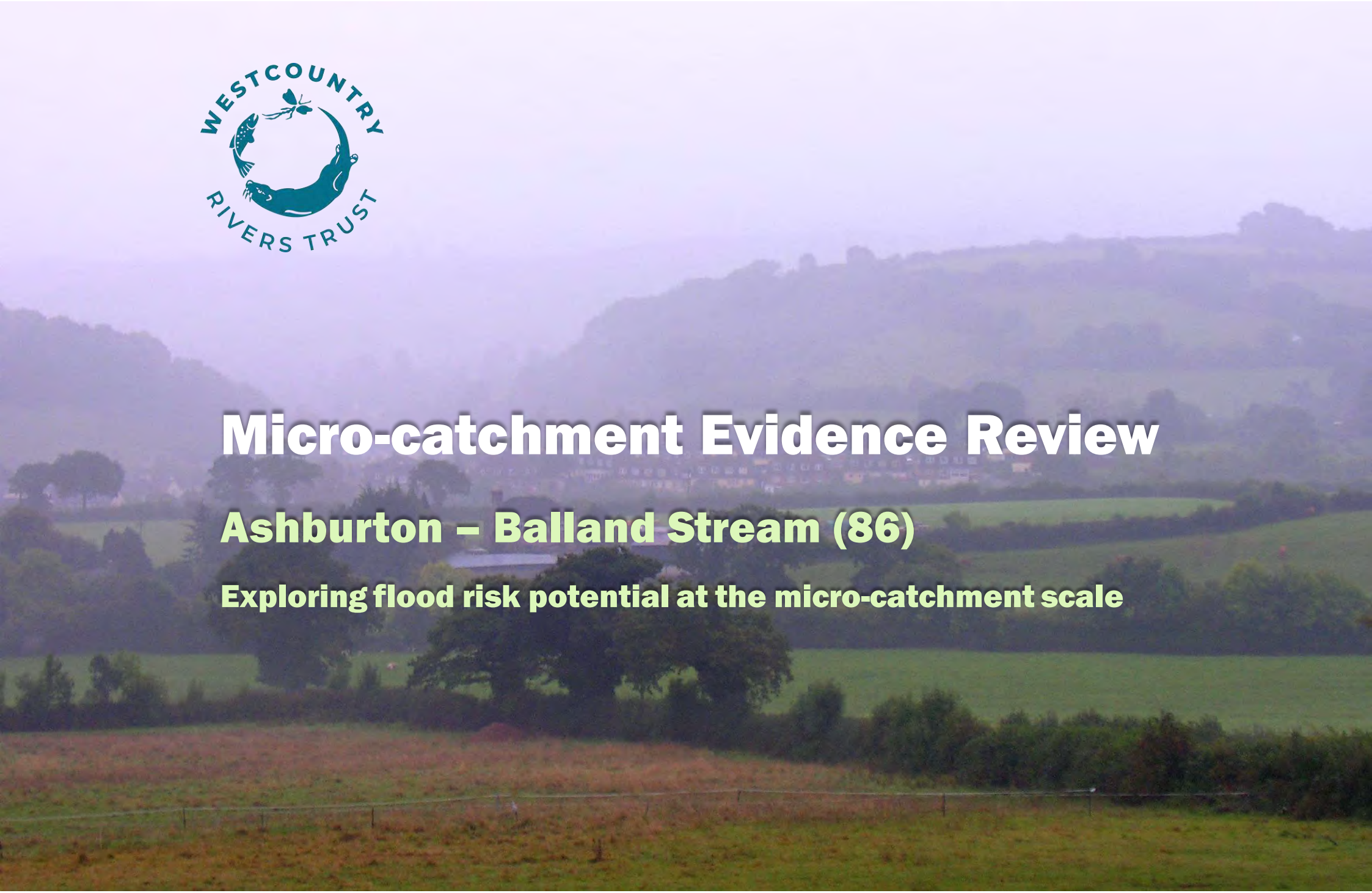


Micro-catchment Evidence Review

Ashburton – Balland Stream (86)

Exploring flood risk potential at the micro-catchment scale

This document is an output from the Devon and Cornwall Soils Alliance, delivered by Westcountry Rivers Trust.

Executive Summary

Flood risk is a major issue for numerous communities across the Southwest and with the expected future impacts of climate change, as well as compounding factors such as population growth and development, it is a problem that is becoming all the more urgent. A number of projects are currently underway to understand the causes of flooding and investigate potential solutions. This includes the Upstream Thinking - Rapid Response Catchments project and Devon and Cornwall Soils Alliance (more info on page 6).

A mapping exercise was carried out to identify all the micro-catchments (5km^2 or 10km^2) above flood-risk properties in Devon and Cornwall. The idea being that Natural Flood Management (NFM) measures and engagement with the local community were most likely to be effective at this scale. These micro-catchments were then prioritised according to a number of factors. The catchment described in this report, the Balland Stream, is one of those prioritised micro-catchments.

The micro-catchment for the Balland Stream is 3.53km^2 and highlights 117 properties potentially at risk from fluvial and surface water flooding, many of these are in Ashburton. There are multiple possible contributing causes of this, including the topography, land use, and lack of surface water runoff diversion from roads. The catchment is failing Water Framework Directive (WFD) regulations on chemical status and is within a Drinking Water Safeguard Zone at risk of contamination by pesticides.

A rapid walkover survey was carried out by an experienced surveyor from the Westcountry Rivers Trust (WRT) to further inform potential issues and opportunities for flood risk mitigation. During the walkover, the micro-catchment displayed localised flood risk. There is opportunity to effect localised flood improvement and the ability to mitigate part of a larger flood risk downstream (less localised) should not be discounted. Additionally, the walkover presented some opportunity to deliver or contribute towards WFD (Water Framework Directive) elemental improvement.

Implementation of Natural Flood Management (NFM) measures may have the potential to mitigate some of the flood risk and simultaneously make progress towards reaching "good" WFD status for the wider River Ashburn catchment that would ultimately benefit the local community. The NFM opportunities identified in this report include in-stream attenuation, pond creation, gateway relocation, and road runoff diversion into natural and wetted areas. Furthermore, riparian woodland planting and other habitat creation surrounding existing habitats across the catchment would slow surface water flow into watercourses and enhance habitat networks. More areas of land south of the A38 entering into an agri-environment scheme agreement would also contribute to improved soil health and biodiversity in the absence of significant habitats. In addition, there are opportunities for floodplain reconnection and runoff attenuation adjacent to the A38. Their proximity to the urban environment will need to be considered when designing these NFM measures, although this presents a major opportunity for community engagement to facilitate their delivery.

Contents

Overview

How this Document Works

This document is a study for causes of flooding, priority considerations, and opportunities for NFM in the micro-catchment for the Balland Stream, covering some of the Ashburton urban area in South Devon.

The study is built on multiple layers of mapped environmental information and the results of the walkover survey. This information has been used to explore the current state of the catchment and its environment, and then map areas for further investigation and actions to make improvements.

This micro-catchment scale assessment will be used to guide efforts in community engagement and NFM.

The study has 5 key chapters, based on the current status of the micro-catchment and what opportunities there might be.

1. Micro-catchment Overview
2. Priority Areas and Drivers
   - Flooding
   - Water Quality
   - Water Quantity
   - Designated Sites
   - Tourism and Recreation
3. Existing Natural Assets and Their Condition
   - Habitats
   - Soils
   - Crops
4. Issues
   - Abstraction, Discharges, Pollution, and Runoff
   - Hydrological Connectivity
   - Issues identified during Walkovers
5. Opportunities
   - Existing Opportunities
   - Opportunities Identified during Walkovers

It is not possible to map all aspects of the status of the micro-catchment with existing datasets, and the true state of the catchment may not be fully reflected in the datasets for various reasons including the age of the data, the resolution, and the level of local knowledge taken into consideration when the data has been collected and mapped.

Assessing the quality and condition of natural assets in particular is challenging due to the level of detail required. Nonetheless, the available data has been reviewed and the best data currently available has been used. A full set of references can be found on pages 53-56.

Overview

Introduction

Flooding is a problem that is experienced widely across Devon and Cornwall, with a large portion of cases linked to rivers (fluvial flooding as opposed to surface water or sea). River water quality is also a key issue in the region, with all 381 assessed rivers failing to achieve "good" status in 2019. One important reason for water quality failure is linked to soil erosion. Soil erosion can also contribute to increased fluvial flood risk due to reduced channel capacities and blockages. Therefore, water quality and flood risk drivers are often interlinked and the solutions to alleviate these pressures are often multifunctional. Two projects currently underway are aiming to tackle these issues by working with local communities to deliver small-scale, land-based measures ("nature-based solutions"). These projects are Devon and Cornwall Soils Alliance (DCSA) and Upstream Thinking Rapid Response Catchments (UST-RRC).

After it was found that over 40% of soils across Devon and Cornwall are degraded, the collaborative project of the DCSA was launched in June 2019. This aims to build the capacity and capability in soils advice for the project partners across the 2 counties to work towards restoring degraded soils. One significant benefit of improving soil health is greater surface water infiltration into the ground before it reaches and overwhelms water courses, thereby reducing flood risk and preventing potential pollutants from entering the water. This also has the potential to make considerable Water Framework Directive (WFD) improvements to water quality.

Across Devon and Cornwall there are hundreds of Rapid Response Catchments that are characterised by quickly draining catchment areas under 10km^2 (and under 5km^2) , where during high rainfall events surface flows and overland run off overwhelm small communities (1-50 properties in flood zone 1). Flood events have increased in these types of catchment due to degraded soils that no longer have the infiltration capacity, simplified drainage patterns and more variable and extreme weather patterns associated with a changing climate. UST-RRC will focus on working with small communities in these rapid response catchments to help them develop and deliver their own climate resilience plans by restoring some of the hydrological functionality within the landscape.

The DCSA is working in partnership with the UST-RRC project across Devon to develop 24 preparatory investigations on prioritised micro-catchments to identify likely areas for nature-based solutions and NFM (Natural Flood Management) interventions where land ownership shows a willingness and water quality can be improved. Community engagement will be critical when implementing NFM as measures need to be numerous and spread out across the catchment to provide the greatest benefits. If property owners and landowners can work together and share perspectives, then measures can be designed that are agreeable to all stakeholders involved. This also helps to foster a sense of community stewardship over their catchment and NFM measures that would enhance their longevity and resilience.

Overview

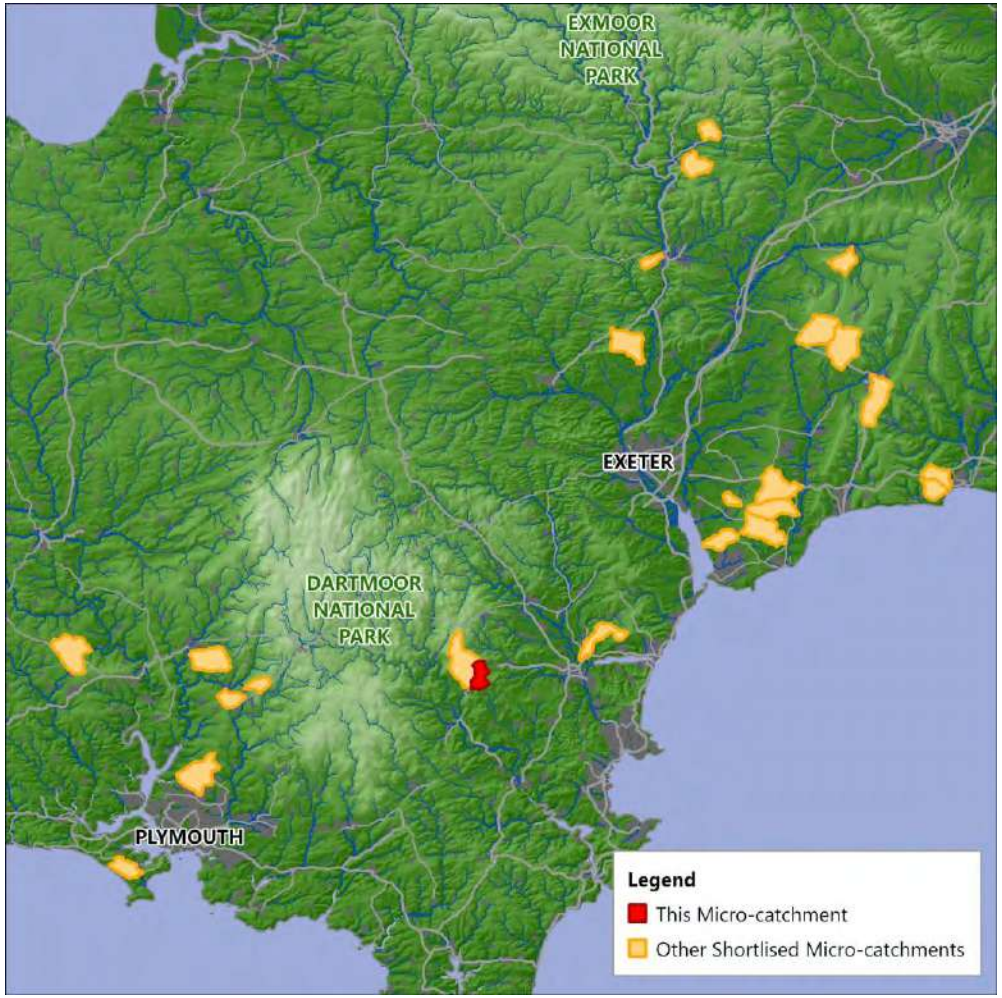
Methodology

There may be opportunities everywhere for NFM measures and other nature-based solutions at low cost that also bring additional benefits to human health, biodiversity, and the aesthetics of the landscape. However, the scattered and fragmented locations of properties at flood risk and the limited accessible funds requires identifying only the largest clusters of flood risk properties with the smallest upstream micro-catchments to deliver the most impact with the resources available.

The process of identifying priority areas for opportunities to deliver improved water quality and quantity for climate change resilience was undertaken in four steps.

1. The South West areas of Devon and Cornwall were modelled using GIS (Geographic Information Systems) to identify where opportunity areas were located.
2. The modelled opportunity areas were ground-truthed in theory using desk-based studies
3. The top prioritised opportunity areas where ground-truthed physically using rapid walkover surveys
4. Internal evidence reviews, external evidence reviews, and 2 pagers summary documents will be written for 24 trial investigation areas where physical interventions can take place.

For more information on the first 3 steps please see the appendix.



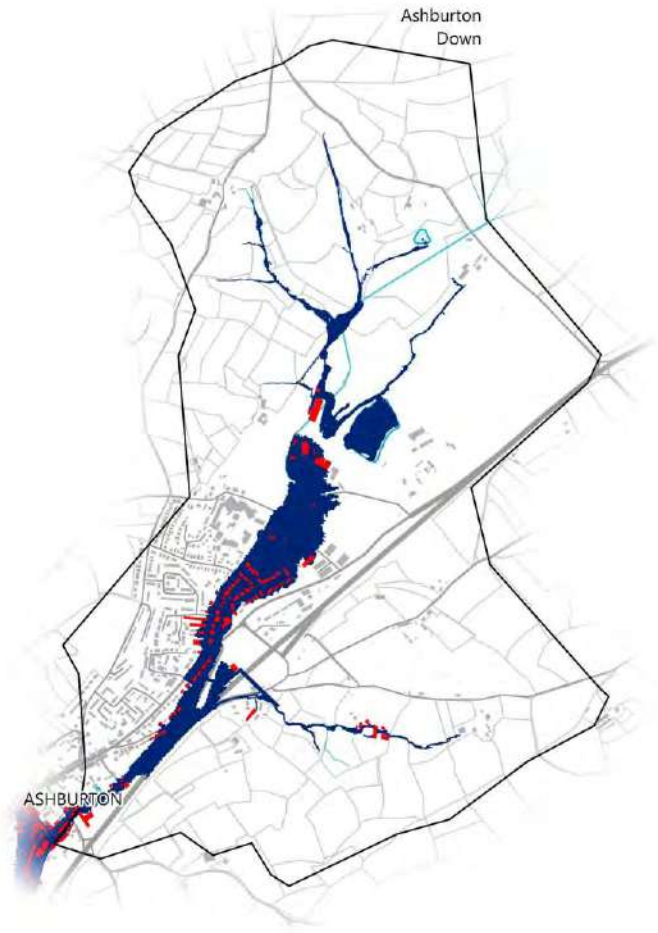
The final 24 micro-catchments, including the Balland Stream which is shown in red.

