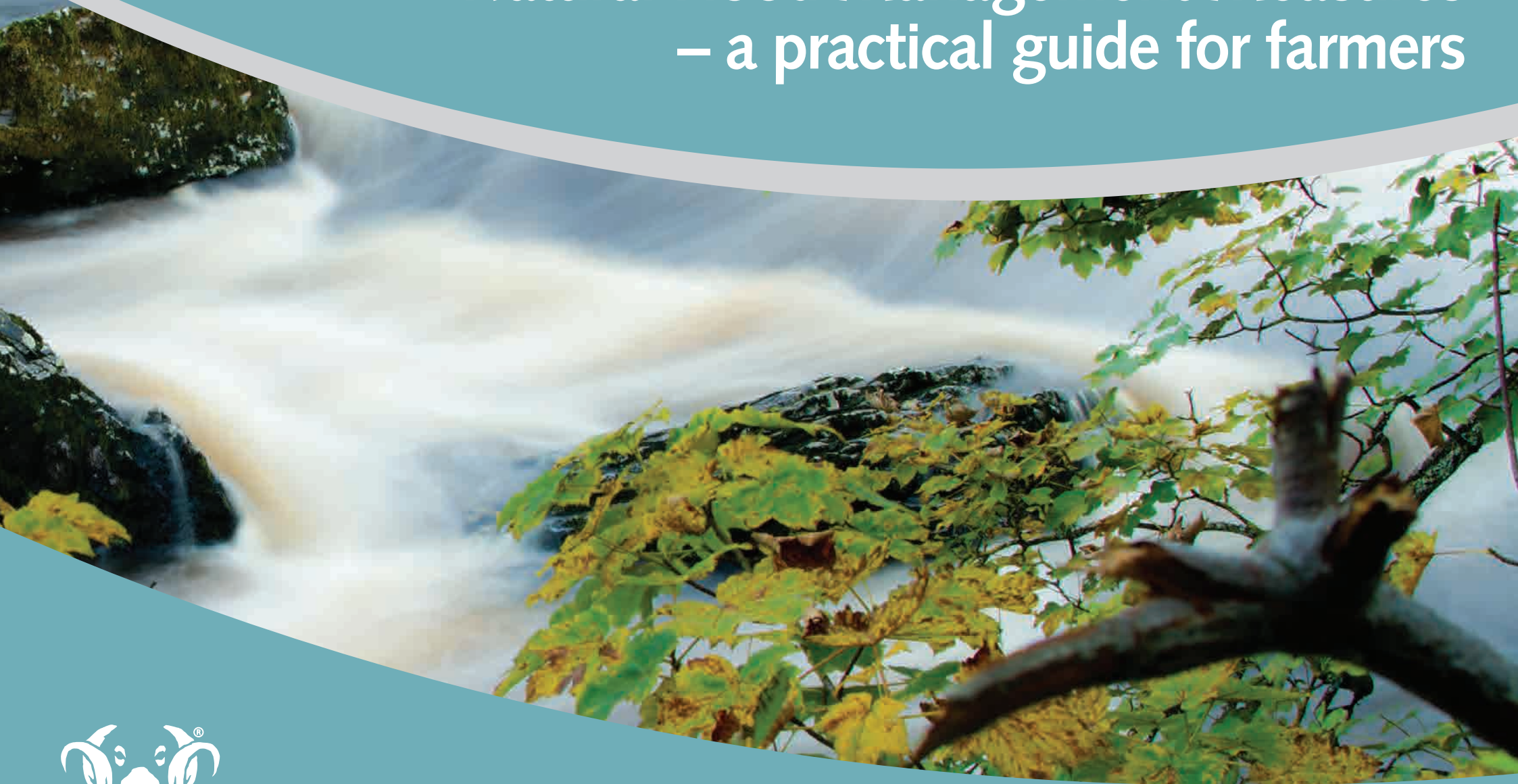


Natural Flood Management Measures – a practical guide for farmers



YORKSHIRE DALES
National Park

one of Britain's breathing spaces



IMAGE © YDNPA

Cover image: Aysgarth Falls © Dave Higgins

All information contained in this publication – including links to websites and further reading – is believed to be correct at the time of going to press.

If you have any comments or need further information about this publication, please contact Helen Keep, Senior Farm Conservation Officer, on 01756 751600 or helen.keep@yorkshiredales.org.uk

This guide has been requested by the farmers and land managers of the Yorkshire Dales National Park to provide simple, clear advice on the provision of natural flood management measures.

The pack has been put together by the Yorkshire Dales National Park Authority (YDNPA), Yorkshire Dales Rivers Trust (YDRT) and North Yorkshire County Council (NYCC), with support from our partners in the Environment Agency (EA) and Natural England (NE).





IMAGE © YDNPA



Introduction

Floods are nothing new. Humans have lived with extreme weather for thousands of years. However, climate change science predicts an increase in occurrence and severity of high rainfall events. Subsequent increases in extreme flooding will follow suit.

Within the UK, our flood defence system includes large-scale, hard engineered solutions in and around major cities, flood banks and small scale engineered solutions for rural communities and farmland, and coastal engineering. There is increasing political and public interest in how the management of the wider countryside can contribute to the UKs flood defence system, with particular reference made to natural flood management (NFM).



IMAGE © LONG PRESTON DEEPS SSSI PROJECT

What is natural flood management?

Natural flood management aims to reduce the downstream maximum water height of a flood (the flood peak) or to delay the arrival of the flood peak downstream, increasing the time available to prepare for floods.

This is achieved by restricting the progress of water through a catchment using a range of techniques. These techniques work with the natural features of the catchment to slow down or store flood waters. They rely on one, or a combination, of the following underlying mechanisms.

1	Increasing soil infiltration: free-draining soil will make saturation less likely, potentially reducing surface runoff.
2	Evaporation from vegetation and soil can also make space for water.
3	Slowing water: by increasing resistance to its flow – for example, by planting floodplain or riverside woods, or blocking grips on moorland.
4	Storing water by using, and maintaining the capacity of, ponds, ditches, embanked reservoirs, channels or land.
5	Reducing water flow connectivity by interrupting surface flows of water – for example, by planting buffer strips of grass or trees.



Natural flood management structures have been designed so that they do not significantly impact on farming, are typically small in size, and can be considered an extension to the farm's land drainage system.

Each structure or technique performs a small amount of runoff storage or attenuation, gradually releasing flood water over 12 to 24 hours. It is the collective network, rather than individual features, that aims to provide flood mitigation in the immediate vicinity and further downstream.

Natural flood management is not the complete solution to flooding, but is one of many tools needed to manage flood events. These tools are more effective at reducing the frequency of flooding for high probability fluvial events (for example, less than a one in twenty year return period) compared to extreme events (for example, a one in 200 year return period). Used in conjunction with other flood management solutions, like hard engineering, natural flood management will have a beneficial impact on slowing the flow of flood water downstream. Research at a number of small-scale catchments has shown this to be the case.

Why land management in the Yorkshire Dales National Park can play its part

The main rivers that rise within the Yorkshire Dales National Park flow through a number of our region's larger towns and cities, and, on occasion, cause significant flood damage.

Within the National Park, the rivers cause flooding to communities and farmland, causing main roads to become blocked and properties to flood. High rainfall events can cause damage to farm property – for example, prolonged inundation of farmland, soil loss, erosion of farm tracks, and flooding of farm buildings.

