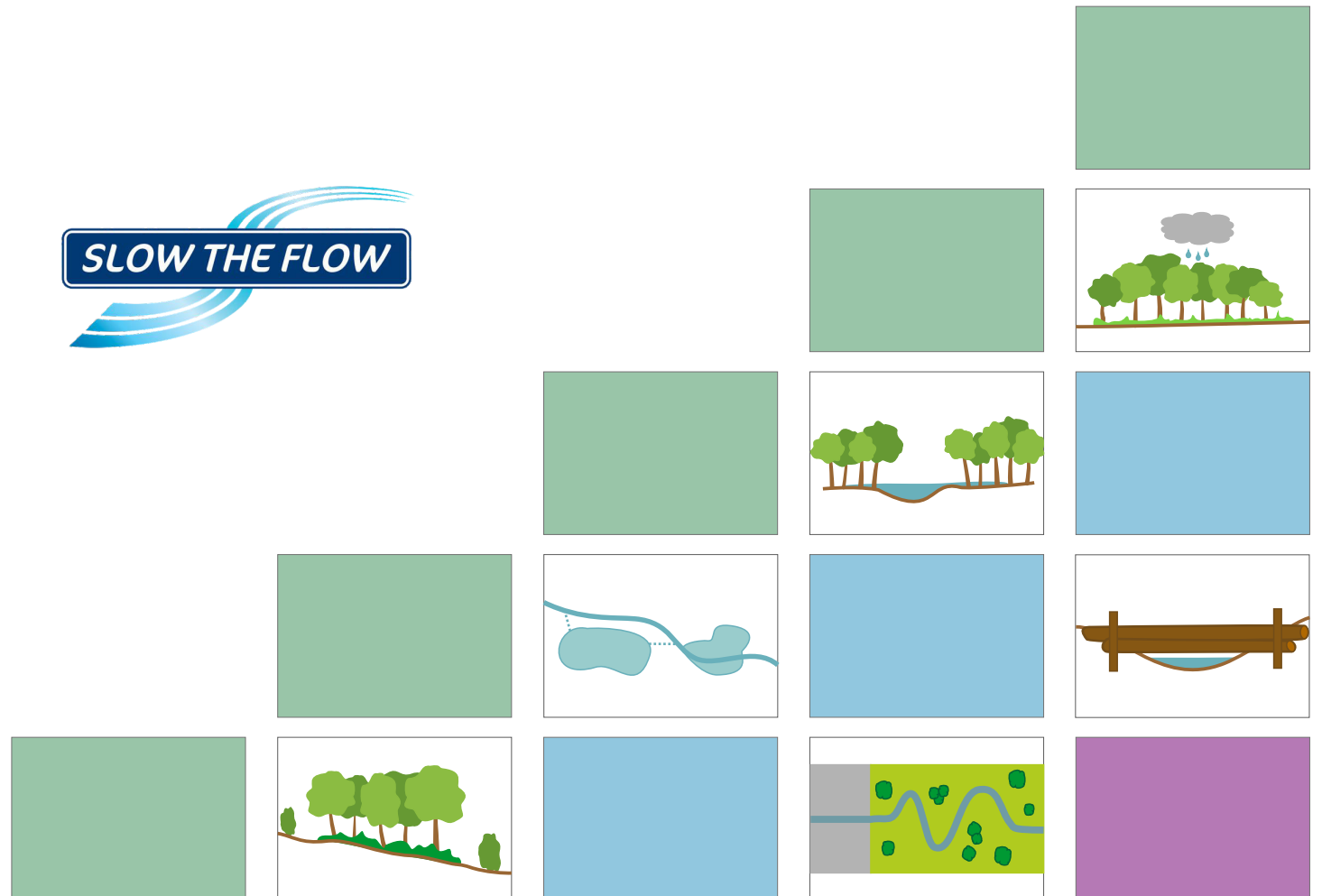


An Introduction to Natural Flood Management Techniques

West Wolds
Slow the Flow



First edition: 2021-07

Natural Flood Management Techniques: An Introduction

What is Natural Flood Management?