Overview

Why this Catchment?

The micro-catchment was selected in the GIS modelling step because it contains a large number of properties in Ashburton that are potentially at flood risk.

The map below shows which buildings overlap with the EA's modelled "Flood Zone 2" area, specifically areas at risk of flooding from rivers, as identified during the micro-catchment mapping process.



There are 103 buildings potentially at risk out of 526 in the catchment, approximately 19.58% of them.

The catchment's size of 3.53km^2 gives an area of 0.03km^2 per building at risk.

The water framework directive (WFD) status in the wider River Ashburn catchment is Failing.

If property owners are willing to work with landowners and vice versa, then small-scale NFM measures upstream in the catchment have the potential to benefit a large number of properties and improve water quality.

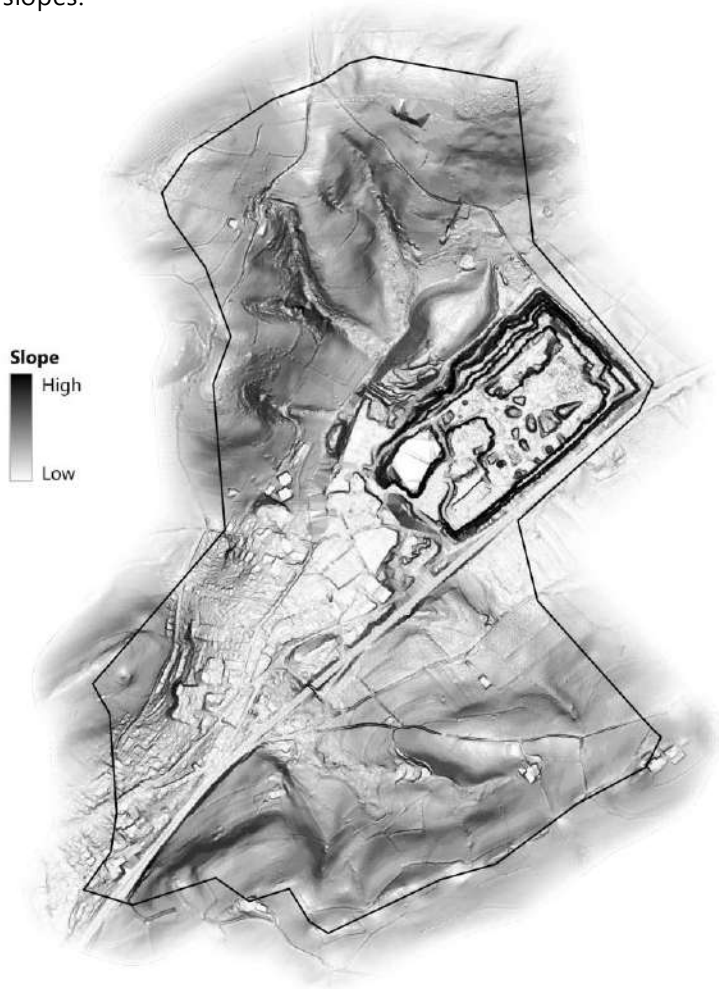
- Micro-catchment Boundary
- Roads
- Rivers
- Buildings
- Field Boundaries
- Surface Water
- Buildings Potentially at Fluvial Flood Risk
- Fluvial Flood Zone 2 (1 in 1000 year)

Micro-catchment Overview

Topography

The micro-catchment covers the northeast urban area of the town of Ashburton as well as several farms, and is intersected by the A38 dual carriageway. The micro-catchment forms the watershed for the Balland stream that flows south southwest through Ashburton where it joins the river Ashburn. The total river length present in the catchment is approximately 5.4km. Also prominent is the Linhay Hill concrete quarry to the east. Overall, the micro-catchment falls within the Ashburton County Parish and is administered by Ashburton Town Council,

The map on the right shows the steepness of slopes. The town of Ashburton has a significantly flatter topography than the northern and southern sides of the micro-catchment, sitting across the bottom of the valley, while the quarry accounts for the steepest slopes.



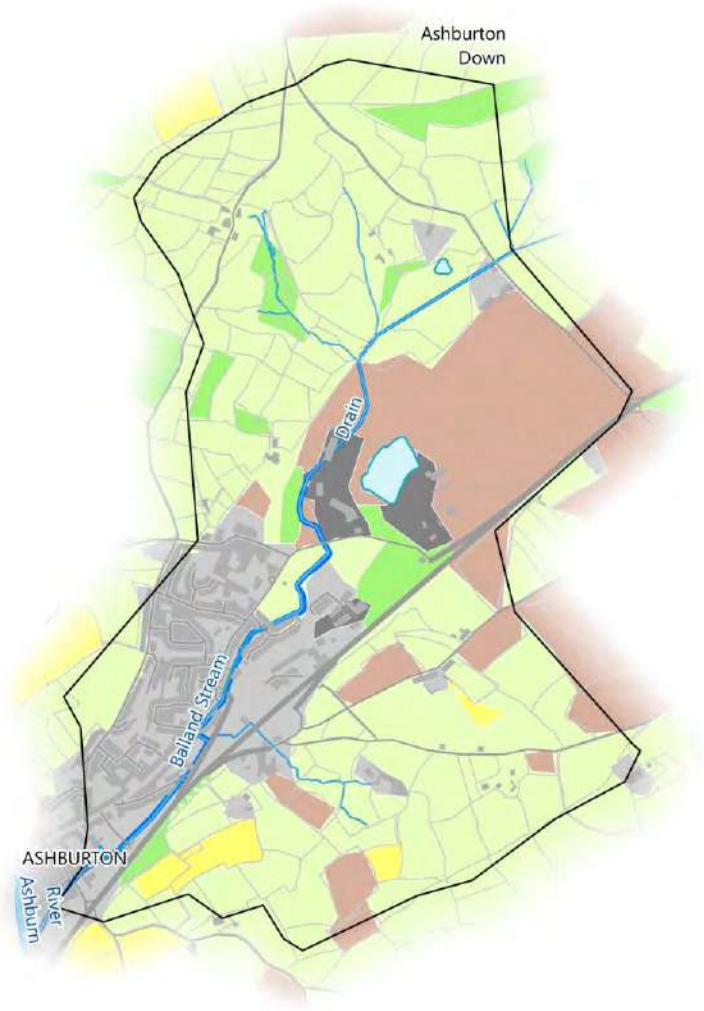
Micro-catchment Overview

Land Cover

The way the land is used has significant impacts on flood management. Land use has been mapped here using the Centre for Ecology and Hydrology's (CEH) Land Cover Map 2019. This is a model derived from satellite imagery at 25m resolution.

The land use here is primarily improved grassland, accounting for 46% of the catchment, followed by the urban area of Ashburton that covers another 26%. Patches of broadleaved woodland are spread throughout the north of the catchment, while fields of arable and horticultural land and neutral grassland are scattered throughout the south.

It should be noted that this land cover map model is not a perfect representation of land use. The model simplifies UK land cover into very broad classes and as such it has no classification for quarries and mining sites. Here it has classified the Linhay Hill quarry as arable land possibly due to the lack of vegetation and buildings.



Micro-catchment Overview

Land Cover

Land use observed during the catchment walkover mostly matched the land use mapped here using the Centre for Ecology and Hydrology's (CEH) Land Cover Map 2019 above.

The woodland around the quarry has likely been planted as visual mitigation, and may change as the quarry expands or is finally restored.

The map doesn't pick up on the networks of riparian woodland and hedgerows that are present in this landscape.

Very steep slopes in the catchment limit the range of land use to primarily permanent pasture.

View northwest from Higher Barn paddock on Pitley Road, south of A38 – overlooking catchment and Ashburton.

View southwest across quarry site from Lower Waye, above Alston Cross.

Priority Areas and Drivers

Flooding has the potential to negatively affect people and communities. By considering both the vulnerability of communities and the opportunities for land management interventions, actions can be targeted to have a positive impact on communities most at risk.

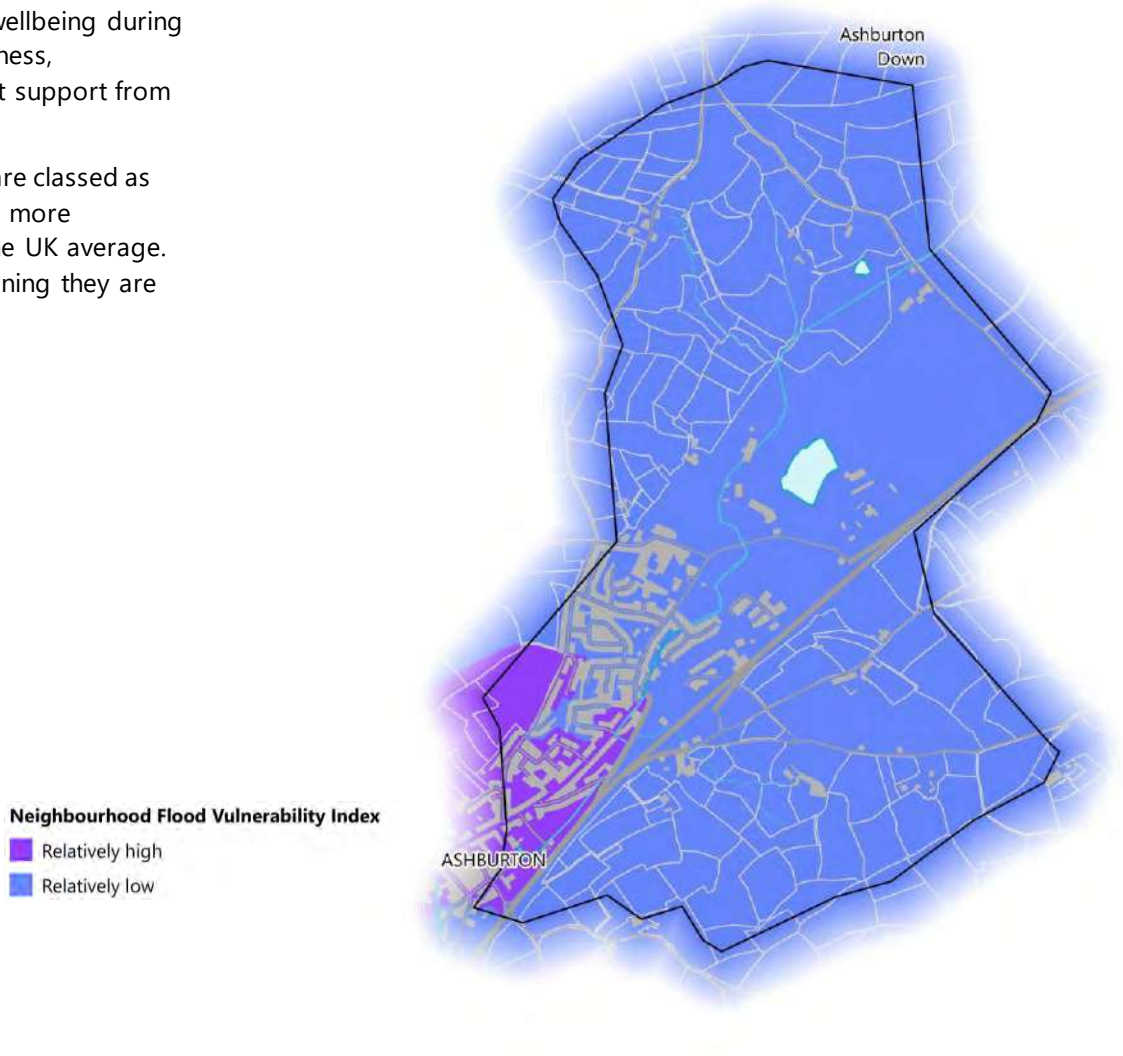
Flooding is one of a number of natural hazards which can cause harm to people, the environment and the economy. The primary driver for targeting this catchment is flooding. However, there are other priority areas and drivers which will be affected by NFM and can determine the most appropriate type of NFM for the catchment. These are mapped in the following pages.

Priority Areas and Drivers

Flooding

The **Neighbourhood Flood Vulnerability Index (NFVI)** characterises vulnerability as communities likely to experience losses in wellbeing during flood events. This is based on their susceptibility, preparedness, responsiveness, and ability to recover, all without significant support from emergency services.

Roughly half of the Ashburton buildings in the catchment are classed as "Relatively High" in the NFVI, meaning that they are slightly more vulnerable to losses in wellbeing from a flood event than the UK average. The rest of the catchment is classed as "relatively low", meaning they are slightly less vulnerable than the UK average.

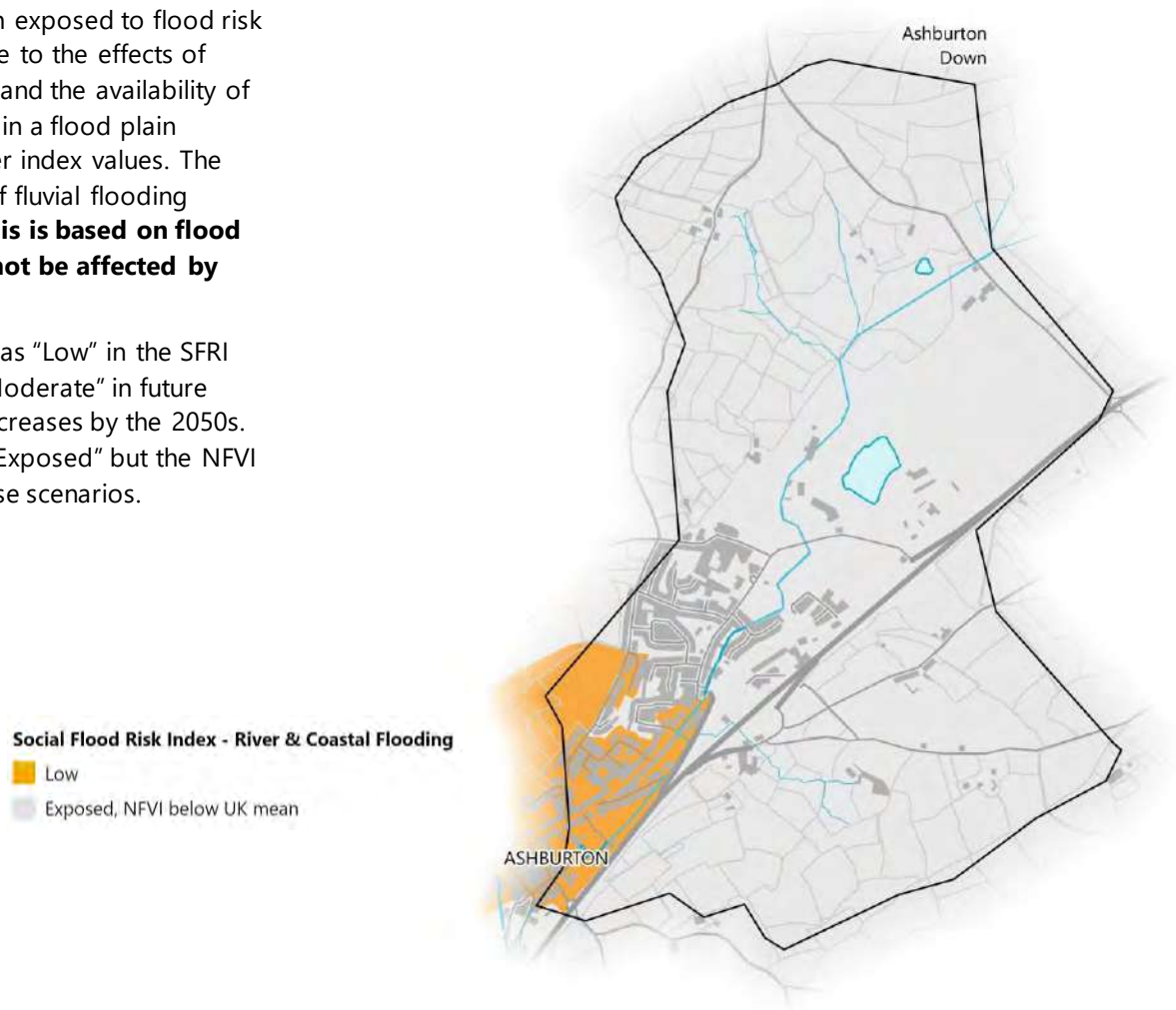


Priority Areas and Drivers

Flooding

The **Social Flood Risk Index (SFRI) is a geographic measure of flood disadvantage.** It identifies communities who are both exposed to flood risk by living on a flood plain and who are more vulnerable to the effects of flooding, due to factors such as health, preparedness and the availability of community support. Higher numbers of people living in a flood plain coinciding with high social vulnerability result in higher index values. The map highlights neighbourhoods identified as at risk of fluvial flooding higher than the national average. **Please note that this is based on flood risk from rivers and the sea, so coastal areas may not be affected by changes in land management upstream.**

At present, much of the town of Ashburton is classed as "Low" in the SFRI for river and coastal flooding, and this increases to "Moderate" in future projected scenarios of 2 and 4 degree temperature increases by the 2050s. The upstream areas of the catchment are classed as "Exposed" but the NFVI remains below the UK mean in all temperature increase scenarios.