Whatever your focus is, as a farmer and land manager you may be in a position to help contribute to reducing flooding, locally or regionally.

Research carried out by Leeds University in Coverdale indicates that a combination of simple flood management measures over 10% of the catchment area can help slow down the flow of water during high rainfall events by up to 12%. This is a significant effect and is something that can be achieved from a farming and land management perspective without sacrificing production levels or greatly altering land management practices.

Using the guide

This guide has been developed to provide the advice and key information needed to aid decision-making, should you wish to install flood management features on your farm. We have included funding sources to support the work you may want to undertake.

The various measures have been grouped into three different levels of intervention:

Level 1

Measures requiring minimum or no consultation with authorities such as the Yorkshire Dales National Park Authority (YDNPA) or Environment Agency (EA). These measures are usually low cost and simple to install, but extremely effective.

Level 2

Measures requiring a certain level of consultation and possibly consent of authorities (see summary of consents section). These measures are a mix of low to medium cost and may need contractors' help to install them.

Level 3

Measures involving a level of design that is targeted to certain locations within the catchment, requiring planning permission and consents from authorities, and, in most cases, involving professional water management consultant advice. These measures are usually high cost and need contractors to install them.

Each measure is described in terms of its flood management effectiveness, its benefit to agricultural production, and its overall cost. Set up and maintenance costs have been colour-coded, with the definition provided here:

Set up costs

High

Requires significant raw materials, specialist equipment, or expert involvement

Medium

Requires some raw materials, specialist equipment, and/or expert involvement

Low

Land manager can implement system with minimal advice, equipment, and specialist material.

Maintenance costs

High

Expert advice or equipment required to be brought in frequently (e.g. < 5 yrs)

Medium

Expert advice or equipment required to be brought in occasionally (e.g. < 10 yrs)

Low

Mostly involves routine inspections and low-grade management, which can be undertaken by the land manager.

IMAGE © YDNPA



Help us keep track

Please keep us updated! If you choose to implement a natural flood management technique on your land, let us know:

- the date of construction
- which treatment was implemented
- the size and number of treatments implemented.

This will help us monitor the use of natural flood management in our area, and enable us to evaluate the success.

Contact details

Farm Conservation Team
Yorkshire Dales National Park Authority
01756 751600
farming@yorkshiredales.org.uk

Possible locations of natural flood management measures within the Yorkshire Dales National Park landscape

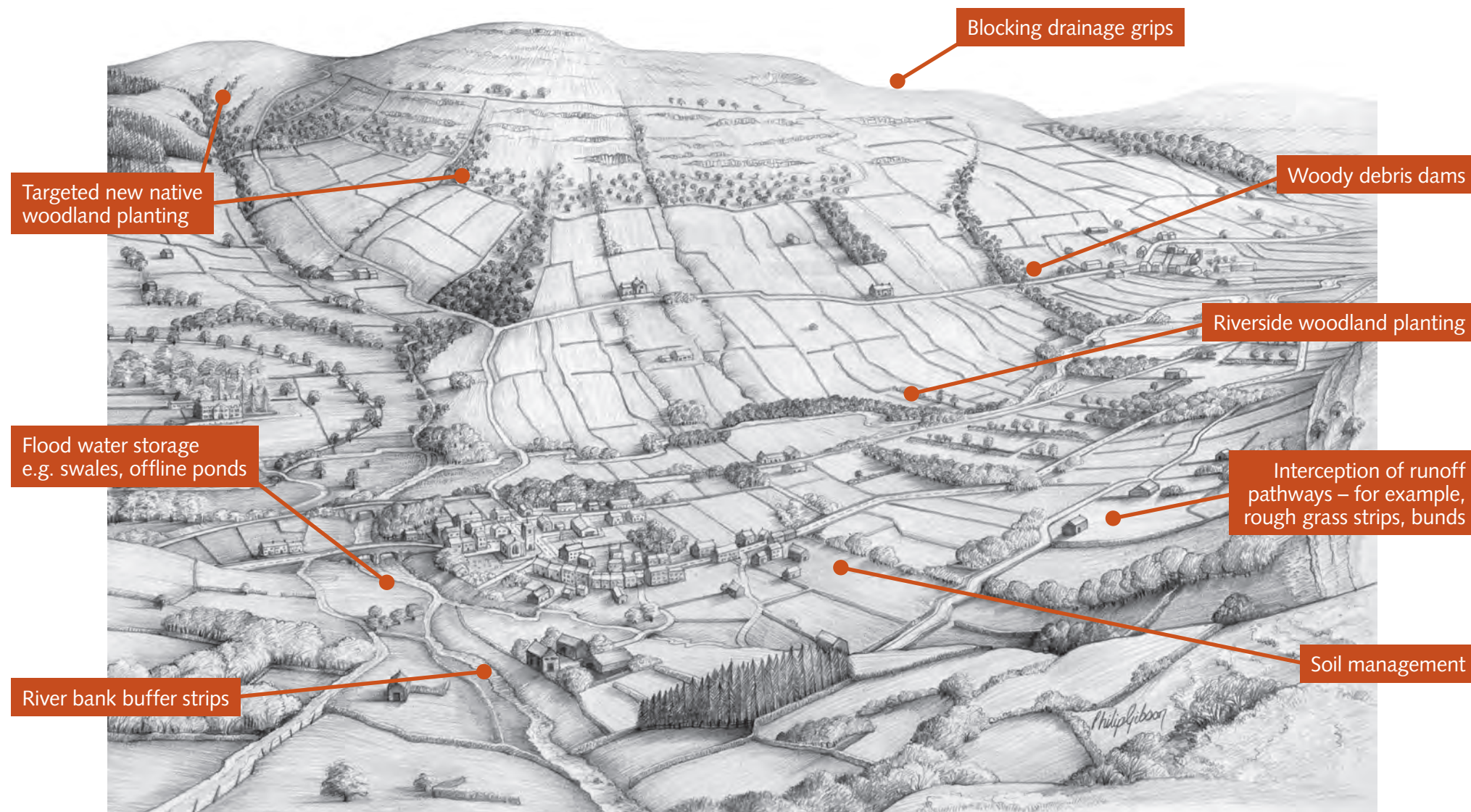


Illustration: Phil Gibson Design © Yorkshire Dales National Park Authority

Intervention treatments: Level 1



IMAGE © YONPA

Increasing soil permeability – reducing soil compaction

Compaction is where soil has been squashed into a solid, impermeable layer, either at the surface or within the topsoil. This band restricts the movement of air, water and nutrients down through the soil profile.

The effects of soil compaction can be detrimental to grass and root growth, reducing the ability of grass to pick up nutrients, particularly nitrogen and water, from the soil. It creates conditions for waterlogging and poaching and increases the risk of runoff, leading to soil and nutrient loss. Wet soils stay colder for longer, reducing the number of available grazing days. They can also make harvesting difficult, which is likely to reduce the quality of the resulting silage. Runoff from compacted soils is 50-60% higher than on aerated healthy soils.* Soil compaction can be caused by a range of things, from grazing livestock to farm machinery.

*Agriculture and Horticulture Development Board (AHDB), 2016



Natural flood management purpose

Managing soil compaction is one of the most effective treatments farmers can undertake to reduce overland flow and lower flood risk.