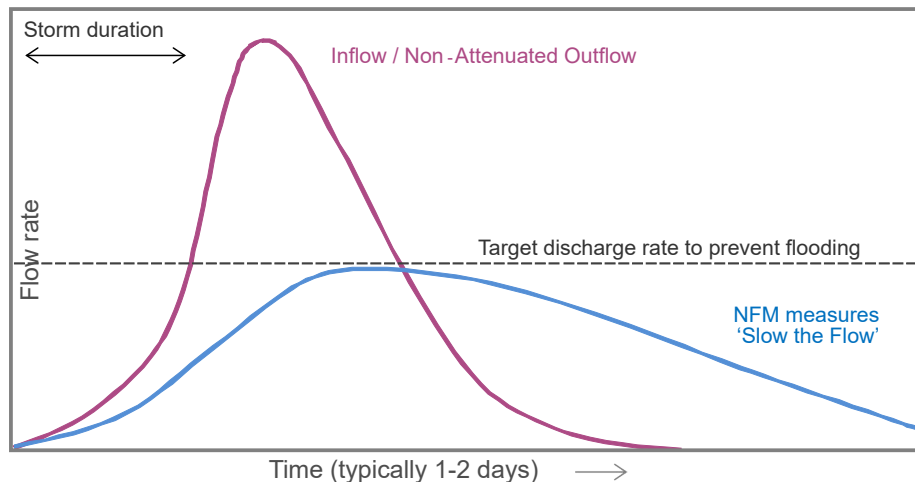
Natural Flood Management (NFM) takes inspiration from nature, catching and detaining storm water where it falls, increasing 'roughness' across all parts of the catchment, to reduce flood risk. NFM measures should be many and small, installed across wide areas, at a landscape or catchment scale.

The principal purpose of NFM is to reduce and slow peaks of surface and river water which follow storm and other intense rainfall events, 'slowing the flow', such that damaging flooding is reduced. The concept is illustrated in the diagram below. Note that the overall volume does not change, but the time over which it occurs is extended, and therefore the height of the peak is notably reduced.

There are many additional Green Infrastructure (GI) benefits to NFM compared to traditional hard engineering solutions, although often both are needed and can complement each other well.

These multiple benefits are set out on the following pages in the form of simple bar-graphs showing the relative benefits and costs.

Slowing the Flow after heavy rainfall



NFM Techniques: outlining the benefits and the challenges

Is it easy or difficult to implement and maintain NFM techniques?

The amount of work required to create various NFM techniques varies, according to their scale, complexity, and to legal requirements such as planning and ordinary watercourse consents. As they are often small in scale, maintenance of NFM features is usually undemanding and straightforward, similar to maintaining any interventions (e.g. drains or fencing) in the landscape.

more simple >>> > < <<< more complex	<p>The NFM Practical Guide for Farmers sets out three Levels, which reflect the difficulty and consents required. These Levels are set out at the top-right of each of the following pages.</p> <ul style="list-style-type: none"> Techniques - which are listed on the following pages 	
	LEVEL 1	
	<p>Measures requiring minimum or no consultation with authorities such as the County Council or Environment Agency. These measures are usually low cost and simple to install, but can still be extremely effective.</p>	<ul style="list-style-type: none"> <i>Catchment Woodland</i> <i>Riparian & Floodplain Woodland</i> <i>Cross-slope Woodland & Hedgerows</i> <i>Soil & Land Management</i>
	LEVEL 2	
	<p>Measures requiring a certain level of consultation and possibly consent of authorities. These measures are a mix of low to medium cost and may need contractors to help to install them.</p>	<ul style="list-style-type: none"> <i>Leaky Barriers</i> <i>Storage Ponds & Basins</i>
	LEVEL 3	
	<p>Measures that are targeted to certain locations within the catchment and may require design, planning permission and consents from authorities. In most cases advice from professional water management consultants will be required. These measures are usually higher in cost and may need contractors to install them.</p>	<ul style="list-style-type: none"> <i>River & Floodplain Restoration</i> <i>Headwater Management</i>

