Ilfracombe FRA is designated as a Rapid Response Catchment, meaning that the onset of flooding can be fast, this is due to the steep and heavily developed nature of the catchment. Due to the rapid response nature of the catchment and the vulnerability of the community to flash flooding, the Environment Agency are committed to:

- notifying residents and businesses about their flash flood risk
- offering community representatives assistance with developing the Ilfracombe Community Emergency Plan (every three years)

The Upper and Lower Slade reservoirs are located to the south of the Ilfracombe FRA on the West Wilder Brook.

The Ilfracombe FRA is also susceptible to flooding from surface water during high rainfall events due to the heavily urbanised nature of the FRA. Compounded by aging drainage infrastructure that has been increasingly overloaded with additional surface water input. Flood risk from new development pressures within the Ilfracombe FRA is managed through the designation of a Critical Drainage Area (CDA).

A CDA is an area that has critical drainage problems that has been notified to the local planning authority by the Environment Agency in line with the National Planning Policy Framework (NPPF). In these locations, there is a need for surface water to be managed to a higher standard than normal to ensure any new development will contribute to a reduction in flooding risks in line with NPPF. These higher standards are determined by the Environment Agency.

## Current flood risk

The Ilfracombe Flood Risk Area (FRA) has a long history of flooding with notable events including:

- 1910
- 1979
- 1981
- 1990
- 1993
- 1996
- 2014

These flood events have been caused by multiple sources including coastal wave overtopping, fluvial, surface water, tide locking and sewage recharge.

Since the production of the first cycle Flood Risk Management Plans in 2015, there have been three recorded flood events in key locations caused by a combination of sources in the Ilfracombe FRA.

During the winter of 2015 and 2016, properties in Ilfracombe had flooded due to intense rainfall causing surface water flooding. In 2019, a tidal flood event affected the Cheyne Beach area of the Ilfracombe FRA.

The flood hazard and risk maps show that in the Ilfracombe FRA, 1,344 people live in areas at risk of flooding from rivers and the sea. Of these people, 95% are considered to live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 153 non-residential properties – including hospitals, schools and colleges and public utilities
- 0.41ha of agricultural land
- 20 listed buildings
- bathing waters
- 3 licensed abstractions

Services at risk include:

- Ilfracombe Infant & Nursery School
- bus station

- care homes
- electricity sub stations
- South West Water sewage pumping station
- lifeboat station
- medical centre
- Wilder Road and the commercial harbour

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Ilfracombe FRA.

Given the scale and significance of flood risk in the Ilfracombe FRA, measures are being taken to increase community resilience to flooding and coastal change.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. This includes:

- Devon County Council
- South West Water
- North Devon District Council

The North Devon Catchment Partnership also covers the Ilfracombe area. They are increasingly considering more natural solutions to flood risk problems in and around North Devon as part of their work plan.

The Devon Flood and Water Management Group, which comprises of all the local RMAs and key partners, meet regularly to:

- discuss work programmes
- discuss topical flood resilience matters
- resolve any operational issues

Other partners to delivery of flood and coastal risk management works include Ilfracombe Town Council, the Ilfracombe Regeneration Board, and Ilfracombe Harbour Board.

Furthermore, Ilfracombe Town Council meet to discuss emergency planning, as well as having a well-developed Community Emergency Plan which includes Flood Wardens.

### Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service

- raising public awareness with associated campaigns

Increasing flood resilience where possible is important as building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them with a flood warning service allows us to reduce the risk to life and property even if defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Ilfracombe Flood Risk Area (FRA) that monitor:

- tide levels
- river levels
- river flow
- rainfall

The tide levels are forecast from Ilfracombe. River levels are monitored at the confluence of the East and West Wilder Brook and at Lambda on the East Wilder Brook. River flow is monitored downstream of Slade reservoir at Saltmer Close which was recently installed as part of the Environment Agency's Flood Warning Expansion Project. Furthermore, the Flood Warning Expansion Project also includes the installation of a level gauge Witheridge Place in Hele. Rainfall is monitored by one telemetered rain gauge at Hore Down with a manually read daily gauge nearby.

The information collected from these monitoring sites are used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents. Our Flood Warning service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea. There is one coastal flood alert area that covers the Ilfracombe FRA. Additionally, there are two coastal flood warning areas that cover the Ilfracombe FRA. There is one flood alert area that covers the Ilfracombe FRA. Currently there are no fluvial flood warnings for the properties at high risk of flooding from rivers in the Ilfracombe FRA.

However, it's anticipated that these properties will receive a flood warning service as part of the Flood Warning Expansion Project by 2022. Further engagement is planned to start during 2021/22 to:

- raise flood awareness and understanding
- support community resilience efforts at Ilfracombe and Hele
- promote the launch of this new Flood Warning Service

The aim is to ensure the community knows how to:

- respond to flood warnings
- stay safe
- minimise damage

This engagement will involve the community flood group to support them refresh their existing Community Emergency Plan.

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic and forecast modelling. Hydraulic models are used to assess current flood risk, impacts of climate change and how future levels of flood risk could be managed.

In 2009, the Ilfracombe flood study was undertaken to model the East and West Wilder Brooks in the Ilfracombe area to gain a better understanding of the flood mechanisms and flood risk. This study highlighted the need to improve the hydrometric monitoring of the catchments area.

In 2017, the Ilfracombe Flood risk and tidal procedure study was undertaken to assess tidal flood risk in Ilfracombe and to inform and update the tidal flood warning procedures.

Flood risk maps are published based on the outputs from the hydraulic modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

## Flood Alleviation Schemes

Many assets along watercourses within the FRA are in private ownership by riparian owners for both residential and commercial properties that sit along watercourses or over culverts. The Environment Agency maintain key flood risk management assets throughout the FRA. For example, main river channels, flood defence walls or embankments.

Similarly, Devon County Council, North Devon District Council and South West Water maintain assets that perform a flood risk management function on the:

- surface water
- ordinary watercourses
- sewer network

In 1985, the Cheyne Beach Flood Defence Scheme was built following the 1979 and 1981 storms. In 1990, the Inner Harbour Flood Defence Scheme was built.

Since the production of the first cycle Flood Risk Management Plans 2015, there have been no notable flood defence schemes delivered. However, schemes are currently under consideration by a partnership of RMAs to address all sources of risk. Work is underway to establish if a viable economic case can be made to progress them. These solutions may include:

- nature-based solutions in the upper catchment of the watercourses
- improvements to Slade reservoirs
- localised improvements to culverts and drainage systems

Ilfracombe has been identified by Devon County Council as a site where surface water flooding is an issue. This has been included in the Devon Surface Water Management Plan (SWMP). They'll continue to progress with the Ilfracombe SWMP to finalise engineering options and prioritise/allocate funding and resources for flood alleviations works.

The North Devon District Council and Ilfracombe Town Council have been actively trying, through its Masterplan, to regenerate the seafront and inner harbour areas, including the:

- Golden Coast
- old bus station
- inner harbour

All of which have significant flooding issues. All sites could provide betterment, perhaps by upgrading the existing defences.

The Harbour also has the potential for regeneration and could fully protect the harbour area from flooding. Although additional works would also be required at Wildersmouth Beach to reduce overtopping and inundation of Broad Street.

Ilfracombe is expanding by 40% towards the south, this will be dealt with by a Sustainable Urban Drainage scheme to the standards set out in the Critical Drainage Area. The TDK Factory (East Wilder Brook) has considered residential development, which is possible with:

- site raising
- river improvements
- extra flood storage

Pressure for additional back garden residential development will be resisted unless it's outside of the flood risk area. Therefore, applying the relevant land use planning tests would ensure it's appropriate and sustainable.

The West Wilder Brook and lower part of the East Wilder Brook are within the reservoir flood risk area. Any large residential development must consider this as the reservoirs were not designed to accommodate flood water.

An update to the Shoreline Management Plan is in development by the North Devon and Somerset Coastal Advisory Group. Upon completion this will be adopted to identify opportunities to increase resilience of vulnerable areas and infrastructure from flooding and erosion. It'll also enable regeneration and growth, and where required, promote the adaptation of development away from unsustainable locations.

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Ilfracombe FRA. Rainfall intensity is expected to increase in the future and cause higher river flows and levels. Sea levels are also expected to rise. As sea levels rise, coastal flooding will become more frequent, as higher water levels and storms will be seen more often. This means that flooding from rivers and the sea will become more frequent.

Sea level rise and increased storminess will result in the Ilfracombe and Hele coastal frontage, development and critical infrastructure being more susceptible to damage. Sea level rise will also increase storm and wave heights, leading to overtopping and coastal flooding occurring more frequently at Wildersmouth and Cheyne Beach. At the current rate of sea level rise during high spring tides, flooding and subsequent tide locking of the inner harbour at Ilfracombe can also be expected by 2050.

Plans are in place to investigate the optimum time to increase resilience or adapt the inner harbour against climate change. Work with North Devon District Council is underway to implement the Wildersmouth Beach Masterplan. This is to reduce the impacts of wave overtopping and regenerate the public space along this frontage.

The geology of the coast will limit erosion along the Ilfracombe FRA coastline, although localised impacts are expected at Capstone Road. Increased sea levels will result in beaches becoming squeezed against hard defences, such as sea walls and submerged for increasing portions of the tidal cycle. This will result in the loss of amenity beaches over time, such as:

- Wildersmouth Beach
- Harbour Beach
- Tunnels Beach

The Ilfracombe FRA is classified as a Rapid Response Catchment. Meaning that the onset of flooding in the present day can be fast. This is due to the steep and heavily developed nature of the catchment. Climate Change predictions indicate that rainfall intensity is expected to increase in future causing higher river flows and levels in the Wilder Brook and Hele Stream. This means that flooding from rivers and surface water will become more frequent in already rapidly responding catchments.

Both the Wilder Brook and Hele Stream are heavily modified watercourses with channel capacity constraints due to numerous bridges. There are limited options to increase the capacity of the existing culverted watercourses, resulting in more frequent and severe impacts of flooding.

Climate change predictions anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Agricultural runoff in the upper catchment will also increase due to the changes in rainfall frequency and intensity. Measures have been included to understand Natural Flood Management techniques and their applicability to managing flood risk.

Furthermore, due to the heavily urbanised nature of the Ilfracombe catchment, increased rainfall is expected to frequently overload the ageing drainage infrastructure. To support in the management of this increased risk from surface water, new developments within the Ilfracombe FRA are managed through the designation of a Critical Drainage Area (CDA).

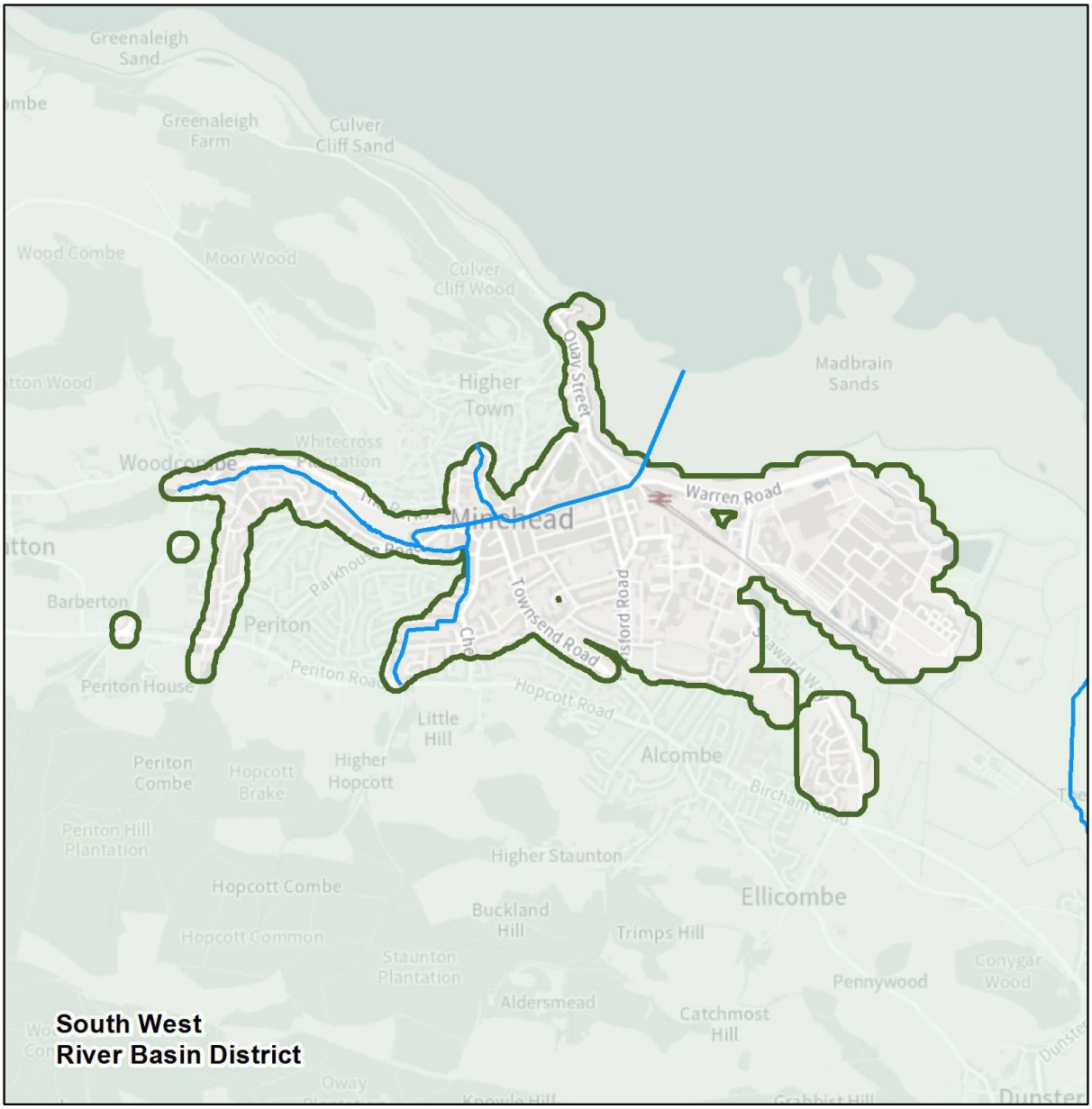
Devon County Council plans to investigate options to increase resilience to surface water flooding. South West Water reviewed their assets, the associated catchment and risks to determine which actions will be required to address the impacts of climate change on the sewer network. Please refer to the Climate change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South-West River Basin District.

## Objectives and measures for the Ilfracombe FRA

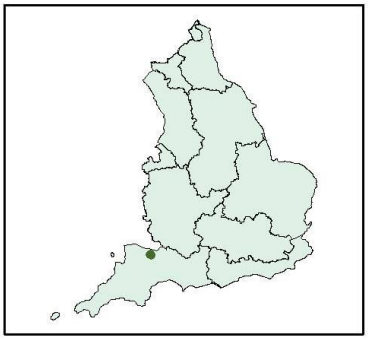
Measures have been developed that apply specifically to the Ilfracombe FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Ilfracombe FRA.

You can find information about all the measures that apply to the Ilfracombe FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Minehead Rivers and Sea Flood Risk Area




Flood Risk Area: Minehead, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

0 0.8 1.6 2.4 Kilometres



**Figure 15: a map showing the boundary of the Minehead Flood Risk Area**

## Introduction to the Minehead Flood Risk Area

The Minehead Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. Somerset County Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses.

Somerset West and Taunton Council hold the role of Coast Protection Authority. The council is responsible for the coastal frontage, as well as being a Risk Management Authority (RMA) for ordinary watercourses in support of the LLFA. Somerset West and Taunton Council are also the Local Planning Authority, who are developing the latest Local Plan for the district. The plan includes significant future development in Minehead.

Wessex Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

The Parrett Internal Drainage Board (IDB) manages a network of lowland, agricultural drainage, which includes some of the urban area on the east side of Minehead.

Minehead is in a lowland area along the coast and is the main service centre for much of the surrounding area. There are a wide range of facilities for:

- employment
- retail
- service
- education
- community and leisure activities

With a population of approximately 12,000, it’s the third largest town in the Somerset West and Taunton district, after Taunton and Wellington, and is the principal coastal town in the district. The town has a high-level of self-containment with 78% of its people living and working in Minehead. It’s the main focus for public transport services in West Somerset, linking to the M5, Taunton and Bridgwater. These factors make it one of the principal settlements in the Somerset West and Taunton area.

Minehead is an important centre, providing a full range of services to an extensive rural hinterland. It’s West Somerset’s main tourist destination with numerous hotels and Butlins holiday park. These are supported by attractions, such as the:

- golf club
- West Somerset Heritage Railway
- numerous pubs and cafes

Extensive development sites have been allocated in the Local Plan. This has the potential to add significant pressure to the existing surface drainage and sewer networks, and highly constrained and culverted fluvial network.

## Current flood risk

The Minehead FRA is at risk of flooding from interconnected sources, including:

- the sea
- a network of urbanised and constrained rivers
- surface water
- public sewers

Minehead benefits from sea defences along its urban frontage, which were built 20 years ago. The eastern end of the town is at increased vulnerability due to ageing and eroding sand dunes and shingle ridge. With sea level rise and continued shoreline processes, this compounds flood risks inland from rivers, surface drainage and sewers, and increases risk to multiple services.

Fluvial flood risk studies and sporadic localised flood incidents have previously shown potential significant flood risk from the town's rivers. The cost of required, comprehensive mitigation is neither economically viable nor affordable when assessed in isolation. Similarly, surface water flood risks are potentially significant, but costly to mitigate on their own. The local geography means that these risks are interconnected and must be considered holistically.

The flood hazard and risk maps show that in the Minehead FRA, 3,100 people live in areas at risk of flooding from rivers and the sea. Of these people, 0.03% live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 369 non-residential properties – including the hospital, schools and colleges and public utilities
- 1.88km of railway
- 38.34ha of agricultural land
- 27 listed buildings
- 1 bathing water
- 5 licensed water abstraction sites

Although not demonstrated in the statistics above, a short stretch of the A39 that approaches Minehead is at some risk of flooding from the sea. Flooding of this section of the A39, including Seaward Road, would impact on the access in and out of the town.

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Minehead FRA.

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with Risk Management Authorities (RMAs) and stakeholders. This includes:

- Somerset County Council
- Somerset West & Taunton Council
- the IDB
- Somerset Rivers Authority (SRA)
- Wessex Water

The RMAs meet with local council and community representatives quarterly through the Somerset West and Taunton Flood & Coast Protection Board. This is hosted by Somerset West and Taunton Council and enables issues, work programmes and operational issues to be raised and discussed.

In addition, the RMAs are currently meeting regularly to discuss the development of an integrated strategy to manage all flood risks in connection with the spatial planning and future development of the town.

The SRA was set up in 2015 following the flooding of the Somerset Levels and Moors in 2013/14 as a partnership of the local flood RMAs. The SRA oversees 'Somerset's 20 Year Flood Action Plan'. This includes additional flood risk mitigation works for Somerset that cannot be delivered under the remits of other RMAs.

The Environment Agency monitor river, tidal and rainfall conditions at 2 sites in and immediately adjacent to the FRA. These sites collect data on:

- river levels
- river flows
- rainfall

The 'South West Regional Coastal Monitoring Programme' operates a wave buoy off Minehead. The nearest Class A tide gauges are at Ilfracombe to the West and Hinkley Point to the East. This information is used to inform activities related to 5 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur.

The water level and flow information are also used to inform and calibrate mathematical modelling of the river network. In 2008 the Environment Agency developed a fluvial hydraulic model for the network of urban watercourses in Minehead. This was used for various flood mitigation appraisals in subsequent years. This informed the reports that concluded that comprehensive fluvial flood risk mitigation schemes would not be economically viable or affordable on their own.

Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

## The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future, causing higher river flows and levels. Sea levels are also expected to rise. This means that flooding from rivers and the sea will become more frequent.

The significant predicted impacts of climate change, aging infrastructure, extensive new development sites have identified a need for substantial investment in Minehead to increase future resilience.

The community has been highlighted by several authorities through their strategic plans as a priority area, due to the anticipated impacts of climate change. There’s a once in a generation opportunity to understand and take action to manage flood risk within Minehead to support the aspirations of the community for:

- housing
- tourism
- recreation
- economic growth
- regeneration

Sited on the coastal plain and surrounded by the high ground and steep slopes of Exmoor, Minehead is at significant risk of flooding from:

- surface water
- the sea
- watercourses

The local geography means that these risks are interconnected and must be considered holistically.

Currently, local agencies are working towards a set of aims for a strategic vision and plan for the future:

- support the development of an integrated vision for the future of Minehead - including all aspects of development, regeneration, housing, recreation, tourism and flood risk
- establish and support robust project governance - including a project board and project team
- identify a lead partner and dedicated project manager

- identify and provide resource and finance to develop the vision - including modelling, consultation, design and implementation
- establish appropriate agreements between all parties

Please refer to section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the Minehead FRA

Measures have been developed that apply specifically to the Minehead FRA. These measures have been developed in addition to those covering a wider geographic area but, also apply to the FRA.

