PENDLE HILL LANDSCAPE PARTNERSHIP

NATURAL FLOOD MANAGEMENT MEASURES

A Practical Guide for Farmers

FOREST OF BOWLAND
Area of Outstanding Natural Beauty

TOGETHER FOR OUR LANDMARK

heritage lottery fund
LOTTERY FUNDED

RIBBLE RIVERS TRUST

Ribble Life Together

This document is based on the publication 'Natural Flood Management Measures – a practical guide for farmers (2017),' which was specifically requested by the farmers and land managers of the Yorkshire Dales National Park, and compiled by the Yorkshire Dales National Park Authority, Yorkshire Dales Rivers Trust and North Yorkshire County Council, with support from Natural England and the Environment Agency.

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.

This publication has been produced with funding from the Countryside Stewardship Facilitation Fund and the Ribble Life project.

November 2018

Image sward slitter © Ribble Rivers Trust

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 UK's flood defence system, with particular reference made to natural flood management (NFM).

Easington Brook Riparian Buffer Strip © Ribble Rivers Trust

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.

Most 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 Ribble Catchment can play its part

The Ribble Catchment covers some 500 square miles, with a wide and varied landscape, of extensive uplands to intensive lowlands, and significant numbers of smaller villages and larger urban areas of the Calder and Darwen Valleys. Many places within the catchment have seen significant flood damage in recent years.

Within the catchment, the Ribble and its tributaries have flooded communities and farmland, meaning people having to leave their homes for prolonged periods whilst the flood water recedes and homes are repaired. Additionally the flooding can block roads, isolating communities and damaging businesses, as well as damaging farm buildings and farm land. This can include a range of measures and interventions and these differ in how they affect farm businesses and are often beneficial to the farm business and do not require significant change to land management.

National and regional research has shown that farmers and land managers can be in a position to help contribute to reducing flooding, locally and also further downstream. This can be from a range of measures and interventions and these range in how they affect farm businesses from being beneficial to the business to not requiring significant change to land or land management.

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 local planning authority 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:

Lower Knotts (Bond Beck) © Ribble Rivers Trust

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.

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:

Pendle Hill Landscape Partnership –
pendlehill.lp@lancashire.gov.uk

Forest of Bowland AONB team –
bowland@lancashire.gov.uk

Ribble Rivers Trust –
admin@ribbletrust.com

Possible locations of natural flood management measures within the Ribble landscape