It can help to increase the amount of water held in the soil over a wide area.

It improves connectivity with groundwater by promoting strong root growth.



Agricultural benefits

Improved air exchange between the soil and atmosphere.

Enhanced soil water uptake.

Improved fertiliser uptake and use.

Reduced water runoff, soil loss and poaching.

Stronger grass roots.

Enhanced heat and drought stress tolerance.

Enhanced thatch breakdown – more earthworms.

More efficient crop growth.



Methods

Dig a hole up to 40cm deep to look at condition of soil and depth of compaction in topsoil and subsoil – look out for signs of waterlogging.

Undertake soil test to identify pH – add lime if below 6. This encourages separation of soil particles from one another, creating air pockets.

Mechanically aerate soils using spiked aerators, sub soiler or sward lifter, depending on depth of compaction.

Undertake minimal tillage for arable crops or when considering re-seeding.

Managing crop and livestock rotation can be ways of reducing compaction, while also improving soil fertility and yield.

Avoid using heavy machinery on wet soils to further protect from compaction.

Consider re-seeding or overseeding using deep rooting plant species – for example, festulolium and clovers for grassland.



Considerations

Sub-surface and surface historic features can be damaged by mechanical treatment – particularly where these operations have not been carried out before.



Level of maintenance

Low



Key locations

Any field below the moorland line, particularly where water is seen to flow across the surface in high rainfall events

Fields used for winter grazing.



Costs

Set-up Low

Maintenance Low



Additional information

Festulolium research

www.surerooroot.uk

Soils

www.beefandlamb.ahdb.org.uk/wp-content/uploads/2016/07/BRP-Improving-soils-for-better-returns-manual-3.pdf

<https://ahdb.org.uk/projects/documents/ThinkSoils.pdf>



IMAGE © YDNPA

Creating and managing buffer strips

Creating a network of grass strips next to watercourses and ditches – known as riparian buffer strips – can provide a physical barrier that helps restrict the flow of storm water, carrying sediment and nutrients, and preventing them from being washed from the field into the watercourse.

In-field buffer strips, as their name implies, are found adjacent to field boundaries and across fields. They can reduce overland flow impacting roads and neighbouring properties.

? Natural flood management purpose

Vegetation in the grass strip increases the roughness of the land surface, which slows the flow of runoff and increases infiltration.

Buffer strips trap sediment and reduce sediment flow into watercourse.

They stabilise the banks of watercourses, helping prevent erosion and siltation from bank material.

✓ Agricultural benefits

Buffer strips trap and filter runoff, preventing loss of fertilisers, sediment and pesticides. Ten metre wide strips reduce sediment loss by 30%.

They reduce frequency of ditch management through decreased rates of siltation and weed development from increased nutrient levels.

They enhance crop management operations by straightening irregular field edges.

They control or prevent erosion of valuable topsoil from fields into watercourses, so reducing contamination by silt and organic wastes.

They help reduce nitrate leaching by vegetation growing on the buffer strip absorbing nitrogen.

They create wildlife corridors and sites for groundnesting birds, small mammals and beneficial insects.

They reduce effects of spray drift.

Buffer strips can also qualify as Ecological Focus Areas (EFAs), under the Common Agricultural Policy (CAP) greening requirements.

Construction dimensions

Riparian buffer strips should be a minimum of 6m wide for maximum effect, and may require fencing to exclude livestock from the river banks.

The in-field buffer strips should be 2m wide. By building a small mound down the in-field buffer strip, a beetle bank can be created, further benefiting the wildlife and encouraging natural predators of crop-eating insects.

💡 Considerations

Implementation next to main rivers may require Environment Agency (EA) consent, if it is to be fenced against livestock.

Check the Basic Payments Scheme (BPS) handbook for further guidance if the strip is to be fenced from grazing. If the fence is within 3m of the middle of the river or field boundary, then the eligible area remains unchanged. Wider than this and there may be implications for field boundary changes and reduction in eligible land area.

🔄 Level of maintenance

Low

📍 Key locations

Throughout the catchment, adjacent to rivers, and especially on grazed land next to streams and ditches that suffer from high sediment loads.

In-field strips on arable land at risk from soil erosion. This option works well alongside other runoff intercepting options, such as contour bunds and hedgerows.

£ Costs

Set-up Low

Maintenance Low

💰 Funding

Currently, the Countryside Stewardship (CS) scheme contains a range of buffer strip, grass margin, and riparian management strip options, with payments ranging from £170 to £557 per hectare.

Local Rivers Trusts (RT) may assist with riparian fencing cost in their project areas.

🔍 Additional information

Basic Payment Scheme (BPS)

www.gov.uk/government/collections/basic-payment-scheme

Grass buffer strips and beetle banks

www.cfeonline.org.uk/1-grass-buffer-strips-next-to-a-watercourse-or-pond

www.swarmhub.co.uk/index.php?dlrid=3991

www.cfeonline.org.uk/2-in-field-grass-strips-to-avoid-erosion

www.rspb.org.uk/Images/Beetle%20banks_tcm9-133200.pdf



IMAGE © YDNPA

Planting and managing hedgerows

Hedgerows are an intrinsic part of the landscape within many areas of the National Park and owe their existence to the need to divide grassland into conveniently-sized grazing pastures for livestock.

Hedgerows provide excellent natural weather barriers and ideal habitat for farmland birds and wildlife species, but also perform a natural flood management function by trapping and slowing water flow.

? Natural flood management purpose

Hedgerows reduce the volume of runoff by promoting rainfall infiltration into the soil and reducing the rate of runoff .

They remove water faster from the soil than crops during periods of excessive rainfall through increased evapotranspiration.

They trap sediment and reduce sediment flow into watercourse.

✓ Agricultural benefits

Hedgerows create areas of shelter and shade for livestock.

They trap and filter runoff, preventing loss of fertilisers, sediment and pesticides.

Animal health may also be improved through reductions in standing water from increased infiltration rates.

Hedgerows provide a barrier to the spread of disease, reducing animal-to-animal contact.

They provide habitat for farmland birds and beneficial insects.

Construction dimensions

New planting: plant a double staggered row hedge using 4-6 plants per metre, with a distance between the rows of 1-1.5m, and plant a varied row of trees between these rows. Use tree tubes (0.7m tall) to protect young plants from rabbit damage. Protect both sides of a new hedge with a stock proof fence, erected at least 1m from the centre of the hedge.

💡 Considerations

Planting should be carried out between November and March.

Up to 75% of the species can be thorns – for example, hawthorn and blackthorn.

Consider a mix of shrub species, including hazel, guelder rose, rowan and holly, to enhance hedgerow for wildlife.

🔄 Level of maintenance

High

Newly planted hedges will require annual maintenance until at least 1.5m tall, particularly with regard to weed control, cutting every two years from then on to ensure life of hedgerow. Cutting to a box shape will increase benefits for wildlife, as well as shelter for stock. The laying of hedge every 12-15 years will increase wildlife benefits and the overall health of the hedge.

📍 Key locations

Consider planting a new hedge across a slope where runoff occurs or perpendicular to the river in a floodplain.

Where hedgerows have been lost from an area or the network is very fragmented.

Restoration and management in areas where there are good networks of hedgerows.