Sources / More Information

This guide is based on a range of previously published information on the subject of NFM, notably:

Natural Flood Management Measures - A Practical Guide For Farmers (Yorkshire Dales National Park Edition)

Working with Natural Processes (WWNP) Evidence Directory - Environment Agency

These documents were used to inform the benefits graphs and to provide technical information. They are highly recommended if you wish to obtain more detail about NFM, with the *Practical Guide* setting out the agricultural benefits, techniques and providing more links to follow.

The *WWNP Evidence Directory* provides considerable detail on multiple benefits of NFM, and how they were calculated.

The purpose of this guidance, however, is to present a brief introduction to the main techniques of NFM - a first 'toe in the water', so to speak.

For more detailed information on NFM, please check the [Further Information](#) links.

For more information about our **Slow The Flow** projects, please visit our websites - see [Contact Us](#) on the last page.



Woodland throughout a catchment area helps to prevent rainwater reaching the ground, allowing it to evaporate back into the atmosphere through leaves, whilst the roots both soak up water and encourage infiltration. Understory planting increases roughness of the land, slowing and reducing runoff.

NFM Interventions - relative benefits and costs:

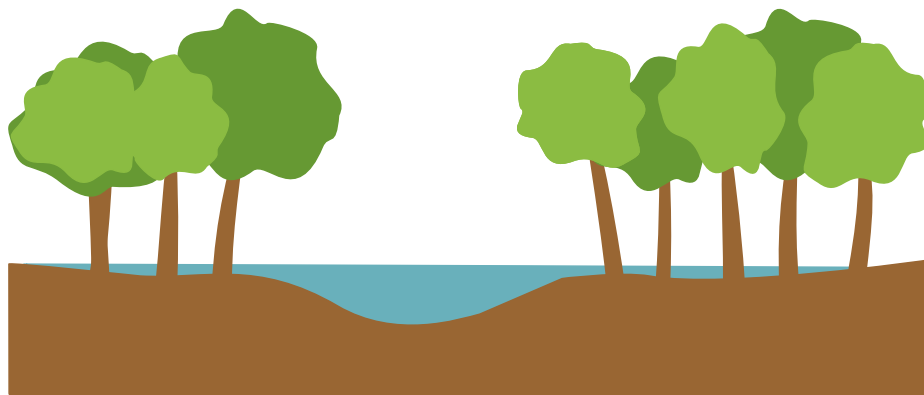
Flooding reduction:	
River/stream	●●●●●●●●○
Surface/ground	●●●●●●●●○
Environmental benefits:	
Water quality	●●●●●●●●○
Air quality	●●●●●●●●○
Habitat improvement	●●●●●●●●●
Climate resilience	●●●●●●●●●
Amenity	
	●●●●●●●●○
Cost:	
Setup	●●●●●●●○
Maintenance	●●○○○○○○○



This woodland covers a large proportion of the steep scarp faces of Drewton Dale in the west Wolds

How does it help?

- Planting and woodland debris creates a rough surface for the water to run across (hydraulic roughness) which slows down its passage across the woodland area;
- Trees reduce the amount of water that reaches the ground by up to 45% due to interception in the canopy;
- Trees help to prevent soil erosion and bind the ground together using their root network. This improves the ground's water absorption capacity, and reduces silt in downstream watercourses.



Riparian planting, along a watercourse, stabilises banks, and reduces sediment deposits from adjacent fields. Woodlands in floodplains can increase their capacity and ability to slow water flow, whilst encouraging sediment deposition to clean the water.



