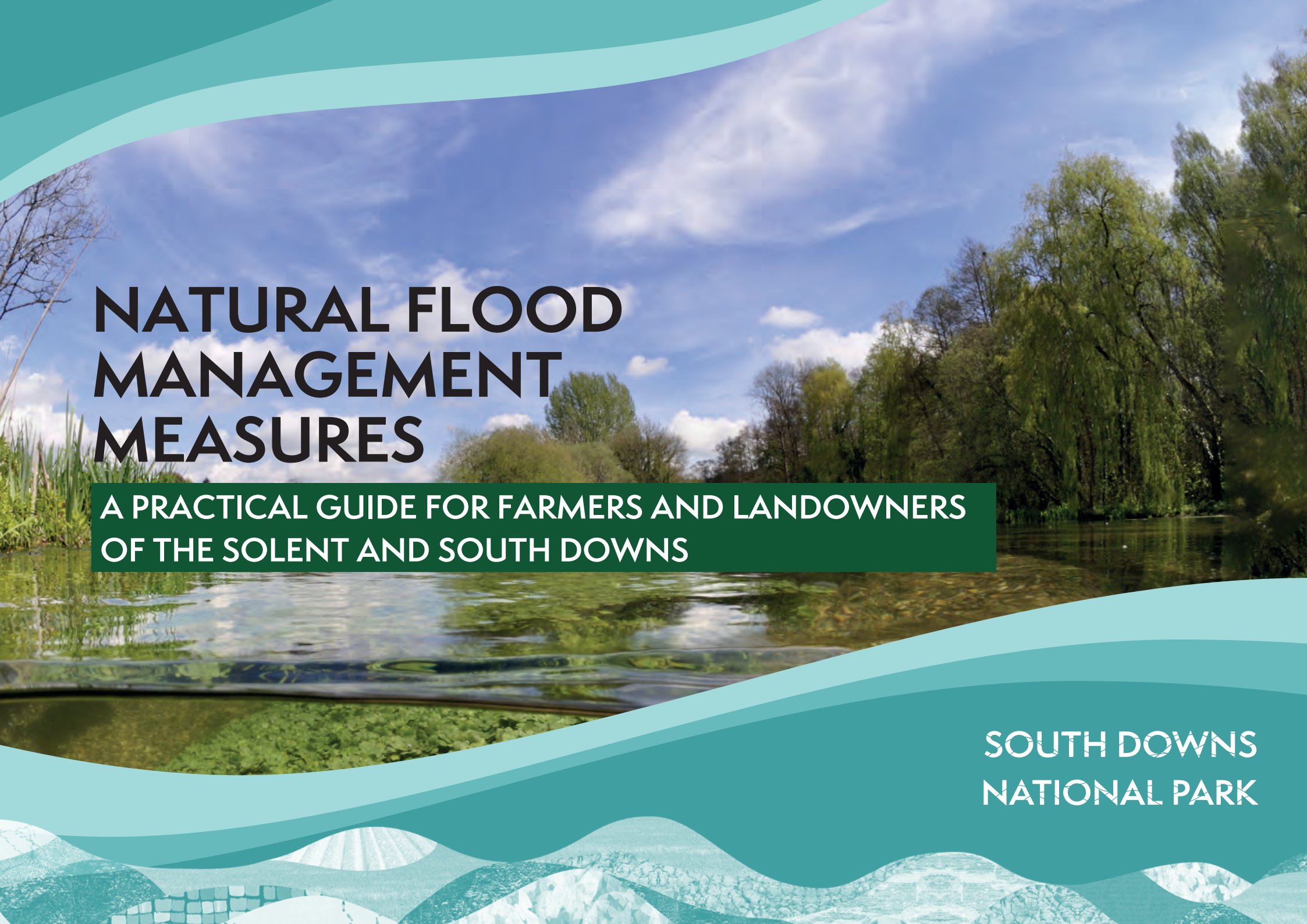

NATURAL FLOOD MANAGEMENT MEASURES

A PRACTICAL GUIDE FOR FARMERS AND LANDOWNERS OF THE SOLENT AND SOUTH DOWNS

SOUTH DOWNS NATIONAL PARK

This guide has been produced for landowners and land managers in the Solent and South Downs, to provide simple, clear advice on the delivery of Natural Flood Management measures. The guide has been put together by the South Downs National Park Authority (SDNPA) and Sussex Flow Initiative (SFI), with support from the Environment Agency (EA).

If you have any comments or need further information about this publication, please contact sussexflowinitiative@gmail.com or visit **sussexflowintiative.org**.

This document is based on the publication 'Natural Flood Management Measures – a practical guide for farmers (2017),' which was requested by 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.

The information in this brochure is intended to be a guide to Natural Flood Management (NFM) and is not definitive. Details relating to localised circumstances may not be included. Readers are advised to seek full advice both from Lead Local Flood Authorities and other NFM experts before acting on any of the recommendations in this brochure.

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.

The Sussex Flow Initiative & South Downs National Park Authority do not accept any liability for those implementing the recommendations outlined in this report.

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River Ouse

SOUTH DOWNS
NATIONAL PARK

Environment
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Contents

Restoring meanders © Environment Agency

1. Introduction

Floods are nothing new. Humans have lived with extreme weather for thousands of years. However, climate change is bringing an increase in the occurrence and severity of high rainfall events and droughts. Subsequent increases in extreme flooding and water shortage are following suit.

1.1 In the UK our flood risk management systems include large-scale, hard engineered flood defences in and around major urban areas, small-scale engineered solutions for rural communities and farmland, and coastal sea defences. More recently, there has been a move to show how a naturalistic approach to management of water in the wider countryside can contribute to the UK's flood risk management system. This is known as **Natural Flood Management** (NFM), and Working with Natural Processes (WwNP).

WHAT IS NATURAL FLOOD MANAGEMENT?

1.2 NFM uses natural methods to reduce the downstream maximum water height of a flood (the flood peak) or to delay the arrival of the flood peak downstream. This helps to increase the time available for people to prepare for floods and decrease the damaging impacts that these floods can have.