Priority Areas and Drivers

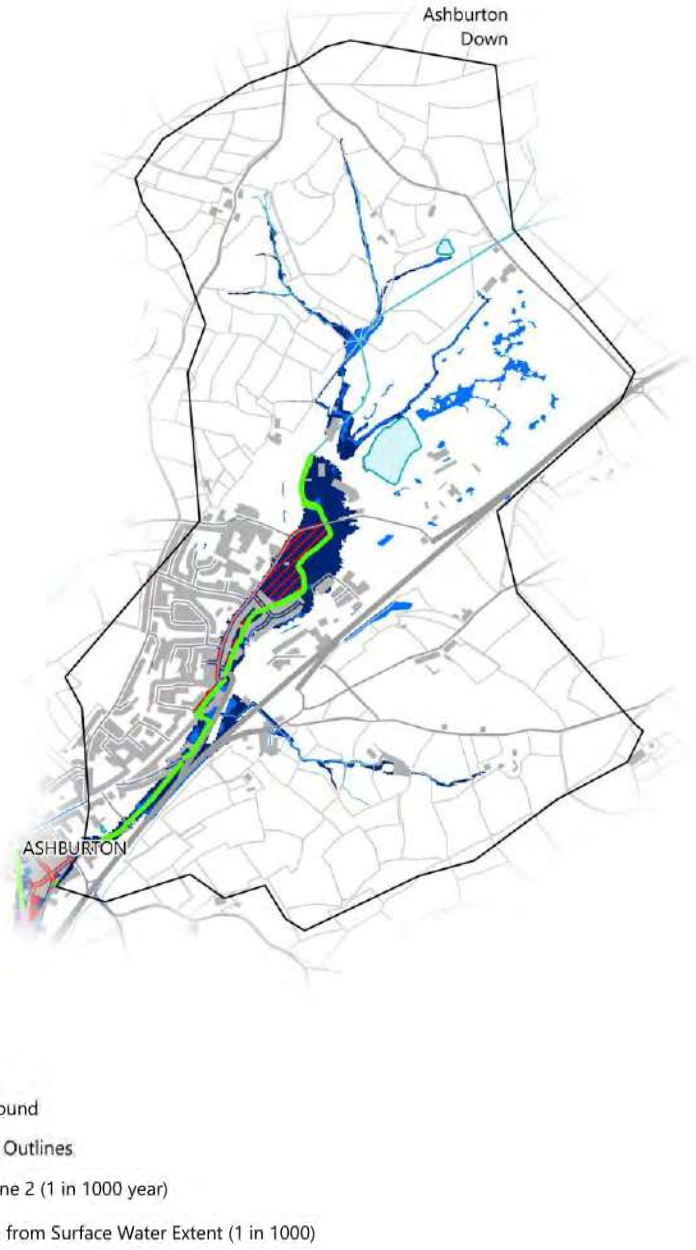
Flooding

When considering flooding, it is necessary to investigate records of previous flood events and combine this with modelled scenarios of what **could** happen, particularly in the face of the uncertainty of climate change affecting weather patterns.

The Balland Stream has previously flooded in February 1990 where channel capacity was exceeded with no raised defences and there are 4 buildings falling within the recorded flood outline. There are currently a series of linear natural high grounds that act as flood defences running either side of the Stream throughout the urban area as far upstream as the quarry, though they are not completely contiguous. These are owned by a mix of private individuals and the local authority, were last inspected in May 2021, and are next due to be inspected in November 2022.

The EA's modelled fluvial Flood Zone 2 dataset show areas predicted to flood from rivers in a storm event so severe it is likely to occur only once every 1000 years. There are 103 properties in flood zone 2 within the Balland Stream catchment. This is also known as a 0.1% Annual Exceedance Probability. Flood Zone 2 was used to identify buildings potentially at flood risk as shown previously on page 8. This extends nearly the full length of the Stream and includes its tributary south of the A38 and all of its tributaries in the north of the catchment.

The EA's Risk of Flooding from Surface Water (RoFSW) dataset shows the extent of flooding caused by rainwater flowing across the ground towards the nearest water course in a 1 in 1000 year storm event. There are 48 properties at Risk of Flooding from Surface Water with the Balland Stream catchment. This overlaps frequently with Flood Zone 2, but also shows depressions in the ground where surface water will accumulate. It is the only modelled risk of flooding in the quarry and adjacent to the A38 on the south side.



Priority Areas and Drivers

Flooding

The walkover survey identified that the Balland stream is quite heavily engineered and channelised in the bottom section through the quarry and Ashburton. Some of this work will reduce flood risk and some may exacerbate it in extreme circumstances.

Higher in the catchment the steep topography and narrow road network are likely contributors to the speed and flashiness of flood events. Although residents spoken to didn't report any significant events recently, commenting that ponds created to take road run off at the eastern edge of the catchment had resolved problems of flood water on the road there.

Above: Steep fields open through gateways onto steep narrow lanes with banked hedges which act as flow pathways.

Right: Balland stream culvert is dry in Ashburton at time of survey. As the stream is ephemeral there are fewer constraints on potential flood management interventions.

Priority Areas and Drivers

Flooding

Community Stakeholder groups exist in the area and could be important in helping shape any project or interventions within the catchment.

Ashburton Climate Emergency (ACE) community response group are a local Facebook group for residents of Ashburton to communicate about local solutions to face the climate emergency. They mainly focus on the areas of Energy (creation & conservation); Food, Farming & Forestry; Transport; Caretaking (biodiversity, water & pollution); Recycling, Re-use, Repair & Making and Wellbeing & Resilience.

Priority Areas and Drivers

Water Quality

Clean and plentiful water is vital for a huge variety of our activities, and for supporting healthy ecosystems. Good water quality supports an efficient water supply, healthy natural habitats and cultural ecosystem services. A plentiful water supply is important for drinking water and household use, irrigation, industrial use and for maintaining habitats. Water quality is a key underpinning for the Water Framework Directive.

There are no Water Framework Directive monitoring sites, priority wetlands, or aquatic habitats in the catchment. It also does not fall within a Nitrate Vulnerable Zone (NVZ).

However, the catchment falls within a wider Drinking Water Safeguard Zone for Surface Water, identified as being at risk of failing the drinking water protection objectives due to contamination by pesticides.

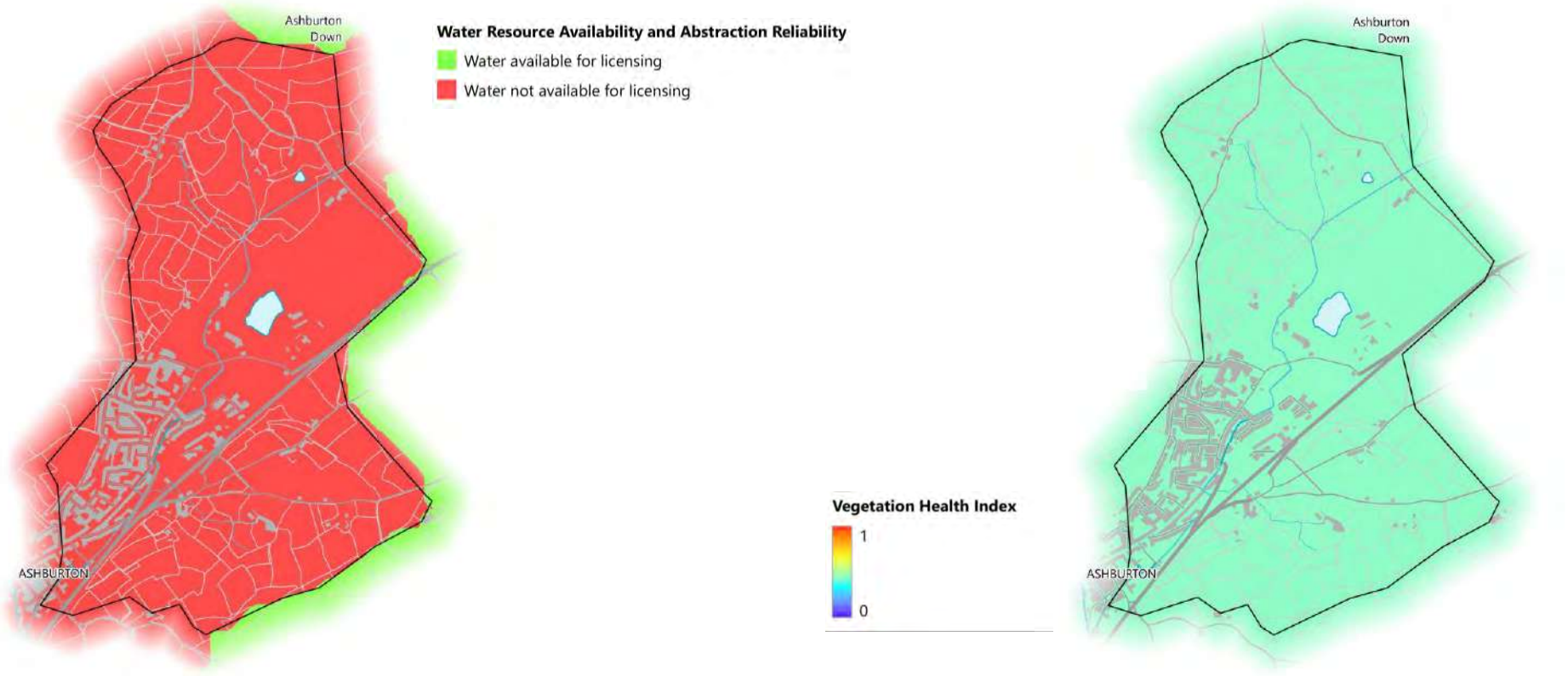
For more information on water quality go to slide 25.

Priority Areas and Drivers

Water Quantity and Drought Risk

The amount of water available for abstraction is an indicator of how much drinking water is available for people. The catchment sits within an area not currently available for licensed water abstraction (left map) but is bordered to the east and north by areas where water is available for licensed abstraction.

In the context of NFM, it is also necessary to consider water availability for plants and wildlife. Drought can cause vegetation to die back, leaving bare soil exposed and more vulnerable to erosion and runoff when it eventually rains. The Vegetation Health Index (VHI) uses satellite data to combine temperature and vegetation condition to characterise vegetation health. Areas are scored between 0 and 1 with lower values indicating low drought risk to plant health and higher values indicating higher risk. The catchment is ranked below average at 0.436 on the VHI (right map), indicating relatively low risk to plant life from drought stress.

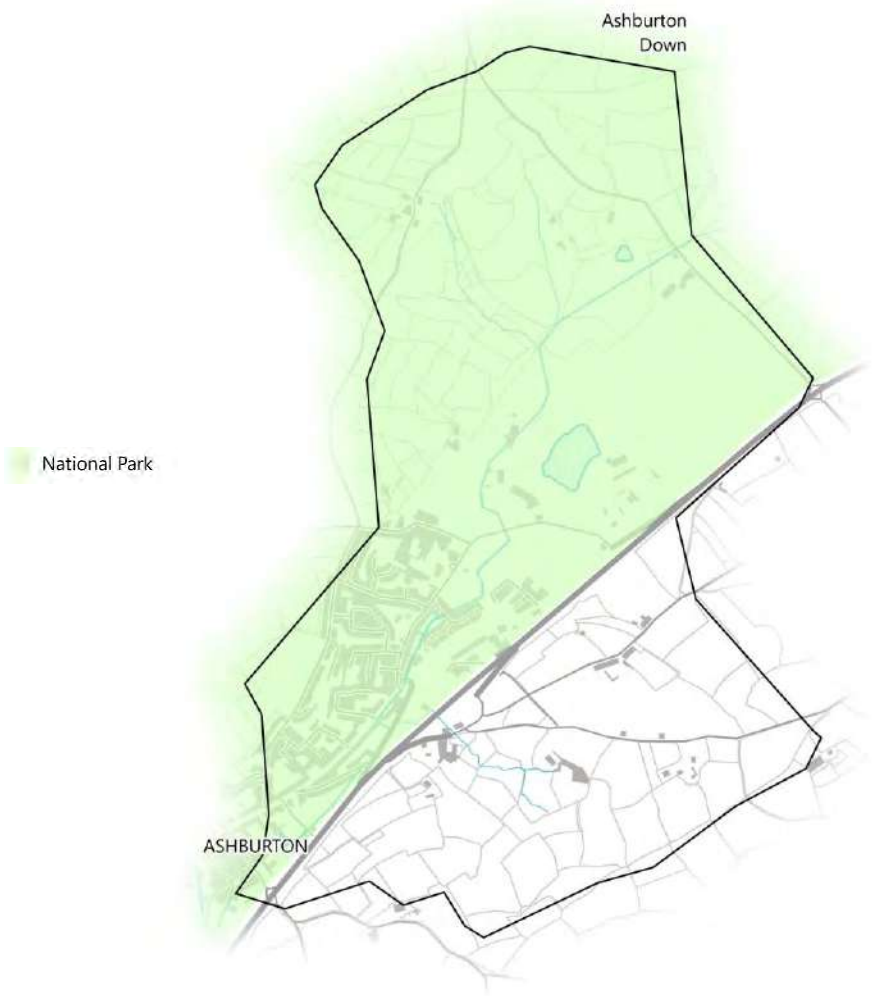


Priority Areas and Drivers

Designated Sites

Designated habitat sites, from small local nature reserves all the way up to large national parks, need to be protected for the wealth of benefits they provide to people and the environment, including already providing some degree of NFM. A site being designated can be an indicator of habitat health.