£ Costs

Set-up	Medium
Maintenance	Low

🐷 Funding

Countryside Stewardship (CS) scheme capital grants – mid and higher tier, hedgerows and boundaries grant.

Yorkshire Dales Millennium Trust (YDMT) Woodland Grant Programme.

Woodland Trust (WT).

Yorkshire Dales National Park Authority (YDNPA), in certain project areas.

🔍 Additional information

Countryside Stewardship (CS) scheme

www.gov.uk/government/collections/countryside-stewardship-get-paid-for-environmental-land-management

Small grants for woodlands

www.ydmt.org/news-details-%c2%a3250k-for-new-woodlands-21695



IMAGE © YDNPA

Using trees

Well-sited and well-managed upland, floodplain and riparian woodland can contribute to the delivery of a host of outcomes. They provide important wildlife habitat, and increased canopy shade and shelter for water-based flora and fauna. They can also provide shade and shelter for livestock, and prevent damage to crops and soil erosion.

There is growing interest in the potential to use woodland measures to help reduce flood risk. The Forestry Commission (FC) has been directly involved in a number of trials and demonstration projects – for example, at Pickering. These projects have shown that looking after existing native woodlands and plantations, and targeting certain areas for tree planting, will significantly slow overland flow of water and reduce river bank erosion within that area.

? Natural flood management purpose

Planting of trees increases the roughness of the vegetation, slowing the flow of water during a flood event.

It reduces the volume of runoff, by promoting rainfall infiltration into the soil and reducing the rate of runoff.

Well-managed woodland cover can increase the capture and evaporation of rainfall.

Interception can reduce the amount of rainfall reaching the ground by as much as 45%, or more for some types of woodland. A reduction of even half of this amount could therefore make a major contribution to flood control.

Woodland soils typically have a relatively open, organic, rich upper layer, which facilitates the rapid entry and storage of rainwater – a 'sponge' effect.

The roots of bankside trees and associated vegetation help to bind and strengthen stream banks, reducing the risk of bank collapse, erosion and siltation.

✓ Agricultural benefits

Using trees creates areas of shelter and shade for livestock.

They reduce floodwater damage on productive farm land.

They trap and filter runoff, preventing loss of fertilisers, sediment and pesticides.

Construction dimensions

The optimum area to be planted varies at each potential site.

💡 Considerations

Existing woodlands should ideally be fenced from livestock to encourage tree regeneration and increase vegetation under the canopy.

New planting will need protecting from grazing livestock.

Under-planting of shrubs and young tree saplings improves the infiltration rates of existing woodland.

For new areas, link up with existing woodland or hedgerows to create a wildlife corridor effect.

Works well alongside the leaky woody dam technique (See In-channel barriers, page 17).

Check Basic Payments Scheme (BPS) Handbook for further guidance; however, if woodland creation is funded through the Countryside Stewardship (CS) scheme, the BPS payment on the site is retained.

🔄 Level of maintenance

Low

For management of existing woodlands.

Medium

For new native woodland – this will involve weeding, checking or straightening guards, and replacing failed trees as the plantation becomes established. Guards will need to be removed when the trees are grown.

📍 Key locations

Throughout the catchment – in particular, remote upper catchment areas.

Across slope following a contour.

Existing gill woodlands, plantations and shelter belts.

Alongside watercourses.

£ Costs

Set-up

Medium

Maintenance

Low

💰 Funding

Countryside Stewardship (CS) scheme – higher and mid tier.

Yorkshire Dales Millennium Trust (YDMT) Woodland Grant Programme.

Yorkshire Dales National Park Authority (YDNPA).

Woodland Trust (WT).

🔍 Additional information

Countryside Stewardship (CS) scheme woodland grants

www.gov.uk/government/publications/countryside-stewardship-woodland-management-plan-grant-manual-2017

Woodland locations and forestry standards

www.forestry.gov.uk/pdf/FR_STF_Pickering_P2_May2015.pdf

www.forestry.gov.uk/ukfs

Basic Payment Scheme (BPS)

www.gov.uk/government/collections/basic-payment-scheme



IMAGE © NATURAL ENGLAND

Winter cover crops

A cover crop is a non-cash crop grown primarily for the purpose of 'protecting or improving' the soil in between periods of regular crop production. Cover crops can be used repeatedly as part of an arable rotation's long-term strategy to reduce winter runoff and soil loss, improve soil quality and organic matter, and provide other benefits.

Agriculture and Horticulture Development Board (AHDB), 2015

? Natural flood management purpose

Planting of vegetation on land that would otherwise be left bare over winter months after harvest reduces overland flow and increases infiltration of rain into the soil.

✓ Agricultural benefits

Careful choice of cover crops can help fix nitrogen in the soil and thereby reduce fertiliser costs

Used consistently over the years, it improves the soil structure and nutrient content, thereby enhancing soil health, increasing soil biological activity and improving crop yields.

It reduces the need for herbicides and other pesticides.

It prevents soil erosion and reduces nutrient losses via runoff and leaching.

It conserves soil moisture.

It protects water quality.

Cover crops can be used in Common Agricultural Policy (CAP) Ecological Focus Areas (EFA) and crop diversification.

Construction dimensions

Sow any plant that has the ability to grow throughout the winter. Leaving crop residues throughout winter can also act to protect the soil surface and increase infiltration.

💡 Considerations

Deep-rooting plants will provide additional benefits by loosening compacted soils. Using cover crops may require altering the arable rotation away from winter drilling towards spring.

Can be used as part of Ecological Focus Area (EFA) for the Basic Payment Scheme (BPS) when two species of cover crop are grown.

🔄 Level of maintenance

Low

📍 Key locations

Works well on arable or temporary grassland adjacent to watercourses, particularly on sloping fields.

Where water is seen to flow across the surface in high rainfall events in lower parts of a catchment.

Land vulnerable to nitrate leaching.

£ Costs

Set-up Low

Maintenance Low

🐷 Funding

Certain types of cover crop can be grant-aided through the Countryside Stewardship (CS) scheme.

🔍 Additional information

Basic Payment Scheme (BPS) guidelines

www.gov.uk/guidance/bps-2017

Cover crops

www.cfeonline.org.uk/5-winter-cover-crops

<https://cereals.ahdb.org.uk/media/655816/is41-opportunities-for-cover-crops-in-conventional-arable-rotations.pdf>

Countryside Stewardship (CS) grants

www.gov.uk/government/publications/countryside-stewardship-mid-tier-including-water-quality-capital-items-manual



IMAGE © YDNPA

Cross drains in farm tracks

Tracks provide a significant transport pathway for water and sediment. This creates problems with erosion of the track and deposition of sediment on farmland, roads or watercourses. Tracks are costly to repair, but are essential to the farm. A cross drain is a system to move water across a path or route and can be used to collect runoff from a vulnerable area.

? Natural flood management purpose

Cross drains divert the main pathway of water, reducing flow volume, velocity and sediment load.

When used with a sediment trap, they can slow the flow of storm water significantly.

✓ Agricultural benefits

Farm tracks suffer from less erosion, less sediment is lost, and they last longer.

Sediment caught in traps can be re-used on the track, saving time and money.

Cross drains potentially reduce a water issue at the end of the track.