Riparian woodland in different settings: a steep-sided Pennine valley, a gentle chalk stream, and a valley floodplain in the North York Moors

NFM Interventions - relative benefits and costs:

Flooding reduction:	
River/stream	●●●●●●●●○○
Surface/ground	●●●●●●○○○○
Environmental benefits:	
Water quality	●●●●●●●●○○
Air quality	●●●●●●○○○○
Habitat improvement	●●●●●●●●●●
Climate resilience	●●●●●●●●●●
Amenity	
	●●●●●●○○○○
Cost:	
Setup	●●●●●●○○○○
Maintenance	●●○○○○○○○○

How does it help?

- Creates shade in areas of the river creating a good habitat for aquatic wildlife;
- Tree roots help to stabilise the banks and prevent erosion as well as collapse;
- Planting in the floodplain increases the amount of water infiltrated in storm events;
- Trees help to reduce the amount of siltation that occurs when the water returns to the watercourse;
- The woodland helps to slow runoff entering the system by adding roughness to the surface.



Cross-slope woodlands and hedgerows are strategically placed along contour lines to intercept and slow water running as a sheet down a hillside. Roots also act to stabilise the hillside, preventing landslips.



A cross-slope woodland or hedge can intercept water running off fields



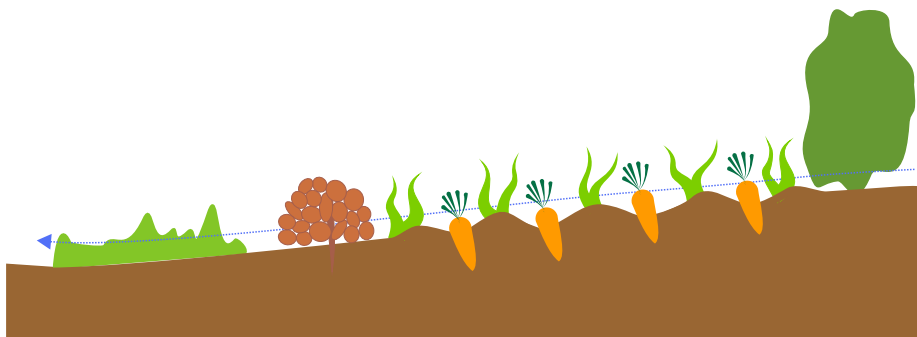
New hedgerows can established quickly if well-maintained. This one is about 4 years old.

NFM Interventions - relative benefits and costs:

Flooding reduction:	
River/stream	●●●●○●○●○●○●○●○
Surface/ground	●●●●●●●●○●○●○●○
Environmental benefits:	
Water quality	●●●●●●●●●●●●●●●●
Air quality	●●●●●●●●●●○●○●○●○
Habitat improvement	●●●●●●●●●●○●○●○●○
Climate resilience	●●●●●●●●○●○●○●○
Amenity	
	●●●○●○●○●○●○●○●○
Cost:	
Setup	●●●●●●●○●○●○●○●○
Maintenance	●●○●○●○●○●○●○●○

How does it help?

- Up to 45% of rainfall does not reach the ground as it is caught by trees;
- Flow is slowed due to the rough ground surface created by vegetation;
- Woodland soil acts as a sponge and soaks up some of the runoff;
- Hedgerows intercept and absorb surface water flows.



Soil improvements may include increased water storage through decompaction, and better hydraulic roughness through planting, slowing runoff. Strong root growth can improve soil structure and permeability and allow rainfall to connect with groundwater, reducing soil loss and watercourse sedimentation from runoff.

Higher levels of organic matter result in carbon capture, less dependence on chemicals for fertility and higher resilience to extremes climate change.