The northern and western areas of the catchment, the areas above the A38, fall within the Dartmoor National Park boundary. Aside from this, there are no other designated sites for habitats present.



Priority Areas and Drivers

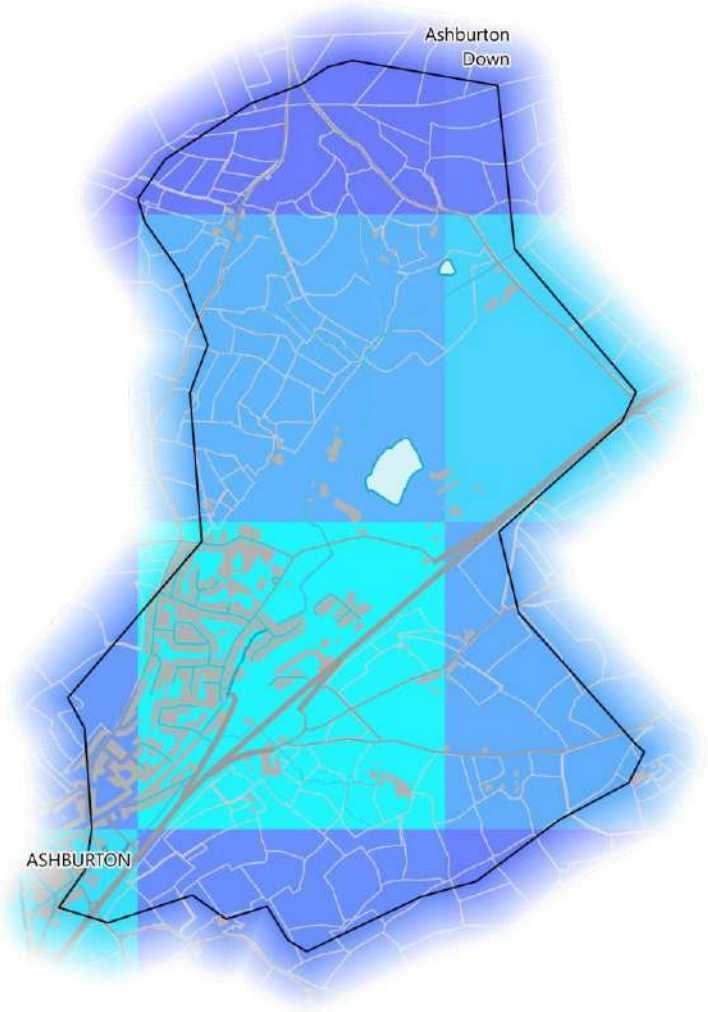
Air Quality

Clean air is important for people's health and for healthy ecosystems. Air quality is the term used to describe the levels of pollution in the air. When air quality is poor, pollutants in the air may be hazardous to people, particularly those with lung or heart conditions. In the past, the main air pollution problem was smoke and sulphur dioxide from fossil fuels such as coal. Now, the major threat to clean air is from traffic emissions. Petrol and diesel motor vehicles emit a variety of pollutants, principally carbon monoxide (CO), oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and particulate matter (PM_x).

A growing body of research suggested that smaller particles, in particular PM less than 2.5µm in diameter ($PM_{2.5}$), is a metric for air pollution which is closely associated with the adverse health effects of poor air quality. Therefore, this section will use data relating to $PM_{2.5}$ where relevant.

Improvements to the soil and surrounding environment have the potential to also deliver improvements to air quality through natural filtering processes.

The central Ashburton area and areas within close proximity to the A38 have a relatively high concentration of air particulate matter at 7.33$PM_{2.5}$ from emissions, but this falls towards the north and southeast of the catchment. The lowest recorded air particulate matter of 6.23$PM_{2.5}$ is in the north.



Priority Areas and Drivers

Tourism and Recreation

Areas and features important for tourism and recreation may also be at flood risk and it is necessary to protect them for a healthy society and environment.

The catchment boasts a large greenspace in its center on the edge of Ashburton, comprising playing fields for different sports. It is important to note here that this greenspace falls within Flood Zone 2 as shown on page 15. In the town itself, there is a small children's play space amongst the residential houses and a greenspace surrounding Ashburton open air swimming pool.

A Public Right of Way (PRoW) runs northeast to southwest in the northern side of the catchment towards the playing fields. Another PRoW runs along the playing fields opposite side. A third PRoW runs westward from the residential area out of the catchment.

Existing Natural Assets and their Condition

Biodiversity, the variety of life of earth, is valuable in its own right. It also supports recreation, food, flood protection and climate regulation. This section will predominantly explore what habitats and other natural assets are present in the catchment that will already be contributing to NFM and could be improved with further NFM measures. Water, soils and crops are natural assets in themselves and will also be investigated.

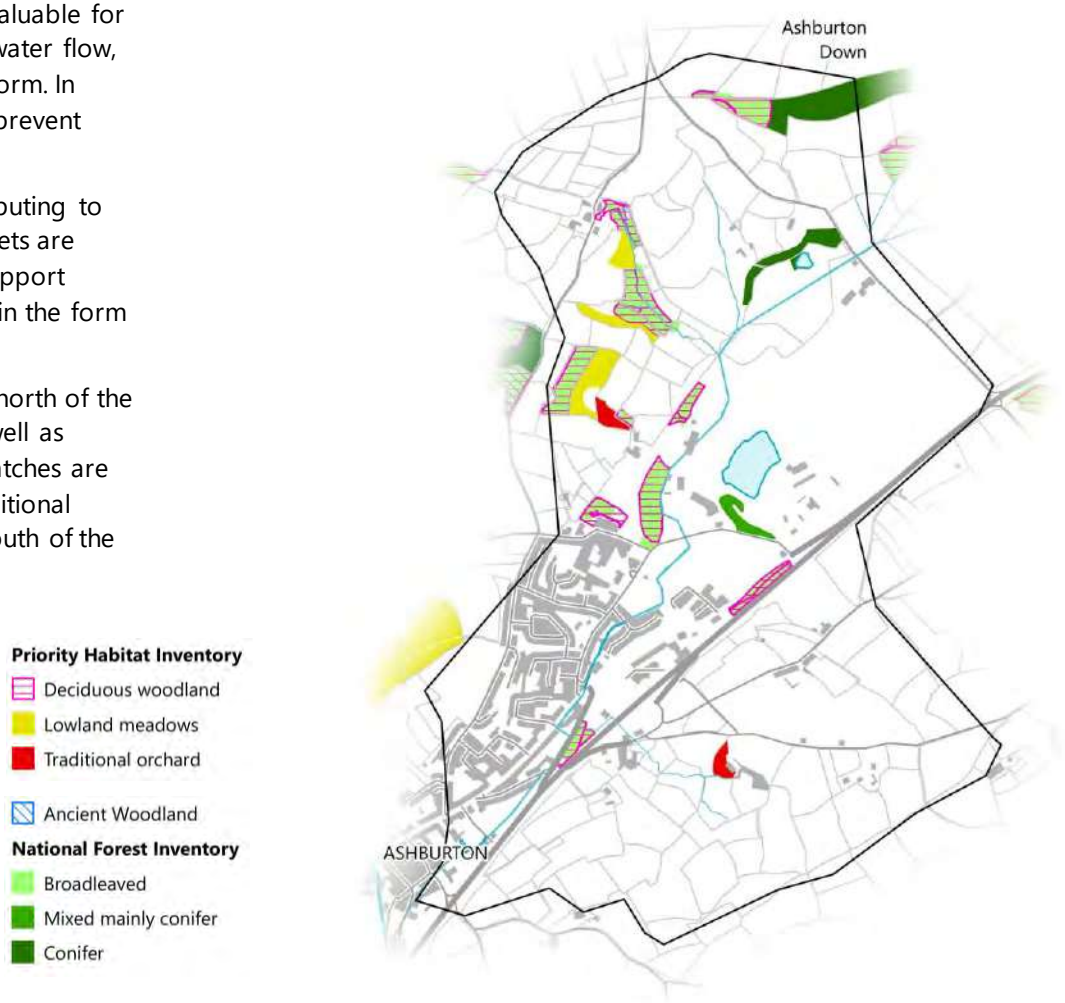
Existing Natural Assets and their Condition

Habitats and their Condition

The natural assets mapped below are habitats which have the potential to support thriving plants and wildlife. Thriving vegetation is very valuable for NFM as it roughens the ground, thereby slowing down surface water flow, meaning water courses are less likely to be overwhelmed in a storm. In addition, plant roots provide structural support for the soil and prevent surface water washing soil into water courses.

Where the assets are present the landscape is likely to be contributing to the provision of habitats, biodiversity and even NFM. Where assets are absent there may be a lack of habitats which contribute to or support thriving plants and wildlife. Assets may still be present however in the form of crops and soils which are mapped in the following pages.

Multiple patches of broadleaved woodland are scattered in the north of the catchment, particularly in the land parcels to the northwest, as well as coniferous woodlands in the northeast. Most of these habitat patches are deciduous woodland priority habitats with the addition of a traditional orchard and 3 lowland meadows. The only habitat in the area south of the A38 however is a traditional orchard.



The above map was created using the NATMAPvector dataset from Cranfield University in March 2022

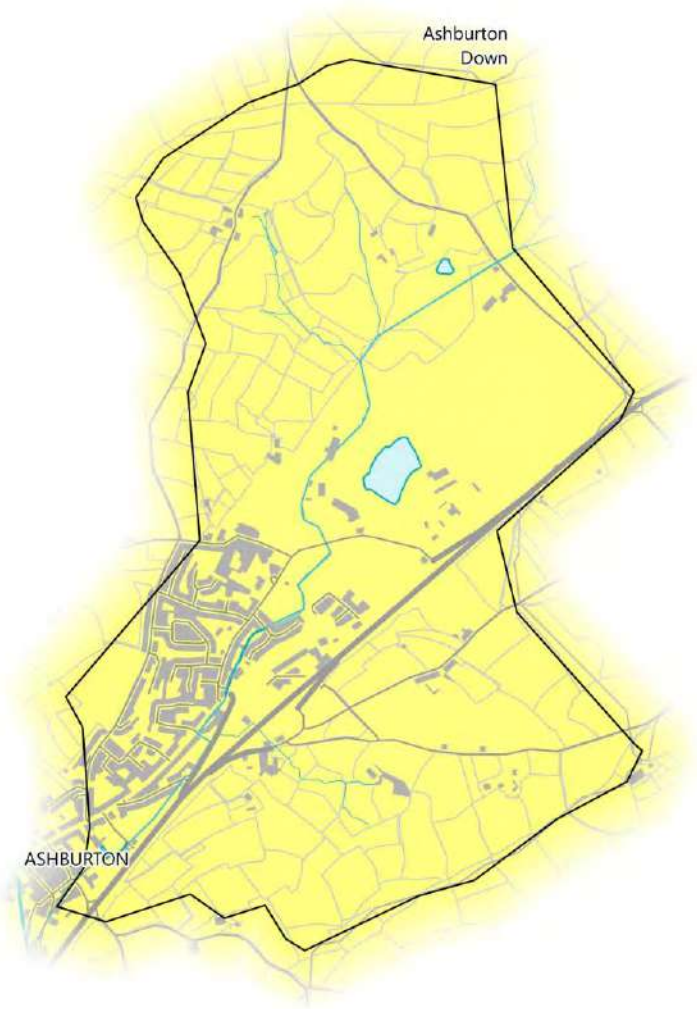
Existing Natural Assets and their Condition

Water Framework Directive

It is important to determine the current condition of water quality. Poor water quality can be detrimental to people, wildlife, and may cause other negative effects during a flood event. Good water quality should always be protected. A key set of evidence used to assess the water quality in a catchment is the Water Framework Directive (WFD). The status of a waterbody is measured using a series of parameters and is recorded on the scale: high; good; moderate; poor; bad (with moderate and worse being regarded as a failure).

There are no assessed WFD river waterbodies present. However, the micro-catchment sits within and on the edge of the larger Ashburn WFD river waterbody catchment, accounting for 19% of it's area.

The River Ashburn is overall classed as Moderate meaning it is failing WFD regulations. It is currently failing on chemical status but is ranked Good for ecological status. In 2019, 100% of waterbodies in the UK failed on chemical status after the EA included monitoring "mercury and its compounds" and "Polybrominated diphenyl ethers (PBDE)" into its water quality monitoring methodology.



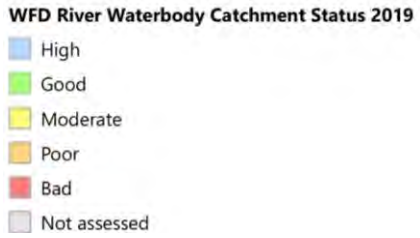
Existing Natural Assets and their Condition

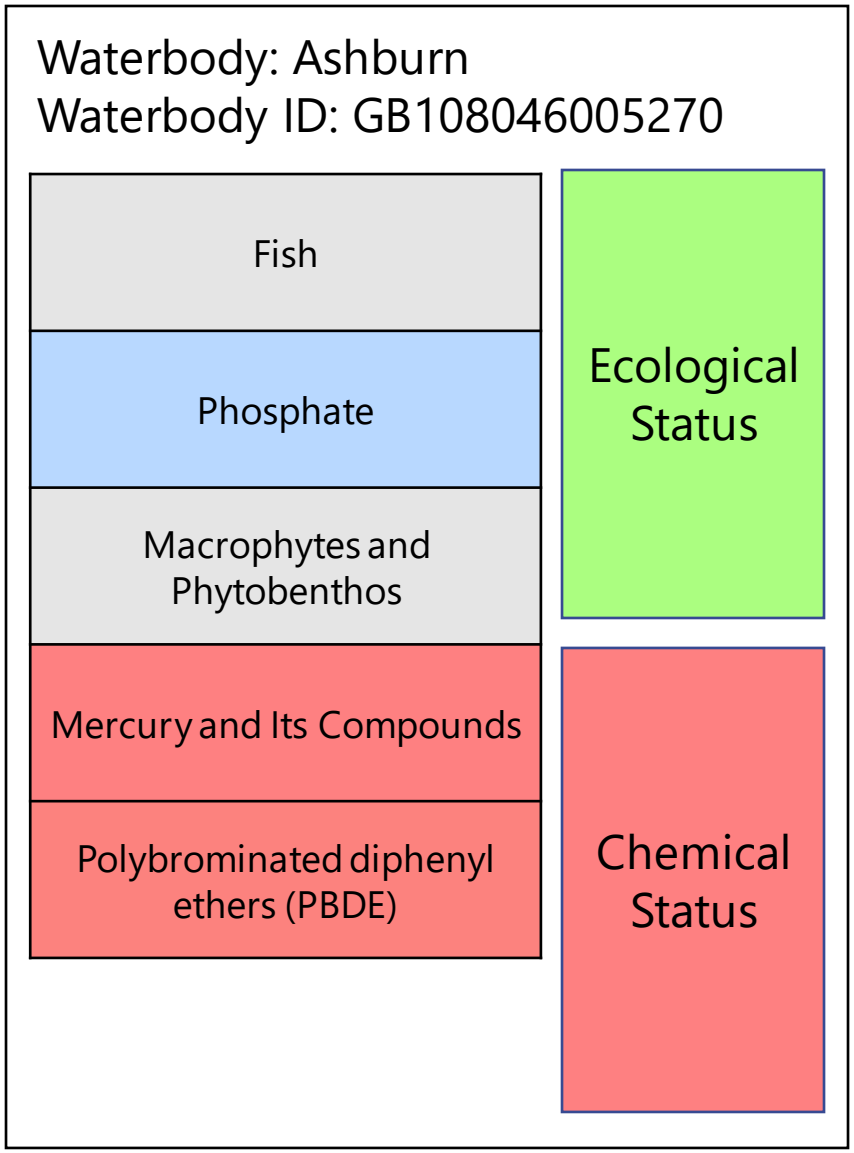
Water Framework Directive

The river Ashburn was not assessed for fish, macrophytes, and phytobenthos in Cycle 2, but was assessed as High for phosphate and several other ecological classification items. Its morphology has been classed as Supports Good, and the Ashburn's overall ecological status is therefore Good and meeting WFD regulations on ecological grounds.