You can find information about all the measures that apply to the Minehead FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Mounts Bay Rivers and Sea Flood Risk Area

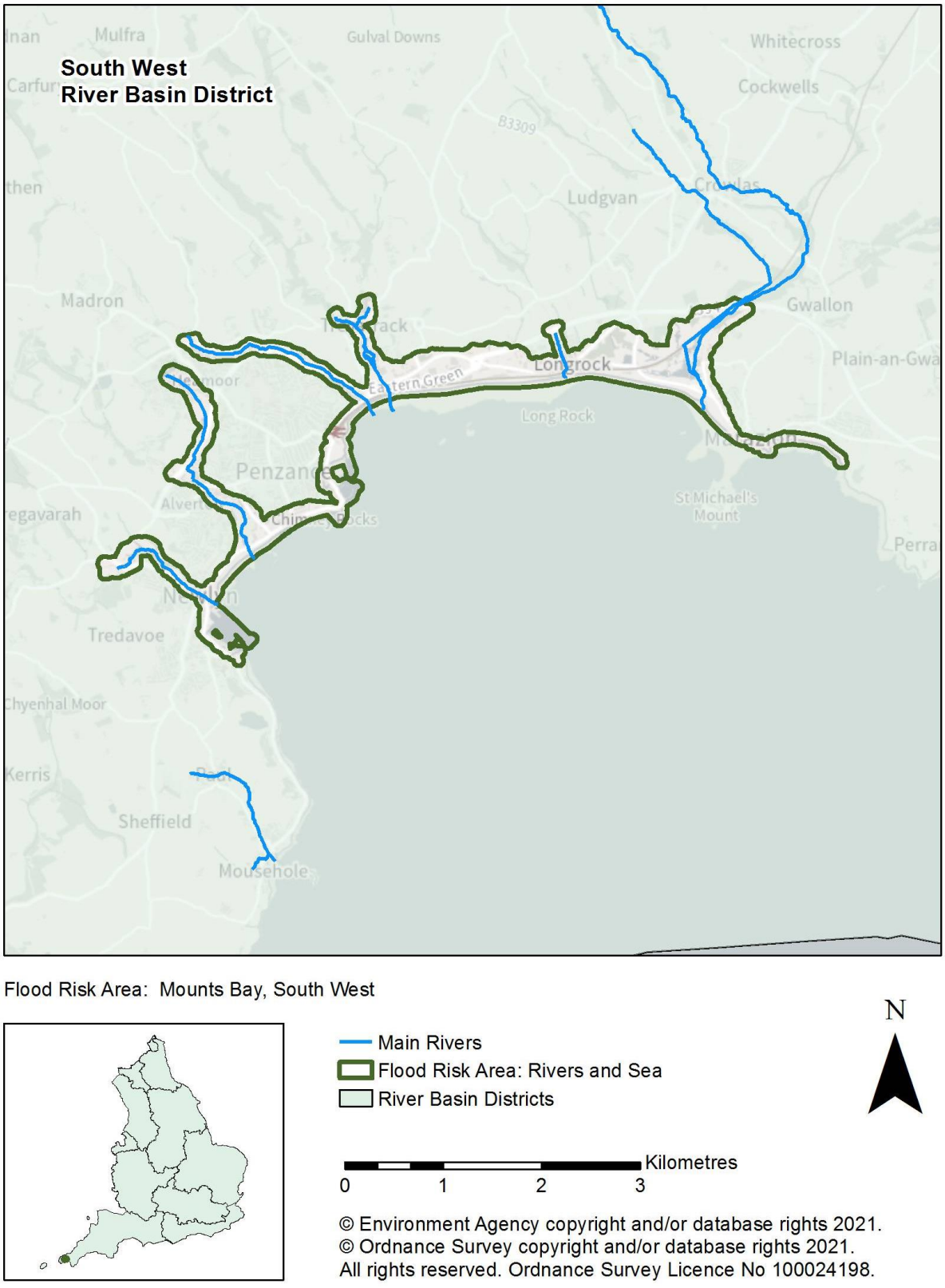



**Figure 16: a map showing the boundary of the Mounts Bay Flood Risk Area**

# Introduction to the Mounts Bay Flood Risk Area

The Mounts Bay Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead in the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Environment Agency is responsible for managing the risk of flooding from main rivers and the sea.

Cornwall Council is the Lead Local Flood Authority (LLFA). Their remit includes managing the risk of flooding from surface water and ordinary watercourses. South West Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in this FRA.

## Description of the Mounts Bay Catchment

The Mounts Bay FRA is on the southern coast of the Penwith Peninsula in west Cornwall. There are numerous small catchments draining from the granite uplands directly into Mounts Bay. Granite makes the upper catchment relatively impervious, which in turn leads to the flashy nature of the rivers. Mounts Bay FRA is mostly comprised of Hornfelsed slate and siltstone. Six rivers drain through the Mounts Bay FRA into the sea. From west to east, these are:

- Newlyn Coombe Stream
- Larrigan River
- Chyandour Stream
- Ponsandane Brook
- Longrock Stream
- Red River (at Marazion)

## Environmental Designations

The FRA is mainly urban but contains unique and diverse environments, such as the Marazion Marsh. This area is designated as a Special Protection Area (SPA) and a Special Site of Scientific Interest (SSSI). The eastern side of Mounts Bay, starting at Longrock, is also designated as a Marine Conservation Zone (MCZ). Conservation areas also sit within the Mounts Bay FRA.

You can find out more information on designated sites in the Mounts Bay catchment in the 'Cornwall draft Local Nature Recovery Strategy'.

The Mounts Bay FRA consists of several communities. These include:

- Penzance
- Newlyn
- Longrock
- Marazion

The FRA has a mixture of residential and commercial properties. The frontage is heavily developed, with both a railway line and main trunk road running along the eastern half of the FRA shoreline. This is from Penzance to the west of Marazion Marsh.

## The drainage system

The Newlyn Coombe, Larrigan and Chyandour Streams in addition to the Ponsadane Brook are all rivers situated to the west of the catchment. They drain from the rural land to the north of Newlyn and Penzance and flow through the towns before discharging into Mounts Bay.

Long Rock Stream to the east of Penzance, is predominantly a rural catchment. The Red River is in the east of Mounts Bay FRA and discharges close to the settlement of Marazion. Due to the steep nature of the rivers' catchments, these rivers have shown to rise rapidly following rainfall events.

As Mounts Bay has developed over time, some of the rivers have been culverted. Rivers that have sections that are culverted include:

- Lariggan River
- Chyandour Stream
- Ponsandane Brook
- Longrock Stream

Due to all the rivers flowing into the urban setting, several of them have structures, like bridges, built over them. These structures can become pinch points for the rivers, increasing the likelihood of flooding in areas close to them. During times of heavy rainfall, the natural process of high river levels overtopping riverbanks can be constrained. This is often made worse, causing distress and hazards when they interact with homes, businesses and infrastructure.

All 6 of the rivers flow into Mounts Bay where they meet with the sea. Most of the development in the Mounts Bay FRA is situated along the low-lying, coastal frontage and is close to the mouths of the rivers. These developments include:

- Newlyn fishing port
- Penzance Harbour
- businesses and residential properties
- critical infrastructure - including the A30, mainline railway (the Penzance terminus and overnight sleeper train facility), Jack Lane Bridge and New Road (providing access to Newlyn fishing port, Penzance Promenade and Western Promenade Road)
- recreational parks and leisure sites - including Newlyn Green, Penzance Skate Plaza and Jubilee Pool
- South West Coast Path

During periods of high spring tides, particularly when combined with south easterly storms and heavy rainfall events, the river levels can increase as a result of tidal locking. In

addition, waves overtopping the coastline during stormy conditions can exacerbate both the fluvial and coastal flood risk. This has been particularly notable at the Newlyn Coombe Stream on the western side of the Mounts Bay FRA. This is where waves overtopped Jack Lane Bridge, creating hazardous conditions for people, roads and residential properties.

High spring tides and storm surges, together with energetic wave conditions can also increase the upstream flood risk on the Lariggan River and Chyandour Stream. This happens by blocking the trash screens at the discharging mouths of the rivers with sand, cobbles and debris. This can result in the river levels upstream increasing, putting people and property at risk of flooding.

## Current flood risk

Mounts Bay FRA has unfortunately experienced recent major flood incidents caused by rivers and the sea. Those of note were the February 2014 winter storms. During this period there was a succession of Atlantic storms coinciding with high spring tides, significant wave action and tidal surge. This caused extensive flooding to the Penzance Promenade, with approximately 100 properties affected over the course of the month. Critical infrastructure was also badly affected, including the railway line and the B3311 road.

During 2012 and 2013, river flooding was experienced in the Mounts Bay FRA. The Newlyn Coombe River surcharged at bridges crossing over it, causing the river to exceed its capacity, which resulted in property flooding.

During 2012, the Larrigan River also experienced fluvial flooding. Intense rainfall resulted in out of bank flows, flooding one confirmed property in Penzance.

More recently, Mounts Bay has experienced minor flood incidents caused by:

- river flooding
- sea flooding
- a combination of both

There have been several small flood events in the FRA. Most of these events impacted the Promenade in Penzance and were caused by significant wave overtopping and spray. There were also 2 recorded incidents of flooding from the Longrock Stream.

### Conclusions from the Flood Hazard and Risk Maps

The flood hazard and risk maps show that in the Mounts Bay FRA, 2,500 people live in areas at risk of flooding from rivers and the sea. Of these people, 19% are at high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 332 non-residential properties
- 3km of A roads
- 5km of railway

- 74ha of agricultural land
- 3 Bathing Waters
- 2ha of SSSI
- 2ha of SAC
- 28 listed buildings

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Mounts Bay FRA.

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the future and current impact it could have on the FRA.

Coastal flood and erosion risks are being addressed in the Mounts Bay Flood and Coastal Erosion Risk Management (FCERM) Strategy. This work is strategically planning for, and developing, a range of interventions to increase flood resilience along the Mounts Bay coastline. The Strategy will also seek to understand the potential cumulative impacts of these schemes to ensure the best practical solutions are implemented here. At the same time, the strategy also seeks to support local community plans and place-shaping activities looking to deliver regeneration and sustainable growth.

There's a high concentration of development and critical transport infrastructure fringing the Mounts Bay coastline which is at risk of flooding from all sources. This infrastructure is particularly susceptible to coastal flooding and erosion. This makes it challenging to deliver the ambitions of the National FCERM Strategy and to move away from hard engineered flood defence solutions.

Piloting a hybrid approach, where hard engineered coastal defences have nature-based solutions imbedded into them, can provide a steppingstone to solutions that help to address the climate and ecological emergencies. This is at the same time as increasing flood resilience. An example of this within the Mount's Bay FRA is the ongoing work on the Newlyn breakwater, partially funded by European Regional Development Fund. This project, in the future, looks to deliver the policy set out in the SMP, and presents the opportunity to influence implementation of innovative solutions along other parts of the coastline.

## How the risk is currently managed

RMAs are involved in collaborative projects to reduce flooding from all sources in Mounts Bay. Alongside the ongoing strategy work, described above, other collaborative projects include Longrock coastal works and works to Marazion Marsh. More information on these projects can be found in the 'Mapping and Modelling' section below.

### The Flood Warning Service

The Environment Agency provide a coastal flood warning service in the area. There are 3 specific Flood Warning Areas within the FRA. By monitoring predicted conditions

(including wind, wave and tide heights), we can issue flood warnings to help inform the local community and partners to act against potential flooding. The Environment Agency also uses computer models to determine thresholds, which are used to trigger the flood warnings.

## Mapping and Modelling

As mentioned above, The Environment Agency updates and develops new models to continually improve the flood warning service. The Environment Agency also uses these models to develop flood maps for planning which are used to assess the risk to properties from:

- rivers
- the sea
- surface water flooding

In the Mounts Bay FRA, a programme of hydrodynamic numerical modelling is being carried out to better understand flood risk from the sea. This includes the Mounts Bay wave modelling pilot study that was completed in 2013. Following this, the Newlyn coastal model was completed in 2019. This was used to explore different possible solutions to the severe wave overtopping at Jack Lane Bridge in Newlyn.

The modelling programme in Mounts Bay is ongoing. A study examining possible solutions to address wave overtopping along the Penzance Promenade is the next planned piece of work.

## Flood Risk Management Schemes

The Environment Agency also operates and maintains assets that perform a flood risk management function from rivers and the sea in Mounts Bay. These include:

- embankments
- outfalls
- flood walls
- culverts
- trash screens
- Newlyn breakwater

As a result of the development of infrastructure along the seafront, including the mainline railway, an arrangement of discrete, predominantly hard-engineered defences have been built. This includes:

- sea walls
- rock armour
- embankments

Sand dunes in front of the Marazion Marsh are also present. There are several screens at key locations along the rivers that are routinely cleared to prevent blockages in the culverts and rivers.

There are a number of schemes that have recently been implemented to increase flood resilience in Mounts Bay. In 2016, Cornwall Council and the Environment Agency completed a shoreline study which identified the Longrock frontage as particularly vulnerable to erosion. In the long run, coastal erosion along this shoreline would create a flood risk to the transport links that run along it. This prompted works to install new rock armour along 350m of the shoreline, reducing the risk of erosion to the community, main road and rail routes.

Other works also included improved access to the beach using a series of ramps and the creation of new amenity areas. These works provided enhanced protection to 295 residential properties and 65 commercial properties. Repairs were also undertaken in 2015 to the Penzance Promenade.

At Marazion Marsh, a ‘Site Improvement Plan’ determined that a ‘Diffuse Water Pollution Plan’ and ‘Water Level Management Plan’ needed to be developed to allow the marsh to continue to provide a habitat for overwintering bird populations. This would also reduce flood risk to surrounding properties. Based on these plans, works were completed to desilt and open new water channels. This included the installation of a water control device to enable raising of the levels during summer and ensuring proper drainage of the levels in winter. This work was completed in late 2020.

Both the Longrock coastal and Marazion Marsh works were funded by grants from the European Regional Development Fund and the Environment Agency Flood Defence Grant-in-Aid. They were delivered by Cornwall Council in partnership with the Environment Agency and with strategic partners, such as the:

- Royal Society for the Protection of Birds (RSPB)
- Natural England
- Network Rail
- St Aubyn Estate

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Mounts Bay FRA. Climate change allowances are predictions of the anticipated change for:

- peak river flow
- peak rainfall intensity
- sea-level rise
- offshore wind speed
- extreme wave height

This is indicated in climate change modelling of the Mounts Bay FRA under the 0.5% AEP climate change scenario. The flood extent increases in depth and the extent of the flood area. From this, there'll be a greater increase in people at risk due to climate change especially in Longrock and seafront properties in Penzance.

Sea level rise and increased storminess will result in the Mounts Bay coastal frontage, development and the critical transport infrastructure that runs parallel to it, becoming more susceptible to damage. This could reduce access to key locations across Mounts Bay and other communities outside of the FRA that rely on these transport links if the risks are not managed. Managed realignment at a significant scale along the Mounts Bay coastal frontage, in terms of landward realignment of the shoreline, is not technically feasible for the most part. However, other innovative options offer an alternative sustainable solution to address flood and erosion risks. Options include:

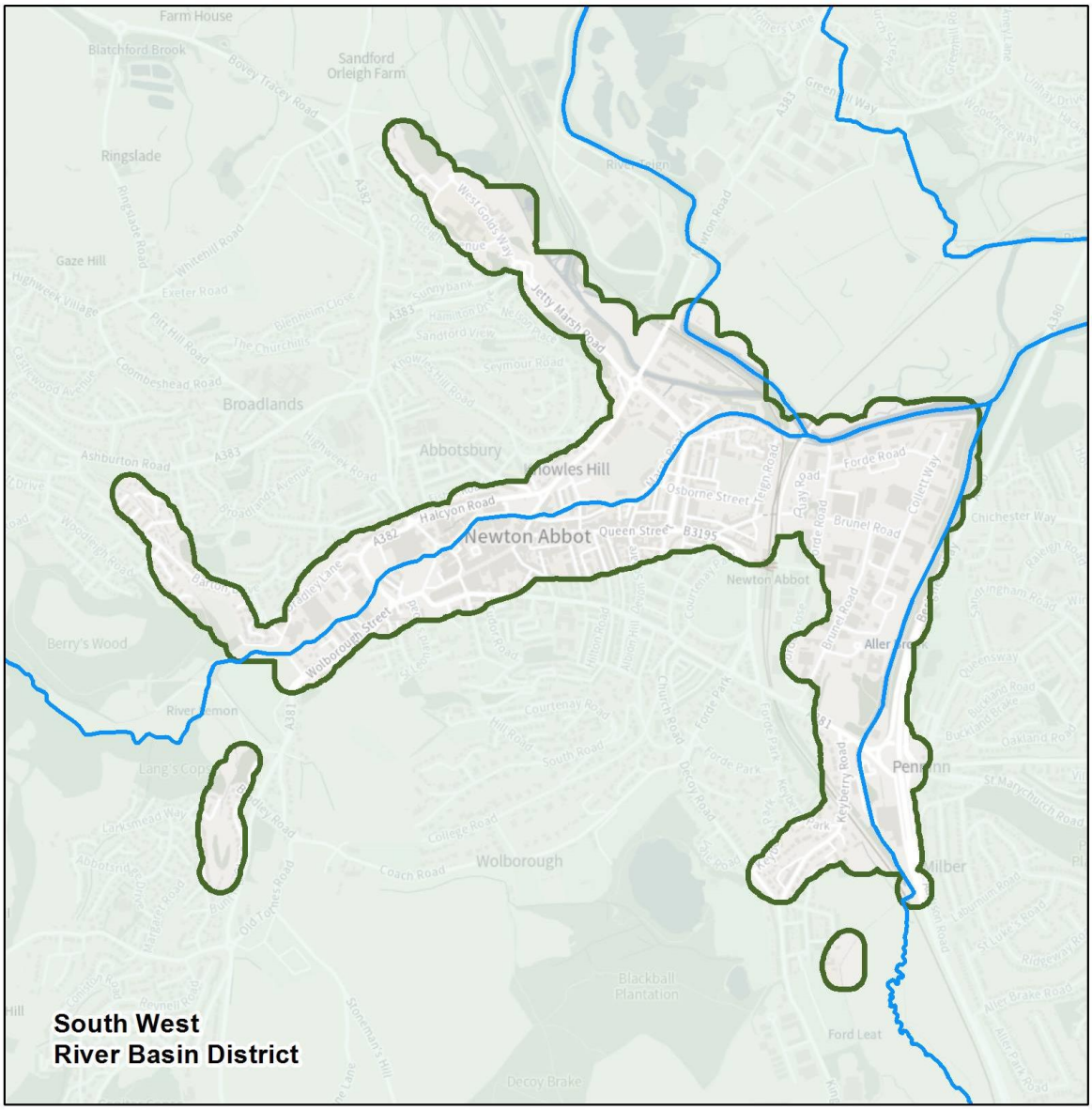
- greening and hybridising hard engineered defences
- re-profiling of the current defence arrangements to physically change the way in which waves interact with the shoreline

## Objectives and measures for the Mounts Bay FRA

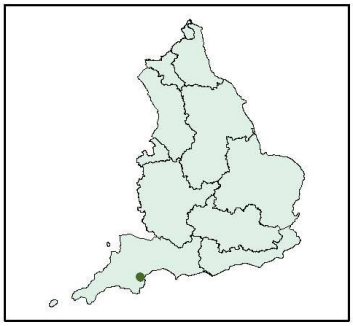
Measures have been developed that apply specifically to the Mounts Bay FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Mounts Bay FRA.

You can find information about all the measures that apply to the Mounts Bay FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Newton Abbot Rivers and Sea Flood Risk Area




Flood Risk Area: Newton Abbot, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

Kilometres
0 0.5 1 1.5



**Figure 17: a map showing the boundary of the Newton Abbot Flood Risk Area**

## Introduction to the Newton Abbot Flood Risk Area

The Newton Abbot Flood Risk Area (FRA) is on the south coast of Devon. The River Teign and its tributaries conveys water from parts of the South Devon Catchment through the Newton Abbot FRA to the Teign Estuary and directly out to sea.

The FRA comprises of several urban communities, including Newton Abbot and Kingskerswell, with a mixture of residential and commercial properties. The Newton Abbot FRA is surrounded by green spaces of mainly farmland and the intertidal habitat of the River Teign Estuary.

The Newton Abbot FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and implementation of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority (LLFA), whose remit includes flood risk from surface water and ordinary watercourses.

South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. Teignbridge District Council are both a Risk Management Authority (RMA) and the Local Planning Authority, whose remit includes:

- management of ordinary watercourses
- flood risk planning
- acting as the Coastal Protection Authority

## Hydrology and geology of the catchment

The River Teign catchment extends from the uplands of Dartmoor to Newton Abbot in the low-lying Teign Estuary. It includes major tributaries, such as the:

- River Bovey
- River Lemon
- Aller Brook

The rivers flow from the uplands through steep-sided, wooded valleys to the south of the A38 Devon Expressway. Here there is a distinct change in the physical character of the catchment. In the lower catchment the land is relatively low-lying and undulating and channel gradients are much shallower.

The River Teign catchment is characterised by impermeable granite on Dartmoor to the north and mainly carboniferous and Devonian deposits to the south. The impermeable geology of the River Teign’s headwaters on Dartmoor, and the low permeability of the Devonian and carboniferous deposits, means that much of the catchment will respond rapidly to any rainfall.

The soils within the River Teign catchment are characterised by 2 main soil types. To the north there is open moorland with high rainfall and acid, peaty soils on the upland granite mass of Dartmoor. To the south the soil is characterised by the rich, red soils that are generally permeable and naturally well drained.

The River Lemon has a similar but smaller catchment. The source of the River Lemon is on the uplands of Dartmoor. The watercourse drains through the catchment and must pass through the Holbeam Flood Detention Reservoir before entering Newton Abbot town centre. This is where it's largely culverted and constrained by walls.

A weir on the River Lemon just upstream of Baker's Park supplies a leat that flows to the south of Hunterswell Road. It collects additional flow from a small watercourse flowing from the north-west, before being culverted under Bradley Lane Industrial Estate, discharging into the River Lemon adjacent to the Asda development.