1.3 NFM works by delaying the progress of water through a catchment using a range of techniques. These techniques work with the natural features

Burton Pond © Natural England

of the landscape to temporarily slow down or store flood waters. They rely on one, or a combination, of the following mechanisms:

1. **Increasing soil infiltration:** a healthy open soil structure will enable more water to infiltrate and be held by the soil, reducing surface water runoff.
2. **Evaporation:** from vegetation and soil makes space for water.
3. **Slowing water:** by increasing resistance to its flow – for example, by planting floodplain or riverside woods, or blocking grips on heathland.
4. **Storing water:** by using, and maintaining the capacity of, ponds, ditches, floodplain washlands or scrapes.
5. **Reducing water flow connectivity:** by interrupting surface flow pathways of water – for example, by having buffer strips of grass, or planting hedges and trees.

1.4 NFM measures are designed so that they do not significantly impact on farming. They are typically small in size, cheap to install, easy to remove/maintain, and can be placed in locations which have minimal impact on farm operations. They can also have a positive impact by storing water for livestock or irrigation.

1.5 Each structure or measure stores or attenuates a small amount of runoff, gradually releasing flood water over 1 to 24 hours. By having multiple NFM measures throughout a river catchment, NFM works cumulatively both local to where the measures are installed and further downstream.

1.6 NFM is one of many tools we can use to manage flood events and water levels by taking a catchment wide approach. It is most effective at reducing the frequency of flooding for high probability/frequent low-level fluvial events (5% chance of happening in any year, or 1 in 20 return period) compared to extreme flood events (0.5% chance of happening in any year, or 1 in 200 return period), but it can significantly reduce the impact of both events. There are some flood events that even hard engineering cannot deal with. However, used in conjunction with other engineering flood management solutions, NFM will have a beneficial impact on slowing the flow of flood water downstream. Research at several small-scale catchments has shown this to be the case. NFM measures can also help you to make your land more resilient to drought by seasonally storing more water on the land.

WHAT CAN NATURAL FLOOD MANAGEMENT DO FOR YOU?

1.7 NFM can not only provide you and others with flood and drought resilience, it can also:

- Provide carbon storage, shade and forage for livestock and wood for harvesting.
- Protect valuable soils.
- Help buffer your farm from extreme drought.
- Enhance wildlife on your farm.
- Buffer noise and air pollution.
- Increase natural pollination.

WHAT NATURAL FLOOD MANAGEMENT CAN YOU DO?

1.8 There are a lot of NFM measures, a few that you could use on your farm include:

- Planting cross-slope hedgerows.
- Planting or allowing natural regeneration of cross-slope, riparian and floodplain woodlands.

- Installing leaky woody dams across flow pathways and in channels.
- Digging or de-silting ponds.
- Soil restoration and conservation.
- Encouraging rougher (meadow/woodland) vegetation and buffer strips.
- Intercepting surface water with swales and sediment traps.
- Ditch management/re-profiling.
- Increasing seasonal storage through creation of wader scrapes.
- Wetland creation through opening up floodplain washlands and restoring meanders.
- Coastal and river flood defence re-alignment.

HELP US KEEP TRACK

1.9 If you choose to implement an NFM technique on your land, let us know:

- The date you carried out NFM work.
- Which NFM methods you used.
- The size and number of NFM measures that you implemented.

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

Send the above details to: **sussexflowinitiative@gmail.com**

© SDNPA

2. Using the guide

This guide has been developed to provide you with the advice and key information you need to make decisions about installing Natural Flood Management (NFM) on your farm. Where possible, we have included funding sources to support the work you may want to undertake.

2.1 The NFM measures have been grouped into three different levels:

Level 1 – Measures requiring minimum or no consultation with authorities such as the Local Authority, Local Internal Drainage Board or Environment Agency (EA) consent. 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 at 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.

2.2 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:

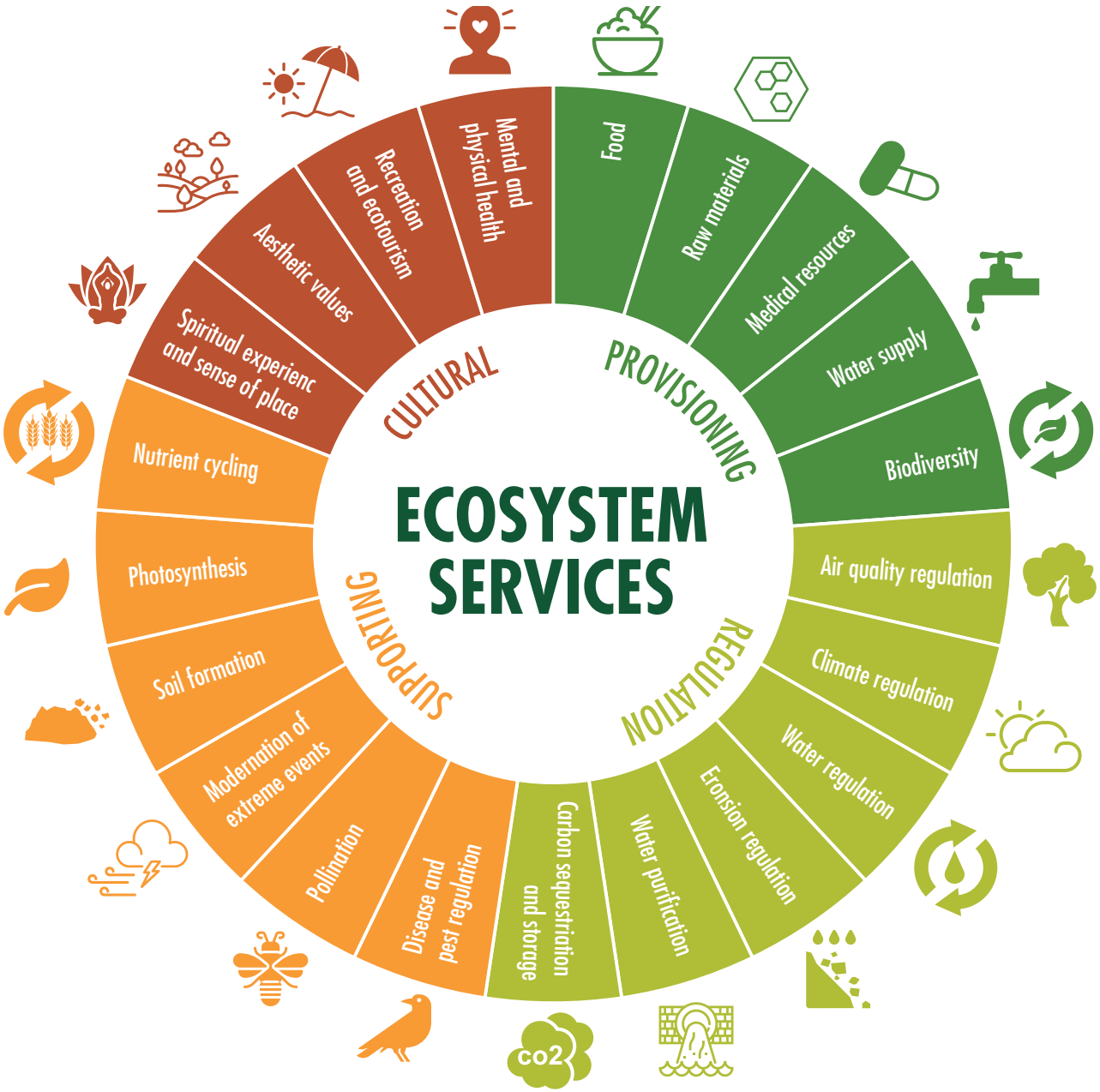
SET UP COSTS:

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.

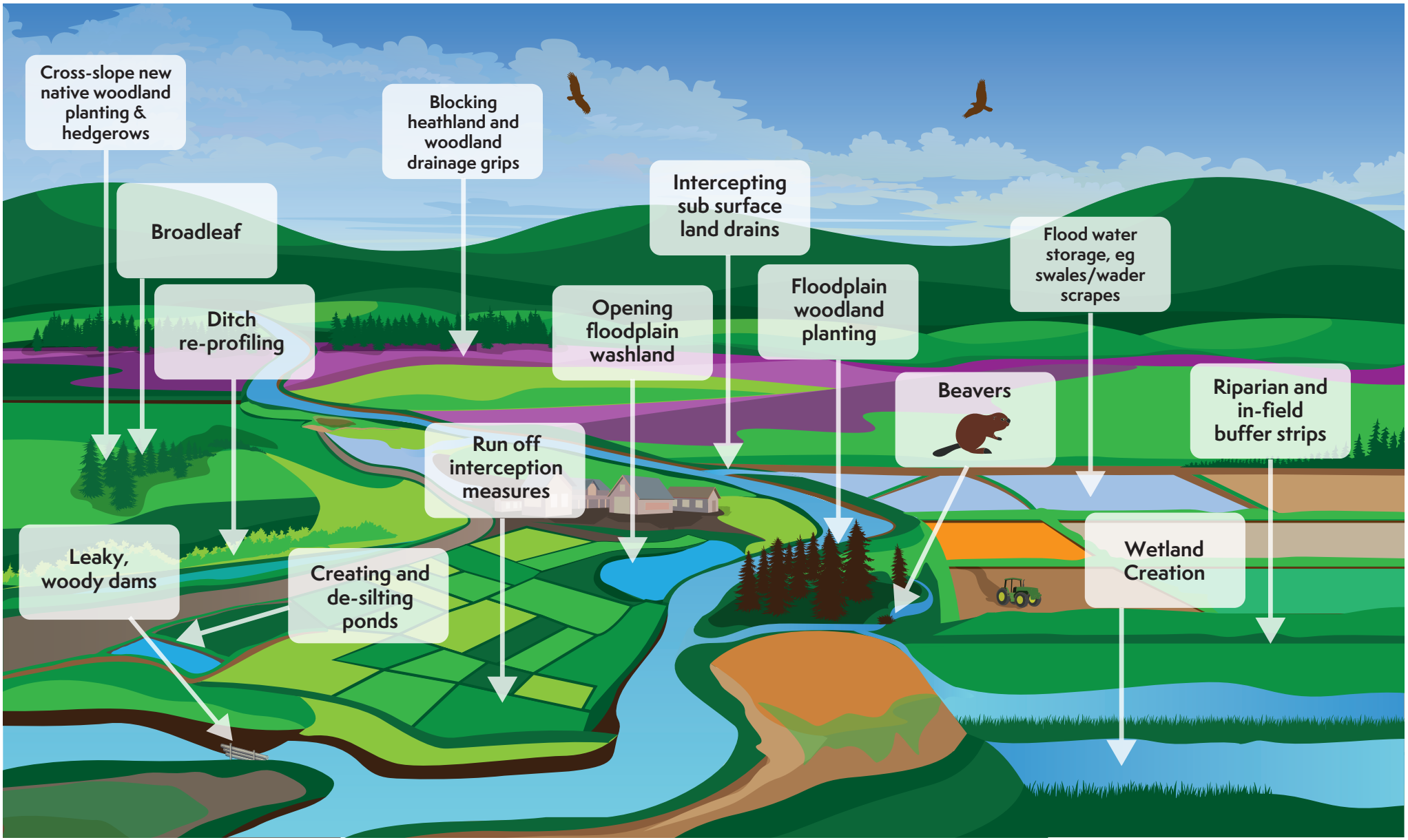
MAINTENANCE COSTS:

High	Expert advice or equipment required to be brought in frequently (e.g. < 5 years).
Medium	Expert advice or equipment required to be brought in occasionally (e.g. < 10 years).
Low	Mostly involves routine inspections and low-grade management, which can be undertaken by the land manager.

2.3 The ecosystem services delivered by each measure are summarised in the following diagram, with the delivered service highlighted under each intervention.



2.4 This diagram shows possible locations of natural flood management measures. Each measure is most effective in different locations within the landscape.