The waterbody is classed as Good for most chemical classification items, except for the previously mentioned Mercury and its compounds and PBDEs where it is classed as Failing. The Ashburn's overall chemical status is consequently failing and is therefore failing WFD regulations on chemical grounds.

There are over 60 metrics that the EA can use to monitor waterbody catchment statuses. For more information and a breakdown of this catchment's status go to https://environment.data.gov.uk/catchment-planning/WaterBody/GB108046005270?cycle=2



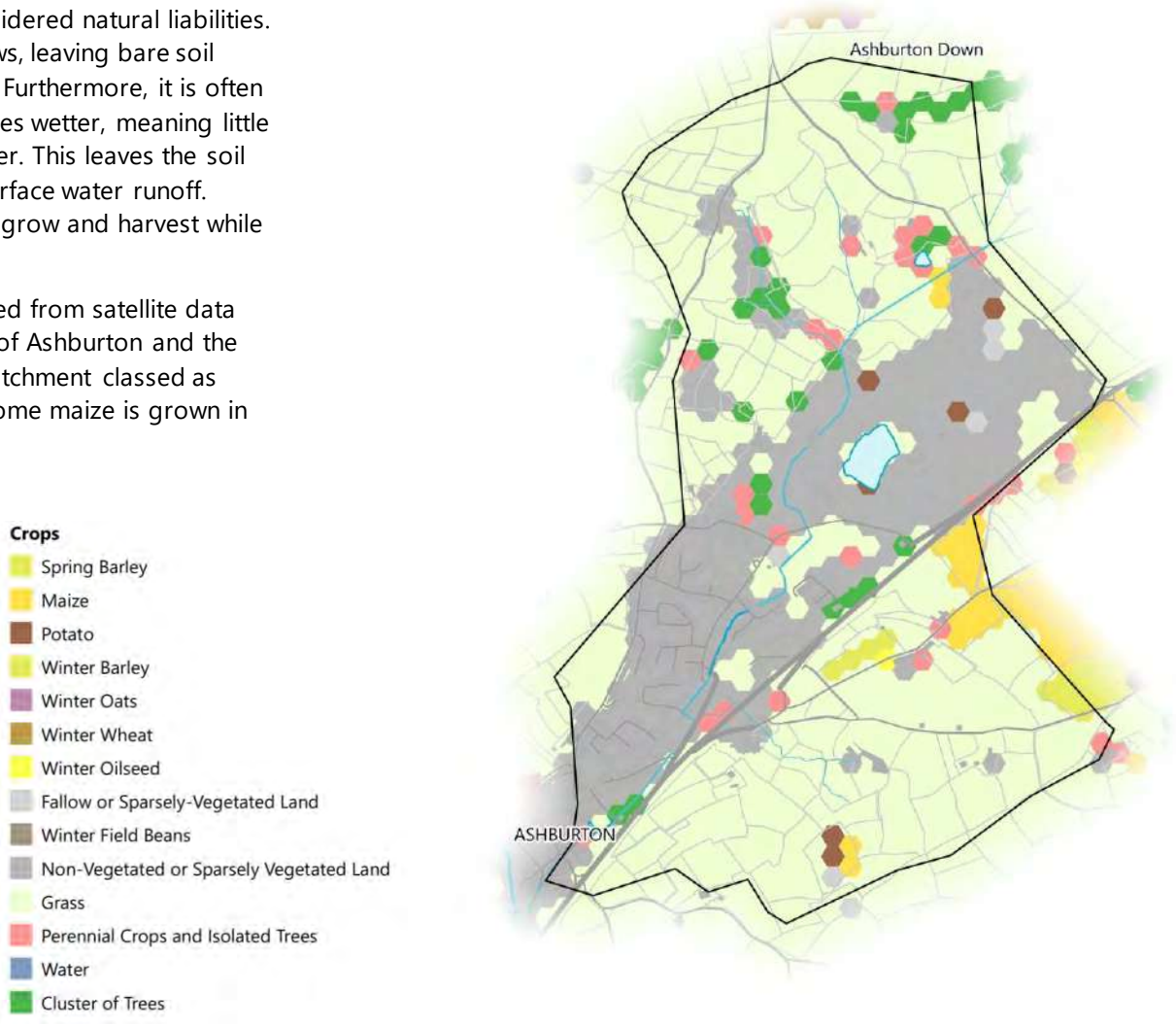


Existing Natural Assets and their Condition

Crops

Crops can be a natural asset in themselves, providing the food we eat and storing carbon. Some crops however, could be considered natural liabilities. One such crop is maize which is planted in wide rows, leaving bare soil exposed and without structural support from roots. Furthermore, it is often harvested in late-Autumn when the weather becomes wetter, meaning little to no vegetation can regrow to protect it over Winter. This leaves the soil much more susceptible to being carried away by surface water runoff. Despite this, maize can be successfully managed to grow and harvest while minimising runoff.

The Crop Map of England (CROME) dataset is derived from satellite data and generalised to hexagons. It identifies the town of Ashburton and the quarry as non-vegetated with the majority of the catchment classed as grassland, and various scattered clusters of trees. Some maize is grown in the southeast below the A38.



Existing Natural Assets and their Condition

Soils

The nature of the soil can determine how much surface water infiltrates into the ground, as well as what plants will grow and where. Understanding soils is vital to providing effective NFM and improving water quality. The aim with water quality improvements is to keep the soil on the land and improve groundwater infiltration and recharge, therefore allowing a slower and more naturally filtered water route to the river.

Degraded soil structure, where the soil profile is compacted at shallow depths or capped at the surface and impermeable can lead to excessive unnatural run-off of surface water instead of percolation and infiltration. More than 60% of soils in Devon and Cornwall are naturally well-drained and should rarely become saturated.

The Farming Rules for Water (FRFW) were introduced at the start of 2018 as legislation to help protect surface water quality. The regulations are designed to help manage cultivated agricultural land well, without over-management, nutrient run-off, or waste affecting surface water.

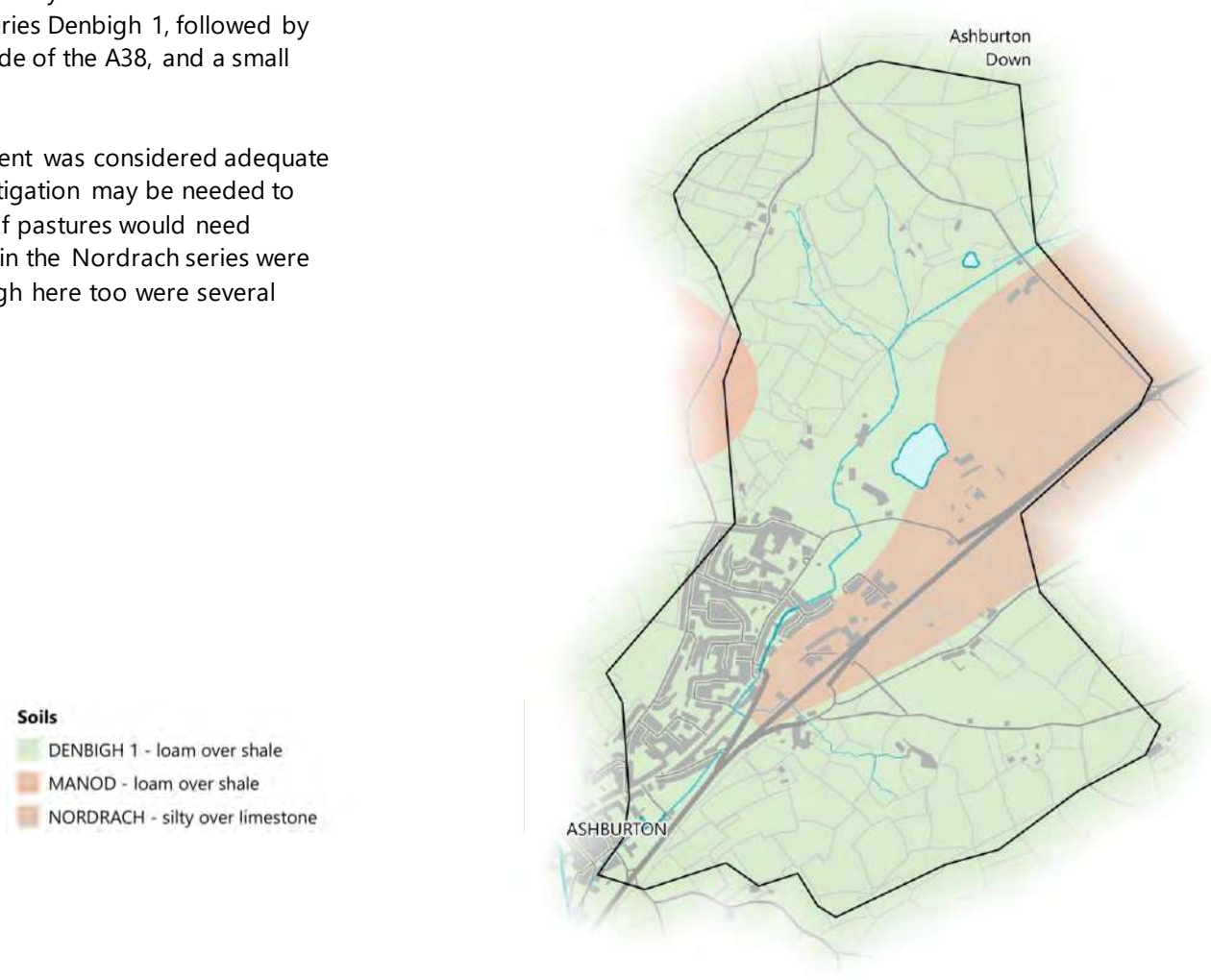
The diagram above shows good soil structure on the left and compacted soil structure on the right. In compacted soil, little surface water can infiltrate into the soil subsoil due to surface capping or compacted layers, while vegetation can be deprived of oxygen due to compression of pores that normally transport air and water (sourced from SEPA NFM Handbook).

Existing Natural Assets and their Condition

Soils

The NATMAP soils dataset from Cranfield University shows that the catchment is primarily composed of the soil series Denbigh 1, followed by Nordrach around the quarry area and either side of the A38, and a small area of Manod to the west.

At the time of survey, soil health in the catchment was considered adequate through general observation and further investigation may be needed to conclusively determine. Possible compaction of pastures would need confirmation through VESS surveys. The fields in the Nordrach series were more likely to be used for arable crops, although here too were several horse paddocks.



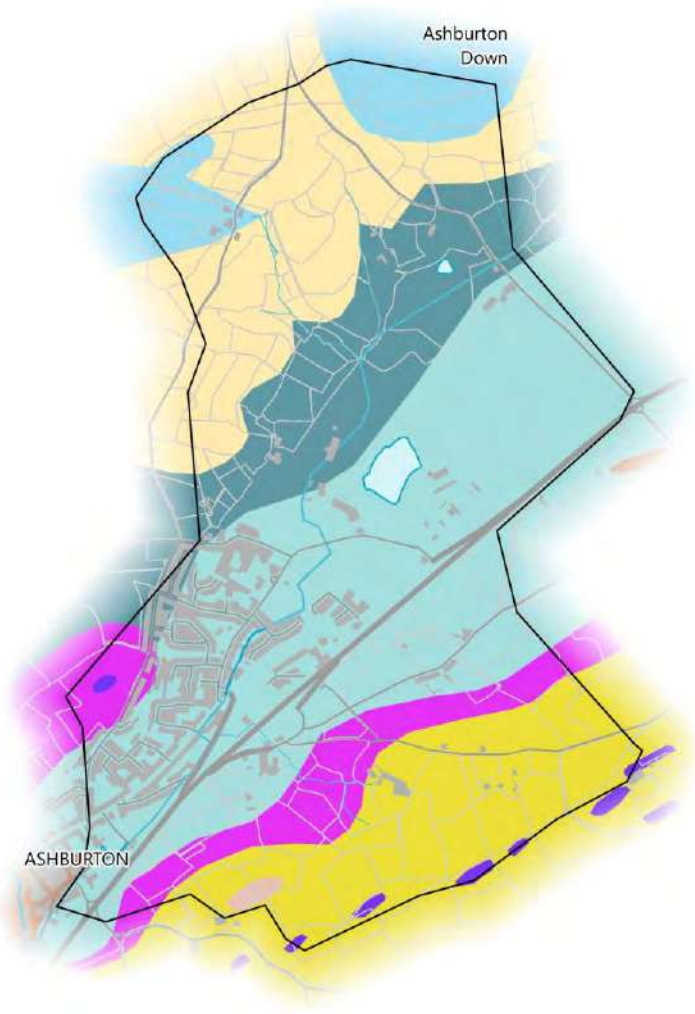
The above map was created using the NATMAPvector dataset from Cranfield University in March 2022

Existing Natural Assets and their Condition

Geology

Geological conditions impacts groundwater and soil type. When rocks are sufficiently permeable it can lead to groundwater flooding. If local flooding is caused be groundwater levels then it is unlikely that changes to land management and NFM will improve flood resilience.

According to the British Geological Survey, Ashburton, the quarry, and the A38 have underlying limestone. The south of the catchment is primarily siltstone and basalt with some occasional pyroclastic rocks, and separated from the limestone in the catchment centre by a band of tuff. A similar band of argillite separates the north of the catchment from the limestone, and is followed by sandstone, mudstone, and chert.



Issues

Multiple issues have already been mentioned and mapped that could be contributing to flood risk and WFD failures. However, there are further potential issues that may be influential which will be explored in the following pages.