The Aller Brook is also a right-bank tributary of the River Teign. It rises in the hamlet of Daccombe on the outskirts of Torquay. At its confluence with the Teign, near Newton Abbot railway station, the Aller Brook has a catchment area of 33km$^2$. The catchment is classified as moderately urbanised. Various flood risk improvements have been made along the watercourse in recent years, as part of major development and infrastructure projects, including the A380 Kingskerswell bypass.

The Stover canal was built in the 18$^{th}$ century to transport clay from the Bovey Basin, and granite from quarries on Dartmoor to the docks at Teignmouth. It runs for approximately 3km, on the right (west) bank of the River Teign, from north of Teigngrace to the outskirts of Newton Abbot.

The canal is now disused and heavily overgrown in places, although it's in the process of being restored by the Stover Canal Trust. It reportedly serves an important flood risk management function in times of high flows in the lower Teign valley. This is by providing some flood storage capacity and conveying flows from the Blatchford Brook to the Whitelake Channel and into the Teign estuary. Historically, the Whitelake Channel provided a tidal link for barges between the Stover Canal and the River Teign.

## Environmental designations

Located within the FRA are the:

- Broadbridge Wood Ancient Woodland
- Wolborough Fen Site of Special Scientific Interest (SSSI)
- Decoy Country Park Local Nature Reserve (LNR)
- Aller Brook LNR
- Jetty Marsh (LNR)
- Churchills (LNR)

Several Local Wildlife Sites are within the watercourses in the FRA, including Aller Brook and Vicary's Field. Also located within 1km of the FRA is the:

- Wolborough Fen SSSI
- East Ogwell Quarry SSSI
- Ransley Quarry SSSI
- River Lemon Valley Woods SSSI

The Newton Abbot FRA is also located within 5km of Dartmoor National Park.

Numerous listed buildings are located within the Newton Abbot FRA. These include:

- Tuckers Maltings
- St Leonards Tower
- Alexandra Theatre and Market Hall

Newton Abbot FRA also includes a Conservation Areas.

## Flood risk sources

The Newton Abbot FRA is at risk of flooding from:

- rivers
- the sea
- reservoirs
- surface water

Much of the infrastructure within the FRA is located immediately behind raised walls along the River Lemon, with both residential and commercial properties extending landwards.

The Newton Abbot FRA is also susceptible to flooding from surface water and sewers during high rainfall events. This is due to the heavily urbanised nature of the area and ageing drainage infrastructure. Additional surface water inputs to combined sewers, as well as becoming tide locked in frequent tidal conditions. This results in increased levels of risk to some areas of the community, as seen in the recent flooding that occurred in 2020.

Flood risk from new development pressures upstream of the Newton Abbot FRA is managed through the designation of a Critical Drainage Area (CDA). A CDA is an area that has critical drainage problems, which has been notified to the local planning authority by the Environment Agency. This is in line with the National Planning Policy Framework (NPPF). In these locations, there is a need for surface water to be managed to a higher standard than normal. This is to ensure that any new development will contribute to a reduction in flooding risks in line with NPPF. These higher standards are determined by the Environment Agency.

The River Lemon channel is heavily modified through Newton Abbot. As the Bradley Lane Industrial Estate is redeveloped, we plan to make improvements to the channel, and riparian enhancements. Other improvements to the River Lemon through the town include:

- weir removal
- improved fish passage
- improved habitat

- flood plain connectivity

## Current flood risk

The Newton Abbot FRA has a long history of flooding with notable events in:

- the 1960s
- 1974
- 1979
- 2013
- 2014

Since the production of the first cycle Flood Risk Management Plans in 2015, there has been one recorded flood event caused by a combination of sources in the in the Newton Abbot FRA.

In 2019, river levels of the Teign rose and entered the floodplain. This caused flooding to Exeter Road in Kingsteignton upstream of the Newton abbot FRA.

The flood hazard and risk maps show that in the Newton Abbot FRA, 2,759 people live in areas of flood risk from rivers and the sea. Of these people, 5.7% live in high risk areas.

Also shown to be at risk of flooding from rivers and the sea are:

- 643 non-residential properties - including schools, emergency service stations and hospitals
- 1.07km of railway including Newton Abbot Railway Station
- 0.05km of roads
- areas of environmentally designated sites
- 38 listed buildings

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Newton Abbot FRA.

Based on this information, Risk Management Areas (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the future and current impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other RMAs and stakeholders. This includes:

- Devon County Council
- South West Water
- Teignbridge District Council
- Newton Abbot Town Council

The South Devon Catchment Partnership also covers the Newton Abbot area. They are increasingly considering more natural solutions to flood risk problems in and around South Devon as part of their work plan.

The Devon Flood and Water Management Group, which comprises of all the local RMAs and key partners, meet regularly to:

- discuss work programmes
- discuss topical flood resilience matters
- resolve any operational issues across Devon

Newton Abbot and Kingsteignton has been designated as a Garden Community by Teignbridge District Council. The Garden Communities programme is about responding to local requirements; preserving what is great about an area, such as its culture, heritage and surroundings; while achieving health, economic and environmental goals identified by the local community. The risk of flooding will need to be addressed positively and efficiently, this should be achieved with cost-effective strategic solutions wherever possible and improving blue/ green infrastructure to ensure communities are climate resilient. The Flood Risk and Resilience strategy being developed through Teignbridge District Council will guide future growth and future flood risk management within the Garden Community area.

Devon County Council are currently investigating surface water flood risks within the Newton Abbot Flood Risk Area. This study will inform future activities, funding requirements and resource planning if any surface water risks are identified.

## Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service
- raising public awareness with associated campaigns

Increasing flood resilience, where possible is important. This is because building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them with a flood warning service allows us to reduce the risk to life and property. This is even if defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Newton Abbot FRA that monitor:

- tide levels
- river levels
- river flow
- rainfall

River levels are monitored at 2 sites on the River Lemon within the Newton Abbot FRA. There are a further 5 river level and flow gauges within the contributing river catchments. Some rationalisation of the gauge network is proposed to improve resilience and forecast performance. This will also include monitoring improvements at Holbeam Flood Detention Reservoir.

Tide levels are monitored at Teignmouth and Coombe Cellars. Tide levels are also forecast from Plymouth and Exmouth. There is one telemetered rain gauge at Bickington that contributes to flood forecasting procedures. There is also one daily monitored rain gauge that can be used to validate forecasts and look at longer term rainfall trends. The information collected from these monitoring sites are used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents.

Our Flood Warning Service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea. There is one coastal flood alert area that covers the Newton Abbot FRA. There is one fluvial flood alert area and 6 flood warning areas that cover the Newton Abbot FRA. Currently there are no fluvial flood warnings for the properties at high risk of flooding from the Aller Brook in the Newton Abbot FRA.

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic and forecast modelling. Hydraulic models are used to assess:

- current flood risk
- impacts of climate change
- how future levels of flood risk could be managed

In 2020, the Newton Abbot and Kingsteignton Modelling and Mapping study was undertaken to model the River Teign and River Lemon in the Newton Abbot area. This was to gain a better understanding of the flood mechanisms, as well as the current and future flood risks.

The Aller Brook modelling has not been updated since the completion of the Kingskerswell bypass which included improvements that were designed to reduce flood risk. The re-modelling of these improvements on the Aller Brook is currently in our six-year modelling investment programme.

Flood risk maps are published based on the outputs from the hydraulic modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

### Flood Alleviation Schemes

The Kingsteignton Flood Alleviation Scheme started in 1983 and delivered raised banks and walls to reduce flood risk for those properties at risk from the lower River Lemon and Teign. A flood storage reservoir, known as Holbeam Dam, is located on the River Lemon, 3km upstream of Newton Abbot. This dam was built as part of a flood alleviation scheme in 1981/82 and can store 390,000m³ of flood water. The catchment draining to the dam accounts for approximately two-thirds of the total catchment area of the River Lemon. The dam includes a radial flood gate, used to limit the flow of water downstream during high flows and flood risk conditions. The gate is normally kept in a partially open position to prevent storage of base flows. Improvements to the dam, including upgraded gate operation, are expected to be completed in 2021.

The Newton Abbot and Kingsteignton Modelling Study (2020) concluded that the River Lemon flood defences are modelled as being largely effective at mitigating flood risk until the 0.1% annual chance event. These defences are a combination of the reservoir and raised defences through Newton Abbot.

Some properties at risk in the Aller Valley have a reduced flood risk because of improvements made on construction of the A380 South Devon Link Road.

Plans for potential future improvements to flood defences through and upstream of Newton Abbot and Kingsteignton are under development currently. Work to enhance the operation of Holbeam Dam is currently progressing to ensure this structure remains fit for purpose into the future. Some work has been done as part of the Howton Barton development to safeguard the footprint of the flood storage areas from encroachment by urbanisation, including the potential to expand the amount of water stored there if required.

Defences within the town centre are currently operating effectively. However, assessments are being commissioned to determine whether any work to prolong their lifespan is required. Coupled to both initiatives we are exploring with partners the opportunity for natural flood management techniques, such as:

- soil restoration
- tree planting
- leaky dams in the headwaters of the catchment

This is to both offset the carbon created by the improvements to the dam, but also to help manage flows within the catchment.

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Newton Abbot FRA. Rainfall intensity is expected to increase in the future and cause higher river flows and levels. Sea levels are also expected to rise. As sea levels rise, coastal flooding will become more frequent, as higher water levels and storms will be

seen more often. This means that flooding from rivers and the sea will become more frequent.

Sea level rise will result in the lower parts of the town, particularly Jetty Marsh Road, becoming more frequently impacted by flooding. Furthermore, it's expected that the Newton Abbot tidal defences will be overwhelmed within a few decades. The Brunel Industrial Estate is also vulnerable to sea level rise, but not to the same extent.

Climate Change predictions indicate that rainfall intensity is expected to increase in the future, causing higher river flows and levels. This means that flooding from rivers will become more likely.

The River Lemon is a heavily modified watercourse with channel capacity constraints. Currently, Holbeam Dam, built as part of the flood alleviation scheme in 1981/82, is largely effective in mitigating flood risk from the River Lemon through the Newton Abbot FRA. However, overtopping of the Holbeam Dam will become more frequent with increased rainfall, resulting in increased flood risk for the town due to more frequent overtopping.

Sea level rise coinciding with increased rainfall events will also impact the capacity of the outfall of the River Lemon to the Teign Estuary through tide locking. There are limited options available to increase the capacity of the River Lemon. Therefore, alternative solutions will include Natural Flood Management techniques and increasing storage capacity of the Dam. Both solutions are being sought through the Local Plan process in partnership with Teignbridge District Council. Tide locking is also expected to occur more frequently along the Whitelake channel and the Aller Brook.

The River Teign and its tributaries have a very shallow gradient through Newton Abbot. Sea level rise will be noticeable as the tidal limit moves further upstream. This will lead to more areas being at greater flood risk, especially when flood flows coincide with high tides. The duration of flooding on the Teign is often more than 12 hours, resulting in an increased chance of flood flows coinciding with high tide. Climate change means that flood levels will be higher due to increased rainfall throughout the catchment. The effect will be most noticeable for low-lying properties around the edge of the Lower River Teign and for roads that cross the floodplain.

Climate change predictions anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Due to the heavily urbanised and low-lying nature of the River Lemon and River Teign catchments, increased rainfall is expected to frequently overload the ageing drainage infrastructure. Surface water flooding along Denbury Road and Keyberry will become more regular with the increased frequency and intensity of storms. To support in the management of this increased risk from surface water, new development within the Newton Abbot FRA is managed through the designation of a Critical Drainage Area (CDA).

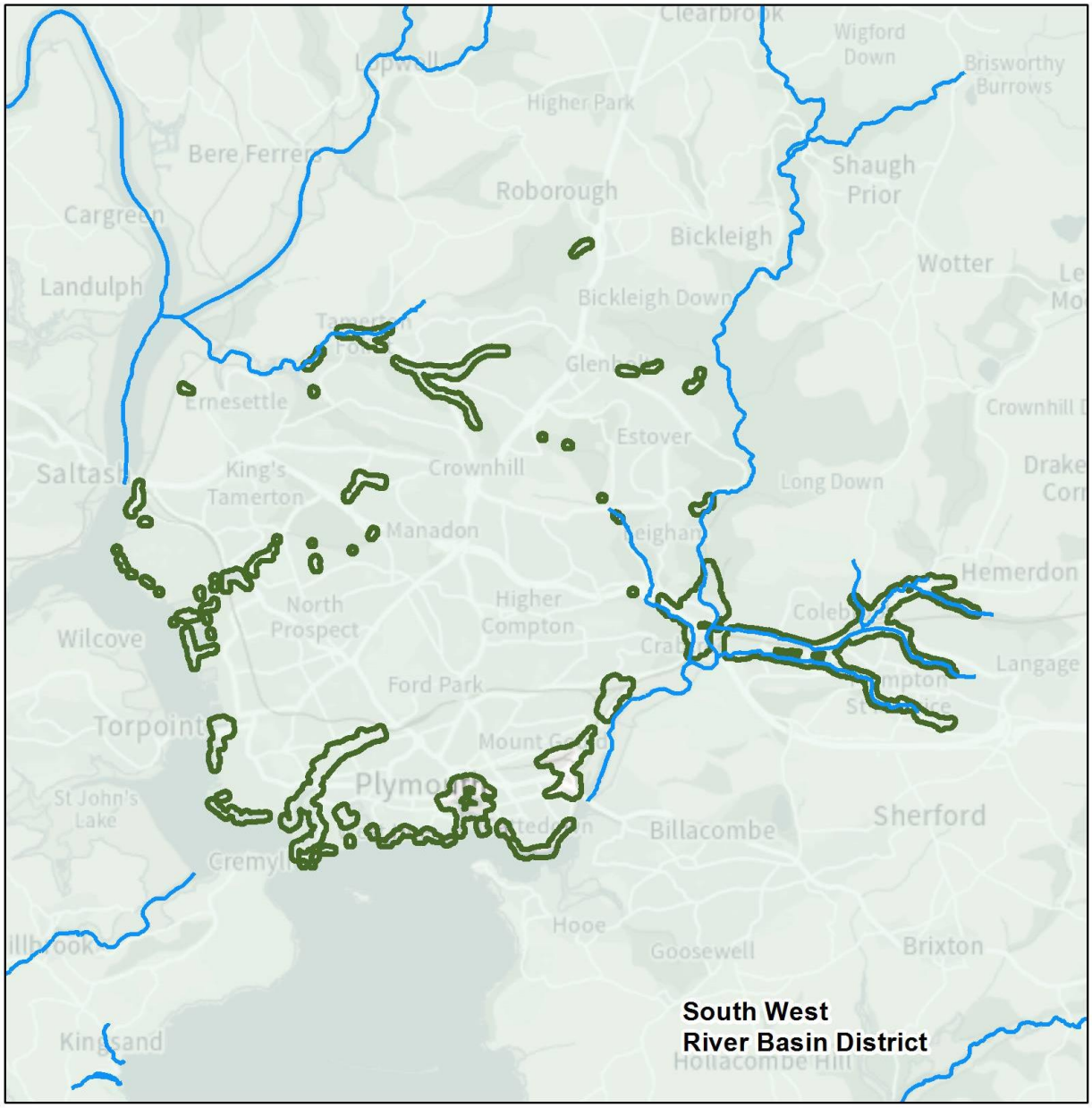
Please refer to section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the South West RBD.

## Objectives and measures for the Newton Abbot FRA

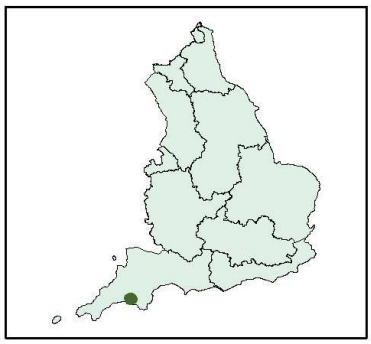
Measures have been developed that apply specifically to the Newton Abbot FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Newton Abbot FRA.

You can find information about all the measures which apply to the Newton Abbot FRA in the Flood Plan Explorer. This includes information on which national objectives each measure helps to achieve.

# The Plymouth Rivers and Sea Flood Risk Area




Flood Risk Area: Plymouth, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

Kilometres
0 2 4 6



**Figure 18: a map showing the boundary of the Plymouth Rivers and Sea Flood Risk Area**

# Introduction to the Plymouth Rivers and Sea Flood Risk Area

The Plymouth Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Environment Agency is responsible for managing flood risk from the main river and sea flooding.

The Environment Agency work in partnership with other Risk Management Authorities (RMAs) to manage all types of flood risk in Plymouth. The key roles and responsibilities for managing flood risk in Plymouth are outlined in the Plymouth Surface Water FRA section.

## Description of the Plymouth Catchment

The Plymouth FRA is in the Tamar catchment, which is on the border of Devon and Cornwall. Plymouth sits at the mouth of the Tamar Estuary and the Plym Estuary, which have several rivers draining to their lowlands. All the rivers in the catchment meet, creating Plymouth Sound.

Dartmoor makes up the headwaters of these rivers. The catchment drains an area of 1,800 square kilometres into Plymouth Sound.

The headwaters are mainly characterised by:

- moorland
- natural grassland
- pasture
- arable farmland

Plymouth’s geology is dominantly comprised of mudstone, siltstone and sandstone while the upper catchment of Dartmoor is characterised by hard granite. Granite makes the upper catchment relatively impervious, which in turn leads to the flashy nature of the rivers and their tributaries springing to the east of Plymouth.

Mineral extraction is a significant feature in the headwaters of some rivers draining to the Plym estuary.

The city itself is mainly urban but also contains unique and diverse natural environments. As Plymouth has developed overtime, small creeks and watercourses have been infilled and built over so that some areas are very low-lying. The overall land use in Plymouth includes:

- residential
- business
- public open spaces
- woodlands

- developed and undeveloped coastlines and marine areas
- surrounding agricultural land

Plymouth hosts an array of environmental and historical designations. More information on designations can be found in the Plymouth Surface Water FRA section.

## The drainage system

Plymouth has a total population of approximately 260,000 people. On the western side of the city, the low-lying coastal frontages include:

- naval dockyards
- public open spaces - such as the Hoe and Devils Point
- mixed business and residential development - such as the Barbican and Sutton Harbour

The eastern side of Plymouth includes low-lying critical rail and road infrastructure and residential development, including Marsh Mills and Laira.

These low-lying areas are at risk of coastal flooding. Marsh Mills, Laira and Plympton are also at risk of fluvial flooding. During a combination of high tide, storm surge and heavy rainfall conditions, these areas are at risk of experiencing tidal locking due to the water being unable to flow out to sea.

The outer fringes of Plymouth are mainly residential. Specific locations that are featured in the Plymouth FRA are:

- Tamerton Foliot
- Plympton
- Plymstock

The fluvial flood risk in the FRA is dominantly from the:

- Tamerton Foliot stream
- Tory Brook
- Long Brook
- River Plym

Draining to the Western side of Plymouth, the River Tamar meets the sea at Plymouth Sound, with the Tamar Estuary extending approximately 22km inland to Gunnislake.

On the eastern side of Plymouth, the River Plym rises on Dartmoor and flows south-west past china clay workings at Shaugh Prior to the confluence with the Meavy. Flowing through a steep, often wooded valley to the edge of Plymouth, it enters the Plym Estuary at Marsh Mills. The River Plym meets with other rivers before conveying water into Plym Estuary. This includes the Tory Brook which has many tributaries and flows through Plympton and the Long Brook, that also flows through Plympton, and responds particularly quickly to rainfall.

The Tory Brook and the Meavy are classed under the Water Framework Directive as Heavily Modified Water Bodies. The Tory Brook and the Smallhanger Brook (a tributary of the Tory Brook) catchments have also been affected by historic and current mining activities.

Over time, many watercourses in Plymouth have been modified due to urbanisation through straightening and channelling, building walls and culverting, with the natural floodplains of rivers raised or built upon. This means during times of heavy rainfall, the natural process of high river levels overtopping riverbanks can be constrained. It can also be made worse, causing distress and hazards when it interacts with homes, businesses and infrastructure.

River levels can also increase during high tides. A flapped tidal outfall is installed along the Long Brook to prevent tidal ingress, allowing fluvial waters to store during periods of tide locking.

On the western side of Plymouth there are a range of smaller watercourses that convey into the Tamar Estuary and then into Plymouth Sound. These include Tamerton Foliot Stream and Ham Brook.

Tamerton Foliot Stream is located on the north-west of Plymouth. The river flows through woodland (the settlement of Tamerton Foliot), conveys into Tamerton Lake and then flows into the Tamar Estuary. Over time, wooded debris and constrictions to the river have caused there to be flood risk within Tamerton Foliot.

The Ham Brook is a much smaller watercourse. It drains through Western Mill within Plymouth and conveys into the Tamar Estuary from the Dockyard.

Plymouth has also been identified as a surface water FRA. There are several locations that are at risk of surface water flooding. Flood risk in these locations could also be exacerbated during times of high tides and increased wave heights along the coast. This is due to tidal locking and waves overtopping defences, which will cause water to pool in low-lying areas. Locations at risk from a combination of surface water and coastal flooding are outlined in ‘Plymouth’s Local Flood Risk Management Strategy’.

## Current flood risk

Plymouth has unfortunately experienced major flood incidents caused by rivers and the sea, especially during the 2013/14 winter storms. There was a succession of Atlantic storms coinciding with high tides associated with significant wave action and tidal surge. This caused extensive damage to:

- coastal frontages
- properties
- infrastructure

During 2012 river flooding was experienced throughout Plympton affecting several residential and commercial properties, including Colebrook.

More recently, Plymouth has experienced minor flood incidents caused by:

- river flooding
- sea flooding
- a combination of river and sea flooding

In September 2019, heavy rainfall, high river levels, strong winds and tidal surge resulted in tide-locking and localised pooling to roads in Lipson Vale. A similar event took place in January 2020 when a small surge, caused by Storm Brendan, resulted in minor wave overtopping from the sea onto slipways. This caused roads to flood across the coastal frontages of Plymouth.