Floodplain connection © Sussex Flow Initiative

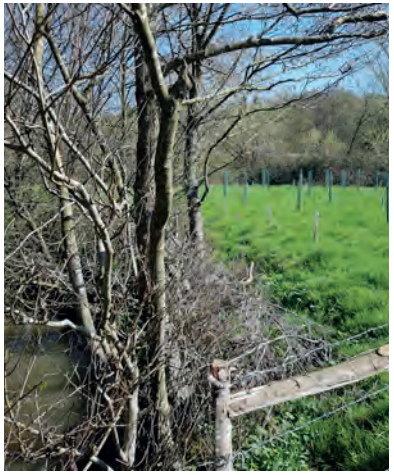
3. Natural Flood Management Measures: Level 1

Consents for Level 1 operations may be required when located within 8m of a watercourse. Further information can be found at **www.gov.uk/guidance/flood-risk-activities-environmental-permits**

PLANTING HEDGEROWS

Hedgerows provide excellent natural weather barriers, protecting crops, soils and livestock, providing ideal food and habitat for farmland birds, insects and other wildlife, and performing an NFM function by trapping and slowing sediment and water flow.

Hedgerows are an intrinsic part of the landscape within many areas of the National Park and were originally used to divide the land into fields and pens, marking the boundaries of farms and parishes. Healthy hedge networks create green corridors between woodlands and other habitats for wildlife to travel along. Hedges are also natural carbon stores, and help with climate resilience.



© Sussex Flow Initiative

Natural flood management purpose

- Reducing the volume of runoff by promoting infiltration into the soil.
- Creating a physical barrier to surface water runoff.
- Remove water faster from the soil than crops during periods of excessive rainfall through evapotranspiration.
- Trap sediment and reduce sediment flow into watercourses.

PLANTING HEDGEROWS

Agricultural and environmental benefits

- Hedgerows create areas of shelter and shade for livestock.
- Trap and filter runoff, preventing loss of soils.
- Plant and soil health may be improved through reductions in standing water from increased infiltration rates.
- Animal health may be improved through reductions in standing water from increased infiltration rates, and through the availability of medicinal hedgerow forage (i.e. willow, ivy, hawthorn berries and elm).
- Hedgerows provide a barrier to the spread of disease, reducing animal-to-animal contact.
- Hedgerows are a food source of leaves, fruits and nuts for wildlife.
- Hedgerows provide habitat for farmland birds and beneficial insects and pollinators.
- Hedgerows act as barriers between fields and protect crops from wind and storm damage.

Ecosystem Service

Provisioning Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply.

Regulating Air quality regulation**,** Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events.

Supporting Soil formation, Photosynthesis & Nutrient Cycling.

Cultural Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

PLANTING HEDGEROWS

Methods

- Planting a double staggered row hedge using 4-6 plants per metre, with a distance between the two rows of 0.4-0.5m. Plant a standard (larger) tree every 6 metres between these rows.
- Use spiral guards (0.45metres tall) to protect young plants from rabbit damage. Protect both sides of a new hedge with a stock proof fence, erected at least 1 metre from the centre of the hedge.
- Having hedgerow trees within the hedge will increase its biodiversity value, protected by 1.2 metre tree guards.

Considerations

- Planting should be carried out between November and February.
- Up to 75% of the species can be thorns – for example, hawthorn and blackthorn.
- Consider a mix of shrub species, including hazel, spindle, field maple, holly, elder, willow, hornbeam, wild service, dogwood and dog rose, to enhance hedgerow for wildlife. Consider native fruit trees such as damson and apple.
- Bear in mind local tree diseases – elm, sweet chestnut, ash, guelder rose and alder may not be locally appropriate if tree diseases are present.

Level of maintenance

Medium

Newly planted hedges will require annual maintenance until at least 1.5 metres tall, particularly with regard to weed control within the guards.

Hedgerows can be cut every two years or more once established.

The laying of a hedge every 12-15 years if 'gappy' at the base will increase wildlife benefits, the overall health of the hedge and improve stock proofing.

PLANTING HEDGEROWS

Key locations

- Consider planting a new hedge across a slope where runoff occurs, particularly at the base of a slope.
- Plant perpendicular to the river in a floodplain.
- Where hedgerows have been lost from historic field boundaries.

Costs

Set up: Medium

Maintenance: Low

Funding

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

The Environmental Land Management (ELM) scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.

Woodland Trust (WT)

Local grants may be available for planting for wildlife, climate mitigation, natural flood management and carbon storage.

Additional information

Countryside Stewardship (CS) scheme

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

woodlandtrust.org.uk/plant-trees/large-scale-planting/morehedges

woodlandtrust.org.uk/media/1816/benefits-of-trees-on-livestock-farms.pdf

assets.sussexwildlifetrust.org.uk/benefits-of-trees-to-arable-farms-evidence-report.pdf

sussexflowinitiative.org/hedgerows.html

WOODLAND PLANTING AND NATURAL REGENERATION

Woodlands can contribute to a host of Natural Flood Management (NFM) outcomes in floodplain and riparian areas, and in the wider landscape. This can be achieved through allowing/ encouraging natural regeneration or tree planting, which will provide important wildlife habitat, increased canopy shade, shelter and habitat for wildlife, as well as a direct physical barrier to water. Trees also provide shade and shelter for livestock, and can prevent damage to crops and soil erosion.

Increasing tree coverage can be anything from planting shaws, copses, new woodlands or Agro-forestry (integrating beneficial trees with agricultural production). All will help to control and reduce flood run off during heavy rain.

© Sussex Flow Initiative

Natural flood management purpose

- Increasing the 'roughness' of vegetation, creating a physical barrier which slows the flow of water during a flood event.
- Reducing the volume of runoff, by promoting water infiltration into soil.
- 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% for some types of woodland.
- Woodland soils typically have an open, organic, rich upper layer, which facilitates the rapid entry and storage of rain water – a 'sponge' effect. Leaf litter on woodland soils also acts like a sponge.
- The roots of bankside trees and associated vegetation help to bind and strengthen stream banks, reducing the risk of bank collapse, erosion and siltation.
- Reducing compaction of woodland soils from heavy machinery helps protect soil structure.

WOODLAND PLANTING AND NATURAL REGENERATION

- Floodplain woodlands in the right place act as a direct physical barrier to river flood water.
- Trees in headwaters help to reduce rapid run-off from steep slopes as well as climate proofing rivers thorugh river shading.