Construction dimensions

The size of the cross drain will depend on local conditions. Small drains are typically 0.1 x 0.1m, constructed of concrete, wood or clay pipe. For heavy rainfall, 0.2 x 0.2m drains can be constructed from stone or wood.

💡 Considerations

On steep slopes or where runoff volume is high, a number of cross drains will be required, located at specific intervals along the track

They can be linked with swales and sediment traps alongside the track to encourage sediment to drop out of the water. This also prevents sediment being washed onto grassland.

🔄 Level of maintenance

Low

Cross drains should be inspected, cleaned out, or reshaped to original capacity after each major storm.

📍 Key locations

Tracks on steep hillsides, adjacent to yards or roads, or within close proximity of a watercourse

£ Costs

Set-up **Low**

Maintenance **Low**

💰 Funding

Countryside Stewardship (CS) scheme.

Local Rivers Trusts (RT) in their project areas.

🔍 Additional information

Countryside Stewardship (CS) grants

www.gov.uk/countryside-stewardship-grants/cross-drains-rp5

Intervention treatments: Level 2



Bunds and detention basins

Earth bunds work most efficiently when located across known runoff pathways which appear following heavy rainfall or when the soil is saturated. The creation of a bund will also mean the corresponding creation of a detention area where water is retained while being dispersed through a combination of infiltration, evaporation, and slow release by flow control (for example, small pipe, orifice plate or filter material). This can be carried out on a small to large scale, depending on the size of the catchment area and the local soil conditions.

The reprofiling of the land can be designed so that the detention area is normally dry and can remain productive, as well as providing an opportunity for reclaiming soil and nutrients.

Alternatively, levels can be set to encourage the development of wetland habitat within the flood storage area by permanently retaining some water.

? Natural flood management purpose

Bunds reduce runoff rates by retention and controlled flow release.

They reduce volume of runoff by increasing the opportunity for infiltration and evaporation .

They trap sediment which can reduce the function of neighbouring watercourses and drainage systems.

✓ Agricultural benefits

Bunds reduce soil loss and surface scour.

They provide opportunity for nutrient reclamation.

They provide pollutant treatment by allowing settlement.

Construction dimensions

Design of the bunds or detention basin should be site specific and carried out by a land drainage specialist.

Detention areas should be sized for the area draining into it.

Design of bunds should take into account the contour of the surrounding land, the position in the landscape, and the soil type. Construction materials will also depend on the size of the detention basin, the method of flow control used, and consideration of future maintenance.

💡 Considerations

The location of these solutions may well be suggested by the reaction of the landscape to heavy rainfall. Their design should be tailored to each distinct location.

Consideration should be given to where the water would go if the storage area becomes full and the bund overtopped. These exceedance flowpaths should not create a new flood risk area.

Permanent standing water will be classed as ineligible features under the Basic Payment Scheme (BPS) rules if they are 0.01 hectares, or if together they add up to 0.01 hectares or more. Bigger features will be mapped by the Rural Payments Agency (RPA) and farmers must deduct them from their eligible areas.

An impoundment licence from the Environment Agency (EA) may be needed if the structure affects a river, stream or lake.

🔄 Level of maintenance

Dependent on the scale and design.

Arrangements for on-going maintenance may need to be submitted as part of any planning application.

📍 Key locations

Small vales and slopes prone to runoff during flood events.

Areas where runoff with a heavy sediment load is known to compromise local drainage.

£ Costs

Set-up **Medium**

Maintenance **Medium**

💰 Funding

Countryside Stewardship (CS) scheme

🔍 Additional information

Design guidance

www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf

www.susdrain.org/resources/ciria-guidance.html

Basic Payment Scheme (BPS) criteria

www.gov.uk/government/collections/basic-payment-scheme



Swales

Swales are linear, shallow, vegetated drainage features that convey and store surface water and provide the opportunity for infiltration and water treatment by encouraging settlement.

They can be built in combination with bunded detention areas, or on their own to channel and redirect water flow that happens after heavy rain.

Easily incorporated into the landscape, the increased roughness of the vegetated channel helps to slow the flow of water. This can be reduced further by the introduction of check dams and berms across the swale.

? Natural flood management purpose

Swales reduce runoff rates by slowing runoff flow.

They reduce volume of runoff by increasing the opportunity for infiltration and evaporation.

They trap sediment which can reduce the function of neighbouring watercourses and drainage systems.

✓ Agricultural benefits

Swales reduce soil loss and surface scour.

They provide pollutant treatment by allowing settlement.

Construction dimensions

Design of the swales should be site specific and take into account the contour of the surrounding land, the position in the landscape, and the soil type.

💡 Considerations

The location of these solutions may well be suggested by the reaction of the landscape to heavy rainfall. Their design should be tailored to each location.

Consult with the Rural Payments Agency (RPA) about eligibility for the Basic Payment Scheme (BPS) as a swale may be considered a 'new watercourse' which would render that area as an ineligible feature.

🔧 Level of maintenance

Low

Some vegetation control may be required. Maintenance is increased by the addition of structures within the swale.

Removal of sediment and re-spreading to land will require a waste exemption licence from the Environment Agency (EA).

📍 Key locations

Shallow slopes prone to runoff during flood events.

Areas where runoff with a heavy sediment load is known to compromise local drainage.

£ Costs

Set-up

Medium

Maintenance

Low

💰 Funding

Countryside Stewardship (CS) scheme

🔍 Additional information

Swale design

<http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000HK277ZX.0HCIIG33ALM59DZ>

www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf

www.susdrain.org/resources/ciria-guidance.html

Basic Payment Scheme (BPS) criteria

www.gov.uk/government/collections/basic-payment-scheme



Sediment traps

Sediment traps can take many forms, but normally comprise an excavation located on a surface runoff pathway. Runoff enters the excavation and is detained there, allowing sediment to settle out before the runoff is discharged, usually via a gravel outlet. Sediment traps are unlikely to derive significant flooding benefits on their own. However, when used in conjunction with other runoff management features, they can help to control the release of sediment to the river network.

Scottish Environment Protection Agency (SEPA), 2015

? Natural flood management purpose

Sediment traps hold some excess floodwater, but many would be needed in a catchment to make a big impact on flood peak.

They reduce siltation of watercourses, so maintaining capacity.

They can be used as a pre-treatment for other natural flood management measures, such as retention ponds.

✓ Agricultural benefits

Sediment traps improve water quality.

They retain washed-off topsoil.

Construction dimensions

Bund height should be created from compacted subsoil and should not exceed 1.3m.

The slope of the sides should be less than 1 in 4 or gentler and vegetated. Where a bund is used to create a sediment trap (such as in a low corner of a field) the field side bank should be as gentle as possible, ideally no steeper than 1 in 20, to provide a filter strip function. Ensure access is provided for dredging.

The size will depend on runoff volumes to be intercepted; however, the greater the scale, the greater the removal efficiency.

💡 Considerations

Consent may be required to remove and spread sediment caught in a sediment trap.

Sediment traps are not intended to treat wastewater or effluents.

Sediment traps will be classed as ineligible features under the Basic Payment Scheme (BPS) rules if they are 0.01 hectares, or if together they add up to 0.01 hectares or more. Bigger features will be mapped by the Rural Payments Agency (RPA), and farmers must deduct them from their eligible areas.