## Conclusions from the Flood Hazard and Risk Maps

The flood hazard and risk maps show that in the Plymouth FRA, 3,863 people live in areas at risk of flooding from rivers or the sea. Of these people, 5% live in areas of high risk.

Also shown to be in areas at risk of flooding from rivers or the sea are:

- 292 non-residential properties – high concentrations include Marsh Mills, Plympton, Lipson and Laira, Sutton Harbour and the Barbican area, Stonehouse and Royal William Yard
- 4.2 km of railway – along Embankment Road, Marsh Mills and Plympton
- 2.8 km of roads – including the A38 in the Marsh Mills area
- environmentally designated sites – including Bathing Waters, Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs)
- 57 listed buildings
- 1.4 ha parks and gardens

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Plymouth FRA.

Based on this information, Risk Management Areas (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the future and current impact it could have on the FRA. The Environment Agency, Plymouth City Council and South West Water should continue to collaboratively manage flood and coastal erosion risks and look to implement options that improve the environment where possible.

## How the risk is currently managed

RMAs are involved in collaborative projects to reduce flooding from all sources in Plymouth. Collaborative projects taking place include developing integrated urban drainage models (IUDM) in specific areas at risk of flooding from combined sources. Other collaborative projects include implementing schemes to separate and manage flood risk from differing sources. More information on IUDM projects can be found in the Plymouth Surface Water FRA section.

## The Flood Warning Service

The Environment Agency monitors river flows at 2 sites in addition to tidal and surface water levels at 2 other sites in Plymouth. The information is used to inform activities related to 5 flood warning areas across Plymouth. This enables people to receive a warning when flooding may occur. This data also informs the operational response during a flood incident.

## Mapping and Modelling

The Environment Agency uses computer software models to develop flood maps for planning, which are used to assess the risk to properties from rivers, sea and surface water flooding.

In 2018, the Environment Agency developed a coastal model for Plymouth. This improved our understanding of the flood risk along the coastal frontage by better predicting the flood risks resulting from sea level rise and wave overtopping.

The study included an assessment of how waves interact with Plymouth and Mount Batten breakwaters. It also looked at the role these structures play in managing coastal flood risk in the city from the sea. The model demonstrated that removing the Plymouth breakwater leads to higher energy wave conditions within Plymouth Sound between the mouths of the rivers Tamar and Plym. Whilst removing the Mount Batten breakwater increases the wave height between Sutton Harbour and along the River Plym.

The Environment Agency also developed a model to gain a better understanding of the flood risks in Plympton.

## Flood risk management schemes

The Environment Agency operates and maintains assets that perform a flood risk management function from rivers and the sea in Plymouth. These include:

- embankments
- outfalls
- flood walls
- culverts
- trash screens
- Sutton Harbour flood gate

These assets are found in:

- Tamerton Foliot
- Plympton
- Marsh Mills
- Sutton Harbour

Maintenance and operations include routine inspection and clearance activities, as well as periodic repair and replacement of assets.

There are other schemes that have recently been implemented to increase the resilience of Plymouth to flood risks from rivers and the sea. The Environment Agency is working with Plymouth City Council to raise the Millbay Dock's quay levels. This is to reduce the risk of flooding to Millbay and the city centre from the sea with climate change and sea level rise.

In addition, Plymouth City Council are leading on the construction of a raised defence along Embankment Road to protect residential and commercial property. This also includes critical transport links from coastal flooding. Phase 1 of this project has already been completed.

The Environment Agency is also maintaining Sutton Harbour lock gate to protect Sutton Harbour and the Barbican from coastal flooding. Preventative work has also been carried out by the Environment Agency to manage flood risks. The Sutton Harbour Development Guidance – Flood Risk Management for New Development was released in 2016. The guidance advises that new developments should build flood risk measures into their designs and should provide a proportionate contribution toward the future upgrade of the Sutton Harbour flood defences. The guidance is found in the Plymouth Local Flood Risk Management Strategy (Part 2).

To manage a combination of both fluvial and tidal flood risks in Plympton, the Environment Agency continues to maintain and improve flood defences assets when appropriate. An example of this includes the improvements the Environment Agency undertook to the Chaddlewood trash screen.

## The impact of climate change and future flood risk

Plymouth is at risk of flooding from all sources due to:

- its large coastal frontage
- the river systems flowing through the catchment
- its drainage system

As rainfall intensity increases, sea level continues to rise, and the coastal frontage experiences prolonged periods of storms, risk of flooding from all these sources will increase.

The Plymouth Coastal Model demonstrates Plymouth's coastal frontage will be even more vulnerable to a wide range of:

- coastal flood risk drivers
- extreme still water flooding
- wave overtopping

It also demonstrates that the city of Plymouth's flood risk from the sea will increase if the Mount Batten and Plymouth breakwaters were removed.

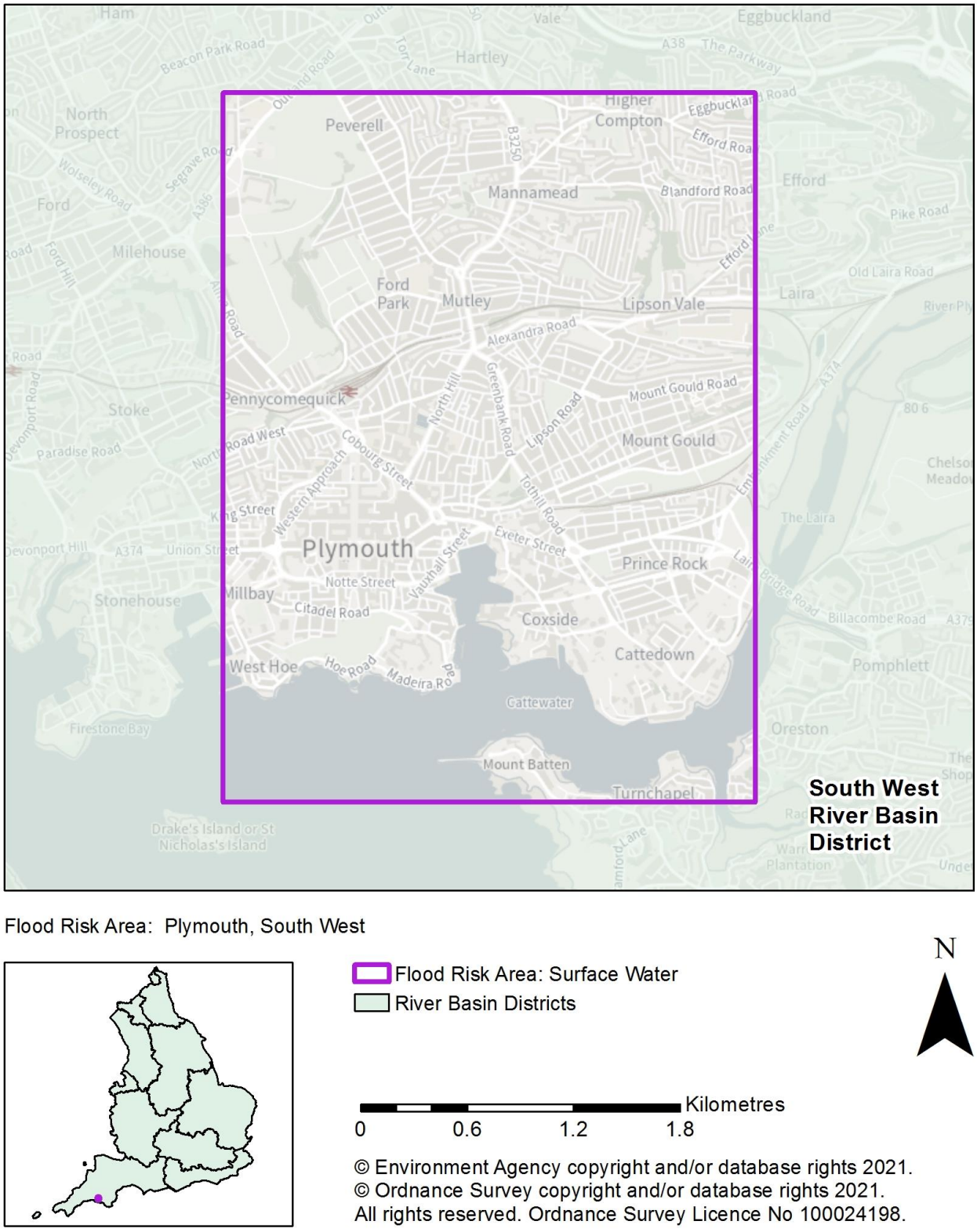
Please refer to Climate Change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South West River Basin District (RBD).

## Objectives and measures for the Plymouth FRA

Measures have been developed that apply specifically to the Plymouth FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Plymouth FRA.

You can find information about all the measures that apply to the Plymouth FRA in the Flood Plan Explorer an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Plymouth Surface Water Flood Risk Area




Flood Risk Area: Plymouth, South West



Flood Risk Area: Surface Water

River Basin Districts

N

Kilometres

0 0.6 1.2 1.8



**Figure 19: a map showing the boundary of the Plymouth Surface Water Flood Risk Area**

# Introduction to the Plymouth Surface Water Flood Risk Area

The Plymouth Flood Risk Area (FRA) for surface water covers the urban centre of Plymouth. There are other areas in Plymouth, such as Plympton and Plymstock, that are at risk of surface water flooding, but have not been outlined in the FRA analysis.

The Plymouth FRA has been identified as an FRA because the risk of flooding from surface water is significant nationally for people, the economy or the environment (including cultural heritage).

Plymouth City Council, the Lead Local Flood Authority (LLFA) for Plymouth, take the lead on managing surface water and ordinary watercourse flood risk.

The Environment Agency is responsible for managing flood risk from main rivers and the sea. South West Water is the water and sewerage company that owns, operates and maintains the public sewer network and wastewater treatment infrastructure in this FRA.

As mentioned earlier, Plymouth is also at risk of surface water flooding in other key areas across Plymouth, outside of the nationally identified surface water FRA. These areas are outlined in 'Plymouth City Council's Local Flood Risk Management Strategy'. Measures to manage surface water flood risk in a number of these areas are included in this Flood Risk Management Plan (FRMP). The 'Plymouth Local Flood Risk Management Strategy' plans for flood risk management in all areas at risk of surface water flooding across Plymouth.

## Description of the Plymouth surface water FRA catchment

The Plymouth FRA is in the urban centre of Plymouth whilst its surrounding catchment is steep-sided and predominately rural. For further information on the Plymouth catchment, please see the 'Description of the Plymouth Catchment' in the previous Plymouth Rivers and Sea FRA section.

The urban, impermeable surfaces across the city, combined with the steep-sided catchments, leads to high rates and volumes of surface water run-off in Plymouth. This is also known as a Rapid Response Catchment. This causes watercourses and drainage systems within the catchment to respond rapidly to rainfall events, leading to sewerage and drainage systems to exceed their capacity. This can lead to surface water flooding, which has the potential to affect:

- residential and commercial property
- key strategic transport links
- critical infrastructure

Climate change is causing rainfall to become more intense and frequent. Plymouth faces the pressure of needing to adapt to more extreme rainfall whilst ensuring future development and growth is resilient to the future climate.

One of the key areas within the Plymouth surface water FRA, identified as a growth area in 'the Plymouth and South West Devon Joint Local Plan', is 'The City Centre and Waterfront Growth Area'. Locations in this area include:

- Sutton Harbour
- The Hoe
- the City Centre comprising of Plymouth University
- the Railway Station
- Millbay
- Devonport

Across Plymouth other areas will also face growth pressures. These include:

- Lipson and Laira
- Stonehouse
- Devonport

The Plymouth catchment contains key areas of environmental and historical significance. These include:

- Dartmoor National Park
- 2 Areas of Outstanding National Beauty (AONBs)
- designated bathing waters
- ancient woodlands
- the South West Coast Path
- Special Areas of Conservation (SACs)
- the Tamar Estuary Complex Special Protection Area (SPA)
- National Nature Reserves (NNRs)
- Special Sites of Scientific Interest (SSSI)
- Marine Conservation Zones
- the newly designated National Marine Park
- listed buildings
- scheduled monuments
- conservation areas

Further information on designated sites in the Plymouth catchment can be found in the 'the Plymouth and South West Devon Joint Local Plan'.

## Drainage System

Plymouth's combined sewerage systems take both foul and surface water flow. Surface water and sewer flooding occur when run-off exceeds the urban drainage system capacity. This situation can also be made worse by the impact of tide locking on the river network and surface water outfalls, restricting any discharge during high tides.

The quality of the coastal and estuarine waters that the combined sewer networks flow into can also be environmentally affected during combined sewer overflows. During times of

heavy rainfall, the capacity of the infrastructure taking the combined flows is exceeded. This results in untreated sewer and industrial water discharging into:

- Plymouth Sound
- Plym estuaries
- Tamar estuaries

This impacts bathing water quality and is environmentally damaging.

Managing flood risk whilst encouraging development and enhancing the surrounding environment requires significant investment to upgrade the existing network. However, it also offers the opportunity to deliver multiple benefits.

Separating surface water from combined sewer systems provides increased capacity for connections from new developments in the city. In doing so, opportunities to reinstate watercourses to the surface can be investigated, while downstream water quality improved, all while reducing flood risk. Plymouth City Council is working in partnership with South West Water and the Environment Agency to do this by developing Integrated Urban Drainage Models (IUDM). More information on this programme of works can be found in the 'How the risk is currently managed' section below.

## Current flood risk

Since the production of 'Flood Risk Management Plan Cycle One', a location to unfortunately experience significant surface water flooding, or flooding caused by a combination of sources in the past 6 years is Lipson Vale. Flooding to approximately 12 households and 2 other properties occurred in 2019, 2020 and 2021.

During 27 August 2020, significant surface water flooding occurred across Plymouth, causing 25 confirmed properties to flood and 10 confirmed outhouses.

### Conclusions from the Flood Hazard and Risk Maps

The flood hazard and risk maps show that in Plymouth surface water FRA, 5,567 people live in areas at risk of surface water flooding. Locations with the highest density of people living at risk of flooding in the Plymouth surface water FRA are:

- Western Approach
- the Pennycomequick area
- Lipson Vale and Laira
- Mount Gould

Also shown to be at risk from surface water flooding in the FRA are:

- 4 services - mainly consisting of schools and the railway line
- 406 non-residential properties - 30 properties at high risk, 57 properties at medium risk and 319 at low risk located in:
- Cattedown

- the Barbican
- the city centre area
- 2.5km of railway line located in Lipson Vale and Laira and the Embankment Road area
- 10 listed buildings mainly located in the:
    - Barbican area
    - Hoe Park
    - Ford Park Cemetery Trust
    - Royal Citadel which is a Scheduled Ancient Monument
- 2 bathing waters directly off the Hoe waterfront

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to reduce the likelihood of surface water and sewerage flooding to people, properties, critical infrastructure and the environment in the Plymouth surface water FRA.

It must be noted that there are other locations at risk of surface water flooding in Plymouth not included in this analysis. This includes key strategic highways that link the A38 to the city centre.

## How the risk is currently managed

Plymouth City Council has been working collaboratively with South West Water and the Environment Agency to collectively reduce the risk of flooding in Plymouth.

South West Water have, with contributions from Plymouth City Council and the Environment Agency, developed an Integrated Urban Drainage Model (IUDM). This is a tool used to better understand how foul and surface water flow can be managed to reduce flood risk. The locations the model has been applied to can be found in the 'Plymouth Local Flood Risk Management Strategy'.

Recent surface water and foul sewerage separations projects, which have been jointly funded by the partners described above, have focused on using IUDMs to upgrade existing assets and install new flood risk management measures.

An example of a completed surface water separation scheme is in the Dean Cross area in Plymstock.

The Risk Management Authorities (RMAs) are currently investigating further work to separate surface water from foul sewerage systems in locations at high risk of surface water flooding. It's important to note, there are several areas in Plymouth that have critical drainage problems and have subsequently been identified as Critical Drainage Areas (CDA). In these locations, connecting surface water drainage to combined sewers is discouraged.

When it comes to ensuring Plymouth develops sustainably with climate change, Plymouth City Council, the Environment Agency and South West Water work closely with developers. This is to manage the risks of surface water flooding for:

- future development
- increased community resilience
- better management of flood risk from all sources across the city

## The impact of climate change and future flood risk

The recent wave study commissioned by the Environment Agency for Plymouth Sound shows a combination of:

- sea level rise
- increased wave heights
- increased rainfall intensity

This will result in surface water flooding becoming more frequent.

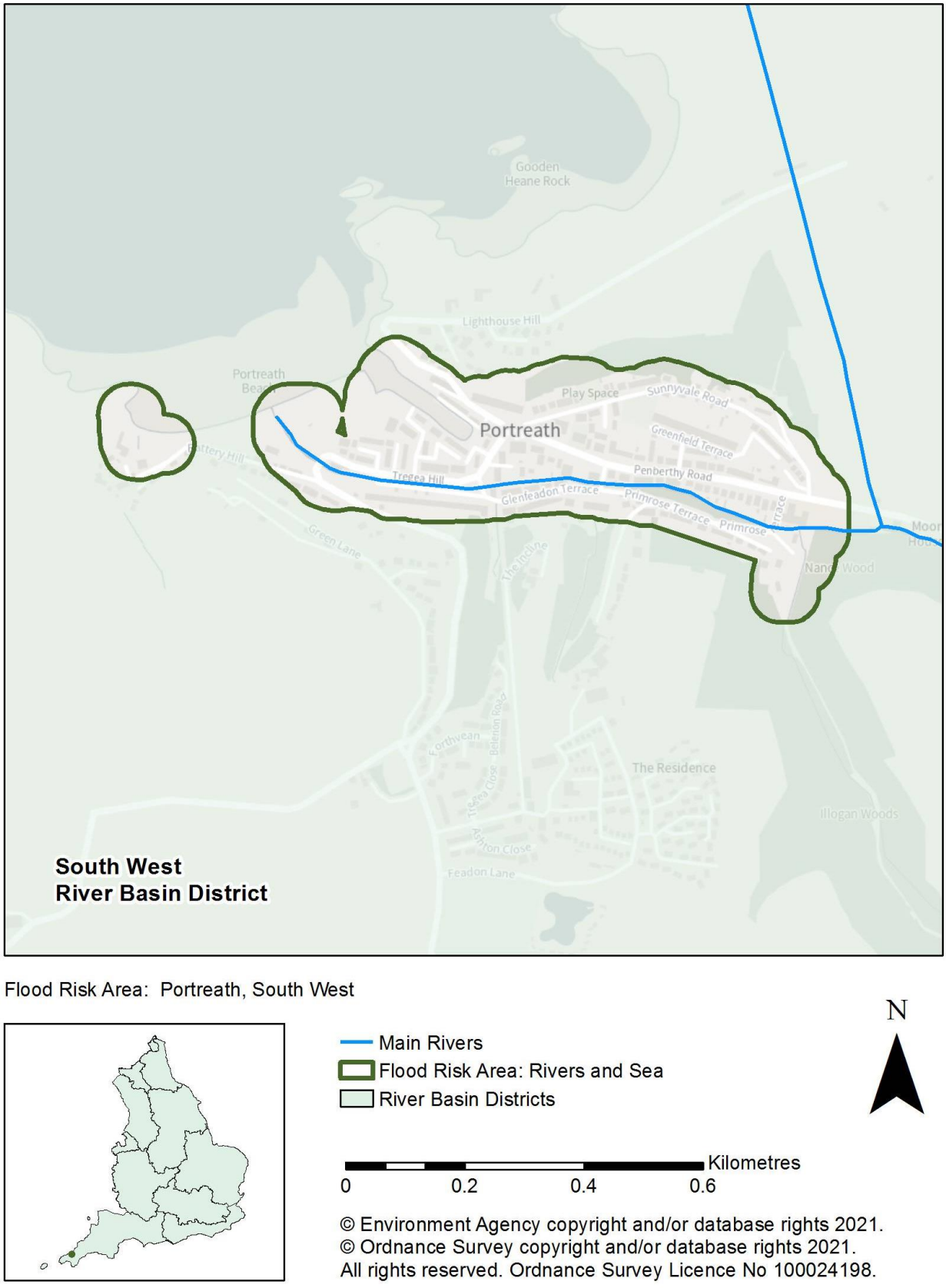
Areas at increased risk of surface water flooding and increased wave overtopping and / or tide locking will need to be made resilient to a combination of flooding in the future. Further information on the impact of climate change and future flood risk can be found in ‘Plymouth’s Local Flood Risk Management Strategy’.

## Objectives and measures for the Plymouth Surface Water Flood Risk Area

Measures have been developed that apply specifically to the Plymouth surface water FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Plymouth surface water FRA.

You can find information about all the measures that apply to the Plymouth surface water FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Portreath Rivers and Sea Flood Risk Area




Flood Risk Area: Portreath, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

Kilometres
0 0.2 0.4 0.6



**Figure 20: a map showing the boundary of the Portreath Rivers and Sea Flood Risk Area**

# Introduction to the Portreath Flood Risk Area

The Portreath Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. The Environment Agency is responsible for managing flood risk from main rivers and sea flooding.

Cornwall Council is responsible for managing the risk of flooding from surface water and ordinary watercourses. South West Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in this FRA.

## Description of the Portreath Catchment

The Portreath FRA is on the northern coastline in the West Cornwall and Fal Management Catchment. Portreath is a low-lying coastal settlement that sits amongst high, steep-sided cliffs at the mouth of the Portreath Stream and at the bottom of Portreath Valley.