Issues

Pollution and Abstraction

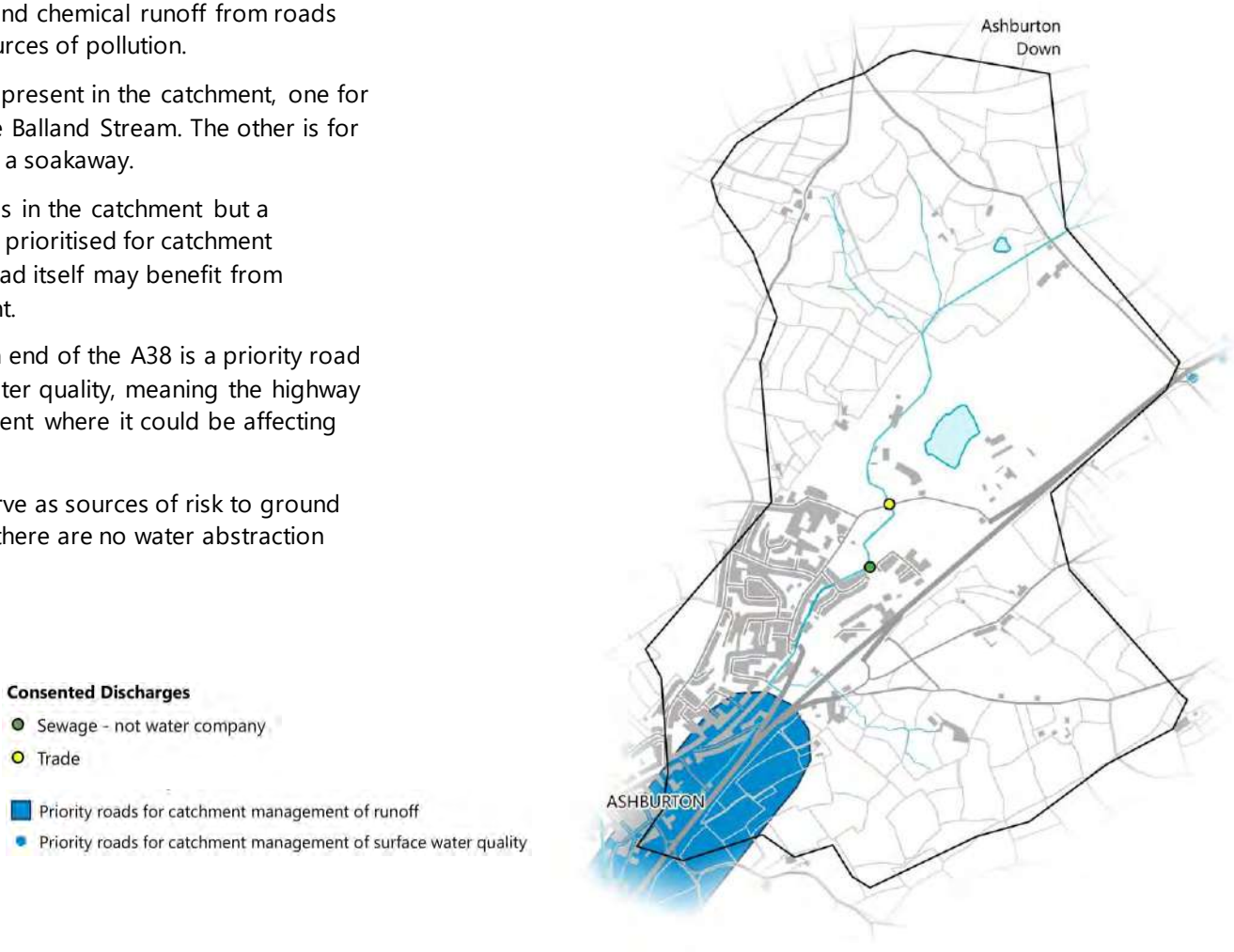
Pollution incidences themselves will directly affect water quality, but consented discharges into watercourses and chemical runoff from roads exacerbated by rainwater may also be sources of pollution.

Two sources of consented discharges are present in the catchment, one for trade discharging treated effluent into the Balland Stream. The other is for treated effluent from a business park into a soakaway.

There are no recorded pollution incidences in the catchment but a southwestern section of the A38 is a road prioritised for catchment management of runoff. This means the road itself may benefit from reduced runoff further up in the catchment.

Just outside of the catchment, the eastern end of the A38 is a priority road for catchment management of surface water quality, meaning the highway drainage system discharges into a catchment where it could be affecting river water quality.

Licensed water abstraction points may serve as sources of risk to ground water quantity and availability. However, there are no water abstraction points present in this catchment.



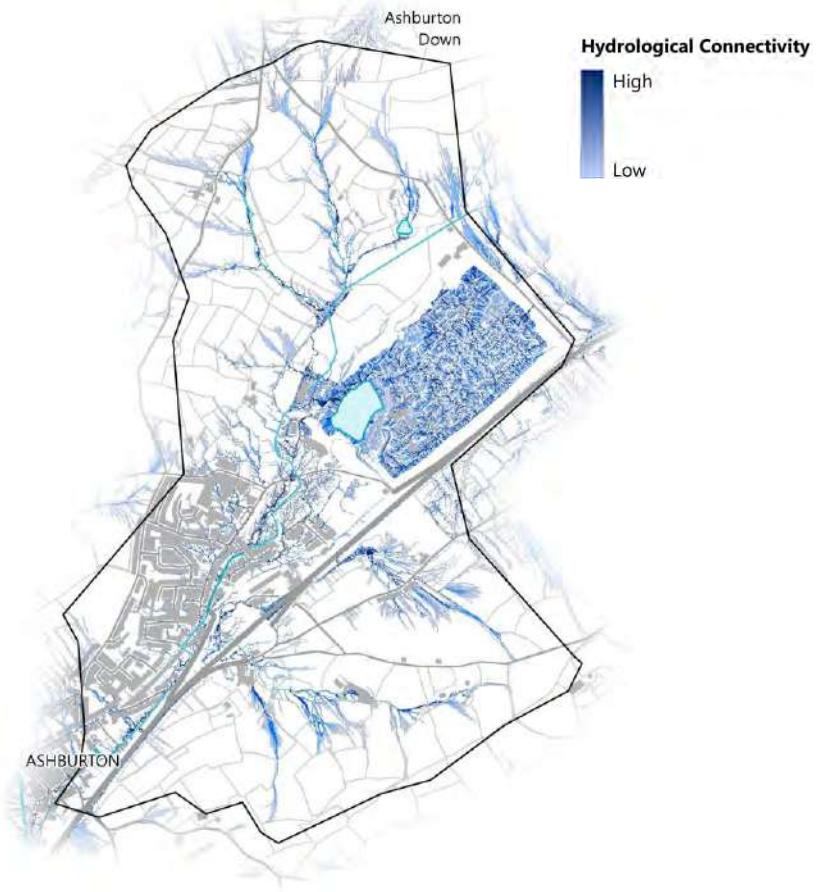
Issues

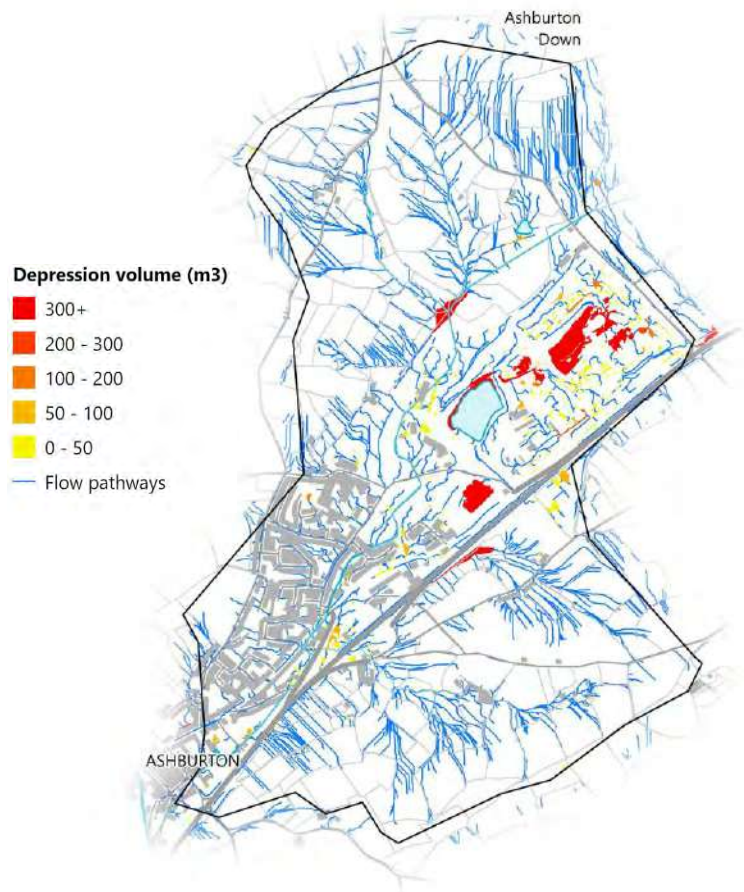
Hydrological Connectivity

Surface flow pathways are the routes rainwater accumulates and follows when it lands to the nearest depression or watercourse. As it flows, surface water can pick up any number of chemicals, soil, and debris and carry them into the watercourse with it. This serves to demonstrate why community engagement and working with land owners is so important, as the effects of practices upstream in the catchment cascade down via these routes. Pathways have been modelled in 2 different ways here.

The first are modelled using topographic data and software called SCIMAP (left). Only the routes with above average wetness are shown. The flat topography of floodplains and the unnatural topography of the quarry skews the modelling process and the pathways in these areas should be considered unreliable.

The second method uses SCALGO Live (right). Flow routes with at least 1km^2 upstream area are shown. Areas that would be flooded if 15cm of rain were to fall during a storm event are also mapped. Flooded areas are coloured by their water volume from light to dark.





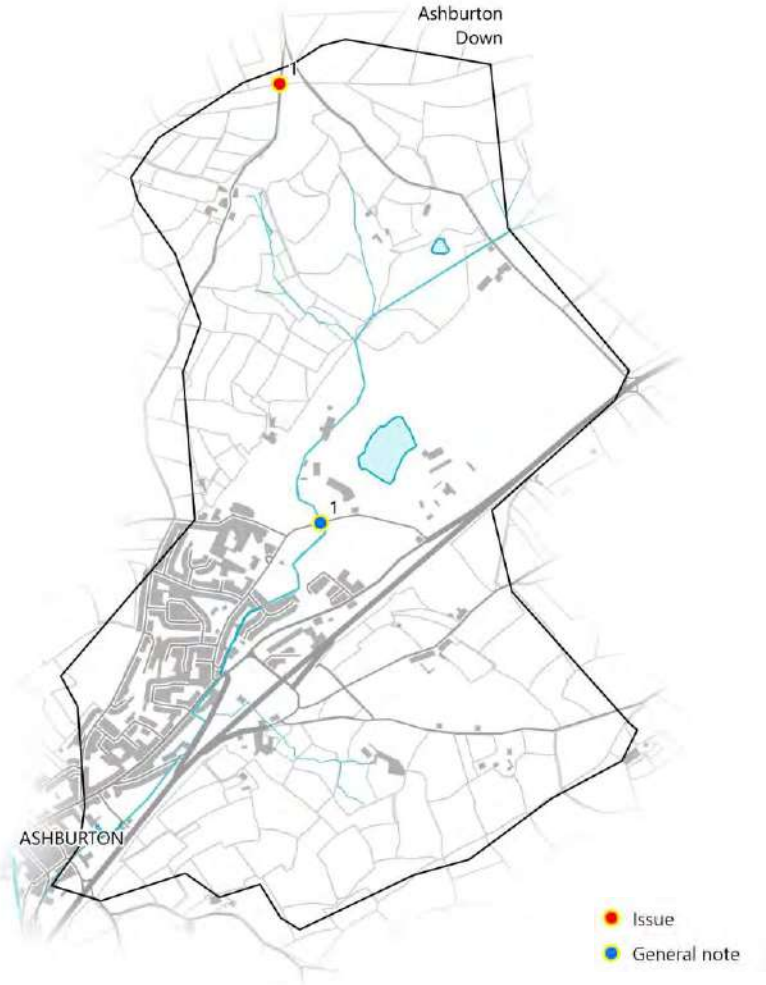
Issues

Issues Identified During Walkover Surveys

During the walkover surveys, experienced surveyors at WRT recorded points of interest and concern, as well as potential natural flood management opportunities. The results are mapped (right) but it should be noted that the map is by no means exhaustive.

Left: Narrow steep lanes with banked hedges channel runoff rapidly downhill.

Left: Steep fields with little vegetative 'roughness' allow run off to pass uninterrupted through open gateways onto lane pathways.



This map of issues was generated after one walkover survey, reflecting the situation at the time of survey. It is not exhaustive and doesn't reflect all issues present in the catchment which will take much more effort to determine. A greater range of all the issues is present within the previous section. Any projects delivering in the catchment should undertake their own walkovers for confirmation and addition to the list

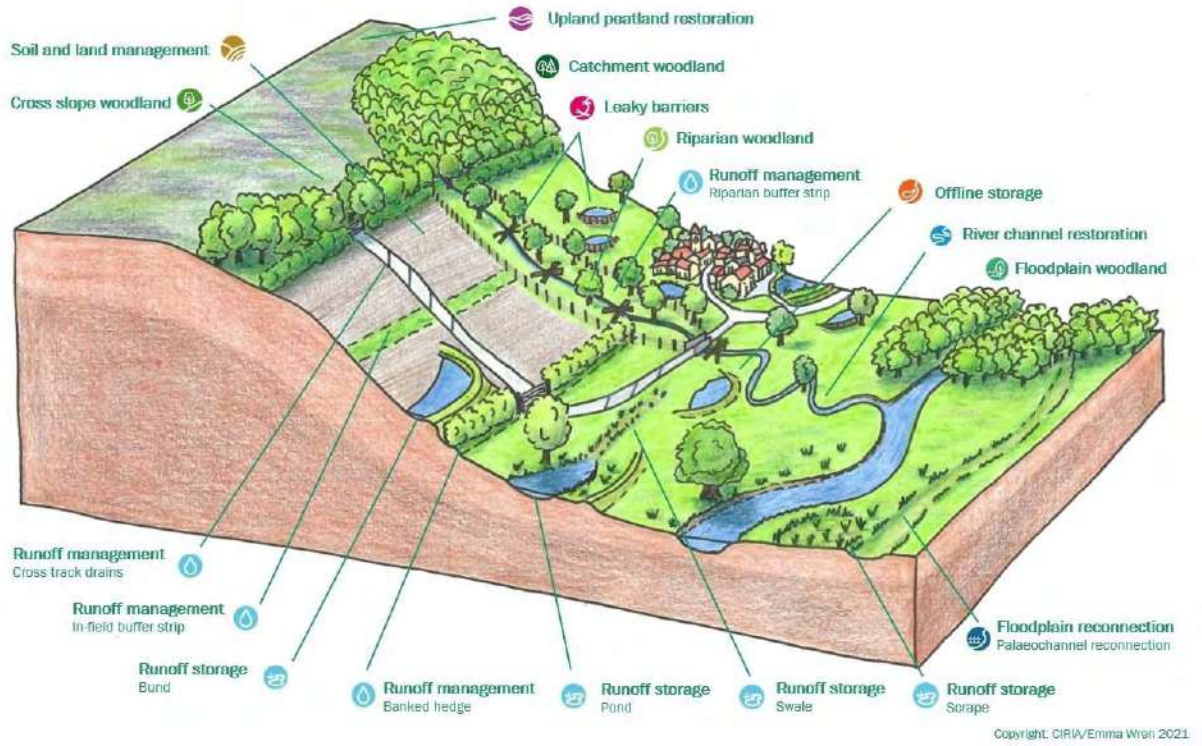
Opportunities

Opportunities

Working With Natural Processes

There are many options to reduce flood and coastal erosion risk across the country which involve implementing measures that help to protect, restore and emulate the natural functions. These options are known as **Working With Natural Processes (WWNP)** or **Natural Flood Management (NFM).** These measures increase flood resilience by slowing the flow of water and disperse energy to keep the water at the top of the catchment or to improve groundwater infiltration and recharge, therefore allowing a slower and more naturally filtered water route to the river.

Where rapid surface water run-off has been noted there may be opportunities for WWNP to mitigate both water quality and to regulate flow. An example of some NFM interventions are given below. They are intended to slow water, store water, increase infiltration and intercept rainfall.



The illustration above shows various natural flood management techniques (sourced from CIRIA).