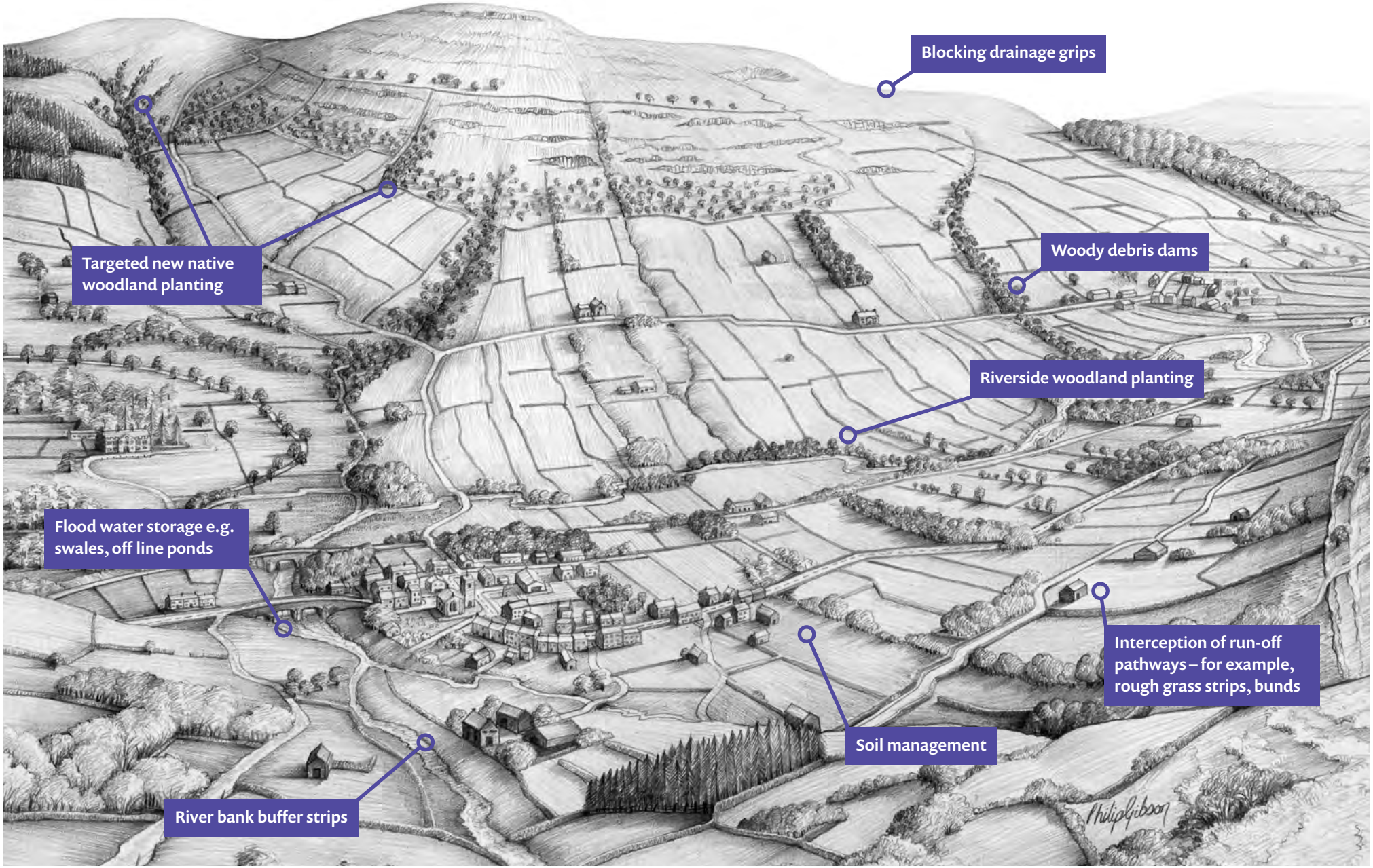


Illustration: Phil Gibson Design © Yorkshire Dales National Park Authority

Intervention treatments: Level 1

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.

Sward Lifter © Ribble Rivers Trust

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.sureroot.uk

Soils – https://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

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.

Leagram brook © Ribble Rivers Trust

Stock Beck © Ribble Rivers Trust

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 top soil from fields into watercourses, so reducing contamination by silt and organic wastes.
- They aid in ensuring compliance with new Basic Rules for farmers (The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018) by preventing livestock poaching of river banks and creating a physical barrier for spreading of nutrients and slurry/manure.
- They help reduce nitrate leaching by vegetation growing on the buffer strip absorbing nitrogen.
- They create wildlife corridors and sites for ground nesting 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

- 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 run-off incepting 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.
- Ribble Rivers Trust (RRT) and Pendle Hill Landscape Partnership (PHLP) may assist with riparian fencing 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

Planting and managing hedgerows

Hedgerows are an intrinsic part of the landscape within many areas of the Ribble Catchment 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.

Laneside Farm West Bradford © Ribble Rivers Trust

Laneside Farm West Bradford © Ribble Rivers Trust

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.
- New hedgerows can provide grazing management benefits, and easier stock handling/management.
- 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).
- Ribble Rivers Trust (RRT) and Pendle Hill Landscape Partnership (PHLP), in certain project areas.
- Forest of Bowland AONB, in certain project areas.
- 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

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.

Harrop Hall © Ribble Rivers Trust

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 rain water – 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, and has been shown to boost productivity
- 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 livestock grazing.
- 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 some 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).
- Ribble Rivers Trust (RRT) and Pendle Hill Landscape Partnership (PHLP)in their project areas