The river springs in the urban town of Redruth where it’s known as Redruth Stream. Surface water run-off from Redruth and the A30 can flow into the river. The river then flows through the two small settlements of Gilberts Coombe and Bridge, before joining the Portreath Stream at Bridge and draining into the FRA.

The topography of Portreath is heavily influenced by the fluvial process from the Portreath stream in the east. The steep sided Portreath Valley leads to the catchment rapidly responding to rainfall.

As the Redruth Stream flows downstream of Redruth, it drains through a wider catchment characterised by more gentle slopes, woodland and agriculture before flowing into the Portreath stream. The underlying geology is sandstone and mudstone, these are soft and erode easily.

The FRA covers the village of Portreath which includes a significant number of residential and commercial properties built on low-lying land directly behind Portreath Beach. This also includes the properties around Smugglers Cove to the west.

The coastal frontage consists of:

- Portreath Beach
- Portreath Harbour
- Breakwater Pier

The breakwater extends past the harbour and is connected to a sea wall. Within the entrance to the harbour and directly behind the wall, there are also stoplogs. The

breakwater, sea wall and stoplogs all play a role in protecting the low-lying properties situated behind from coastal erosion and flooding from the sea.

The Portreath Stream experiences water quality issues that are mainly related to historical mining influences. The Portreath Stream is a Heavily Modified Waterbody for flood protection and is deprived of ecology.

## Environmental Designations

Within the FRA, environmental designations include:

- parts of 2 Sites of Special Scientific Interest (SSSIs) - Nance Woods and Godrevy to St Agnes coastline
- parts of the Cornwall and West Devon Mining Landscape World Heritage Site (WHS)
- 3 listed buildings

You can find out more information on designated sites in the Portreath catchment in the 'Cornwall draft Local Nature Recovery Strategy'.

## The Drainage System

The Portreath Stream flows through Portreath. Combined flows from the catchment converge at the edge of the settlement, through a large trash screen at the inlet of a kilometre-long culvert. This is known as the Portreath Tunnel.

A channel known as the perched channel (or Mill Leat) continues from the tunnel and into the village. The Illogan Stream discharges into the Mill Leat near the primary school and subsequently flows out onto the beach. A blockage to the trash screen at the inlet to the Portreath Tunnel would result in river water flowing down Penberthy Road. This would result in pooling around properties surrounding the harbour, which is located north-east of the beach. In addition, high river levels in the Mill Leat would also result in pooling at the low-lying areas surrounding the harbour.

Due to Portreath's low-lying topography, it's also at risk of flooding from the sea, with the possibility of the sea overtopping the defences. Portreath Harbour has low-lying quays that can be overtopped by waves and high water levels. Water overtopping here can flow and pool into the low-lying land behind the quay, posing a flood risk to properties surrounding the harbour.

A combination of flood risk from all sources can exacerbate the risks to the low-lying areas of Portreath. These rapidly responding characteristics are common for small coastal settlements at the bottom of river valleys across the South West River Basin District (RBD).

## Current flood risk

Portreath has unfortunately experienced major flood incidents caused by rivers and sea flooding. Since the production of the 'Flood Risk Management Plan Cycle One', there have been 5 recorded flood events in Portreath. All were linked to heavy rainfall, resulting in river, surface water and tidal flooding over the past 6 years. Thirteen properties were affected by river flooding in 2016.

Storm Eleanor in 2018 lead to failure and breach in the sea flood defences with the high energy waves damaging the sea wall. There was no record of properties being affected, and the wall has since been rebuilt by the Environment Agency.

### Conclusions from the Flood Hazard and Risk Maps

The flood hazard and risk maps show that in the Portreath FRA, 455 people live in areas at risk of flooding from rivers and the sea. Of these people, 67% live in areas at high risk. Locations with the highest density of people living at risk of flooding include the eastern part of Portreath between the primary school and community hall.

Also shown to be at risk from surface water flooding in the FRA are:

- 21 non-residential properties - 16 at high risk, 4 at medium risk and 1 at very low risk
- 4 services - including a school and town hall
- 12ha of agricultural land
- 10ha of WHS
- 3 listed buildings

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Portreath FRA.

Based on this information, Risk Management Areas (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the impact it can have to people, properties, critical infrastructure, and the environment in the FRA.

At the time of writing, feasibility work is ongoing to assess and progress opportunities to reduce flood risk in Portreath from the Portreath Stream.

## How the risk is currently managed

### The Flood Warning Service

The Environment Agency monitors river levels and rainfall conditions in the area. This data is used to issue flood warnings for the Portreath Stream, to inform the community of when flooding may occur. This information also informs operational activity on the Portreath Stream.

### Mapping and Modelling

The Environment Agency uses computer software models to develop flood maps for planning, which are used to assess the risk to properties from:

- rivers
- the sea
- surface water flooding

The Environment Agency is developing a ‘Devon and Cornwall Coastal Flood Risk Modelling’ project. This will be used to map flood risk from the sea for 19 coastal communities across Devon and Cornwall, Portreath being one of them. The models consider offshore wave conditions and tidal levels.

### Flood Risk Management Schemes

The Environment Agency operates and maintains assets that perform a flood risk management function from rivers and the sea in Portreath. These include:

- weirs
- trash screens
- culverts

Most of these assets are found at the convergence point, just upstream of Portreath at the inlet of a kilometre-long culvert, known as the Portreath Tunnel. Under normal conditions, all flow from the river is diverted to the sea through the Portreath tunnel, bypassing the village in the process.

At the Portreath tunnel inlet the Environment Agency upgraded and extensively improved the existing trash screen. The screen collects debris to reduce the risk of a blockage within the tunnel. During flood events, operational field teams regularly check and clear the screen of debris to reduce the risk of flooding in Portreath.

The coastal defences consist of a variety of sea and harbour walls and, together with a breakwater, reduce the risk of flooding from the sea. After Storm Eleanor significantly damaged the Portreath harbour wall in 2018, £840,000 of recovery works were carried out to repair 23m of the sea wall. This subsequently reduced flood risk to approximately 54 properties. However, during spring high tide, properties surrounding the harbour are at risk of flooding from the sea due to the water level exceeding the crest height of the quay walls.

## The impact of climate change and future flood risk

Portreath is amongst several small rapid response communities situated in the South West RBD. As rainfall intensity increases, sea levels continue to rise and storms become increasingly more severe and frequent, which means more water will drain through the catchment. This will subsequently increase the likelihood of the river surcharging at the

inlet to the Portreath Tunnel. There will also be a higher likelihood of low-lying locations in Portreath experiencing flooding from wave overtopping and high tides.

Please refer to the Climate Change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South West RBD.

## Objectives and measures for the Portreath FRA

Measures have been developed that apply specifically to the Portreath FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Portreath FRA.

You can find information about all the measures which apply to the Portreath FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The St Blazey and Par Rivers and Sea Flood Risk Area

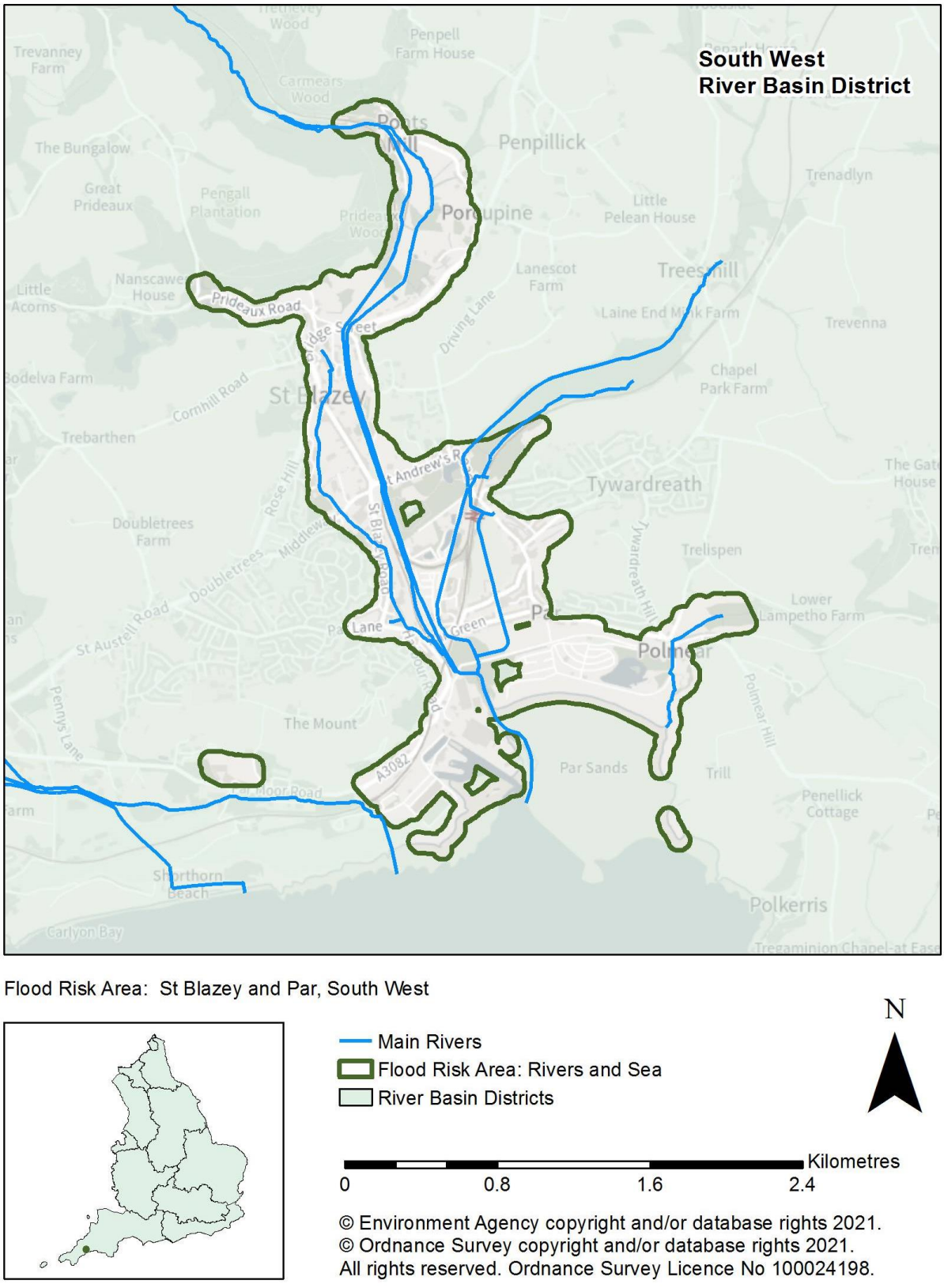



**Figure 21: a map showing the boundary of the St Blazey and Par Flood Risk Area**

# Introduction to the St Blazey and Par Flood Risk Area

The St Blazey and Par Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA. Cornwall Council is the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water and ordinary watercourses. South West Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in this FRA.

## Description of the St Blazey and Par Catchment

The St Blazey and Par rivers and sea FRA is on the southern coast of Cornwall within the St Austell Bay. The FRA is broken down into 2 key settlements. St Blazey sits directly north of Par. Both settlements are situated on the eastern side of St Austell Bay.

There are 7 main rivers that flow through the catchment:

- Par River
- Treffry Canal
- St Blazey Stream
- Tredenham Close
- Tywardreath Stream
- Treesmill Stream
- Polmear Stream

The system is unique by the 2 larger rivers (Par River and Treffry Canal) being perched above the infilled estuary the town is built on. The riverbed is one metre above the surrounding residential thresholds in some locations. This is a result of historic mining use of the catchment when the rivers were used to transport materials in suspension. Other tributaries, such as the Prideaux Stream, drain through the catchment and converge with the Par River.

The wider catchment includes a wide expanse of moorland which drains into a steeply sided valley between Luxulyan and Ponts Mill. The underlying geology is mudstone turning to hard granite just north of St Blazey, which makes the upper catchment relatively impervious. This in turn leads to the flashy nature of the catchment. The soft mudstone rock erodes easily putting some coastal properties in Par at erosional risk.

As St Blazey and Par have developed over time, the estuary which it once sat on has been infilled and built over so that some of the areas are very low-lying. The land use of the FRA itself is diverse. It includes:

- residential
- business
- public open spaces

- wooded valleys
- developed coastlines (Par Docks)
- undeveloped coastlines (sand dunes)
- agricultural land

## Environmental Designations

The St Blazey and Par catchment hosts an array of environmental and historical designations. This includes:

- the World Heritage Site of Cornwall and West Devon Mining Landscape
- Local Nature Reserve
- Falmouth Bay to St Austell Bay Special Protected Area (SPA)
- ancient woodlands
- local wildlife sites
- Par Sands designated bathing water

There is also a conservation area situated within the St Blazey and Par FRA.

You can find out more information on designated sites in the St Blazey and Par catchments in the 'Cornwall draft Local Nature Recovery Strategy'.

## The Drainage System

The Par River begins as a small stream which springs in Criggan Moors, close to the A30 and A39. Its geology is comprised of igneous bedrock. It flows into Luxylan where it forms into the Par River. It then flows through the wooded Luxylan Valley where it diverges with the Treffry Canal. These 2 main rivers flow through both St Blazey and Par before flowing into St Austell Bay.

To the west, the St Blazey Stream flows through St Blazey, converging with Par River directly north of Par Docks. To the east, the Treesmill Stream springs upstream of Treesmill before flowing through the wooded valley of Par Marsh, along with the Tywardreath Stream. The Polmear Stream springs in Pinnock Wood before flowing though Polmeor. These rivers flow into a Special Area of Protection (SPA).

The coastal frontage of Par consists of sand dunes lining the eastern coastline, directly in front of a caravan park. The western frontage consists of Par Docks, which is made up of quays and a breakwater. Due to Par and St Blazey's proximity to the coastline, the river networks are influenced by tidal locking, especially during high spring tides and strong southerly winds.

As outlined in the 'Cornwall Local Plan', Par Docks is experiencing a regeneration. The Docks will be developed into an eco-town, where new housing will be built.

## Current flood risk

The St Blazey and Par area has an unfortunate history of frequent flooding. There are many recorded flood events since 1959 (including November 2010) caused by 2 main mechanisms of flooding; fluvial and surface water run-off. However, tide locking of the Par River also occurs.

Of the recorded events, one was limited to overtopping of the banks of the River Par. All the other events were as a result of combinations of flooding from the Prideaux and St Blazey Streams (overtopping of riverbanks). This also includes numerous incidents of surface water flooding. Station Road and Fore Street appear to be the most frequently flooded areas of St Blazey, while the Par Lane / St Blazey Road areas are the worst affected areas of Par.

The worst incident on record occurred in February 1970 where 80 properties were reported to have flooded with a further 50 only prevented from flooding by placement of sand bags. Most of the properties were in the low-lying area in Par. The flooding was caused by prolonged, intense rainfall in addition to periods of tidal locking of the River Par. This resulted in a flood defence system being constructed in the 1970s to protect against flooding.

Since the production of the first cycle FRMPs, there have been 5 recorded flood events in the FRA. All were linked to heavy rainfall causing fluvial and surface water flooding over the past 6 years. There has been no recorded flooding of properties since 2015. The last flood to directly impact properties was in December 2012 when a fluvial flood in Par unfortunately affected 23 static homes.

### Conclusions from the Flood Hazard and Risk Maps

The flood hazard and risk maps show that in the St Blazey and Par FRA, 1,503 people live in areas at risk of flooding from rivers or the sea. Of these people, 22% live in areas of high risk.

Also shown to be in areas at risk of flooding from rivers or the sea are:

- 195 non-residential properties - 82 at high risk, 96 at medium risk and 17 at low risk
- 6 services - including the train station and pharmacy
- 0.46km of A roads
- 4.53km of railway
- 61.63ha of agricultural land
- 9 listed buildings

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the St Blazey and Par FRA. Based on this information, further steps should be taken to increase flood resilience in the St Blazey and Par FRA. Like many communities with similar characteristics in the South West River Basin District, an

array of flood resilience measures will need to be implemented to manage the flood risk in St Blazey and Par.

To increase flood resilience, working in partnership across all Risk Management Authorities (RMAs) and infrastructure providers is key. The approach partners and the community take to increase flood resilience in St Blazey and Par should improve its long-term sustainability. This may require significant changes to the built environment to accommodate this approach, which will be set out in an Adaptation Plan. An Adaptation Plan takes a longer-term view of the potential impacts of climate change on St Blazey and Par. This approach to increasing flood resilience will boost economic prosperity, livelihoods and wellbeing.

## How the risk is currently managed

RMAs are involved in the ongoing collaborative project ‘St Austell Bay Resilient Regeneration’ (StARR). It aims to reduce flood risk to communities living and working in the St Austell Bay area, particularly in St Blazey and Par. The proposed scheme will also bring additional benefits to the area by encouraging investment and making St Blazey and Par a better place to work, live and play.

StARR is a collaborative project which includes the following partners:

- Cornwall Council
- Environment Agency
- South West Water
- Westcountry Rivers Trust
- University of Exeter

StARR is part funded by the European Regional Development Fund. To date, activity that has worked towards increasing flood resilience in this location includes:

- developing outline designs for Urban Infrastructure sites
- detailed designs for works alongside the River Par

The RMAs have also held workshops for community leaders to help shape the use of the open space around parts of St Blazey and Par. This includes imbedding nature-based solutions to reduce flood risk, such as proposed ponds and raingardens.

The University of Exeter has also partnered with Westcountry Rivers Trust to develop habitat plans near Lower Molinnis. They have also engaged with landowners across the Par River catchment. Finally, RMAs have commissioned the first part of a long-term Adaptation Plan to help the community develop and adapt to the challenges of climate change.

### The Flood Warning Service

The Environment Agency monitor river and rainfall conditions at 9 sites in the FRA. These include 8 operational controls and 1 effluent site. These are used to warn and inform the

community of potential flood risks in the 2 flood warning areas located in the FRA. This data also informs the operational response during a flood incident.

### Mapping and Modelling

The Environment Agency uses computer software models to develop flood maps for planning. They're used to assess the risk to properties from:

- rivers
- the sea
- surface water flooding

In 2018, the Environment Agency completed a model for St Blazey and Par to gain a better understanding of the flood risks here.

### Flood risk management schemes

The Environment Agency operates and maintains assets that perform a flood risk management function from rivers and the sea in St Blazey and Par. Overall, flood risk management schemes in St Blazey and Par are made up of the following assets:

- dams
- flood storage areas
- pumping stations
- flood storage areas
- penstocks
- tidal flaps
- culverts

Due to the historic mining use of the catchment, some of the rivers (particularly the River Par and Treffry Canal) are engineered straight and are constrained very tightly in position by urban development built on the infilled estuary. The river networks are manually controlled by Environment Agency. There are also several pinch points across the river systems, including bridges and railway lines that pose a flood risk to the FRA.

## The impact of climate change and future flood risk

Climate change is causing sea levels to rise, and river levels and flows to increase. At present, the current flood risk system works but has a lower than satisfactory standard of protection and requires active management.

In the future, we expect flood depths and extents to increase, which will lower the standard of protection for these assets. As Par and St Blazey sits on the coast, studies suggest that coastal flooding could take place once a year by 2065, if the flood risk is not managed at the Treesmill tide gate.

Sea level rise and increased storminess will also increase erosion to the sand dunes, which currently contribute towards protecting Par from sea flooding. The erosion of these dunes could cause coastal inundation to low-lying coastal areas of the FRA, further increasing the flood risk to the community.

Increased rainfall resulting in high river levels and flows will flow through the straight, raised, artificial watercourses. This will increase the erosional risk to the watercourse, which in turn could lead to tidal locking further downstream. Higher flows moving through the river systems could cause increased flood risk, particularly in locations where man-made structures intercept the flow.

Please refer to the Climate Change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the St Blazey and Par FRA

Measures have been developed that apply specifically to the St Blazey and Par FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the St Blazey and Par FRA.