NFM Interventions - relative benefits and costs:

Flooding reduction:	
River/stream	●●●●●●●●●●
Surface/ground	●●●●●●●●●●
Environmental benefits:	
Water quality	●●●●●●●●●●
Air quality	●●●●●●●●●●
Habitat improvement	●●●●●●●●●●
Climate resilience	●●●●●●●●●●
Amenity	
	●●●●●●●●●●
Cost:	
Setup	●●●●●●●●●●
Maintenance	●●●●●●●●●●



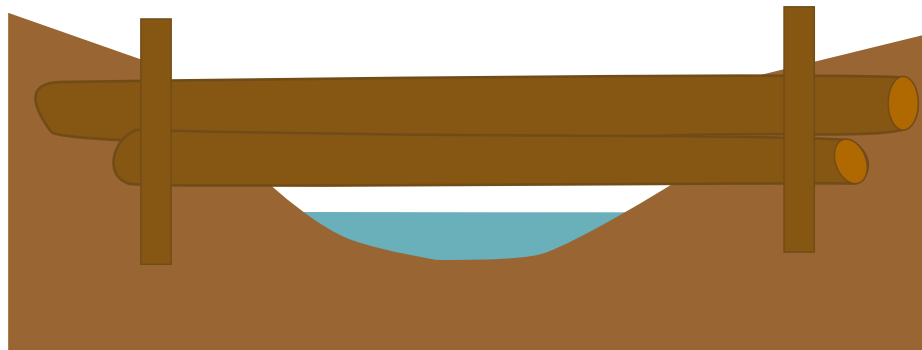
Cover crops would help to prevent this kind of winter soil erosion



This example of a cover crop is from the Good Soil Guide (<https://soilguide.co.uk>) a free resource for farmers, developed in partnership with Yorkshire Water

How does it help?

- Prevents channels being created which speed up the flow of water;
- Improved soil structure reduces the amount of runoff and allows more water to be infiltrated;
- Soil erosion can be reduced and less sediment will get carried into the watercourse.
- Soil nutrients and moisture are retained and crop yields increased, whilst reliance on fertiliser is reduced.



Leaky barriers replicate the effect of fallen trees over watercourses. They allow normal water levels ('base flow') to pass unimpeded but, in a flood event, they encourage ponding behind them, slowing and spreading the flow of the storm water.

Where there is no permanent watercourse, gully-stuffing or contour logs can help to displace water from temporary, incised channels, and spread it across the woodland floor, where it can soak into the ground.

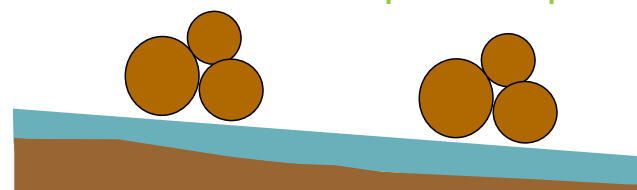
NFM Interventions - relative benefits and costs:

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Habitat improvement	●●●●●●●●○○
Climate resilience	●●●●●●●●○○
Amenity	
	●●○○○○○○○○
Cost:	
Setup	●●○○○○○○○○
Maintenance	●●○○○○○○○○

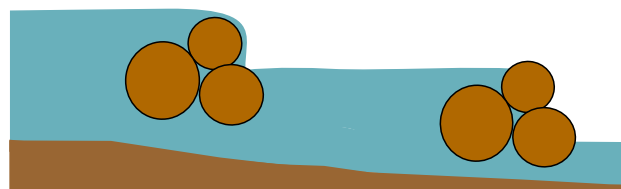


Leaky barriers can be deployed on anything from a small river (above) to a ditch (above right) or gullies (right)

Watercourse Normal Flow - passes unimpeded



Watercourse High Flow - slowed



How does it help?

- Time taken for storm-water to travel downstream is increased and maximum flood peak reduced;
- Disperses water onto the floodplain to slow the flow and help with infiltration;
- Drains down once the main flood has passed.



Drainage networks often go back hundreds of years. In some cases, they have been compromised by built development and by having to cope with increasingly severe flood events, as a result of climate change. In such situations, review and alteration of established drainage patterns may result in a system which is better suited to the area it now serves. Relatively simple measures, such as moving a field gate, raising a bank, or intercepting and re-directing flow paths or drains, may make a huge difference to surface and ground water flooding.