🔄 Level of maintenance

Sediment traps will need to be regularly emptied – the frequency will depend on the area being drained and how much sediment is carried by the stream or ditch. Removal of sediment and re-spreading to land will require a waste exemption license from the Environment Agency (EA).

📍 Key locations

Within an area where surface runoff flows downhill.

Adjacent to, or within, ditches

£ Costs

Set-up Low*

Maintenance Low

*Dependent upon scale

🐷 Funding

Countryside Stewardship (CS) scheme.

Local Rivers Trusts (RT) within their project areas.

🔍 Additional information

Agri-environment scheme guidance on sediment traps and bunds
<https://www.ruralpayments.org/publicsite/futures/topics/all-schemes/agri-environment-climate-scheme/management-options-and-capital-items/rural-sustainable-drainage-systems---sediment-traps-and-bunds/guidance-for-sediment-traps-and-bunds/>

Basic Payment Scheme (BPS) criteria

www.gov.uk/government/collections/basic-payment-scheme



IMAGE © YORKSHIRE FARMING & WILDLIFE PARTNERSHIP

In-channel barriers

These can be constructed in streams and ditches. When whole trunks, secured into place with stakes and wires, are used they are often known as large woody dams. More engineered structures are also called leaky dams. The dams are set above normal stream level, so only flood flows are blocked. Water is stored within the channel behind constructed dams, reducing the downstream flood peak by slowing the flow.

? Natural flood management purpose

A network of in-channel barriers installed on a local scale can control channel flows.

The dams are created to be slowly leaky, draining the trapped water once the flood period has passed.

In-channel barriers could reduce the 1 in 100 year flood peak by 20%.

Dams can be constructed so that floodwater spills onto the floodplain for additional temporary storage where conditions are suitable.

✓ Agricultural benefits

Dams can successfully reduce localised flooding within the farm holding.

Construction dimensions

Large woody dams are created by laying two large tree trunks in a cross formation across the channel to rest safely on both banks, wedged in position. Smaller timbers can be wedged in place between the larger ones.

Leaky dams are constructed by securing a support across the channel and securing slats, either horizontally or vertically to form a discontinuous barrier.

Varying the height of the timber above normal flow will determine the rate and volume of retained floodwater. This will also permit fish passage.

💡 Considerations

Many barriers are likely to be needed in a catchment and their implementation will need careful planning to make sure that the overall pattern of flood flows is not altered as this can cause flood peaks to coincide.

Debris bundles can also be constructed in wooded areas to further roughen the surface of the floodplain and trap overland flows.

Removal of sediment and re-spreading to land will require a waste exemption license from the Environment Agency (EA).

🔧 Level of maintenance

Large woody dams will need periodic checking to ensure the logs are still wedged in the right position. Periodic clearance of debris from the leaky dams will prevent blockage and overflow of water.

📍 Key locations

Generally suited to smaller watercourses and ditches throughout the catchment, where holding water back is not going to create additional problems.

Steep woodland in the upper catchment, recommended to be implemented alongside runoff attenuation features – for example, understory planting.

Can also be located within fields on overland flow pathways.

£ Costs

Set-up **Low**

Maintenance **Low**

🏠 Funding

Countryside Stewardship (CS) scheme

Local Rivers Trusts (RT) within project areas.

🔍 Additional information

Slowing the flow at Pickering

www.forestry.gov.uk/pdf/FR_STF_Pickering_P2_May2015.pdf



IMAGE © YDNPA

Offline flood storage pond (permanent structure)

Offline flood storage ponds are constructed adjacent to watercourses and – during periods of high flow – some of the river flow is diverted out and into the pond. By forcing some of the flow to travel through a storage pond, the route for the flow downstream is more tortuous, and therefore flood peaks downstream are slower to rise.



Natural flood management purpose

Floodwaters are directed out of the channel into a pre-constructed storage area. The water then slowly infiltrates or is released back into the channel via an outlet point once the flood peak has passed.

Ponds can be designed to hold some water all year, adding to the wildlife value of the farm.



Agricultural benefits

Sediment is removed from the flow which improves water quality and it can be returned to the farmer's field during maintenance.

The depth and the speed of drainage can be manipulated according to the site and the requirements of the farmer.



Construction dimensions

Offline ponds must be individually designed according to the characteristics of the site and as part of a wider consideration of how flood events affect the wider catchment.

The maximum bund height should not exceed 1m and grass cover should be established as quickly as possible.

Ponds should drain within 6-10 hours, so that there is storage available in the eventuality of multi-day extreme events.



Considerations

Test pits will be needed to see how well the pond will hold water, if a permanent source of water is desired.

Ponds will be classed as ineligible features under the Basic Payment Scheme (BPS) rules if they are 0.01 hectares, or if together they add up to 0.01 hectares or more. Bigger features will be mapped by the Rural Payments Agency (RPA), and farmers must deduct them from their eligible areas.



Level of maintenance

Medium

Check for scouring of inlet feature. The soil barrier may erode, but should stabilise after grass has established. Sediment may accumulate to the level of the pipe and may need removal.



Key locations

Near to watercourses in non-productive areas of land - buffer strips, inside small meanders or field corners, throughout the catchment.



Costs

Set-up

High

Maintenance

Low



Funding

Countryside Stewardship (CS) scheme



Additional information

Design guidance

http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Fluvial_Design_Guide_-_Chapter_10.sflb.ashx



IMAGE © YORKSHIRE PEAT PARTNERSHIP

Blocking moorland drainage grips

Upland drainage has resulted in changes in water flow paths through and over blanket peatlands and has been reported to both increase and decrease flood peaks. The drainage slightly lowers the water table, providing extra water storage capacity during rainfall events. However, the ditches themselves speed up the removal of water from the land into streams and rivers.

Blocking of grips and moorland drainage channels converts drained moorland back to peatlands. Restoration of wet moorland protects the peat (a carbon sink) and reduces peat and soil erosion, which contributes to discoloured waters and a high sediment load in rivers.

? Natural flood management purpose

Areas of peat that have been restored via grip blocking become wetter, with higher water tables and subsequent positive vegetation recovery, increasing the sponge effect.

Blocked grips slow down the water that would otherwise flow quickly through the bare peat of the grips, which in turn reduces the energy of the water and its capacity to erode, carry sediment, and generate water colour.

With water staying on the peat longer there is an expected flood risk benefit for that specific area.

✓ Agricultural benefits

Blocking grips makes the moor safer for livestock and can reduce the numbers of lost livestock in deep gullies and grips.

Construction dimensions

Number, type and material for blocks will vary according to the ground conditions, depth of erosion, and slope. Specialist technical assessment of a drained moorland is required prior to works being undertaken.

💡 Considerations

Some research suggests that selective grip blocking can reduce some flood risk but in some places can increase it, depending on which grips are blocked and the balance between connectivity and storage. Specialist help is therefore needed to assess the moorland prior to any works being undertaken. The assessment will also consider other forms of moorland erosion – for example from peat hags – and may suggest re-profiling of hags and overhanging sides to grips.

🔄 Level of maintenance

Low

📍 Key locations

Drained moorland, especially in areas where use for livestock grazing is reducing. Within the moorland line – on allotments or open fell.