You can find information about all the measures that apply to the St Blazey and Par FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Taunton Rivers and Sea Flood Risk Area

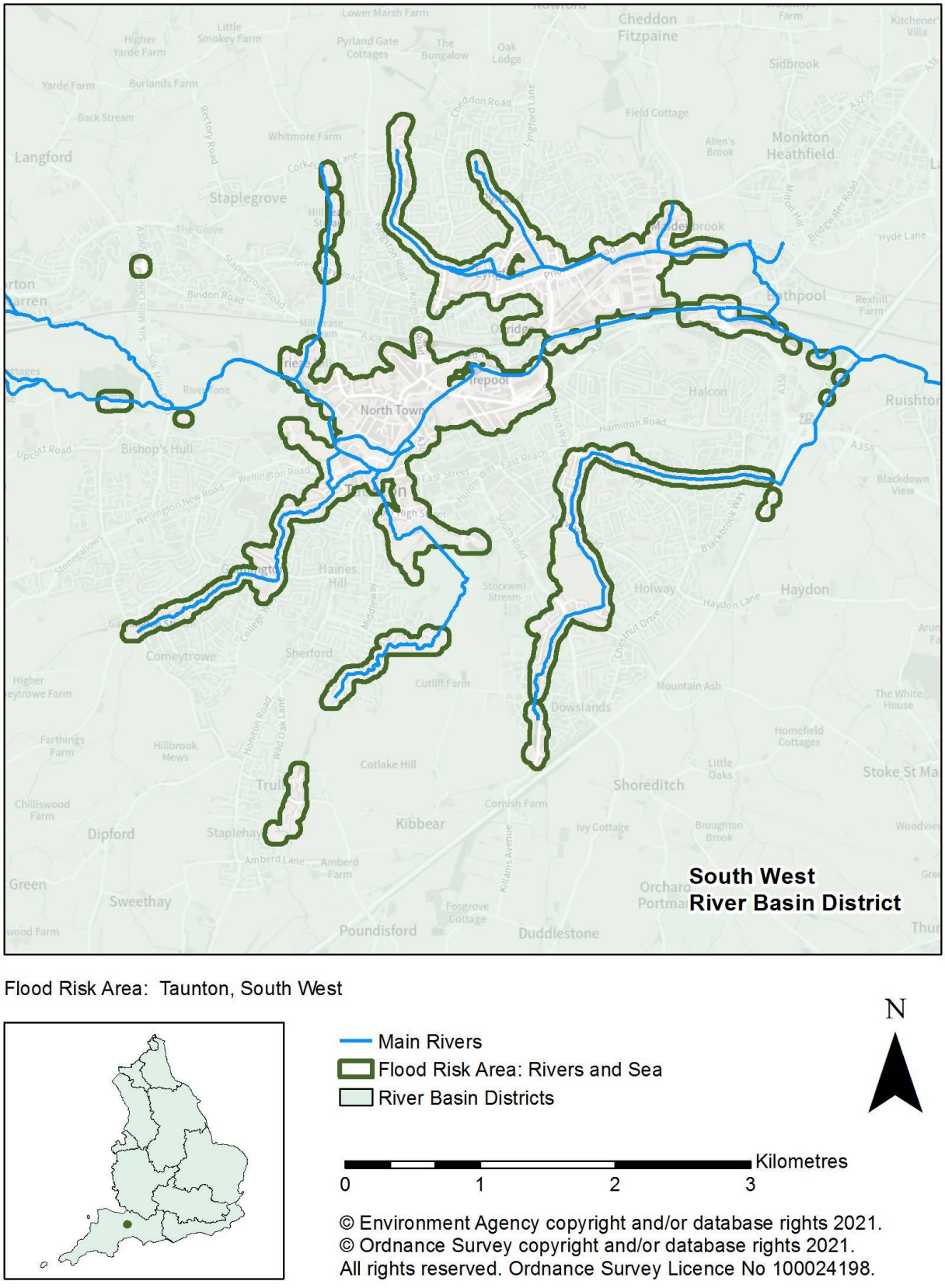



**Figure 22: a map showing the boundary of the Taunton Flood Risk Area**

## Introduction to the Taunton Flood Risk Area

The Taunton Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency takes the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

Somerset County Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from:

- surface water
- groundwater
- ordinary watercourses

Somerset West and Taunton Council are a Risk Management Authority (RMA) who support the LLFA on flood risk matters related to ordinary watercourses. They're also the Local Planning Authority (LPA) and lead partner in the 'Taunton Flood Alleviation Scheme', in partnership with the Environment Agency.

Wessex Water is the water and sewerage company that owns, operates and maintains the sewer network and wastewater treatment infrastructure in the FRA.

The Taunton FRA covers many of the urban districts of Taunton, which includes:

- residential properties
- businesses
- amenity areas
- surrounding green belt (mainly farmland and some public parkland)

Taunton was designated a garden town in 2017. As a result, Somerset West and Taunton Council is working towards providing and improving green infrastructures at the heart of the neighbourhoods.

Somerset County Council and the 4 district councils (Sedgemoor, Mendip, Somerset West and Taunton, and South Somerset) in Somerset have all declared a climate emergency. This has resulted in a combined 'Climate Emergency Strategy', led by Somerset County Council. This strategy outlines the ambitions to make the councils and the area carbon neutral by 2030. Somerset West and Taunton Council have also produced a 'Green Infrastructure Strategy'. The Environment Agency is working closely with the councils to make sure flood risk issues remain high on their agenda and appropriate mitigations and outcomes are delivered.

### The Tone Catchment

The River Tone is the main river that flows through the Taunton FRA. It rises in the Brendon Hills near Ralegh's Cross and is 33km long from its source to the confluence with

the River Parrett in the Somerset Levels and Moors. Over this distance it falls approximately 370m in altitude. Just downstream of its source, the Tone enters the Clatworthy Reservoir, a major public water supply reservoir managed by Wessex Water. From here the river runs south and then east, past the town of Wellington and several villages to Taunton. Thereafter it flows through the nearby villages of Ruishton, Creech St Michael and Ham before entering the Somerset Levels. This is where it becomes tidal at New Bridge Sluice before joining the River Parrett at Burrowbridge.

When in flood the River Tone can remain high for some time, preventing tributaries in Taunton and the surrounding area from discharging naturally. This increases the flood risk to the communities located near to where the tributaries join the Tone.

The Bridgwater & Taunton Canal (24.6km) leaves the River Tone at Firepool Lock in central Taunton. The canal flows to Bridgwater where a weir allows excess water to run into the tidal River Parrett.

Taunton is also at risk from surface water flooding, which either occurs because of surface water drains exceeding their capacity or from direct rainfall on the hard surfaces of the built-up area. Surface water drains can also be impeded when the River Tone is high. Somerset County Council developed a 'Surface Water Management Plan' for Taunton in 2013, which provides an overview of these risks and options for managing them.

In October 1960, Taunton suffered a severe flood from the River Tone and tributaries, which affected a large area of the town, particularly:

- Station Road
- Bridge Street
- the North Town area

More than 360 houses, shops and business premises were flooded. This resulted in the 'Tone Valley Flood Alleviation Scheme' (FAS) being delivered in the late 1960s, which significantly modified the river channel between French Weir and Bathpool. The scheme also provided ring bank defences for several villages downstream. Through the town centre, the River Tone channel was straightened and lined with pitching stone revetment on the banks. Various obstructing services and structures were removed. Sections of raised flood wall were added around French Weir Park, Goodlands Gardens and along riverside residential and business properties through the town centre.

Downstream of Town Bridge, Firepool Weir was extended with a new section of weir. The defences were tested with a flood event in 1968 and records confirm that the defences protected the centre of Taunton. Some of these flood walls were later improved to a higher level in the early 1990s. The town flood walls have since been subject to ad-hoc, ongoing structural repairs and raising in recent years, as have the 2 weirs at French Weir and Firepool.

## Current flood risk

In October 2000, the Taunton FAS was tested by a flood event of a similar magnitude to that recorded in 1968. From information collected during the 2000 event, the defences on the River Tone were successful in protecting the centre of the town. Flooding that occurred from the tributaries was more significant, and surface water flooding affected several other areas.

Flood water from the river was observed overtopping the canal lock gates at Firepool causing flooding in Bathpool downstream, directly from the canal. Smaller flood events occurred in 2007, 2009 and 2012 within the Tone catchment, with tributaries causing flooding across the town.

In 2012 notable flooding occurred in Vivary Park from the Sherford Stream (a tributary of the Tone) and to the adjacent Taunton Deane cricket club. In the same flood event, flooding occurred in Bathpool from local tributaries that could not drain into the River Tone because it was high for an extended period.

A major flood incident occurred on the Somerset Levels and Moors in late 2013, which resulted in an extensive area being flooded for 3 months. Taunton town centre avoided serious flooding, but parts of the town experienced significant disruption to local services and businesses from localised tributary flooding and surface water flooding of highways. This demonstrated that flooding events do not just impact the inundated area.

The flood hazard and risk maps show that in the Taunton FRA, 4,742 people live in areas at risk of flooding from rivers and the sea. Of these people, 6% live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 547 non-residential properties
- 60 listed buildings
- 0.12ha of Scheduled Ancient Monuments
- 0.48km of railway
- 35.12ha of agricultural land
- 2 licensed water abstraction sites

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Taunton FRA.

The flood mechanisms in Taunton are well understood. The existing FAS along the River Tone was originally designed in the 1960s and further improved in the 1990s. This was to protect against a flood with a 1% chance of occurring within any given year. Recent modelling has shown that this flood risk has now increased to around 2% in places due to the risk of the defences being overtopped. The current scheme capacity will become increasingly sensitive to any climate change impacts that manifest in increased flood flows.

After considering the experience of floods elsewhere, it's reasonable to estimate that a single major flood in Taunton could cost the local economy approximately £50 million (2019 cost base).

Based on this information, Risk Management Authorities have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other RMAs and other stakeholders. These include:

- Somerset County Council
- Somerset West and Taunton Council
- the Somerset Rivers Authority (SRA)
- Wessex Water

RMAs and stakeholders meet regularly through groups, such as the:

- SRA
- Somerset Catchment Partnership
- Wessex Regional Flood and Coastal Committee (RFCC)

The groups discuss:

- strategic and operational matters
- capital programmes
- funding
- other related initiatives

The SRA was set up in 2015 as a partnership of the local RMAs following the flooding of the Somerset Levels and Moors in 2013/14. The SRA oversees the 'Somerset Levels and Moors 20 Year Flood Action Plan'. This includes additional flood risk mitigation works for Somerset that cannot be delivered under the remits of other RMAs. This includes financial contributions to the development of future strategic flood mitigation schemes in Taunton.

The Environment Agency monitors river and rainfall conditions at 5 sites in and immediately adjacent to the FRA. We collect data on:

- river levels
- river flows
- rainfall

This information is used to inform activities related to 7 flood warning areas that cover the FRA which enable people to receive a warning when flooding could occur.

The water level and flow information are also used to inform and calibrate mathematical modelling of the river network. All the main river watercourses across Taunton have

hydraulic models that were updated in a partnership between the Environment Agency and Somerset West and Taunton Council to inform the latest flood risk strategy project.

Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

The Environment Agency maintain flood risk management assets throughout the FRA, such as:

- river channels
- flood defence walls
- embankments

Similarly, Somerset County Council, Somerset West and Taunton Council, the IDB and Wessex Water maintain assets that perform a flood risk management function on the drainage network.

## The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. This means that flooding from rivers and surface water will become more frequent.

Therefore, climate change is forecast to put existing and planned properties at increasing levels of fluvial and surface water flood risk in the future. As well as increased river flows from climate change, the existing and ageing flood defences through the town are reaching the end of their design life. This creates additional challenges to maintaining the current Standard of Protection of these defences.

The Taunton FRA has some challenging flooding problems to address due to conflicting needs. Considerable urban growth and development has begun in recent years and is planned to continue into the medium-term. Much of this is in the river corridor as well as in the town's periphery. All of which puts increasing pressure on local drainage and river systems. Protecting properties and business to enable social and economic growth must be undertaken sustainably and balanced with other needs. This includes maintaining the river navigation requirement and abstraction for the canal by maintaining the weirs.

Social and economic changes over the last decade have left a legacy of redevelopment challenges and opportunities for the town.

Due to our ongoing strong partnership work with Somerset West and Taunton Council, flood risk management issues, coupled with the future economic and social needs in Taunton have been well assessed and understood. Consequently, we're undertaking comprehensive and strategic flood mitigation planning into the short, medium and long-term. This is to take account of the future risks of climate change and development. This

will underpin the town's future growth and complement the Garden Town status the town has been afforded.

Somerset West and Taunton Council and the Environment Agency have developed the 'Taunton Strategic Flood Alleviation Improvements' project. It has multiple phases from the short to long-term and will enable adaptive mitigation approaches for the future.

The first phase includes two short-term interventions - one to improve the ageing flood defence walls along the left bank of the River Tone from Frieze Hill to the Town Bridge and another to raise Firepool lock gates and improve the defences between the canal and the River Tone from Firepool to the A358 Obridge Viaduct. These will be undertaken over the coming years, with committed funding. Flood storage ponds just upstream of the town centre have already been created as part of the Longrun Meadow country park amenity area. Further investigation of this area has also been planned to improve the flood storage.

A study is underway to provide long-term protection to Taunton through the creation of a large Tone flood storage scheme a few miles upstream of the town.

All these schemes are essential to support continued growth in Taunton town centre and its urban extensions that would otherwise be exposed to increasing risk of flooding. The schemes will also reduce the flood risk to existing properties.

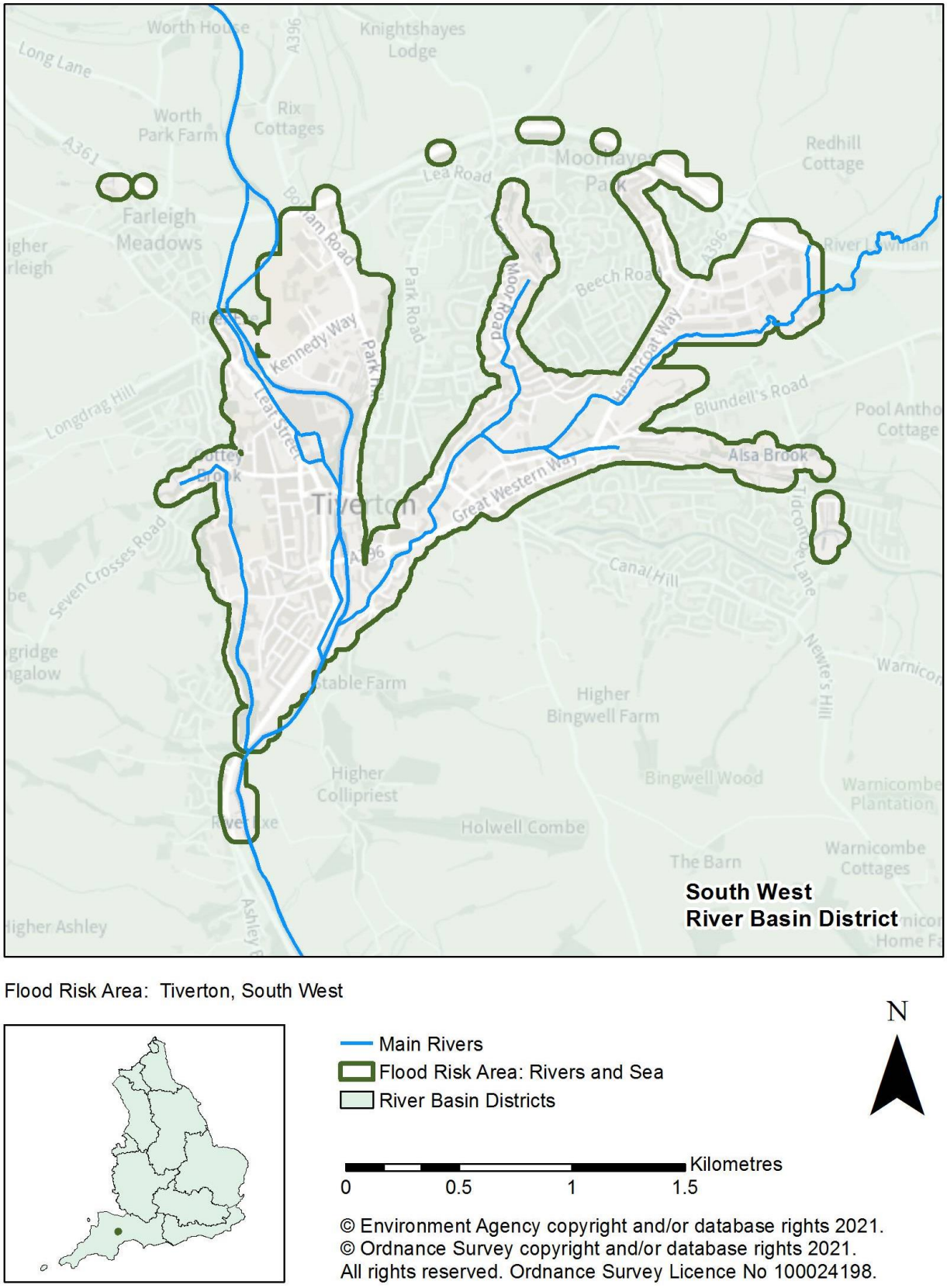
Please refer to section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the Taunton FRA

Measures have been developed that apply specifically to the Taunton FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Taunton FRA.

You can find information about all the measures that apply to the Taunton FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Tiverton Rivers and Sea Flood Risk Area




Flood Risk Area: Tiverton, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

Kilometres
0 0.5 1 1.5



**Figure 23: a map showing the boundary of the Tiverton Flood Risk Area**

## Introduction to the Tiverton Flood Risk Area

The Tiverton Flood Risk Area (FFRA) is inland of mid-Devon. The Tiverton FRA covers many of the urban districts of Tiverton that includes:

- residential properties
- businesses
- amenity areas

It’s also surrounded by a gently undulating landscape of green space and farmland.

Tiverton was first documented as a developing Saxon Market town as early as 899. The town stands at the confluence of the rivers Exe and Lowman. Its economic development and urban character were formed by its relationship with the rivers Exe and Lowman. The rivers Exe and Lowman provided a valuable trade route and allowed the town to prosper from the booming textile industry.

The Tiverton FRA has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and implementation of the Flood Risk Management Plan (FRMP) for this FRA. Devon County Council are the Lead Local Flood Authority, whose remit includes flood risk from surface water and ordinary watercourses.

South West Water owns, operates and maintains the public sewer network and wastewater treatment infrastructure in the FRA. Mid Devon District Council are both a Risk Management Authority (RMA) and the Local Planning Authority, whose remit includes management of ordinary watercourse flood risks and planning.

## Hydrology and geology of the catchment

The Tiverton FRA is located on the confluence of the Rivers Exe and Lowman. The headwaters of the River Exe are within Exmoor National Park and upstream of the Tiverton FRA. The upper reaches of the River Exe, flow through narrow valleys coming off Exmoor which at times respond rapidly to rainfall with high velocities and depths. The landscape downstream opens out into wide flood plains meandering through valleys separated by low hills.

The geology within the Exe catchment spans approximately 400 million years from the Devonian period through to the present day. The headwaters of the Exe in the north of the catchment comprise of:

- Devonian siltstones
- sandstones
- shales

These rocks are generally of low permeability and therefore produce more surface water runoff in the upper catchment. The middle and eastern parts of the catchment are underlined by:

- Permo Triassic sandstones
- mudstones
- breccias

These stones form the Aylesbeare Mudstone Group and because of their good porosity form the aquifers found within the catchment. The lower Exe comprises of sandstone breccias within the Permo Triassic strata. Groundwater is contained within the sandstone aquifers of the lower Exe. Recharging of these aquifers during wet periods will have some effect on reducing peak flows in the Rivers Exe. This is because some of the floodwater volume may be removed by storage into the underlying rock strata.

Soil types affect the response of rivers and surface water to rainfall, and therefore have implications for flood risk. The Exe catchment has a broad distribution of soil types, most soils in the catchment are freely draining. The upland areas of the catchment, on Exmoor, are characterised by peaty soils with low permeability. To the east of the catchment, silty, clayey soils in the Culm valley have much smaller particle size and are also low in permeability.

Overall, the nature of the geology and soils of the catchment will lead to:

- a fast response of flood flows to rainfall in the Barle and upper Exe catchments
- a tendency to localised surface water flooding
- little risk of groundwater flooding

## Environmental designations

The Tidcombe Lane Fen Site of Special Scientific Interest is located on the far east of Tiverton FRA on the on the Alsa Brook.

Tiverton Castle is a Scheduled Ancient Monument and is located within the Tiverton FRA. Numerous listed buildings and a Conservation Area are also located within the FRA.

## Flood risk sources

The greatest source of flood risk to the Tiverton FRA is from the Rivers Exe and Lowman. Other watercourses drain smaller more local areas of the Tiverton FRA. These are:

- Little Gornhay Stream
- Cottey Brook
- Aisla Brook
- Moorhayes Stream
- Alsa Brook
- the Town Leat

All the watercourses associated with the Tiverton FRA have historically heavily modified for milling, power supply and industrial reasons.

The Wimball Lake is located on Exmoor and is a water supply reservoir constructed in the 1970s and completed in 1979. The Wimball Lake is upstream of the Tiverton FRA on the River Exe. The lake is also used for recreational purposes and a haven for wildlife. However, the Wimball Lake does pose a risk of flooding from the reservoir to the Tiverton FRA downstream.

The Grand Western Canal is located to the east of the Tiverton FRA and is managed by Devon County Council.

There has been significant development in and around the Tiverton FRA over the last 100 years. Therefore, the FRA is also susceptible to flooding from surface water during high rainfall events, due to the heavily urbanised nature of the FRA. It's also compounded by aging drainage infrastructure that has been increasingly overloaded with additional surface water input.

## Current flood risk

The Tiverton FRA has a long history of flooding with notable events in:

- the 1960s
- 2000
- 2012

Since the production of the first cycle Flood Risk Management Plans in 2015, there have been two recorded flood events in key locations caused by a combination of sources in the in the Tiverton FRA.

In December 2015, properties were reported to have flooded at Oaklea in Tiverton. Properties in Atherton Way came close to flooding. The road and properties at this location are affected by flood waters on a regular basis where surface water cannot drain into the already overloaded culvert.

In July 2020, Chapel Street in Tiverton was flooded after heavy rain. Highways attended and cleared a blocked drain which alleviated the issue.

The flood risk and hazard maps show that in the Tiverton FRA, 4,242 people live in areas at risk of flooding from rivers and the sea. Of these people, 15.6% live in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 324 non-residential properties – including hospitals, schools and colleges and public utilities
- 1.31km of roads including parts of the trunk road network
- 21.1ha of agricultural land

The flood risk and hazard maps provide more detailed information on the likelihood and consequence of flooding for the Tiverton FRA.

Based on this information, Risk Management Areas (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the future and current impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other RMAs and other stakeholders. This includes:

- Devon County Council
- South West Water
- Mid Devon District Council
- the East Devon Catchment Partnership

The Devon Flood and Water Management Group, which comprises of all the local RMAs and key partners, meet regularly to:

- discuss work programmes
- discuss topical flood resilience matters
- resolve any operational issues across Devon

Furthermore, Tiverton Town Council meet to discuss emergency planning and have a Community Emergency Plan, which includes Flood Wardens.