NFM Interventions - relative benefits and costs:

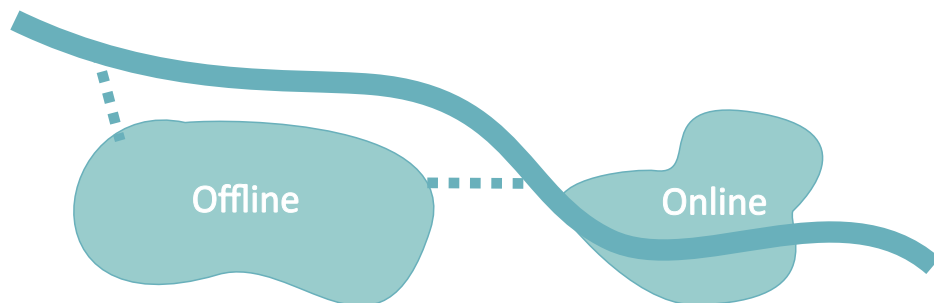
Flooding reduction:	
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Amenity	
	●●●●●●●●●●
Cost:	
Setup	●●●●●●●●●●
Maintenance	●●●●●●●●●●



This land drain runs into a culvert which frequently backs-up during storms, resulting in flooding to houses which have been built over the drain/culvert in recent decades. Looking at the catchment upstream of this drain, it may be possible to safely detain and divert water around these houses.

How does it help?

- Existing drainage infrastructure can be re-evaluated and re-purposed to meet today's needs and changing climate;
- Fairly small changes in topography can have a substantial impact on where storm water flows, and can direct it away from vulnerable roads and properties;
- In combination with the above, the capacity of ditches and drains can be improved using other techniques, like attenuation areas and leaky dams;
- These are relatively low-cost solutions, using features that already exist.



'Online' ponds, such as millponds, are always wet, but with extra capacity in heavy rainfall. 'Offline' ponds are normally dry or at low level, with capacity for high levels to be diverted from a nearby watercourse in heavy flow events. The pond outfall then returns the water to the same watercourse, more slowly, downstream.

Dry basins, like the one illustrated to the right, only hold water for a short time (1-2 days) after the storm peak.



The pond (below) is connected with the beck and adds to its capacity in times of heavy rain



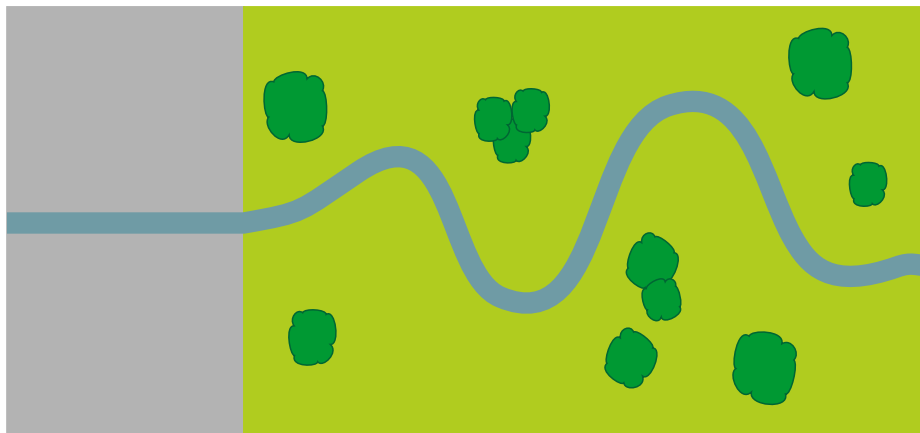
This normally dry basin - at Oldroyd in Calderdale - can detain water during a flood event © Stuart Bradshaw

NFM Interventions - relative benefits and costs:

Flooding reduction:	
River/stream	●●●●●●●●●●●●●●
Surface/ground	●●●●●●●●●●○●○●
Environmental benefits:	
Water quality	●●●●●○●○●○●○●○
Air quality	●●●○●○●○●○●○●○
Habitat improvement	●●●●●●●○●○●○●○
Climate resilience	●●●○●○●○●○●○●○
Amenity	
	●●●●○●○●○●○●○●○
Cost:	
Setup	●●●●●●●○●○●○●○
Maintenance	●●●○●○●○●○●○●○

How does it help?