£ Costs

Set-up **High**

Maintenance **Low**

💰 Funding

Countryside Stewardship (CS) scheme

🔍 Additional information

Yorkshire Peat Partnership (YPP)
www.ypppartnership.org.uk

Moors for the Future
www.moorsforthefuture.org.uk

IUCN UK Peatland Programme
www.iucn-uk-peatlandprogramme.org



IMAGE © DAVE HIGGINS

Intervention treatments: Level 3

Floodplain restoration

While natural flood management measures associated with land management seek to reduce flood water generation, natural flood management measures in the river channel or on its bank or floodplain seek to improve the ability of rivers to manage those floodwaters.

Scottish Environment Protection Agency (SEPA), Natural Flood Management Handbook, 2016

Restoring the connection between a river and its floodplain provides a valuable contribution to natural flood management, allowing floodwater to spill naturally onto land to provide significant flood storage, reducing risk to lives and property further downstream. The mid and lower parts of the river system, where the river enters the flatter floodplain, are the most appropriate areas.

Restoration always needs to be carefully planned by specialist water engineers and ecologists as it will influence the behaviour of the flow of floodwater over a wide area. It will need detailed computer modelling and design, and will require planning and other permissions and consents. It is likely to be high cost and need specialist contractors.

Initial advice as to a site's suitability can be given by local Rivers Trusts (RT), Environment Agency (EA) or Yorkshire Dales National Park Authority (YDNPA) staff, and early contact is highly recommended.

River and floodplain restoration encompasses a range of different techniques which are often used in conjunction. They include restoring meanders and removal or setting back of flood banks, often together with habitat creation such as wetlands, habitat for breeding and wintering waders, and wet woodland.



IMAGE © YDNPA

Restoring meanders

In the past, rivers have been managed to increase the land available for agriculture (by straightening the channel) and to protect land from flooding (by building embankments). Even small becks have often been altered. These changes combine to disconnect rivers from their natural floodplain. Reducing the area naturally available to store floodwater means that the speed and volume of the flood arriving downstream is increased, often affecting villages and towns.

Scottish Environment Protection Agency (SEPA),
Natural Flood Management Handbook, 2016

? Natural flood management purpose

Restoring the shape (morphology) of the beck or river by re-creating meanders will increase the time taken for the floodwater to flow downstream by making it go further. This slows the flow and allows the river to carry a greater volume of water before it spills out of its course.

✓ Agricultural benefits

Potential benefits will be specific to the location chosen.

Construction dimensions

Dimensions are entirely site dependent and will need detailed specialist advice.

💡 Considerations

Reconstructed meanders usually substantially improve the fisheries of the beck.

The Rural Payments Agency (RPA) will need to be informed about changes to the land parcel area.

🔄 Level of maintenance

Low

Very little, once the initial work is done

📍 Key locations

Re-meandering needs careful planning, but can be used anywhere where becks and rivers have been straightened. It is most likely to be practical where the same landowner owns both sides of the channel. Small becks in the upper parts of the catchment will be easier to restore than main rivers. Remnant meanders can often be identified using aerial photos.

£ Costs

Set-up **High**

Maintenance **Low**

💰 Funding

Specialist advice on funding is needed.

🔍 Additional information

Example re-meander projects

www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/3.6_Dearne.pdf

www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/1.11_Highland_Water.pdf



IMAGE © LONG PRESTON DEEPS SSSI PROJECT

Reconnecting the river with its flood plain

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This is work to directly reconnect the river with its floodplain using a wide range of techniques. Choice of technique is dependent upon the type and characteristics of the water body in which it is going to be applied.

These include:

- River restoration
- Reconnecting old side channels
- Breaching of existing earth bunds
- Improving the operation of flap valves within embankments
- Lowering of flood defences
- Connecting the river to floodplain wetland
- Removing or modifying pumping stations
- Breaching embankments as part of habitat creation projects.

Natural flood management purpose

Storage of potentially large amounts of floodwater on the floodplain, with a controlled discharge back to the river once the flood event has passed.

Agricultural benefits

Potential benefits will be specific to the location chosen.

Construction dimensions

Dimensions are entirely site dependent and will need detailed specialist advice.

Pre-works assessments and surveys will be required to ensure that works do not increase flood risk (for example, an embankment may be holding water back during a flood event and removal could increase flood risk).

Considerations

The Rural Payments Agency (RPA) will need to be informed about any changes to the land parcel areas.

Environment Agency (EA) advice and consent will be required as part of the planning process for this kind of project.

Level of maintenance

Medium

Areas of restoration will need to be monitored to ensure that further erosion of the riverbanks does not occur.

Key locations

Principally, where floodplains are wide and flat and there is no risk to property or infrastructure. [Scottish Environment Protection Agency (SEPA), Natural Flood Management Handbook, 2016]

Costs

Set-up	High
Maintenance	Medium

Funding

Specialist advice on funding is needed.

Additional information

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Example floodplain project

www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/6.3_Long_Eau.pdf

22 // Natural Flood Management Measures – a practical guide for farmers

Consent and approval

Some intervention treatments may require consent prior to construction.

Land drainage consent

On ordinary watercourses

Works in the water course may require land drainage consent from the Lead Local Flood Authority (North Yorkshire County Council or Cumbria County Council). For guidance and application forms see:

www.northyorks.gov.uk/article/25714/Land-drainage-consents

or

www.cumbria.gov.uk/planning-environment/flooding/consenting.asp

On main rivers

Consent will be required from the Environment Agency (EA) for any works within 5m of the watercourse.

Planning consent

This may be required for larger structures, and a discussion about proposed works should be held with the local planning authority (Yorkshire Dales National Park Authority). Standard construction dimensions are recommended for each intervention treatment to enable quicker approval.

New woodlands

An Environmental Impact Assessment (EIA) may be required if more than 2ha of woodland planting is grant funded from sources other than the national agri-environment schemes. The Forestry Commission (FC) would need to undertake this assessment. If it is funded by the national agri-environment schemes, an EIA would not be required. Website for further information:

www.forestry.gov.uk/forestry/infd-6dfl55

Specialised consent

In some cases, a higher level of consent would be required before any intervention treatment can be put in place – for example, where Scheduled Monuments, Sites of Special Scientific Interest (SSSI) or Public Rights of Way are involved.

Public Rights of Way

Public footpaths, public bridleways and byways within the National Park are all managed by the Yorkshire Dales National Park Authority, which acts as the highway authority. Consent must be obtained before any work takes place that might affect either the physical right of way or those using it. Be aware that the actual 'used' route that the public walk or ride across your land could differ from the legal definitive line.

IMAGE © YDNPA



Open Access land

Almost all moorland and much of the higher rough pasture land within the National Park is designated as Open Access land. The public have a legal right of access on this land and, before any works take place that might affect this access, consent may be required.

Feature	Consent required from	Contact information
Scheduled Monument	Historic England	01793 414883
Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) or Special Protection Area (SPA)	Natural England	0300 060 3900
Public Rights of Way and Open Access land	Yorkshire Dales National Park Authority	01756 751647 (Alan Hulme)

Summary of consents

Guideline consent required for each treatment level and type (consent required for treatments along major rivers may vary).