Agricultural and environmental benefits

- Creating areas of shelter and shade for livestock.
- Reduce floodwater damage on productive farm land.
- Trap and filter runoff, preventing loss of fertilisers, sediment and pesticides.
- Cuttings can be used as tree forage for livestock.
- Opportunities for added value, e.g. from bioenergy, wood fuel, building materials, fencing products and agroforestry to cricket bat production.
- Increasing food and shelter for wildlife, and provide pollination benefits.
- Huge long term benefits for carbon storage / climate proofing.

Ecosystem Service

Provisioning Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply

Regulating Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events

Supporting Soil formation, Photosynthesis & Nutrient Cycling

Cultural Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

Methods

- The optimum area to be planted and tree mix varies at each potential site – consult a local expert for advice i.e. Woodland Trust.
- Reducing or removing grazing pressure will enable natural tree regeneration. Natural regeneration can be as, or more effective, for NFM and wildlife.

WOODLAND PLANTING AND NATURAL REGENERATION

Considerations

- Make sure you put trees in the right place i.e. not on species rich grasslands or other priority habitat.
- Consider whether tree planting or natural tree regeneration is right for you.
- Infrastructure and/or individual protection required to protect from livestock, deer etc. during establishment.
- Under-planting of shrubs and young tree saplings improves the infiltration rates and roughness of existing woodland.
- Link up with existing woodland or hedgerows to create a wildlife corridor effect.

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 woodland becomes established. Guards will need to be removed when the trees are grown.

Key locations

- Throughout the catchment, in particular upper catchment areas.
- Across slope following a contour.
- Creating links between woodlands and features.
- Alongside watercourses.
- Perpendicular to river floodplains BUT this needs consent from the Environment Agency and/or Lead Local Flood Authority. Check with an expert that it will not cause flood risk.

Costs

Set up: Medium

Maintenance: Low

WOODLAND PLANTING AND NATURAL REGENERATION

Funding

- Countryside Stewardship (CS) scheme – higher and mid tier.
- The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
- Woodland Trust (WT).

Additional information

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

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

woodlandtrust.org.uk/plant-trees/large-scale-planting/morewoods

assets.sussexwildlifetrust.org.uk/wt-trees-for-water-leaflet.pdf

sussexflowinitiative.org/woodlands.html

HEALTHY SOILS

Soil is one of the most important habitats on the planet. Around 95% of the food we eat comes from soil. UK soils hold nearly 10 billion tonnes of carbon, and a quarter of all known species on Earth live in soil.

Healthy organic matter (plant and animal residues) in soil, helps it to perform these functions, to prevent floods and to mitigate the effects of drought. Healthy soil can store one and a half Olympic swimming pools of water per hectare, but every minute we lose 30 football pitches of fertile soil. Damaged soil loses its ability to support plant growth, and can erode away. It can take up to 1,000 years for a single centimetre of topsoil to re-form.

Soil husbandry is therefore crucial for natural flood management and much more.

© Ouse and Adur Rivers Trust

Natural flood management purpose	■ Reduced overland flows and lower flood risk. ■ Increased water holding capacity of soils. ■ Improved connectivity with groundwater. ■ Healthier vegetation, helping to slow the flow. ■ Increased water infiltration through healthy roots and soil pores.
Agricultural and environmental benefits	■ More efficient crop growth and stronger roots. ■ Enhanced soil/plant water uptake. ■ Improved crop nutrient uptake and use. ■ Reduction in cultivation costs. ■ Reduced water runoff, soil loss and poaching. ■ Improved air exchange between the soil and atmosphere. ■ Enhanced heat and drought stress tolerance. ■ Enhanced beneficial soil biology – for example earthworms.

HEALTHY SOILS

Ecosystem Services	**Provisioning** – Food, Biodiversity & Water Supply **Regulating** – Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification & Moderation of extreme events **Supporting** – Soil formation, Photosynthesis & Nutrient Cycling **Cultural** – A healthier and more accessible natural environment.
Methods	■ Assess current soil health – structure and soil biodiversity. ■ Present soil condition and land use will dictate the regenerative agricultural approach to restoring soils.
Considerations	■ Consider all archaeological features before starting any mechanical treatment, to reduce archaeological damage – particularly where operations are new.
Level of maintenance	**Low**
Key locations	■ All fields, particularly where water is seen to flow across the surface during high rainfall; winter grazed; or soils vulnerable to erosion / compaction. ■ Any field where an impact on crop development is seen. ■ Areas such as gateways and headlands used for travelling.
Costs	**Set up: Low** **Maintenance: Low**

HEALTHY SOILS

Funding

- The current 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. As well as 'winter cover crops' or 'enhanced maize management'.
- The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
- Farmers can use their Ecological Focus Area (EFA) fallow options to create buffers.

Additional information

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

ahdb.org.uk/projects/documents/ThinkSoils.pdf

landis.org.uk/soilscapes

soilandwater.org.uk

Soil Association

Catchment Sensitive Farming

Regenerative Agriculture and Groundswell ag

RIPARIAN AND IN-FIELD BUFFER STRIPS

Natural vegetation can help with Natural Flood Management (NFM) by creating a physical barrier which slows the flow and filters out pollution during floods and heavy rainfall.

Riparian buffer strips are vegetated/grass strips next to watercourses and ditches which create a simple physical barrier between your field and a watercourse. Riparian buffer strips can be used in both arable and pasture fields, protecting the watercourse from soil, chemical and nutrients being washed into it, increasing biodiversity and preventing river bank poaching.

In-field buffer strips can be put adjacent to hedges etc. and across fields. They can reduce overland flow, and soil loss which can impact roads and neighbouring properties. Buffer strips that run across flow paths will reduce runoff, increase water infiltration and slow water flows down more.

Natural flood management purpose

- Increasing the roughness of the land surface, which slows the flow of water and runoff and increases infiltration.
- Vegetation traps sediment, reducing sediment pollution in watercourses.
- Stabilises the banks of watercourses, helping prevent erosion and siltation from river bank material.