- Creates an area for a large volume of water to be held back during heavy rainfall events, reducing flood risk downstream;
- Can create new habitats by holding some water all year round, creating small ponds;
- Drains back slowly into the main waterway, so there is no rush of water when released.



Re-naturalising watercourses improves their habitat and flow paths. Restoration may include 'day-lighting' culverts (uncovering watercourses that have been forced into underground man-made channels) or undoing 'straightening' of rivers - giving them room to flow more slowly and meander naturally, using their natural floodplains.

NFM Interventions - relative benefits and costs:

Flooding reduction:	
River/stream	●●●●●●●●○○
Surface/ground	●●●●○○○○○○
Environmental benefits:	
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Climate resilience	●●●●●●●●○○
Amenity	
	●●●●●●●○○○
Cost:	
Setup	●●●●●●●●○○
Maintenance	●●○○○○○○○○

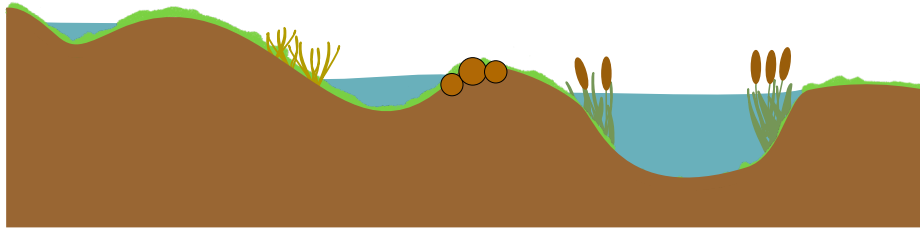
This 'canalised' river in the Lake District is separated from its floodplain, resulting in rapid run-off downstream



At 'Newbald Beckies', the beck is well-connected to its floodplain and spills on to it in time of high flow, making more space for the water and improving biodiversity

How does it help?

- Creating bends in the river slows the water down by making it take a longer route, giving more capacity and a shallower gradient;
- Floodwater can be held on the floodplains and discharge slowly back into the watercourse once the storm peak has passed;
- Restoration can help to create a more biodiverse environment by creating wet woodlands and wetlands.



A large number of small interventions in the upland environment or wider catchment, for example: blocking grips and gullies (man-made or natural ditches) with a series of dams; restoring peat bogs with sphagnum moss, diverting flow paths in fields, or cross-draining ditches & tracks.

These measures can combine, over large areas, to make a substantial difference to the amount, rate and direction of water run-off from upland areas.

NFM Interventions - relative benefits and costs:

Flooding reduction:	
River/stream	●●●●●●●●○
Surface/ground	●●●●●●●●●●
Environmental benefits:	
Water quality	●●●●●●●●○
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Amenity	
	●●●●○●●○
Cost:	
Setup	●●●●●●●○
Maintenance	●●○●○●○●○



This simple stone cross-drain intercepts water on the footpath and prevents it eroding and rushing down the track



Timber weirs and coir mats block these gullies and help to re-wet this upland area, increasing its biodiversity and reducing run-off

Pendle Hill

© Stuart Bradshaw

How does it help?

- Improves the efficiency of bogs, allowing more water to be soaked up, like a huge sponge;
- Can reduce the amount of sediment entering the watercourse;
- Dams and drain blocking slow down the amount of water leaving moorlands to a more steady rate;
- Climate regulation through the increase in captured carbon.

Further Information

As well as the contact websites on the previous page, the following sources of information may be useful:

National Flood Forum

A charity to help, support and represent people at risk of flooding. Also, a great source of information and advice.