### Monitoring, forecasting, modelling and warning

One of the ways we manage flood risk is through the process of increasing community resilience. This involves:

- flood forecasting
- emergency planning with our professional partners
- operating a flood warning service
- raising public awareness with associated campaigns

Increasing flood resilience, where possible, is important as building flood defences does not entirely remove the risk of flooding and is not appropriate or possible everywhere. Educating communities about the risks and empowering them to act, whilst providing them with a Flood Warning Service allows us to reduce the risk to life and property. This is even if defences are not viable or appropriate.

To inform our response to flood incidents there are many hydrometric monitoring sites in and around the Tiverton FRA that monitor:

- river levels
- river flow
- rainfall

On the River Exe, the Tiverton FRA is served by the monitoring network in the upper catchment with a total of 6 gauges. River flow is monitored on the River Lowman within the FRA. Rainfall is monitored by 6 telemetered rain gauges in the catchment. There are also 8 manually read daily gauges in the catchment that can be used to validate forecasts and identify longer term rainfall trends.

The information collected from these monitoring sites are used for many operational reasons. One of the main purposes is to inform activities related to flood warning and informing during flood incidents. Our Flood Warning Service provides information to:

- the public
- professional partners
- the media

It enables people at risk to be warned, reducing the financial and personal cost of flooding from rivers and the sea. There are 2 fluvial flood alert areas and 5 fluvial flood warning areas that cover the Tiverton FRA.

The data recorded from our hydrometric monitoring sites are also used to inform hydraulic and forecast modelling. Hydraulic models are used to assess:

- current flood risk
- the impacts of climate change
- how future levels of flood risk could be managed

In 2009, the Tiverton Modelling and Mapping study was undertaken to gain a better understanding of the flood mechanisms and flood risk.

In 2015, the Tiverton Modelling and Mapping study was updated to include planning developments and the upgrading of the Lowman Business Park flood defences along the Gornhay Stream.

Flood risk maps are published based on the outputs from the hydraulic modelling to inform:

- the public and business of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

## Flood Alleviation Schemes

The Environment Agency maintains flood risk management assets on main rivers throughout the FRA. This includes:

- river channels
- flood defence walls
- embankments or engineered channels

Similarly, Devon County Council, Mid Devon District Council and South West Water maintain assets that perform a flood risk management function on:

- surface water
- ordinary watercourses
- the drainage network (respectively)

During the major floods in 1960, over 500 properties flooded as well as businesses and the secondary school. This event led to the design and construction of the River Exe Flood Defence Scheme in Tiverton. This was a large and ambitious project with significant engineering works in the form of concrete walls and the replacement of an arched bridge at Bridge Street. The Heathcoat fabrics factory complex is defended by the River Exe defences. There are several flood gates within the defences that require operating to help protect the factory complex and other parts of Tiverton.

A project was proposed in the Environment Agency investment programme between 2015 and 2021 to investigate and reduce flood risk from the:

- Exe
- Lowman
- Cottey Brook

However, it had to be postponed due to being unable to build a complete funding package to deliver the works required. Further work is required to review the recommendations of this study to identify any viable options to pursue and revisit the ability to fund them in the future. Flood awareness engagement is programmed to take place during 2022/23, if funds are secured to invest in a capital project to reduce the chance of flooding.

In summer 2000, Devon County Council constructed earth defences that protect Tiverton High School and Petroc College. This prevented the flooding of the school and college during the winter 2000 flood events and the December 2012 event.

Over the last 40 years, the channel capacity of the River Lowman has been improved. However, in December 2000, residential and commercial properties were flooded form the River Lowman. Subsequently, flood defence improvements were undertaken for the Tiverton Business Park scheme.

Improvement works were carried out in 2014/15 to try and alleviate some of the risk and issues caused by the surface water not draining properly through an already overloaded culvert near to Canal Hill. Further investigations are currently ongoing, as well as the clearance of the culverts. Other improvement options are being moved forward as part of a partnership approach between:

- Devon County Council
- Mid Devon District Council
- South West Water

## The impact of climate change and future flood risk

Climate change is likely to be the most significant factor influencing the increase in flood risk within the Tiverton FRA. Rainfall intensity is expected to increase in the future and cause higher river flows and levels. This means that flooding from rivers will become more frequent.

The greatest source of flood risk to the Tiverton FRA is from the Rivers Exe and Lowman. The latest climate change peak river forecasts predict an increase in the potential maximum river flow through the town of Tiverton, leading to higher depths and frequency of flooding. Particularly vulnerable areas are those along the River Exe corridor, which includes:

- Tiverton and District Hospital
- Kennedy Way
- Kennedy Way Industrial Estate
- Morrison's
- Heathcoat Fabrics Limited's factory complex
- the West Exe area (in more extreme events)

The climate change prediction of an increase in the potential maximum river flow also applies to the River Lowman and Chettiscombe stream. These increases in river flow in the River Lowman will lead to an increased risk of:

- overtopping of existing flood defences by 2100 - impacting commercial property within the Lowman Green Business Park
- flooding to commercial developments and residential accommodation – including sheltered housing accommodation, the police station, Mid Devon District Council's offices, and Great Western Way
- flooding of the North Devon Link Road - resulting in transport impacts and disruption to and from North Devon

There are limited options available to increase the capacity of the already heavily engineered channel of the River Lowman, particularly Lowman Green Bridge due to its listed status. Any solutions to help manage increased flows through the town centre will need to be placed upstream of the main town. This will most likely be in the form of improved floodplain storage and natural flood management measures, such as tree planting in the upper catchment.

The Cottey Brook will also be impacted by climate change with a predicted increase in river levels and flow as a result of increased rainfall. The West Exe area will be at risk from the Cottey Brook with an increase in flooding to:

- the fire station
- commercial businesses
- residential properties

Particularly vulnerable receptors in this area are bungalows located between the River Exe and the Cottey Brook. These properties could suffer increasingly frequent and rapid onset of potentially deep flooding with limited opportunities for safe refuge in an upper storey. Furthermore, flooding from the Cottey Brook is more likely to cause travel disruption to the west of Tiverton, including the A396.

Climate change predictions anticipate increased rainfall intensity and duration leading to increased risk of surface water flooding. Due to the heavily urbanised and low-lying nature of the Tiverton FRA, increased rainfall is expected to frequently overload the ageing drainage infrastructure and pond behind existing flood defences.

One area of particular concern for vulnerability to surface water and sewer flooding is the heavily urbanised Moorhayes Stream, due to the capacity of the network. Good performance of existing drainage assets in this location is dependent on appropriate maintenance being carried out. Investigations into opportunities to address climate change impacts on the Moorhayes Stream are planned.

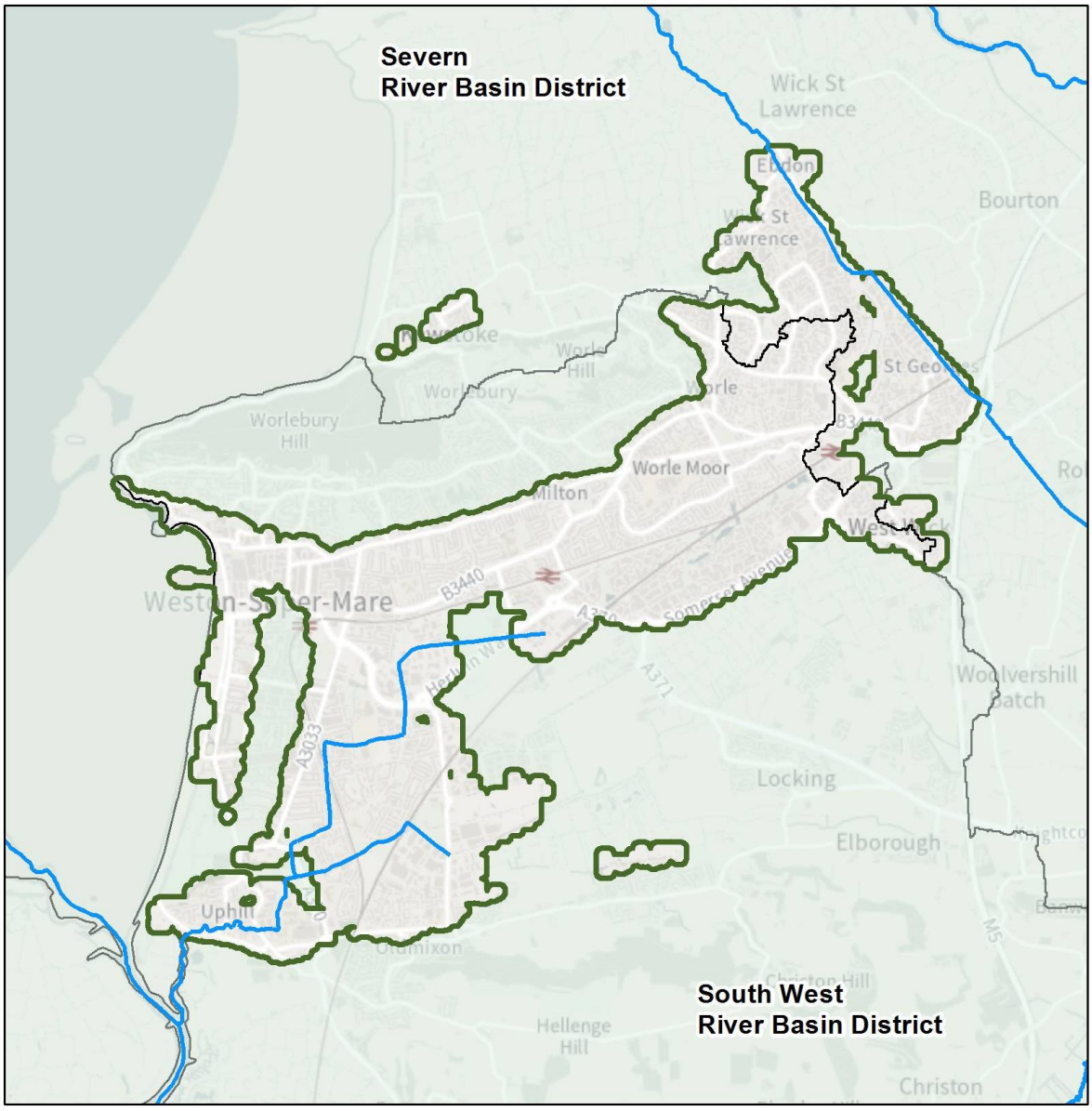
Mid Devon District Council is working in partnership with the Environment Agency to ensure any new development in the flood zone is compatible with the increased risk from climate change. Please refer to the Climate change and the South West RBD section for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the Tiverton FRA

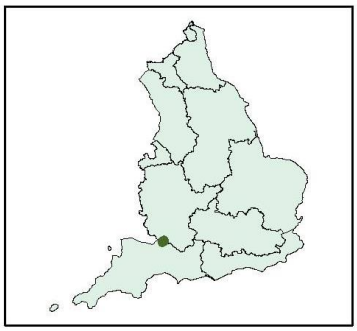
Measures have been developed that apply specifically to the Tiverton FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Tiverton FRA.

You can find information about all the measures that apply to the Tiverton FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Weston-super-Mare Rivers and Sea Flood Risk Area




Flood Risk Area: Weston-Super-Mare, South West



Main Rivers
Flood Risk Area: Rivers and Sea
River Basin Districts

N

0 1 2 3 Kilometres



**Figure 24: a map showing the boundary of the Weston-super-Mare Flood Risk Area**

## Introduction to the Weston-super-Mare Flood Risk Area

The Weston-super-Mare Flood Risk Area (FRA) has been identified as an FRA because the risk of flooding from rivers and the sea is significant nationally for people, the economy or the environment (including cultural heritage).

The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this FRA.

North Somerset Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from:

- surface water
- groundwater
- ordinary watercourses

Wessex Water is the water and sewerage company that owns, operates and maintains the sewerage network and wastewater treatment infrastructure in the FRA.

The North Somerset Levels Internal Drainage Board (IDB) are responsible for land drainage and flood defence works on the local rhyne network.

Weston-super-Mare is a popular seaside resort town lying within Weston Bay, along the Severn Estuary. Weston Bay is west-facing with a wide intertidal mud area and sandy foreshore. The coastline is largely developed, fronted by properties that are both residential and commercial.

With a population of approximately 80,000, it’s the largest town in North Somerset. As well as permanent residents, Weston-super-Mare attracts many tourists each year over the summer. This includes those staying in one of the many camping grounds and caravan sites in the area.

The Severn Estuary is designated as a:

- Site of Special Scientific Interest (SSSI)
- Special Protection Area (SPA)
- Special Area of Conservation (SAC)
- Ramsar site

Ellenborough Park SSSI and a small section of the Uphill Cliff SSSI are also located within the FRA.

## Current flood risk

Flooding from the Severn Estuary is the main source of flood risk in this area. Runoff from the hills rapidly reaches low lying areas where, under saturated catchment or tide locked conditions, it’s difficult to drain away to the sea. These low-lying areas are predominantly located on impermeable clay soil, which is particularly susceptible to drainage problems.

The main non-tidal source of flooding is surface water and sewer flooding (including impacts of tide-locking) with flooding being:

- shallow
- relatively slow moving
- confined to low-lying land

The coastal risks in the area are varied, with all locations susceptible to waves, either at risk of erosion or overtopping. Formal flood defences either constructed of concrete and stone or provided by a beach recharge protect most of the coastline. The natural dune area at Uphill is subject to erosion from storm damage as experienced by the very high tides of March 2020.

The coastal storm of December 1981 impacted much of the Bristol Channel and Severn Estuary. The coastline between Uphill and Sand Bay was also greatly affected. Following the storm, 4 schemes were delivered in this area, and the Weston-super-Mare flood defences were improved in 2010.

The flood hazard and risk maps show that in the Weston-super-Mare FRA some 64,414 people live in areas at risk of flooding from rivers and the sea. Of this, 0.1% live in areas considered to be at high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 2,431 non-residential properties - including the hospital, schools and colleges and public utilities
- 5.57km of roads - including parts of the A370 and a small section of the M5
- 10.88km of railway
- 547.71ha of agricultural land
- 0.75ha of registered parks and gardens
- 25 listed buildings
- 2 environmental permitting regulatory sites
- 1 licensed water abstraction site
- areas of designated environmental sites - including 14.83ha of the Severn Estuary SAC, 14.82ha of both the Severn Estuary SPA and Ramsar site, and 16.49ha of the Severn Estuary SSSI

The flood hazard and risk maps provide more detailed information on the likelihood and consequence of flooding for the Weston-super-Mare FRA.

Based on this information, RMAs have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the FRA.

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other Risk Management Authorities (RMAs) and other stakeholders. These include:

- North Somerset Council
- the IDB
- Wessex Water

North Somerset Council co-ordinate regular meetings under the North Somerset Flood Risk Management Partnership for RMAs to:

- discuss work programmes
- identify opportunities to work in partnership
- develop flood management strategies
- resolve operational issues

The Environment Agency monitors river and rainfall conditions at 11 sites in and adjacent to the FRA. These sites collect data on:

- river levels
- river flow
- rainfall

Sea levels are monitored from the Hinkley Point tidal gauge that is south of the FRA. This information is used to inform activities related to 10 flood warning areas that cover the FRA. This enables people to receive a warning when flooding could occur.

The water level and flow information are also used to inform and calibrate mathematical modelling of the river network. Flood risk maps are published based on the outputs from the mathematical modelling to inform:

- the public and businesses of their flood risk
- potential developers and local planning authorities
- the assessment and design of flood risk management works

The Environment Agency work with North Somerset Council to review, remodel and plan flood and erosion risk projects to meet future challenges.

Funding for Flood and Coastal Erosion Risk Management (FCERM) capital projects follow the Department for Environment Food and Rural Affairs' 'Partnership Funding Policy'. This relies on organisations working together to fund and develop FCERM projects in England. Projects progress by building partnerships that support sound investment choices and secure related funding agreements. These projects are partly funded by the government, with financial contributions from FCERM Grant in Aid. They offer organisations and communities greater opportunities and incentives to have a financial share in managing risks, and a greater say in protecting their local area.

The coastal schemes delivered since 1981 have managed the risks well with subsequent storms posing limited spray overtopping issues or episodic erosional impacts. Investment since the storm has ensured we have continued to maintain the defences, ensuring they remain effective against the tides and waves. The Environment Agency are now investigating how sea level rise and increased storminess will impact on flood defences and the natural dunes in the future.

The Environment Agency are developing partnership projects based on both the 'North Devon & Somerset Shoreline Management Plan (SMP)' and the Severn Estuary SMP. These plans set out the overarching polices for coastal management of which Hold the Line and Managed Realignment policies dominate.

The 'Draft Severn Estuary Flood Risk Management Strategy' also provides additional information to help us consider the SMP policies in more detail. This allows us to pay particular attention to:

- potential high level scheme options
- funding and benefits
- habitat requirements

Since 2006, the Environment Agency has also been working in partnership with other RMAs on the delivery of strategic flood risk infrastructure to enable growth proposals in Weston-super-Mare. These partners include:

- North Somerset Council
- Wessex Water
- the IDB
- the developer community

Several flood risk management schemes have now been put in place. This includes the Super Pond (flood storage area in Hutton) and the River Banwell Scheme (flood storage area in St Georges). These schemes address surface water runoff issues and provide floodplain compensation for development on the old Weston Airfield site and surrounding area.

In 2015, North Somerset Council, produced the 'Weston-super-Mare Surface Water Management Plan' in partnership with:

- the Environment Agency
- the IDB
- Wessex Water

Many other stakeholders were also consulted with during its development. This plan outlines actions to manage the risk of surface water flooding to local communities. This includes the scheme recently completed at Summer Lane (2021).

## The impact of climate change and future flood risk

Rainfall intensity is expected to increase in future causing higher river flows and levels. Sea levels are also expected to rise. This means that flooding from rivers and the sea will become more frequent.

Please refer to section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the South West River Basin District (RBD).

## Objectives and measures for the Weston-super-Mare FRA

Measures have been developed that apply specifically to the Weston-super-Mare FRA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the FRA.

You can find information about all the measures that apply to the Weston-super-Mare FRA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# The Somerset Levels and Moors Strategic Area

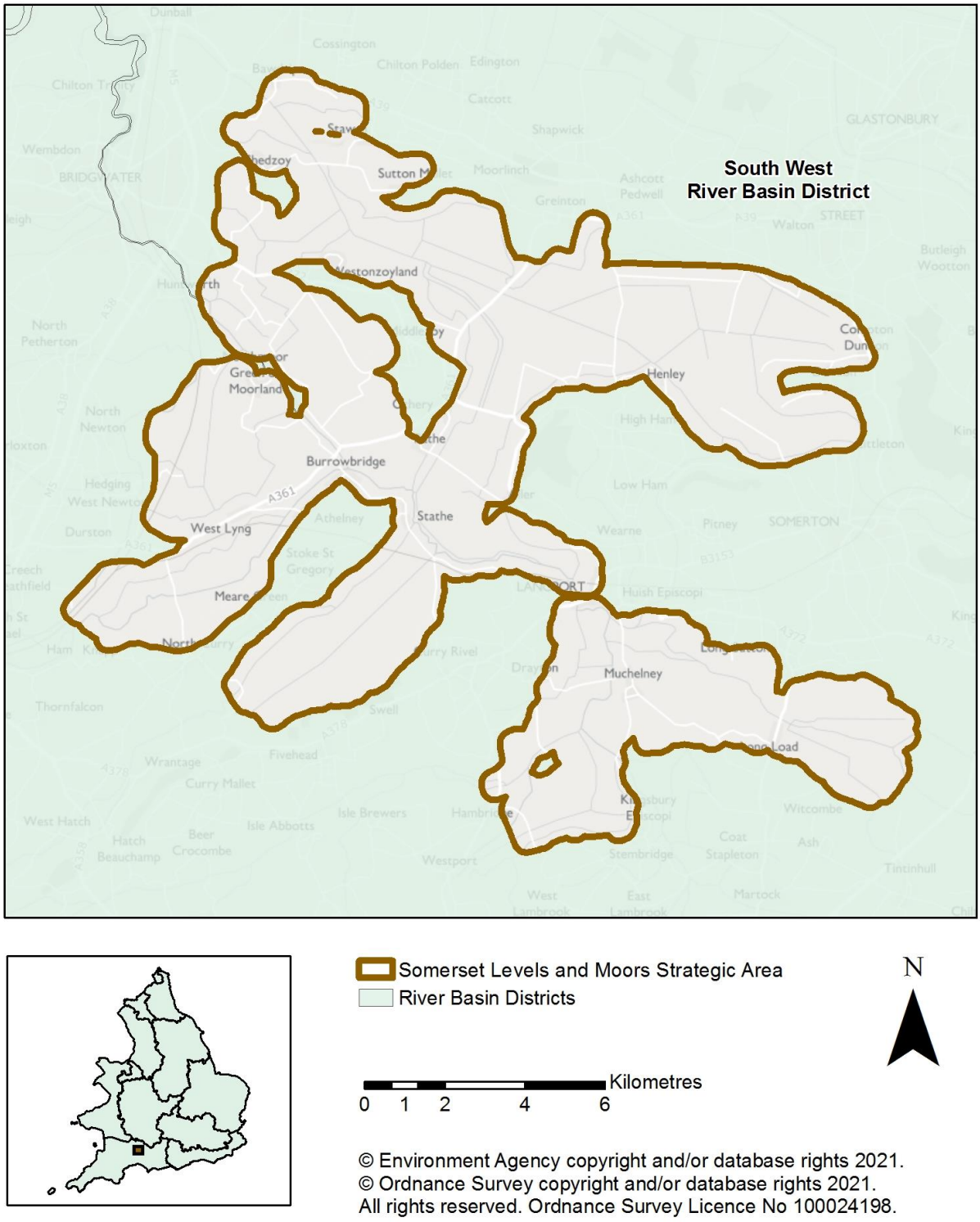



**Figure 25: a map showing the boundary of the Somerset Levels and Moors Strategic Area**

## Introduction to the Somerset Levels and Moors Strategic Area

The Somerset Levels and Moors Strategic Area (SA) is a unique, manmade wetland landscape of international importance for nature and archaeology. At its heart is the largest lowland grazing marsh system in Britain, which is of outstanding environmental interest.