RIPARIAN AND IN-FIELD BUFFER STRIPS

Agricultural and environmental benefits

- Buffer strips trap and filter runoff, preventing the loss of fertilisers, soil and pesticides. Ten-metre-wide strips reduce sediment loss by 30%. This aids compliance with the **New Farming Rules for Water**.
- Reduce frequency of ditch management through decreased rates of siltation and weed development from increased nutrient levels.
- Enhance crop management operations by straightening irregular field edges.
- Control or prevent erosion of valuable top soil from fields into watercourses, so reducing levels of silt and contamination by organic wastes.
- Create wildlife corridors and sites for ground nesting birds, small mammals and beneficial insects, including pollinators.
- The root system of the vegetation in the buffer strip absorbs nitrogen, naturally fertilising the soil.
- They help reduce nitrate leaching.

Ecosystem Service

Provisioning Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply.

Regulating Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events.

Supporting Soil formation, Photosynthesis & Nutrient Cycling.

Cultural Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

RIPARIAN AND IN-FIELD BUFFER STRIPS

Methods

- Riparian buffer strips should be a minimum of 6 metres wide for maximum effect, and may require (temporary or permanent) fencing to exclude livestock from the river banks.
- The in-field buffer strips should be a minimum of 2 metres wide – wider buffers and increased vegetation structure will deliver greater benefits. 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. This can be easily achieved by ploughing in opposite ways.

Considerations

- Permanent fencing next to main rivers may require Environment Agency consent.
- Check the Basic Payments Scheme (BPS) handbook for further guidance if the strip is to be fenced from grazing. If the fence is within 3 metres 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.
- If livestock are drinking directly from watercourses, in-field water provision must be in place prior to fencing off access.

Level of maintenance

Low

Key locations

- Throughout the catchment, adjacent to any watercourse, and especially on grazed or arable land next to streams and ditches that suffer from high sediment loads.
- In-field strips on arable land at risk from soil erosion caused by wind and/or water. This option works well alongside other run-off intercepting options, such as contour bunds and hedgerows.
- Areas next to watercourse that flood regularly.
- Across notable surface water flow paths.

RIPARIAN AND IN-FIELD BUFFER STRIPS

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.
- The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
- Farmers can use their Ecological Focus Area (EFA) fallow options to create buffers.

Additional information

Basic Payment Scheme (BPS)

gov.uk/government/news/new-farming-rules-for-water

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

Grass buffer strips and beetle banks
cfeonline.org.uk/1-grass-buffer-strips-next-to-a-watercourse-or-pond

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

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

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

DITCH NATURALISATION

With weather patterns predicted to be more erratic with climate change, holding water back in ditches and encouraging infiltration could also help to mitigate against drought. Some ditches are essential for flood drainage, but others can be naturalised to create a fully functioning floodplain through collapsing incised banks. Naturalised ditch networks can create multiple benefits for people and wildlife, whilst also fulfilling your duties as a riparian owner.

Ditches can be used as a form of pond which help to slow the flow of water into main rivers and streams by holding water during rainfall events.

© Sussex Flow Initiative

Natural flood management purpose	■ Store excess water during heavy rainfall events, encouraging water infiltration into soil, and water storage in times of drought. ■ Instream and bank side vegetation can help to slow the flow. ■ Reduced velocity and erosion of sediment. ■ Backwaters, junction ponds and 2 stage channels (particularly where soil is moved out of the floodplain) provide extra flood storage capacity.
Agricultural and environmental benefits	■ Conserving water into and through drought conditions. ■ Vegetation can trap pollution and sediment leaving farm systems. ■ Increase in biodiversity. ■ Increased groundwater recharge.

DITCH NATURALISATION

Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events **Supporting** Soil formation, Photosynthesis & Nutrient Cycling **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.
Methods	■ Collapsing incised banks. ■ Creating junction ponds, meandering edges and/or creating a 2 stage ditch channel. ■ Adding backwaters and leaky dams.
Considerations	■ Works well together with soil and land management to avoid soil erosion, sediment traps and riparian buffer strips. ■ Site specific advice can be given by Local Drainage Board or Environment Agency, especially in particularly flat or pumped catchments. ■ Consult Lead Local Flood Authority where obstructions are being placed in the channel. ■ Precautions will need to be made if protected species are present, such as nesting birds, great-crested newts and water voles.
Level of maintenance	**Low**
Key locations	Ditches and artificial drainage channels throughout the catchment, mainly found on low-gradient agricultural land.
Costs	**Set up: Low** **Maintenance: Low**

DITCH NATURALISATION

Funding

- Countryside Stewardship (CS) Scheme – mid tier.
- The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.

Additional information

Association of Drainage Authorities (ADA). Value of Water Level Management

The River Trusts – Managing Ditches
theriverstrust.org/media/2017/04/Pinpoint-21.0-Soil-Management-Managing-ditches.pdf

The Drainage Channel Biodiversity Manual
ada.org.uk/wp-content/uploads/2017/01/The-Drainage-Channel-Biodiversity-Manual.pdf

© Sarah Wilder

4. Natural Flood Management Measures: Level 2

LEAKY WOODY DAMS

Leaky dams can be constructed in watercoures or ditches, across flow paths, or just across the top of a watercourse to deflect high flows. Water is stored within the channel behind simple, constructed dams, preferably using local woody material harvested from site, or kicked out across floodplains using pinned tree trunks called bank top diverters. Something as simple as a brash bundle can be pinned across a flow path, reducing the downstream flood peak by slowing the flow.

Natural flood management purpose	■ Reducing and slowing flood flows. ■ The dams are created to be leaky, draining the trapped water once the flood period has passed. ■ Leaky woody dams 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 and environmental benefits	■ These structures can successfully reduce localised flooding within the farm holding. ■ Increase in biodiversity. ■ Conserve surface water.

LEAKY WOODY DAMS

Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.
Methods	■ 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. ■ 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.

LEAKY WOODY DAMS

Considerations

- All leaky dams on or in a ditch or channel will need an Ordinary Watercourse Consent from your Lead Local Flood Authority, or EA consent if within a main river.
- Be aware of your local stream's conditions during both low and flood flows. Water levels can vary greatly in different seasons, the barrier may need to be secured more than you think.
- Protected or sensitive sites such as an ancient or ghyll woodland, Site of Special Scientific Interest, Special Area of Conservation, or if it has sensitive archaeology – liaise with the appropriate organisation.
- Avoid barriers within 30 metres upstream and downstream of any bridge, footpath, culvert, road or track.