Opportunities

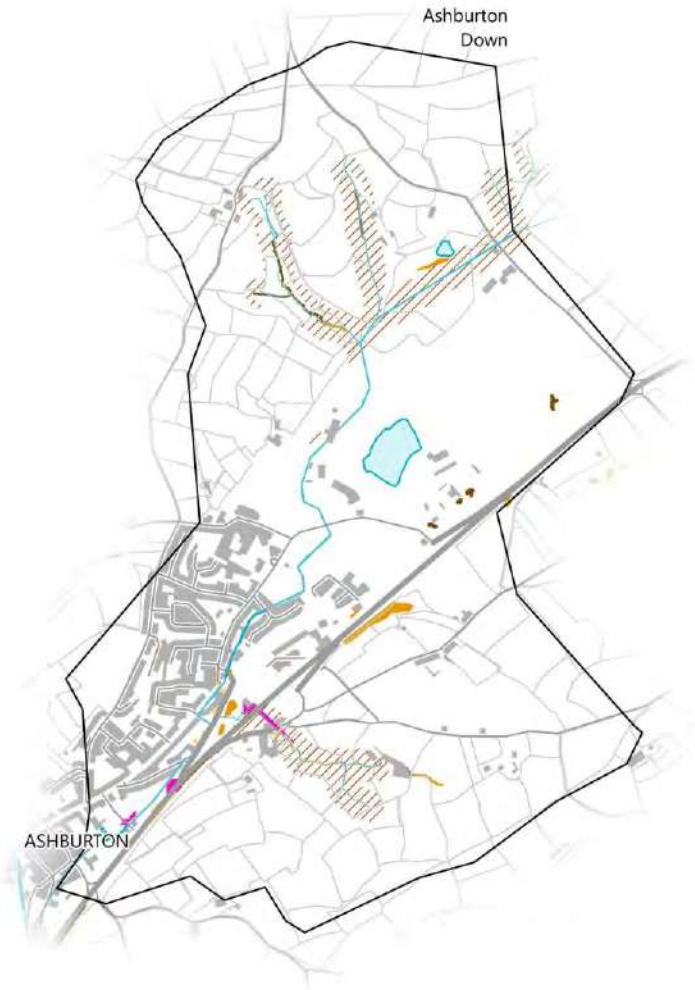
Working With Natural Processes

The Environment Agency have mapped potential opportunities for WWNP to reduce flood and coastal erosion risk across the country. These include opportunities for different types of woodland planting, floodplain reconnection features like restored riverside wetlands and meadows, and runoff attenuation features which aim to slow pathways of water across the land, like storage ponds or leaky barriers. A number of areas are also excluded from the woodland maps such as urban areas and existing woodland. These are mapped separately on page 40.

The greatest opportunity identified by these WWNP datasets for the catchment is riparian tree planting along the small streams further up the catchment before they converge to form the Balland Stream.

In addition, there are opportunities to construct smaller scale runoff attenuation features near the streams and the main roads that are strategically placed to slow the flow of surface water before it reaches the water course, allowing excess water to dissipate rather than flood during a storm event.

Furthermore, it may be possible to reconnect some small areas of floodplains downstream in the catchment adjacent to the A38 that work in tandem with the runoff attenuation features.



Opportunities

Habitat Creation and River Restoration Projects

There may be current habitat creation and river restoration projects where opportunities exist to work together with organisations to provide simultaneous benefits to habitats, rivers, and flood resilience.

Natural England have also identified opportunities to expand on existing habitats to create habitat networks across the landscape.

While there are no recorded habitat creation or river restoration projects in the catchment, there are significant opportunities for expanding habitat networks around existing priority habitats (see page 24).

There are Fragmentation Action Zones around the lowland meadows. Natural England defines these as "Land immediately adjoining existing habitat patches that are small or have excessive edge to area ratio where habitat creation is likely to help reduce the effects of habitat fragmentation."

Just outside this and below the A38 surrounding the traditional orchard is Network Enhancement Zone 1, defined as "Land within close proximity to the existing habitat components that are more likely to be suitable for habitat re-creation for the particular habitat. These areas are primarily based on soils but in many cases has been refined by also using other data such as hydrology, altitude and proximity to the coast."

Elsewhere in the catchment is the Network Expansion Zone, defined as "Land within relatively close proximity to the Network Enhancement Zones that are more likely to be suitable for habitat creation for the particular habitat and identifying possible locations for connecting and linking up networks across a landscape."

Much of the urban area is classed as Network Enhancement Zone 2, "Land within close proximity to the existing habitat components that are unlikely to be suitable for habitat re-creation but where other types of habitat may be created or land management may be enhanced including delivery of suitable Green Infrastructure."

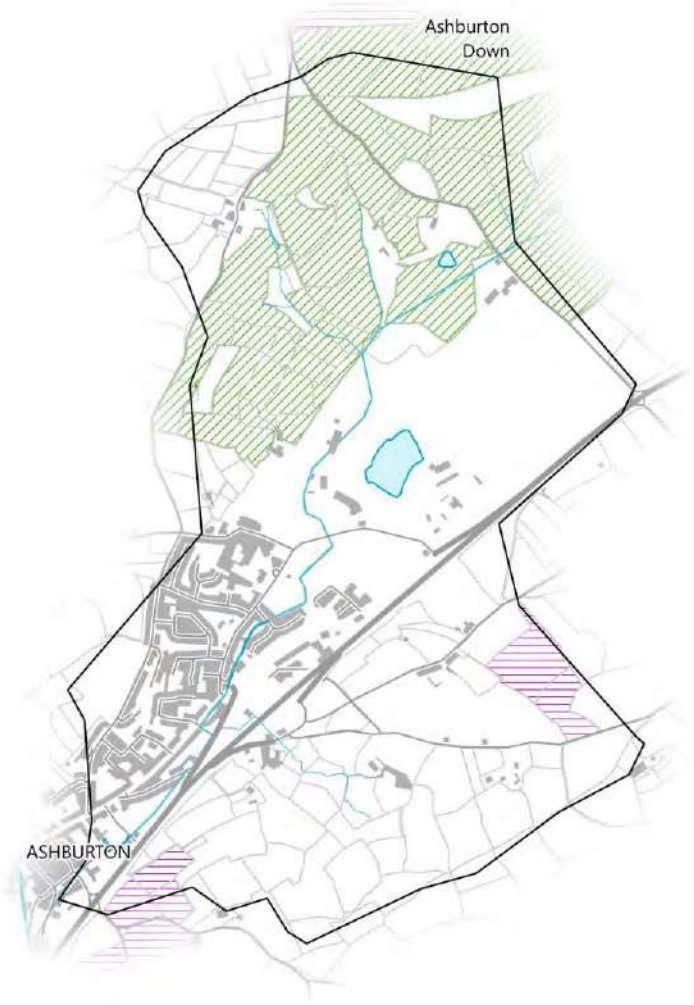
Opportunities

Agri-environment Schemes

Agri-environment schemes are government initiatives that aim to financially compensate farmers for providing benefits to wildlife on their land. Areas under agri-environment scheme agreements may provide opportunities simultaneously for the landowner to meet the agreement's objectives and deliver NFM to benefit the catchment community.

The majority of the land parcels in the northern area of the catchment are under Organic Farming Scheme Agreements, while a handful of land parcels south of the A38 are under Environmental Stewardship Agreements.

There may be opportunities for landowners in the northwest and south of the catchment to enter into agri-environment schemes. Habitat creation in the south in particular may be facilitated in the Habitat Enhancement and Expansion Zones as identified on page 38 if landowners were to enter into an agri-environment scheme.



Opportunities

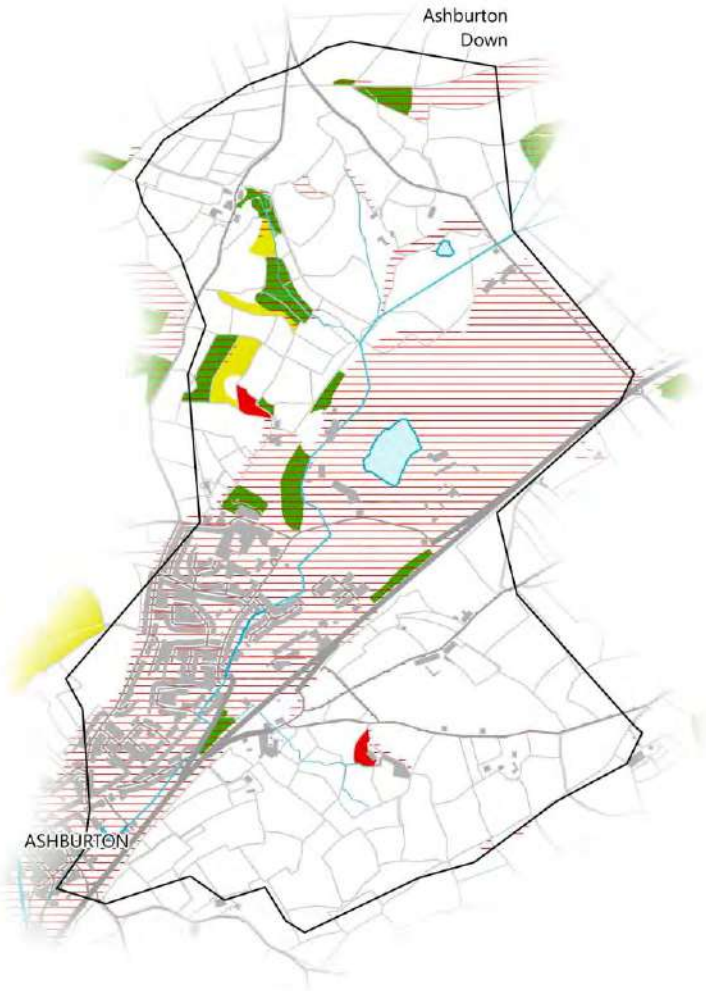
Restrictive Areas

A further consideration for the targeting of NFM via soil improvement, habitat enhancements, restoration or creation is existing areas which may not be suitable for changes in land use or land management. This may be because they are already valuable sites for wildlife (e.g. designated wildlife sites), because the land use is difficult to change (e.g. urban land) or because the land is highly valuable for farming (high grade agricultural land). There may be further historic or natural heritage designations to consider.

The Dartmoor National Park designation (see page 20) north of the A38 in the catchment may provide administrative challenges, as will the woodland, lowland meadows, and traditional orchard priority habitats. However, there is still the opportunity to improve these habitats and designated sites further by getting more partner organisations involved in the process and even access additional sources of funding.

The WWNP woodland constraints dataset highlights any urban areas and existing woodlands (including woodlands not listed as priority habitats not shown here) where additional tree planting may be difficult. This excludes much of the urban centre of the catchment and the quarry. This does not mean urban tree planting is impossible, and would also provide another avenue to get the community involved the closer the planting is. The northwest and southern areas of the catchment on the other hand have few to no restraints.

The agricultural land grade is grade 3 across the catchment which is considered average and there is therefore no high grade land present. There are also no scheduled monuments present.

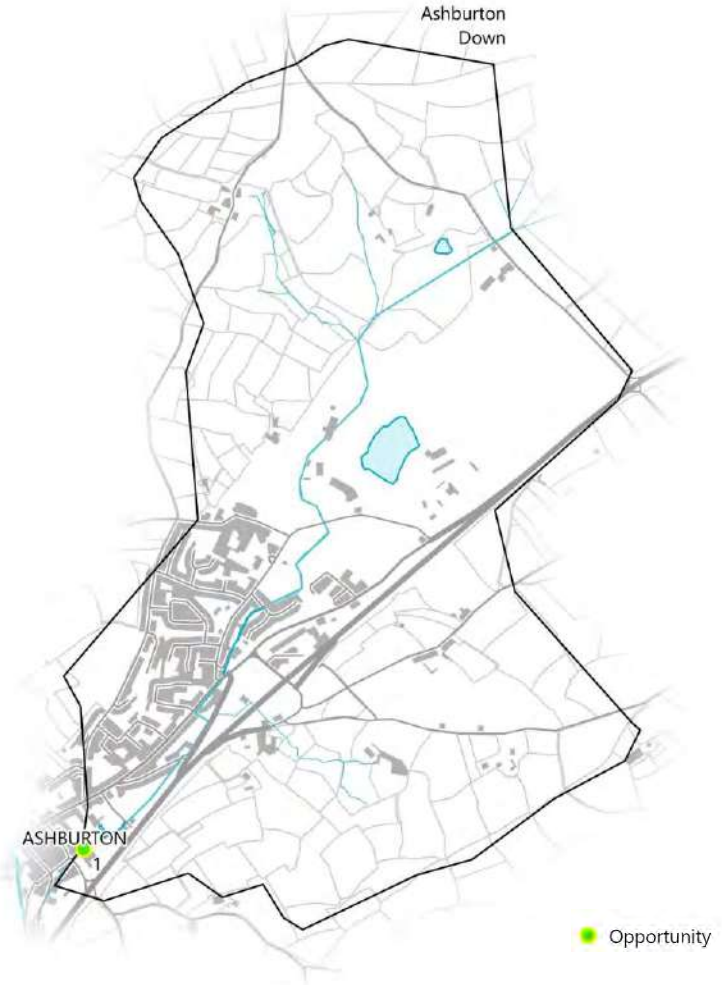


Opportunities

Opportunities Identified During Walkover Surveys

During the walkover surveys, experienced surveyors at WRT identified opportunities for NFM measures and improvements to other key considerations mentioned. The results are mapped (right) but it should be noted that the map is by no means exhaustive.

Area north of quarry where tributaries of Balland stream join. Existing sediment ditch captures run off from spoil bund pictured. Opportunity to naturalise and enhance area next to PRoW, subject to quarry expansion works.



A greater range of all the opportunities is present within the following section. Engagement with landowners and stakeholders is required for a more comprehensive list of opportunities and ascertain if suggestions can be implemented in conjunction with current land use, future land use and business plans.

Opportunities

Soil Opportunities Identified During Walkover Surveys

There are some opportunities to improve flood resilience, especially in the upper catchment through changes to soil management.

Natural Flood Management (NFM) or Working with Natural Processes (WWNP)	Potential benefit in catchment	Potential provider identified	Location of opportunity matches GIS maps
Improve soil health and rainfall acceptance potential	✓		Na
Sub-soil, aeration, or decompaction	✓		
Contour ploughing or cross slope working	✓		
Change land use	✓		
Interspersed woodland or agroforestry for infiltration	✓		
Peatland/wetland/culm restoration			

Opportunities

Pathway Interruption Opportunities Identified During Walkover Surveys

There are some opportunities to improve flood resilience in the Balland Stream through water pathway interruption.

Natural Flood Management (NFM) or Working with Natural Processes (WWNP)	Potential benefit in catchment	Potential provider identified	Location of opportunity matches GIS maps
Cross-slope planting of trees or hedges	✓		
Gateway relocation	✓		
Cross-slope buffer (beetle bank or cross-drain)	✓		
Timber/stone instream deflectors	✓		

Opportunities

Attenuation Opportunities Identified During Walkover Surveys

There are some opportunities to improve flood resilience in the Balland Stream through water attenuation on non-floodplain wetland.

Natural Flood Management (NFM) or Working with Natural Processes (WWNP)	Potential benefit in catchment	Potential provider identified	Location of opportunity matches GIS maps
Attenuation pond / farm pond / wildlife pond	✓		
Run-off scrape or swale / temporary pond			
Run-off bunded storage or off-line storage			
Blind ditching in drainage ditches			
Headwater drainage management	✓		
Attenuation pond / farm pond / wildlife pond			

Opportunities

Slow the Flow Opportunities Identified During Walkover Surveys

There are some opportunities to improve flood resilience in the Balland Stream through increasing channel and floodplain roughness to slow the flow.

Natural Flood Management (NFM) or Working with Natural Processes (WWNP)	Potential benefit in catchment	Potential provider identified	Location of opportunity matches GIS maps
Channel restoration, sinuosity			
Large/coarse wooded debris introduction	✓		
Floodplain reconnection (palaeochannel reconnection)			
Riparian buffer strips or woodland (sloped)	✓		
Floodplain woodland or wet woodland			
Peak flow leaky barriers	✓		
Bed renaturalisation – armour/ gravel augmentation			

Engagement

Engagement

Current Engagement

There are 21 landowners in the catchment. WRT has engaged with farmers managing 14.45% of the total farm area under UST. The 3 largest landowners own 34.23% of the catchment.