	Pre application consultation & consents		Recommended consultation			Grant funding		Affect on schemes ¹	
Intervention treatments	Planning permission: GPDO or full planning permission	Land drainage, main river works	Historic environment (YDNPA)	Wildlife (YDNPA)	Hydrological specialist support	Available	What/who	BPS	ES, CS
Level 1									
Increasing soil permeability – reducing soil compaction	N	N	Y ²	N	N	N		N	N ⁵
Creating and managing buffer strips	N	N	N	N	N	Y	CS	Y	Y
Planting and managing hedgerows	N	N	N	N	N	Y	CS, YDMT	Y	Y
Using trees	N	Y ³	Y	Y	N	Y	CS, FC, YDMT, RT, YDNPA	Y	Y
Winter cover crops	N	N	N	N	N	Y	CS	N	N
Cross drains in farm tracks	N	N	N	N	N	Y	CS	N	N
Level 2									
Bunds and detention basins	Y	N	Y	N	N	Y	CS	N	Y
Swales	Y	N	Y	Y	Y	Y	CS	Y	Y
Sediment traps	Y	N	Y	N	N	Y	CS	Y	Y
In-channel barriers	N	Y	N	N	N	Y	CS	N	N
Offline flood storage pond (permanent structure)	Y	N	Y	Y	Y	Y	CS	Y	Y
Blocking moorland drainage grips	N	Y	Y	Y	Y	Y	CS	Y	Y
Level 3									
Restoring meanders	Y	Y	Y	Y	Y	Y	EA	Y	Y
Reconnecting the river with its flood plain	Y	Y	Y	Y	Y	Y	⁴ CS, EA	N	Y

KEY

Basic Payment Scheme (BPS)
 Countryside Stewardship (CS) scheme
 Environment Agency (EA)
 Environmental Stewardship (ES) scheme
 Forestry Commission (FC)

General Permitted Development Order (GPDO)
 Local Rivers Trust (RT)
 Wildlife Trust (WT)
 Yorkshire Dales Millennium Trust (YDMT)
 Yorkshire Dales National Park Authority (YDNPA)

¹Applies if you receive payment from the schemes listed

²and⁵ Depends on which machinery is used – yes, for subsoiler and sward lifter

³If tree planting is within 20m of a main river

⁴CS grant funding available if river is designated SSSI

Sources of advice



IMAGE © YDNPA

Rural Payments Agency

To confirm if a flood mitigation feature is permanently ineligible, temporarily ineligible or eligible for Basic Payment Scheme (BPS) funding, call 01609 773751.

Environment Agency

Swale, Ure and Nidd

Claire Tunningley, 07776 170320
claire.tunningley@environment-agency.gov.uk

Wharfe

Keith Davie, 020 3025 6576
keith.davie@environment-agency.gov.uk

Aire and Calder

Rachel Kipling, 020 3025 6702
rachel.kipling@environment-agency.gov.uk

Ribble

Helen Dix, 020 3025 1290
helen.dix@environment-agency.gov.uk

Lune

Simon Bennett, 07920 535860
simon.bennett@environment-agency.gov.uk

Eden

Liz Davey, 07833 360131
liz.davey@environment-agency.gov.uk

Natural England

Natural flood management leads, Yorkshire and Humber

Claire Bradley, 07789 273292
claire.bradley@naturalengland.org.uk

Richard Dimon, 07789 747519
richard.dimon@naturalengland.org.uk

Natural flood management leads, Cumbria

Tim Nicholson, 07836 615146
timothy.nicholson@naturalengland.org.uk

Chris Turner, 07771 977355
christopher.turner@naturalengland.org.uk

Forestry Commission

National Park in North Yorkshire

Jeremy Dick, 07771 806956
jeremy.dick@forestry.gsi.gov.uk

National Park in Cumbria or Lancashire

Cumbria dales, Orton Fells area

Jim O'Neill, 07831 174639
jim.oneill@forestry.gsi.gov.uk

Barbondale and edge of Lunesdale

Andy Bennett, 07584 34272
andy.bennett@forestry.gsi.gov.uk

Rivers Trusts

Yorkshire Dales (for Swale, Ure and Wharfe)

Dan Turner, 07818 532650
dan.turner@yorkshiredalesriverstrust.com

Ribble

Jack Spees, 01200 444452
jack@ribbletrust.com

Lune

Sarah Littlefield, 015242 22174
sarah@luneriverstrust.org.uk

Eden

Matthew Jenkinson, 01768 866788
office@edenrt.org

Yorkshire Dales National Park Authority

Development Planning

01969 652345
planning@yorkshiredales.org.uk

General number for teams listed below:
0300 456 0030

Historic Environment

herinfo@yorkshiredales.org.uk

Wildlife

wildlife@yorkshiredales.org.uk

Trees & Woodlands

trees@yorkshiredales.org.uk

Farm Conservation

(including agri-environment support)
farming@yorkshiredales.org.uk

Yorkshire Dales Millennium Trust

015242 51002, info@ydmmt.org

Woodland Trust

Cumbria: Pete Leeson, 01476 581111

Yorkshire Peat Partnership

Tim Thom, 01756 796895 / 07824 139263
tim.thom@ywt.org.uk

Existing natural flood management projects

Upper Aire Project

Phil Lyth, 07713 333170,
phil.lyth@farmingandwildlife.net

Don Vine, 07818 403138
don.vine@ywt.org.uk

Princes Countryside Fund NFM project for Wensleydale and Wharfedale

Yorkshire Dales Rivers Trust:
Dan Turner, 07818 532650
dan.turner@yorkshiredalesriverstrust.com

Farmer-led natural flood management groups

Wensleydale

Tarja Wilson, 07970 873314
tarja.wilson@yorkshiredales.org.uk

Swaledale

Carol Moffat, 07917 666514
carol@thefarmernetwork.co.uk

Wharfedale

Dan Turner, 07818 532650
dan.turner@yorkshiredalesriverstrust.com

Lune catchment

Hannah Fawcett, 07818 048750
hannah.fawcett@yorkshiredales.org.uk

Ribblesdale

Adrian Shepherd, 015242 51002
adrian.shepherd@ydmmt.org

References and further information

Natural Flood Management Handbook (2015), Scottish Environment Protection Agency (SEPA)
www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

Runoff Attenuation Features (2011), Newcastle University/Environment Agency (EA)
https://research.ncl.ac.uk/proactive/belford/papers/Runoff_Attenuation_Features_Handbook_final.pdf

Simply Sustainable Water (2013), Linking Environment and Farming (LEAF)
www.leafuk.org/resources/000/691/685/SSW.pdf

Farming in the uplands for cleaner water and healthier soil (2010), Natural England (NE)
<http://publications.naturalengland.org.uk/publication/9031>

Water Friendly Farming and catchment management, Game & Wildlife Conservation Trust/Freshwater Habitats Trust/The University of York/Syngenta
<http://freshwaterhabitats.org.uk/research/water-friendly-farming>

From source to sea: natural flood management – the Holnicote experience (2015), National Trust
<https://www.nationaltrust.org.uk/holnicote-estate/documents/from-source-to-sea---natural-flood-management.pdf>

Slowing the flow at Pickering, Forest Research
www.forestry.gov.uk/fr/slowingtheflow

Working with natural processes to reduce flood risk (2014), Environment Agency
www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk-a-research-and-development-framework

To find out more about
Yorkshire Dales National Park:
Visit www.yorkshiredales.org.uk
Call **0300 456 0300**
Email info@yorkshiredales.org.uk

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