<https://nationalfloodforum.org.uk/>

Slowing the Flow at Pickering

A summary of pioneering work upstream of Pickering, on the edge of the North York Moors

<https://www.forestresearch.gov.uk/research/slowing-the-flow-at-pickering/>

Calderdale: Natural Flood Management - What consents and approvals do I need?

A useful reminder that it is not as simple as just getting stuck in - consents or approvals may be required. For example: planning, ordinary watercourse, environmental permit, felling licence.

<https://eyeoncalderdale.com/Media/Default/NFM/Natural-Flood-Management-Guide-2020.pdf>

Lowland Natural Flood Management Measures – a practical guide for farmers

A detailed guide to different levels of NFM interventions, their costs and benefits.

https://www.ydrt.org.uk/wp-content/uploads/2021/04/DVRN_lowland_NFM.pdf

Yorkshire Dales: Natural Flood Management Measures – a practical guide for farmers

Similar to the above but with examples of Upland NFM

<https://www.ydrt.org.uk/wp-content/uploads/2021/04/YDNP-NFM-handbook.pdf>

Working with Natural Processes (WWNP) – Evidence Base

An Evidence Directory which summarises the effectiveness of WWNP measures from a Flood and Coastal Risk Management (FCRM) perspective as well as their wider ecosystem service benefits.

<https://catchmentbasedapproach.org/learn/working-with-natural-processes-evidence-base/>

Natural Flood Management Toolbox: a 7 step guide to developing NFM schemes

A detailed guide to implementing NFM by the Environment Agency

<https://catchmentbasedapproach.org/learn/natural-flood-management-toolbox-a-7-step-guide-to-developing-a-nfm-scheme/>

West and North Northamptonshire Councils: Flood Toolkit

An impressive resource of information by a pioneering Lead Local Flood Authority (LLFA), including the 'Flood Library' of guidance documents.

<https://www.floodtoolkit.com/pdf-library/>

UK Government: River maintenance, flooding and coastal erosion

Landing page for UK Government Information on Flooding

<https://www.gov.uk/environment/river-maintenance-flooding-coastal-erosion>

The Environmental Land Management scheme: an overview

Explains what the Sustainable Farming Incentive, Local Nature Recovery and Landscape Recovery schemes are, and how you can get involved.

<https://www.gov.uk/government/publications/the-environmental-land-management-scheme-an-overview>

Contact Us

If you would like to know more about implementing NFM measures on your land or in your area, please take a look at the online resources for **Slow The Flow** (based in Calderdale, West Yorkshire) or **West Wolds Slow the Flow** (based in East Yorkshire), and if you have further queries do get in touch.

We are keen to share our knowledge and contacts to further the implementation of widespread NFM – but please note that, as volunteer-run organisations, we have limited resources. We will do our best to be as responsive as possible.



Slow The Flow is a registered charity working to advance the education of the public in Natural Flood Management, Sustainable Drainage Systems and other renewable methods of managing the environment, including the exploration of alternative practices which safeguard the natural environment and its resources in a manner which best fits the specifics of a local geography.

Slow The Flow was set up to look at the issue of why and how the Calder Valley floods and to look at natural flood prevention measures and solutions to slow the volume of water which comes down the hillsides into the River Calder.

<https://slowtheflow.net>

West Wolds Slow the Flow

West Wolds Slow the Flow is an informal partnership, of like-minded individuals and organisations, which aims to reduce flooding in the West Wolds villages and surrounding areas using nature-based solutions. Geographically, we cover the parishes of Newbald, Hotham, North Cave, South Cave, Ellerker and Brantingham, which roughly corresponds with the 'Mill Beck Catchment'.

Vision

To use nature-based solutions to reduce flooding in our area, whilst achieving multiple benefits such as improvements to biodiversity, amenity and water quality. This involves working in partnership with local residents and businesses, landowners and farmers, parish and county councillors, and officers of the Flood Risk agencies: East Riding Flood Risk Management, Environment Agency, Yorkshire Water and the Ouse and Humber Internal Drainage Board

<https://www.westwoldsslowtheflow.org.uk>