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

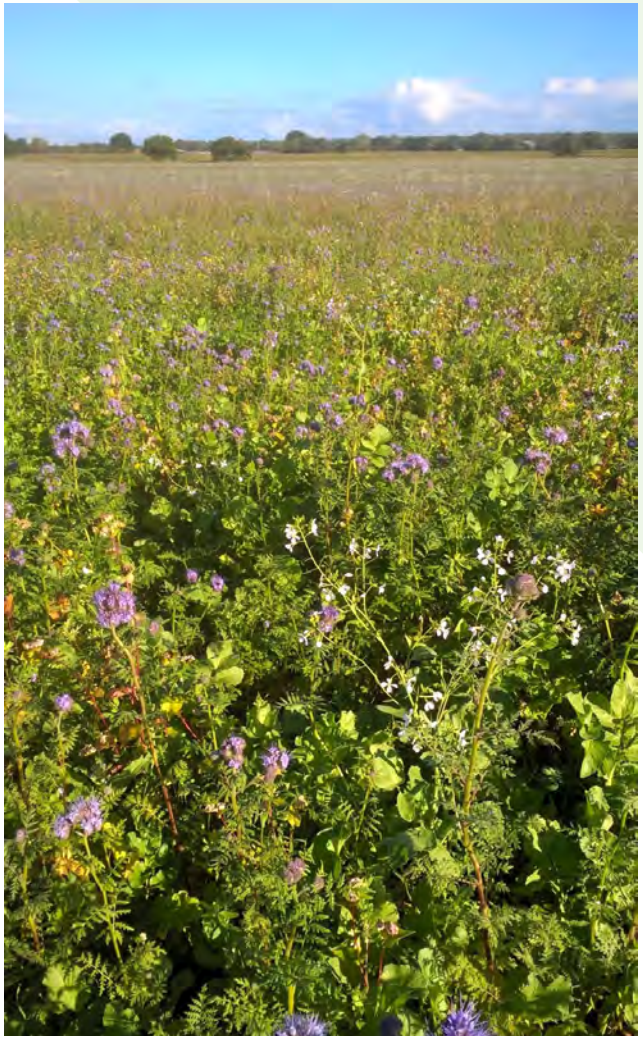
www.forestry.gov.uk/ukfs

Basic Payment Scheme (BPS) - www.gov.uk/government/collections/basic-payment-scheme

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



Phacelia cover crop - ©Natural England

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/guidence/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

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.

Cross drain ©Terra Firma Ltd

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 x0.2m 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.

Cost

Set up: Low

Maintenance: Low

Funding

- Countryside Stewardship (CS) scheme.
- Ribble Rivers Trust (RRT) in their project areas.

Additional information

Countryside Stewardship (CS) grants - www.gov.uk/countryside-stewardship-grants/cross-drains-rp5

Intervention treatments: Level 2

Detention basins and bunds

Detention basins can be created through the exavation or reprofiling of land in such a way that water is intercepted and held in the basin for short periods of time. Alternatively installation 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 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 retention 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.

Detention Basin (Lower Knotts) © Ribble Rivers Trust

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 detention basins and 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.

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

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 valleys and slopes prone to runoff during flood events.
- Areas where runoff with a heavy sediment load is known to compromise local drainage.

Cost

Set up: Medium

Maintenance: Medium

Funding

- Countryside Stewardship (CS) 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 bunds, 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 benefit

- 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.

Knott Lane © Ribble Rivers Trust

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.

Cost

Set up: Medium

Maintenance: Low

Funding

- Countryside Stewardship (CS) scheme
- Ribble Rivers Trust (RRT) if within the project areas

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 top soil.

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.

Cost

Set up: Low (dependent upon scale)

Maintenance: Low

Funding

- Countryside Stewardship (CS) scheme.
- Ribble Rivers Trust (RRT) 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

Bashall Brook © Ribble Rivers Trust

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.

Cost

Set up: Low

Maintenance: Low

Funding

- Countryside Stewardship (CS) scheme.
- Ribble Rivers Trust (RRT) and Pendle Hill Landscape Partnership (PHLP) within project areas.

Additional information

Slowing the flow at Pickering - www.forestry.gov.uk/pdf/FR_STF_Pickering_P2_May2015.pdf

Agden Brook Offline flood storage pond © Ribble Rivers Trust

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.

Cost

Set up: High

Maintenance: Low

Funding

- Countryside Stewardship (CS) scheme
- Ribble Rivers Trust (RRT) if within their project areas

Additional information

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

Blocking Peat moorland restoration

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.

Anglezarke wooden dams and reprofiling ©Forest of Bowland AONB

Abbeystead peat dams ©Forest of Bowland AONB

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 haggs - and may suggest re-profiling of haggs 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.

Cost

Set up: High

Maintenance: Low

Funding

- Countryside Stewardship (CS) scheme
- Forest of Bowland AONB
- Ribble Rivers Trust (RRT) if within their project areas

Additional information

Yorkshire Peat Partnership (YPP) – www.yppartnership.org.uk

Lancashire Peat Partnership - https://forestofbowland.com/Lancashire-Peat-Partnership

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

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 Ribble Rivers Trust (RRT) or the Environment Agency (EA), 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.

River Hodder at Newton-in-Bowland © Rod Calbrade

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.

Cost

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

Reconnecting the river with its flood plain

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 needed 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.

Long Preston Deeps SSSI © Ribble Rivers Trust

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]

Cost

Set up: High

Maintenance: Medium

Funding

Specialist advice on funding is needed.

Additional information

Example floodplain project - www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/6.3_Long_Eau.pdf

Consent and approval

Some intervention treatments may require consent prior to construction. The type of consent varies depending on the intervention, but also on the type of watercourse involved. Water courses fall into one of two categories, “ordinary watercourse” or “main river”. “Main rivers” are usually larger streams and rivers, but some of them are small watercourses of significance. They include certain structures that control or regulate the flow of water in, into or out of the channel, and consents are provided by the Environment Agency. For all other watercourses they are classed as “ordinary watercourse” and consents are issued by the Lead Local Flood Authority. You can check if the watercourse you want to work on is a main river on this map: https://tinyurl.com/y93b9ast

Land drainage consent

On ordinary watercourses

Works in the water course may require land drainage consent from the Lead Local Flood Authority which in the Ribble catchment is dependent on where the works are being carried out, it could be one of the following councils. Lancashire County Council, North Yorkshire Council, Blackburn with Darwen Unitary Authority, or Preston City Council. For guidance and application forms see:

- http://www.lancashire.gov.uk/council/planning/
- https://www.northyorks.gov.uk/planning-and-development
- https://www.blackburn.gov.uk/Pages/Planning-advice.aspx
- https://www.preston.gov.uk/yourservices/planning/

On main rivers

Consent will be required from the Environment Agency (EA) for any works within 8m of the watercourse. https://www.gov.uk/permission-work-on-river-flood-sea-defence

Planning consent

This may be required for larger structures such as some level 2 and 3 interventions, but rarely if ever will level 1 interventions require planning permission. For level 2 and 3 interventions a discussion about proposed works should be held with your local planning 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. Contact your local planning authority for assistance.

Public Rights of Way

Public footpaths, bridleways and byways within the catchment are all managed by your particular County Council or Unitary 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.

Open Access land

Almost all moorland and much of the higher rough pasture land within the catchment 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	northwest@HistoricEngland.org.uk 0161 2421416
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	Lancashire County Council North Yorkshire County Council Blackburn with Darwen Council Yorkshire Dales National Park	PROW@lancashire.gov.uk 01772 530317 paths@northyorks.gov.uk 0845 8727374 PROW@capita.co.uk 01254 273 525 info@yorkshiredales.org.uk 0300 456 0030

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		
Intervention treatments	**Planning permission GPDO*, full planning permission**	**Land drainage, main river works**	**Historic environment (Local authority)**	**Wildlife (Local authority)**	**Hydrological specialist support**
Level 1					
Increasing soil permeability - reducing soil compaction	N	N	Y[1]	N	N
Creating and managing buffer strips	N	N[3]	N	N	N
Planting and managing hedgerows	N	N	N	N	N
Using trees	N	Y[2]	Y	Y	N
Winter cover crops	N	N	N	N	N
Cross drains in farm tracks	N	N	N	N	N
Level 2					
Bunds and detention basins	Y[4]	N	Y	N	N
Swales	N[4]	N	Y	Y	Y
Sediment traps	N[4]	N	Y	N	N
In-channel barriers	N	Y	N	N	N
Off line flood storage pond (permanent structure)	Y[4]	N	Y	Y	Y
Blocking moorland drainage grips	N	Y	Y	Y	Y
Level 3					
Restoring meanders	Y	Y	Y	Y	Y
Reconnecting the river with its flood plain	N[4]	Y	Y	Y	Y

[1] Depends on which machinery is used – yes, for subsoiler and sward lifter

[2] If tree planting is within 8m of a main river

[3] If flood gates are needed a consent or permit

[4] Discussion should be held with local planning authority

Sources of advice

Rural Payments Agency

To confirm if a flood mitigation feature is permanently ineligible, temporarily ineligible or eligible for Basic Payment Scheme (BPS) funding, call 03000 200 301

Environment Agency

Lutra House office,
Preston
08708 506506

Natural England

Crewe office
0300 060 3900

Forestry Commission

North West & West Midlands Area Office,
Penrith
0300 067 4190

Rivers Trusts

Ribble Rivers Trust
01200 444452
admin@ribbletrust.com

Local Authority - Planning departments

Yorkshire Dales National Park Authority -
planning@yorkshiredales.org.uk
01969 652345

Craven District Council -
planning@cravendc.gov.uk
01756 706470

Pendle Borough Council -
planning@pendle.gov.uk
01282 661333

Burnley Borough Council -
planning@burnley.gov.uk
General: 01282 425011

Hyndburn Borough Council -
planning@hyndburnbc.gov.uk
General: 01254 388 111

Blackburn with Darwen -
planning@blackburn.gov.uk
01254 585960

Ribble Valley Borough Council -
planning@ribblevalley.gov.uk
01200 414499

South Ribble Borough Council -
planning@southribble.gov.uk
01772 625400

Preston City Council -
planningpolicy@preston.gov.uk 01772 906570

Fylde Borough Council -
planning@fylde.gov.uk 01253 658435

West Lancashire Borough Council -
plan.apps@westlancs.gov.uk 01695 577177

Overland flow © Ribble Rivers Trust

Woodland Trust

North West Office -
017687 75060

Forest of Bowland AONB Team

Pendle Hill Landscape Partnership Team Office
01200 420420

Dunsop Bridge Office
01200 448000

Farmer-led natural flood management groups

Pendle Hill Farmers Network -
Pendle Hill Landscape Partnership –
01200 420420

Ribblesdale Farm Group –
Yorkshire Dales Millennium Trust –
015242 51002

River Loud Farm Group –
Ribble Rivers Trust –
01200 444452

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

PENDLE HILL
LANDSCAPE
PARTNERSHIP

www.pendlehillproject.com