The area covers many rural villages and hamlets of the Somerset Levels and Moors, which includes:

- residential properties
- businesses (primarily farms)
- amenity areas

Communities living in this area are resilient and prepared for flooding, but continued vigilance and further adaptation is necessary in a rapidly changing climate. Some of the resilience measures that help to protect the community include:

- careful management of water levels
- the storage and pumping of water from the moors
- targeted dredging
- the delivery of further flood risk management interventions

The natural geography of the Somerset Levels and Moors SA, in combination with climate change predictions, indicates some communities must remain prepared for flooding.

Continued operation and maintenance of flood risk structures and equipment is essential to protect the communities living in this unique and diverse landscape. Future investment needs to factor in climatic change and help this landscape to reach carbon net zero.

The government's drive to tackle climate change, alongside the UK exiting the EU, is leading to an evolution of environmental, flood risk and farming policy over the next decade. This gradual shift will present tangible economic and environmental opportunities for the communities living and working in the Levels and Moors SA in the future. A significant component of this change could be greater financial incentives for farmers and landowners, to keep water on their land for longer. In this intensively pump-drained landscape, this may be a fundamentally different economic driver to what has gone before.

The Environment Agency, with its partners, continue to work hard to protect communities from the risk of flooding, whilst preparing for this potential change. Therefore, the Levels and Moors SA will become a more climate resilient place where communities continue to thrive alongside nature.

The catchment contains several designated sites of national and international importance. A significant part of the low-lying Somerset Moors is designated as a Special Protection Area and a Ramsar site, which depend upon flooding. Flooding is essential to maintain adequate water levels to support wetted habitats for the populations of nationally and internationally recognised species of wildfowl in the area. As part of wider nature recovery

goals, the Environment Agency and partners will seek opportunities to deliver improvements to environmental condition and achieve Biodiversity Net Gain targets, particularly in combination with capital projects and initiatives. The area is also rich in archaeological sites that are reliant on waterlogged conditions for their preservation.

The Somerset Levels and Moors SA also includes:

- the Severn Estuary Special Area of Conservation (SAC)
- several Sites of Special Scientific Interest

## Current Flood Risk

The steepness of the uplands, coupled with the geology and soil conditions, generate substantial runoff from widespread and prolonged rainfall. The upland areas of the wider catchment (Mendip, Blackdown and Quantock hills) are very steep, but the lowland areas of the Somerset Levels and Moors SA are very flat.

Therefore, rainfall runoff travels quickly down from the uplands. It then slows down and overflows the perched rivers of the:

- Parrett
- Tone
- Yeo
- Isle
- Brue

It then becomes stored in the low-lying Levels and Moors. As the elevation of much of the Levels and Moors is below mean high tide level (75% is below 6m), and has a very shallow gradient, floodwater cannot discharge when there’s a high tide.

This means that where gravity drainage is possible, it drains very slowly and can only reach the Parrett Estuary on a low tide. This is the case along the River Sowy and Kings Sedgemoor Drain system. Elsewhere, floodwater in the Moors can only be drained via a complex network of drainage channels and pumping stations. These are limited to pumping when the receiving river level has dropped below bank full.

Tide locking is a particular feature of the Somerset Levels and Moors SA. The lower reaches of the rivers Tone and Parrett are tidal for some 30km (18.6m) inland from the Bristol Channel. The discharge ability of these channels can be significantly reduced by high tidal conditions, particularly as the Parrett has no tidal exclusion sluice or control structure.

Widespread flooding of the lowland Moors happens regularly from the main rivers that run through them. The Moors are protected by raised embankments or piled flood defences, as are many of the small villages and their communities.

In 2012/13 and 2014, the area was greatly affected by prolonged summer and winter floods. During the 2013/14 fluvial floods, the Environment Agency’s defences across the

area protected over 200km$^2$ of land and over 3,500 properties. However, large areas of land and communities were still flooded for many weeks, including 172 properties. Strategic infrastructure, such as main roads and the rail network, were also badly affected. Some small communities were cut off for several months.

With climate change, this area will be more prone to flooding and the frequency and magnitude of flooding may increase.

The flood hazard and risk maps show that in the Somerset Levels and Moors SA, some 1,991 people are in areas at risk of flooding from rivers and the sea. Of this, 4.7% are in areas of high risk.

Also shown to be at risk of flooding from rivers and the sea are:

- 166 non-residential properties
- 6.66km of railway
- 100.86ha of agricultural land
- 0.25ha of Scheduled Ancient Monuments
- 71 listed buildings
- 15 licensed water abstraction sites
- 1 environmental permitting regulatory site
- areas of designated environmental sites - including 34.16ha of the Somerset Levels & Moors Ramsar site and Special Protection Area, and 42.6ha of Sites of Special Scientific Interest

Based on this information, Risk Management Authorities (RMAs) have concluded that further steps should be taken to reduce the likelihood of flooding and the current and future impact it could have on the Flood Risk Area (FRA).

## How the risk is currently managed

The management of flood risk from rivers and the sea is led by the Environment Agency in collaboration with other RMAs and stakeholders. The Environment Agency take the lead on the development and delivery of the Flood Risk Management Plan (FRMP) for this SA.

Somerset County Council are the Lead Local Flood Authority (LLFA) whose remit includes flood risk from surface water, groundwater and ordinary watercourses.

The Parrett and Axe-Brue Internal Drainage Boards are the body responsible for land drainage and flood defence works on the local rhyne network. This complex drainage network feeds into and relies on the arterial network managed by the Environment Agency.

Wessex Water is the Water and Sewerage Company that own, operate and maintain the sewer network and waste water treatment infrastructure in this SA.

The Environment Agency maintains its flood risk management assets such as the arterial river channels and principal drains, flood defence walls or embankments, pumping stations

and other water control structures throughout the SA. The Environment Agency monitor river and rainfall conditions in the Somerset Levels and Moors SA. These sites collect data on river levels river flows and rainfall. This information is used to inform activities related to flood warning areas that cover the SA. This enables people to receive a warning when flooding could occur.

The water level and flow information are also used to inform and calibrate mathematical modelling of the river network. All the main river watercourses have hydraulic models, which are combined into the large and complex Somerset Levels and Moors model. This was last reviewed and updated comprehensively in 2016.

## Partnership working

RMAs and stakeholders meet regularly through groups such as the Somerset Rivers Authority, Somerset Catchment Partnership and Wessex Regional Flood and Coastal Committee (RFCC). The groups discuss strategic and operational matters, capital programmes, funding and other related initiatives.

The Somerset Rivers Authority (SRA) was launched in January 2015 in response to the floods of 2013-14. Its creation was proposed in the 2014 'Somerset Levels and Moors Flood Action Plan'. The partnership includes:

- Parrett and the Axe Brue Internal Drainage Boards
- the Environment Agency
- Somerset County Council
- Sedgemoor District Council
- Somerset West and Taunton Council
- South Somerset District Council
- Mendip District Council
- Wessex RFCC
- Natural England

The 'Somerset Levels and Moors Flood Action Plan' provides the focus for activities for the next decade for this SA. It covers the catchments of the rivers:

- Parrett
- Tone
- Axe
- Brue

The plan is led by the SRA with its actions and objectives reaching beyond managing flood risk for the area. The measures are categorised into 5 key themes:

1. Dredging and River Management.
2. Land Management - such as Natural Flood Management and agri-environmental land management.
3. Urban Water Management - such as Sustainable Drainage Systems (SuDS) and urban drainage improvements.

4. Resilient Infrastructure - such as highway drainage works.
5. Building Community Resilience - helping communities be prepared for and responding to / coping with floods.

Many of the flood management actions listed in the plan have already been completed. These include:

- dredging various sections of the River Tone and River Parrett back to historic profiles
- flood flow capacity improvements, control structures and highway raising – completed at Beer Wall on the River Sowy and Langacre Rhyne
- new defences – completed at Westonzoyland village
- a highway being raised by up to 1.5m at Muchelney – providing access to the village that was cut off in 2014
- a large pumping platform – completed at Dunball to accommodate ultra-high volume mobile pumps (if ever required again)
- improvement to North Moor Pumping Station – to accommodate up to 10 high volume mobile pumps
- the repair and improvement of several kilometres of raised embankments, piled defences and spillways
- the refurbishment and improvement of various control structures (Chedzoy Sluice, Egypts Clyce) and raised water level structures at Moorlinch and West Moor
- the improvement and combining of the hydraulic models for the Parrett, Tone and Sowy rivers – used to create a large-scale Somerset Levels and Moors model
- the completion of an options appraisal and design to enlarge the conveyance capacity of the River Sowy and King's Sedgemoor Drain - phase 1 is to be delivered late summer 2021

The Action Plan has also acted as a catalyst for the development of the Bridgwater Tidal Barrier (see 'The Bridgwater Rivers and Sea Flood Risk Area' section for further information). This is due to start construction later in the 2020s, subject to regulatory approval from central government.

As well as the original 'Flood Action Plan' measures, the SRA develops and oversees an annual capital programme of mitigation solutions to deliver 'additionality' alongside the remits of the RMAs. This is known as the Enhanced Programme, and forms the SRA's future measures. These all comply with and complement the 20 Year Flood Action Plan. The SRA raises funds for this programme through a shadow precept on Somerset householders.

You can view the most up to date information on the implementation status of the measures in the plan on the Somerset Rivers Authority website.

## The impact of climate change and future flood risk

The changing climate means that the existing defences and drainage systems in the Somerset levels and Moors Strategic Area will have to cope with more water, more

frequently. Maintenance and improvements will be vital to ensure that these assets can withstand the pressures from future climate change. At the same time, there may be longer periods of dry weather, resulting in scarcity of water resources in the area. This may also lead to negative impacts on the habitats and species of the designated sites.

Climate change poses a serious threat and a continued programme of maintenance and investment in flood defences and drainage systems will be needed for existing standards of protection - including provision for climate change - to be maintained in the medium and long-term.

Please refer to section Climate change and the South West RBD for more information on what we know are likely to be the implications of climate change in the South West River Basin District.

## Objectives and measures for the Somerset Levels and Moors Strategic Area

No additional specific FRMP objectives have been set for the Somerset Levels and Moors SA.

Measures have been developed that apply specifically to the Somerset Levels and Moors SA. These measures have been developed in addition to those covering a wider geographic area, but also apply to the Somerset Levels and Moors SA.

You can find information about all the measures that apply to the Somerset Levels and Moors SA in the Flood Plan Explorer, an interactive mapping tool. This includes information on which national objectives each measure helps to achieve.

# Links between the FRMP and the draft RBMP

In parallel to flood risk management planning, the Environment Agency works with others to protect and improve the quality of the water environment. It does this through river basin management planning. The Environment Agency aims to co-ordinate the Flood Risk Management Plans (FRMPs) and the River Basin Management Plans (RBMPs) so that all organisations can do more for the environment. By developing the plans together, ways to achieve objectives for flood risk and drought management, and the water environment including water quality and biodiversity, can be joined together wherever possible.

Please refer to the diagram in 'FRMPs and other plans and strategies' section in the 'Part A: National Overview of Flood Risk Management in England for Second Cycle Flood Risk Management Plans' to see how these plans align.

Aligning these plans is particularly important in order to achieve the main aim of the Water Environment (Water Framework Directive (WFD) England and Wales) Regulations 2017. The main aim of the WFD is to establish a framework for the protection of inland surface waters, estuaries, coastal waters and groundwater. You can find more information about this in the South West RBMP 2022.

The Environment Agency has worked with LLFAs, other RMAs and partners to develop joint measures to reduce flood risk and improve the wider water environment. Aligning measures also helps to simplify the delivery of outcomes and make it more efficient.

38% of the FRMP measures across the South West RBD have the potential to contribute to the achievement of RBMP objectives. For example, by:

- assessing the potential of all future flood risk management schemes to deliver environmental improvements with partner organisations
- integrating biodiversity net-gain into the maintenance of flood risk management schemes
- recognising the role of good soil and catchment management to increase catchment resilience to climate change, in terms of water quality, drought tolerance and flood risk reduction
- aligning habitat creation to Local Nature Recovery Strategies that deliver nature-based solutions to manage flood risk. For example, peatland restoration, wetland creation, woodland planting and enabling beaver re-introduction
- aligning flood risk, environmental and water company investment programmes

In a statutory RBMP consultation in 2019/20 known as 'Challenges and Choices', the Environment Agency sought views on the:

- challenges that our waters face
- choices and changes we all need to make to help tackle those challenges

Further information on the responses received can be found in the Challenges and Choices consultation summary report.

To ensure FRMP measures align with RBMP objectives the Environment Agency worked closely with the Catchment Partnerships across the South West River Basin District (RBD) during the Challenges and Choices consultation. The above examples are closely aligned with some of the main themes in responses that identify with the South West RBD.

By visiting the South West RBMP 2022, you can find out more information on the objectives and measures for the South West RBMP 2022.

# How we will monitor implementation of the FRMP

For the duration of the second cycle (2021 to 2027), the Environment Agency will work with LLFAs and other RMAs to monitor progress in achieving all the measures set out in the Flood Risk Management Plan (FRMP). This is a summary of the steps we will follow:

1. The implementation status of each measure in the FRMP will be reviewed and updated every year. This will be done by the authority responsible for implementing the measure.
2. This updated information will be collated by the Environment Agency and analysed to identify any trends in the data. This will allow the identification of possible common interventions which may help measure delivery.
3. Summary statistics will be produced to show how much progress has been made in that year.
4. These statistics and other key messages will be included in the annual report produced under Section 18 of the Flood and Water Management Act (2010). This report is published each year and submitted to the relevant regional flood and coastal committee for review. It will also be available online to the public.
5. The updated status of each measure will also be viewable in Flood Plan Explorer.

At the end of the 6 year planning cycle, the FRMP will be reviewed and a summary of implementation progress over the duration of the planning cycle will be included. This is a requirement of the Flood Risk Regulations (2009).

# List of abbreviations

This list of abbreviations is intended as a reference tool. It includes the main abbreviations and terms used in the second cycle flood risk management plans.

| Short form | Long form |
|---|---|
| AONB | Area of Outstanding Natural Beauty |
| CaBA | Catchment Based Approach |
| CDE | Catchment Data Explorer |
| Defra | Department for Environment, Food and Rural Affairs |
| DWMP | Drainage and Wastewater Management Plan |
| EIA | Environmental Impact Assessment |
| ELMS | Environmental Land Management Scheme |
| EPR | Environmental Permitting Regulations |
| FAG | Flood Action Group |
| FCERM | Flood and coastal erosion risk management |
| FPE | Flood Plan Explorer |
| FRA | Flood Risk Area (as identified under the Flood Risk Regulations 2009) |
| FRM | Flood Risk Management |
| FRMP | Flood Risk Management Plan |
| FRR | Flood Risk Regulations 2009 |
| FWMA | Flood and Water Management Act 2010 |
| HRA | Habitats Regulations Assessment |

| Short form | Long form |
|---|---|
| IDB | Internal Drainage Board |
| LEP | Local Enterprise Partnership |
| LFRMS | Local Flood Risk Management Strategy |
| LLFA | Lead Local Flood Authority |
| LPA | Local Planning Authority |
| MHCLG | Ministry of Housing, Communities and Local Government |
| MMO | Marine Management Organisation |
| NaFRA | National Flood Risk Assessment |
| NFM | Natural Flood Management |
| NNR | National Nature Reserve |
| NPPF | National Planning Policy Framework |
| NRW | Natural Resources Wales |
| PFRA | Preliminary Flood Risk Assessment |
| RBD | River Basin District |
| RBMP | River Basin Management Plan |
| RFCC | Regional Flood and Coastal Committee |
| RMA | Risk Management Authority |
| RoFSW | Risk of Flooding from Surface Water |
| SAC | Special Area of Conservation |
| SEA | Strategic Environmental Assessment |

| Short form | Long form |
|---|---|
| SEPA | Scottish Environment Protection Agency |
| SMP | Shoreline Management Plan |
| SPA | Special Protection Area |
| SSSI | Site of Special Scientific Interest |
| SuDS | Sustainable Drainage Systems |
| SWMP | Surface Water Management Plan |
| UKCP18 | UK Climate Projections 2018 |
| WFD | Water Framework Directive |

# Glossary

This glossary is intended as a reference tool. It includes the main terms used in the second cycle flood risk management plans and a short description of what they are.

**25 Year Environment Plan**

A plan produced by government which sets out goals for improving the environment, within a generation and leaving it in a better state. It details how government will work with communities and businesses to do this over the next 25 years.

**Catchment**

The area from which precipitation contributes to the flow from a borehole spring, river or lake. For rivers and lakes this includes tributaries (a river or stream flowing into a large river or lake) and the areas they drain.

**Coastal erosion**

The loss of land due to the effects of waves and, in the case of coastal cliffs, slope processes (such as high groundwater levels). This may include cliff instability, where coastal processes result in landslides or rock falls.

**Flood Risk Area**

Areas identified through the PFRA process where the risk of flooding is significant nationally for people, the economy or the environment (including cultural heritage).

**Flood Risk Management Plan**

A statutory plan prepared by the Environment Agency and LLFAs under the Flood Risk Regulations 2009. The plans are reviewed and updated every 6 years. The current plans cover the period 2021 to 2027.

**Flood Risk and Hazard Mapping**

Maps prepared under the Flood Risk Regulations 2009 to show potential risks and impacts of flooding in identified Flood Risk Areas. They are reviewed and updated every 6 years. The current maps use data and risk assessment data available in December 2019.

**Flood Plan Explorer**

A new, online, map-based tool which displays all of the measures proposed as part of the second cycle of flood risk management plans in England.

**Fluvial flooding**

Flooding from/of rivers.

**Groundwater flooding**

Occurs when water levels in the ground rise above the natural surface. Low-lying areas underlain by permeable layers are particularly susceptible.

**Internal Drainage Board**

A public body that manages water levels in areas known as internal drainage districts.

**Internal Drainage District**

Areas where there are special drainage needs, managed by internal drainage boards.

**Lead Local Flood Authority**

These are County, Unitary or Metropolitan Boroughs that are responsible for managing flooding from surface water, smaller watercourses and groundwater. There are 152 in England.

**Local Flood Risk Management Strategy**

Statutory strategies produced by Lead Local Flood Authorities under the Flood and Water Management Act 2010.

**Main river**

A watercourse shown as such on the main river map. They are usually the larger rivers and streams, and for which the Environment Agency has responsibilities and powers.

**Management catchment**

An amalgamation of a number of river water body catchments that provide a management unit.

**National Flood and Coastal Erosion Risk Management Strategy**

A statutory strategy prepared under the Flood and Water Management Act 2010, by the Environment Agency for England.

**Ordinary watercourse**

A watercourse that does not form part of a main river and is not shown on the main river map. LLFAs, district councils and internal drainage boards may carry out flood risk management work on ordinary watercourses.

**Preliminary Flood Risk Assessment**

The first stage in the six-year planning cycle to deliver the Flood Risk Regulations. The latest PFRAs were reviewed in 2017 for local sources of flood risk and 2018 for main rivers, the sea and reservoirs.

**Preparedness measure**

A measure (action) which aims to prepare people for flooding. Examples include flood forecasting and warning, flood emergency response planning and improving public preparedness for flooding.

**Prevention measure**

A measure (action) which aims to avoid putting people or the environment at risk of flooding. Examples include watercourse regulation, flood risk modelling and mapping and development planning and control.

**Protection measure**

A measure (action) which aims to better protect people from the risk of flooding. Examples include building flood defences, nature based solutions and asset maintenance.

**Recovery and review measure**

A measure (action) which aims to use learning from flood incidents. Examples include reviewing lessons learnt from flood response, supporting communities businesses and the environment to recover from flooding.

**Reservoirs**

A natural or artificial lake where water is collected and stored until needed. Reservoir owners and operators (‘undertakers’) must meet certain requirements under the Reservoir Act 1975.

**River Basin District**

Large river catchments in England. They cover an entire river system, including river, lake, groundwater, estuarine and coastal water bodies.

**River Basin Management Plan**

Statutory plans developed by the Environment Agency which set out how organisations, stakeholders and communities will work together to improve the water environment.

**River flooding**

Occurs when water levels in a channel overwhelms the capacity of the channel.

**Services**

Services include schools, hospitals, nursing/care/retirement homes, police stations, fire and ambulance stations, prisons, sewerage treatment works and electricity installations.

**Sewer flooding**

Flooding as a result of overloading of the sewerage system due to limited system capacity or failure of sewer asset.

**Strategic Area**

A locally defined area included in the Flood Risk Management Plans. They are areas with a similar geography or strategic ambition where it is important to consider flood risk management across administrative boundaries and river catchments.

**Surface water flooding**

Occurs when intense rainfall overwhelms local drainage capacities.

**Tidal flooding**

The temporary inundation of coastal areas during exceptionally high tides or storm surges.

**Tide locking**

Occurs when the level of the incoming high tide stops the river water from flowing out to sea. This can increase the risk of river flooding.

## Find out more about us and your environment

### Call

**03708 506 506** (Monday to Friday, 8am to 6pm)

### Email

enquiries@environment-agency.gov.uk

### Visit our website

www.gov.uk/environment-agency

### Call our incident hotline

**0800 807060 (24 hours)**

### Call our floodline

**0345 988 1188** (24 hours)

Find out about call charges at www.gov.uk/call-charges

### Environment first

Are you viewing this document online? Please consider the environment and only print if necessary. If you're reading a paper copy, please remember to reuse and recycle this document.