Level of maintenance

Low

Large woody dams will need periodic checking to ensure the logs are still secure in the right position.

Key locations

- Generally suited to a variety of watercourses and ditches throughout the catchment, where holding water back is not going to create additional problems.
- Areas of woodland away from sensitive areas (houses), where the supply of materials is readily available or where naturally fallen trees could be employed.
- Areas of woodland, 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

LEAKY WOODY DAMS

Additional information

woodlandtrust.org.uk/media/1764/natural-flood-management-guidance.pdf

theflowpartnership.org/stroud

sussexflowinitiative.org/wood-in-rivers.html

catchmentbasedapproach.org/wp-content/uploads/2019/05/190521-Assessing-the-risk.pdf

sussexflowinitiative.org/uploads/1/6/3/1/16313516/sfi_lwd_guidance_booklet_nfm_final.pdf

sussexflowinitiative.org/uploads/1/6/3/1/16313516/kiln_wood_case_study.pdf

sussexflowinitiative.org/uploads/1/6/3/1/16313516/case_study_fore_wood.pdf

sussexflowinitiative.org/uploads/1/6/3/1/16313516/prickeridge_farm_case_study_final.pdf

POND CREATION AND ENHANCEMENT

Ponds are a 'transition zone' between land and water. Attracting and supporting a huge diversity of wildlife, as well as storing water and being an attractive landscape feature. In periods of drought, ponds are oasis's in a desert; they can provide water for livestock and wildlife to drink. They are hugely important in storing carbon and mitigating climate change.

The features themselves can take many forms, but normally comprise an excavation located on a surface runoff pathway or are created making use of the natural topography of the landscape.

© Sussex Flow Initiative

Natural flood management purpose	■ Increase water storage.
Agricultural and environmental benefits	■ Retaining surface water onsite. ■ Increase biodiversity.
Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

POND CREATION AND ENHANCEMENT

Methods	■ Design should be site specific and take into account the contour of the surrounding land, the position in the landscape, and the soil type. ■ Sides should gradually slope to increase opportunity for marginal vegetation and draw down zone, to maximise biodiversity value. Gradual sloping sides enable wildlife to escape the pond safely. ■ The size and depth will depend on the location, the larger the pond the greater thermal capacity and the period it will retain water. ■ Variation in the depth to enable the natural colonisation of aquatic plants. ■ Allow to fill from rain water.
Considerations	■ Ponds are not intended to treat wastewater or effluents. ■ 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	**Low** Ponds may need periodic desilting or vegetation removal to ensure they retain biodiversity and Natural Flood Management value.
Key locations	■ Within an area where surface runoff flows downhill. ■ Adjacent to, or within, ditches where 'junctions' meet. ■ Lowest/dampest part of a field. Whether there is a natural recharge of water (i.e. a spring or rain water)
Costs	**Set up: Low (dependent upon scale and utilising natural subsoil for lining)** **Maintenance: Low**

POND CREATION AND ENHANCEMENT

Funding	■ Countryside Stewardship (CS) scheme. ■ The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
Additional information	**Sussex Wildlife Trust – Pond creation and enhancement** **assets.sussexwildlifetrust.org.uk/pond-creation.pdf** **Freshwater Habitat Trust** **freshwaterhabitats.org.uk/projects/million-ponds/pond-creation-toolkit/#Advice%20factsheets** **gov.uk/government/collections/basic-payment-scheme** **sussexflowinitiative.org/flood-storage-ponds.html**

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SEDIMENT TRAPS

Sediment traps are small- to medium-scale runoff attenuation features that can provide localised slowing and conserving surface flood water on a holding. Used across a catchment, the cumulative result is a reduction in flood peaks downstream.

In addition, these features can benefit water quality by retaining soils and nutrients, effectively minimising the ability of faecal bacteria and fertilisers from reaching the watercourses through runoff.

The features themselves can take many forms, but normally comprise an excavation located on a surface runoff pathway or are created making use of the natural topography of the landscape. Runoff is retained in the depression for a short period by a mechanism such as an earth bund, sluice or leaky dam which allows the slow release of the water. This allows the sediment to settle out while the water in the trap drains down over a period of 24 to 48 hrs.

Soils and nutrients retained in the traps require periodic removal to maintain the storage capacity.

© Sussex Flow Initiative

Natural flood management purpose

- Increase water storage.
- Reduce siltation of watercourses, thereby maintaining their capacity.
- Used as a pre-treatment for other natural flood management measures, such as retention ponds.

Agricultural and environmental benefits

- Improve water quality.
- Retaining surface water onsite.
- They retain washed-off top soil which can be re-spread to land.

SEDIMENT TRAPS

Ecosystem Service

Provisioning Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply.

Regulating Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events.

Supporting Soil formation, Photosynthesis & Nutrient Cycling.

Cultural Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

Methods

- Optimum position of sediment traps is often indicated by the preferred flow path of water in times of heavy rain or when the land in saturated.
- Position can also be indicated by heavy sediment in local watercourses.
- Design should be site specific and take into account the contour of the surrounding land, the position in the landscape, and the soil type.
- Consider ease of future maintenance e.g. access for machinery.
- 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 de-silting.

Considerations

- 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.

SEDIMENT TRAPS

Level of maintenance	**Medium** 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. ■ Lowest/dampest part of a field.
Cost	**Set up: Low (dependent upon scale)** **Maintenance: Medium**
Funding	■ Countryside Stewardship (CS) scheme. ■ The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
Additional information	**Rural Sustainable Drainage Systems (RSuDS)** **assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291508/scho0612buwh-e-e.pdf** **Basic Payment Scheme (BPS) criteria** **gov.uk/government/collections/basic-payment-scheme** **sussexflowinitiative.org/flood-storage-ponds.html**

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MODIFYING DRAINAGE GRIPS

Drainage grips have resulted in changes in biodiversity and water flow paths, increasing flood peaks. These redundant drainage features speed up the removal of water and cause erosion, increasing sediment entering streams and rivers.