The local community appears to already have measures to increase the climate resilience of Ashburton. Details of the village's flooding group can be found on slide 17. The community response group are a local Facebook group called Ashburton Climate Emergency (ACE). This is for residents of Ashburton to communicate about local solutions to face the climate emergency. They mainly focus on the areas of Energy (creation & conservation); Food, Farming & Forestry; Transport; Caretaking (biodiversity, water & pollution); Recycling, Re-use, Repair & Making and Wellbeing & Resilience.

ACE are sanctioned and supported by Ashburton Town Council. It was set up in the Spring of 2019 and expanded its activities in March 2020 to include social and mental wellbeing in the face of the COVID-19 pandemic.

Engagement

Getting Involved

As well as the opportunities identified in the previous section, there may be opportunities for you to get involved as an individual.

WRT runs a Citizen Science Investigation (CSI) team of volunteers across the south west, whereby volunteers receive a testing kit and training to procure water samples from a watercourse. Westcountry CSI aims to engage people with their local environment, and produce water monitoring data that can identify pollution events quickly and target improvement work.

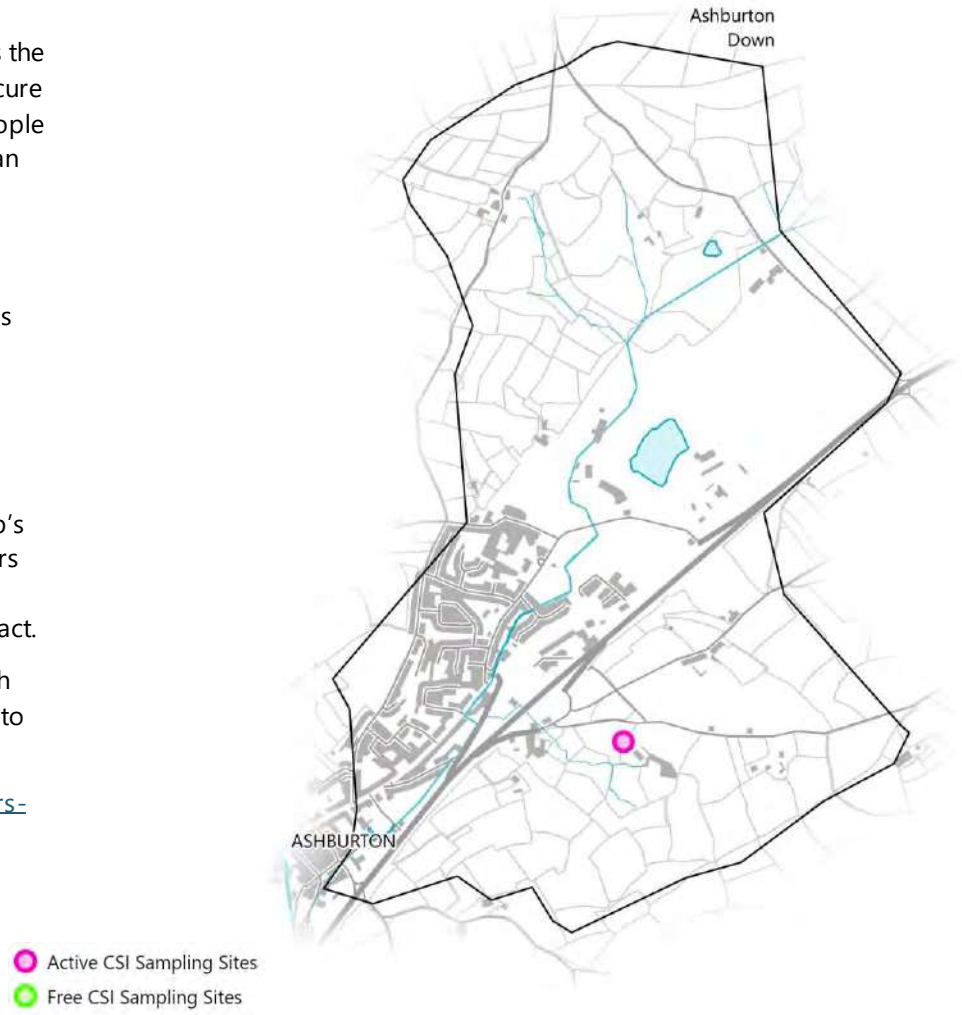
There is an active CSI sampling site in the south of the catchment. There may be the potential for more sampling sites along the main Balland Stream in Ashburton and further up the catchment in the north if there is suitable access to the water.

For more information about Westcountry CSI, including instructions on what's involved and how to sign up, visit our website at wrt.org.uk/westcountry-csi

Another opportunity for you to get involved in is the Riverfly Partnership's Anglers' Riverfly Monitoring Initiative (ARMI). This recognises that anglers are very well placed to monitor river water quality and facilitates communication between them and their local Environment Agency contact.

There are no riverfly survey sites within the micro-catchment, but, as with CSI sites, it may be possible to start a new site if there is suitable access to the water and with communication with the Environment Agency.

For more information on ARMI, visit their website at riverflies.org/anglers-riverfly-monitoring-initiative-armi



Summary and Next Steps

Multiple reasons for the possible causes and remedies for flooding in the micro-catchment for the Balland Stream have been mapped in this study, as have other factors that are key to consider when making NFM decisions.

It is likely that a combination of causes are at play here contributing to there being properties at flood risk, including the topography, land use, lack of surface water runoff diversion from roads, and absence of habitats in certain areas of the catchment.

The next steps are to engage and empower the community in the catchment to discuss and work towards building flood resilience through some of the opportunities mapped in the previous pages. It is imperative that property owners and landowners share perspectives and work together to find solutions agreeable to all sides. Some opportunities may provide secondary benefits towards improving the catchment's WFD chemical status.

Appendix

Methodology Details

Step 1: Micro-catchment Mapping Method

The process for identifying the highest-impacting locations of NFM measures across Devon and Cornwall involved several steps in a Geographic Information System (GIS). The first step was to identify watercourses with an upstream watershed less than 10km^2 and less than 5km^2 in size, then to identify properties adjacent to these watercourses that overlapped with the Environment Agency's (EA) fluvial "Flood Zone 2" dataset. Next, pour points were placed on the watercourses in front of the furthest downstream flood risk properties. These pour points were then used to delineate the upstream micro-catchment boundaries. A total of 1270 micro-catchments with properties potentially at risk were identified across the 2 counties.

For every micro-catchment identified, its area was divided by the number of flood risk properties within it to calculate the area per property at risk for each micro-catchment. Those with the lowest area per property indicated higher potential for small-scale NFM measures to benefit the greatest number of flood risk properties.

Lastly, additional factors, such as WFD classifications and previous WRT engagement with farmers, were considered alongside the area per property at flood risk to prioritise a small number of micro-catchments to target community engagement and NFM delivery.

Modelling assumptions and constraints:

- Due to the large geographic extent (Devon and Cornwall) and the manual element of the mapping (both causing the mapping process to be time-consuming), the resolution/accuracy of some datasets may be compromised.
- The buildings dataset (OS VectorMap Buildings) is not as accurate as OS MasterMap - some properties are amalgamated into a single polygon and very small buildings are not shown. Therefore properties at risk of flooding may be underestimated.
- Potential flood-risk is identified by selecting building polygons that intersect the flood zones; no detailed local information (e.g. drainage or defences) or modelling has been used.
- The spatial resolution of the topography data is coarse (50m). This is used to calculate the upstream catchment area for each community at-risk. Therefore, some errors may occur (additions or omissions) when identifying micro-catchments.
- The mapping method involves an element of manual validation, which has the potential to be subjective and/or possible errors.

Methodology Details

Step 2: Theoretical Ground Truthing

Once catchments were modelled and the information tabulated to show theoretical flood risk in conjunction with WFD failures, a systematic approach to ground-truthing was adopted.

Catchments that were perceived to have elevated water quality and water quantity risks were discussed with local land management advisors and regulators to determine if the modelled risk was likely to be correct.

Upon a theoretical, or desk-based ground-truthing, the catchments were then surveyed using a rapid walkover survey to observe run-off pathways and confirm if useful managed interventions could be implemented to reduce flood risk locally and improve water quality in the process.

Step 3: Rapid Walkover Survey

A further modelling process using SCIMAP was undertaken to identify high risk run-off pathways of the specific micro-catchment being surveyed to assist the surveyor in locating issues within a <10km^2 area.

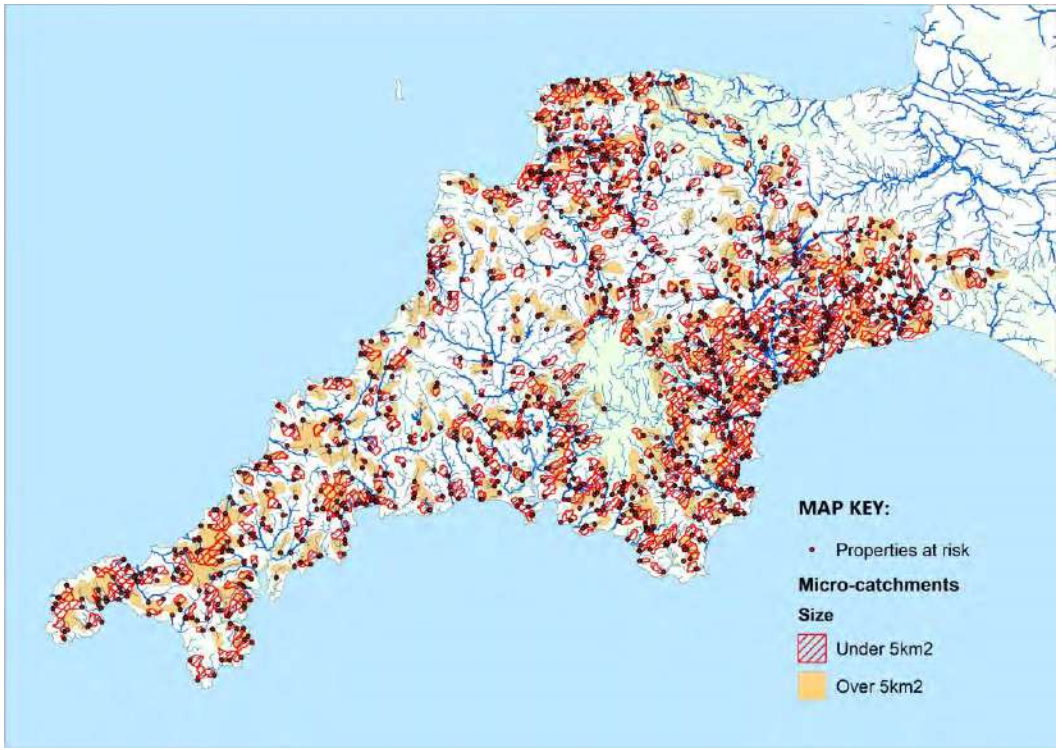
Where possible, surveyors reacted to high rainfall predictions and went out to observe the catchment when the conditions were right.

Walkover surveys were undertaken noting observations about surface water run-off and taking photographs of key areas and issues. All walkovers aimed to provide:

- Dry or Wet weather photos,
- Identify stakeholder PROVIDERS where NFM can be instigated,
- Identify stakeholder BENEFICIARIES by property and number people,
- Establish opportunities in each catchment and feasibility of action.

Georeferenced photos were taken to provide a visual overview of issues, opportunities, and as general reference notes.

Where issues and opportunities existed, further investigation was made or attempted to establish the realistic chances of further action. This was achieved by either speaking with the local community or contacting community groups or key landowners.



All 1270 micro-catchments with properties potentially at risk were identified across the 2 counties.

References and further information

Reference	Resource description	Link
CIRIA (Slide 43)	The Construction Industry Research and Information Association's (CIRIA) Natural Flood Management Manual (C802) (PDF)	https://www.ciria.org/Books/Free_publications/C802F.aspx
FRFW (Slide 32)	Statutory guidance for Farming Rules for Water (FRFW) (Webpages)	https://www.gov.uk/government/publications/applying-the-farming-rules-for-water/applying-the-farming-rules-for-water
SEPA NFM Handbook (Slide 32)	Handbook describing various natural flood management interventions and case studies (PDF)	https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

Mapping Data Sources

Dataset	Source	Attribution Statement
Agricultural Land Classification	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Air Quality Management Areas	UKAIR	© Crown copyright and database rights licensed under Defra's Public Sector Mapping Agreement with Ordnance Survey (licence No. 100022861) and the Land and Property Services Department (Northern Ireland) MOU206.
Ancient Woodland	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
AONB	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Areas Benefitting from Flood Defences	Environment Agency	© Environment Agency copyright and/or database right 2018. All rights reserved.Some features of this map are based on digital spatial data from the Centre for Ecology & Hydrology, © NERC (CEH) © Crown copyright and database rights 2018 Ordnance Survey 100024198
Bathing Water Monitoring Locations	Environment Agency	© Environment Agency copyright and/or database right 2015. All rights reserved.
Consented Discharges		
Country Parks	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Countryside Stewardship Scheme Agreements	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Crop Map of England	Rural Payments Agency	© Rural Payments Agency
CRoW Access Land	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
CRoW Registered Common Land	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Detailed River Network	Environment Agency	© Environment Agency Crown copyright and databse right 2022.
Drinking Water Safeguard Zones (Ground Water)	Environment Agency	© Environment Agency and/or database rights. Derived from BGS digital data under licence from British Geological Survey copyright NERC.
Drinking Water Safeguard Zones (Surface Water)	Environment Agency	© Environment Agency copyright and/or database right. All rights reserved. Derived from BGS digital data under licence from British Geological Survey ©NERC. Derived from Centre of Ecology and Hydrology data ©CEH
Energy Crop Scheme Agreements	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Environmental Stewardship Scheme Agreements	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Flood Defences	Environment Agency	© Environment Agency copyright and/or database right 2020. All rights reserved.
Flood Zone 2	Environment Agency	© Environment Agency copyright and/or database right 2018. All rights reserved. Some features of this map are based on digital spatial data from the Centre for Ecology & Hydrology, © NERC (CEH). © Crown copyright and database rights 2018 Ordnance Survey 100024198
Greenspaces	Ordnance Survey	Contains OS data © Crown copyright and database right 2022
Habitat Networks	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
Hillshade		
Historic Landfill Sites	Environment Agency	© Environment Agency copyright and/or database right 2018. All rights reserved. Contains information © Local Authorities

Mapping Data Sources

Dataset	Source	Attribution Statement
Land Parcels	Rural Payments Agency	© Crown copyright and database rights 2020 OS
LCM2019 25m Parcels	Centre for Ecology and Hydrology	Morton, D., Marston, C. G, O'Neil, A. W., & Rowland, C. S. (2020). Land Cover Map 2019 (25m rasterised land parcels, GB) [Data set]. NERC Environmental Information Data Centre. https://doi.org/10.5285/F15289DA-6424-4A5E-BD92-48C4D9C830CC
LNR	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
MCZ	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2022.
National Forest Inventory	Forestry Commission	Contains Forestry Commission information licensed under the Open Government Licence v3.0
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SCIMAP Flow Pathways	SCIMAP	SCIMAP modelling system - SCIMAP was developed at Durham and Lancaster Universities as part of a NERC grant
Slope	TellusSW	Ferraccioli, F.; Gerard, F.; Robinson, C.; Jordan, T.; Biszczuk, M.; Ireland, L.; Beasley, M.; Vidamour, A.; Barker, A.; Arnold, R.; Dinn, M.; Fox, A.; Howard, A. (2014). LiDAR based Digital Terrain Model (DTM) data for South West England. NERC Environmental Information Data Centre. https://doi.org/10.5285/e2a742df-3772-481a-97d6-0de5133f4812
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