Blocking of grips restores natural mire and wet woodland communities. Their restoration increases carbon storage, reduces soil erosion, and creates more resilient landscape to climate change and wildfires.

Blocking drainage grips will help slow the flow of water into main rivers and streams by holding water during rainfall events. With rainfall patterns predicted to change in the future holding water onsite will make the site more resilient to drought conditions.

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Natural flood management purpose	■ Areas restored via grip blocking become wetter, with higher water tables and subsequent positive vegetation recovery, increasing the sponge effect. ■ Restoration can increase flood storage volume. ■ Blocked grips slow down the water that would otherwise flow quickly through the soil of the grips, which in turn reduces the energy of the water and its capacity to erode and carry sediment.
Agricultural and environmental benefits	■ Blocking grips is safer for livestock and can reduce the numbers of lost livestock in deep gullies and grips. ■ Greater resiliency to wildfires and climate change. ■ Reduction in maintenance cost of tracks. ■ Soil erosion is reduced. ■ Increase in biodiversity.

MODIFYING DRAINAGE GRIPS

Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.
Methods	■ Design and dimension are entirely site dependent, with number, type and material for blocks varying according to the ground conditions, depth of erosion, and slope. ■ Heather bales or vegetation for the site can be utilised. ■ Digging up, breaking and back filling historic land drains. ■ Creation of leaky dams with woody debris.
Considerations	■ Need to get advice on whether blocking drainage network will be beneficial for the ecology of the site. ■ Any work undertaken should not conflict with protected species and designation of site. ■ Consider all archaeological features before starting any mechanical treatment, as these can be damaged.
Level of maintenance	**Low**
Key locations	■ Areas of degraded heathland. ■ Woodlands.
Cost	**Set up: Low** **Maintenance: Low**

MODIFYING DRAINAGE GRIPS

Funding

- Countryside Stewardship (CS) scheme.
- The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.

Additional information

Wet Heath – CaBA

catchmentbasedapproach.org/wp-content/uploads/2018/09/CaBA-Biodiversity-Pack-Wet-Heaths.pdf

Grip Blocking – RSPB

rspb.org.uk/globalassets/downloads/documents/farming-advice/gripblockingadvisorysheet_england_207527.pdf

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INTERCEPTING SUB SURFACE LAND DRAINS

In some circumstances land drains are historic relics which are no longer needed for agricultural cultivation, or have collapsed. With an increase in the frequency and length of drought conditions, these historic land drainages may no longer be desirable as water is lost from the site. This water can be utilised to recharge soil moisture to increase yield or retained in ponds/scrapes for times of drought.

Knowing the location of land drains can make it relatively easy to intercept them, break them, and channel and utilise the water into surface ponds, swales and scrapes to create wetland habitat, and increase drought resilience, and flood storage.

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Natural flood management purpose

- Creating surface water storage areas.
- Slowing the flow and removing sediment, pollution and debris.

Agricultural and environmental benefits

- Additional livestock drinks and on-farm water sources.
- Trapping and storing of sediment, soil and pollution.
- Creation of additional wildlife habitat.

Ecosystem Service (diagram)

Provisioning Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply.

Regulating Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events.

Supporting Soil formation, Photosynthesis & Nutrient Cycling.

Cultural Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

INTERCEPTING SUB SURFACE LAND DRAINS

Methods	■ Utilising farm drainage maps if they exist. ■ Known locations of collapsed land drain can help to locate other drainage lines. ■ Some sub-surface land drains are visible in snow and frost as warmer (less icy) lines across the field. ■ Otherwise Ground Penetrating Radar can be used to locate them. ■ Dig down and remove section of drain pipe.
Considerations	■ The amount of water flowing through your land drains may be more than you anticipate at certain times of year. Make sure that provision is made to prevent erosion by high water flows.
Level of maintenance	**Medium**
Key locations	■ At the break of slope, at the bottom of a cultivated field, where the slope meets the floodplain. ■ In land drained areas which are struggling for summer water. ■ Areas with a slight slope, so that land drains can be broken at intervals, creating a cascading surface water storage system.
Cost	**Set up: Medium to High** **Maintenance:**
Funding	Local NFM projects
Additional information	Example project: **sussexflowinitiative.org/uploads/1/6/3/1/16313516/hillsdown_case_study_final.pdf**

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 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, or levels can be set so that wetland habitat develop by permanently retaining some water.

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Natural flood management purpose	■ Bunds reduce runoff rates by retention and controlled flow release. ■ Reduce volume of runoff by increasing the opportunity for infiltration and evaporation. ■ Trap sediment which can reduce the function of neighbouring watercourses and drainage systems.
Agricultural and environmental benefits	■ Bunds reduce soil loss and surface scour. ■ Provide opportunity for pollutant treatment by allowing settlement and nutrient reclamation. ■ Improved crop yields due to sediment deposited during attenuation (see references for details of the Runoff Attenuation Feature Handbook) ■ Holding water in detention basins and encouraging infiltration could help to mitigate against drought.

BUNDS AND DETENTION BASINS

Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.
Methods	■ 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 flow paths should not create a new flood risk area. ■ If looking at already wet field corners, consider the habitat already developed. If the habitat that has developed is good then leave it, if not then consider altering it to act as a temporary storage area or wetland habitat. ■ 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.

BUNDS AND DETENTION BASINS

Level of maintenance	**Medium** Dependent on the scale and design. Arrangements for on-going maintenance may need to be submitted as part of any planning application. Clearing of pipes and sediment.
Key locations	■ Small valley and slopes prone to runoff during flood events. ■ Areas where runoff with a heavy sediment load is known to compromise local drainage. ■ Low points on the fields, buffer strips or woodland. ■ The best method to confirm pathways is to visit site during heavy rainfall and to photograph pathways as they are active.
Cost	**Set up: Medium** **Maintenance: Medium**
Funding	Countryside Stewardship (CS) scheme. The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
Additional Information	**Design guidance** **susdrain.org/resources/ciria-guidance.html** **Basic Payment Scheme (BPS) criteria** **gov.uk/government/collections/basic-payment-scheme** **research.ncl.ac.uk/proactive/belford/papers/Runoff_Attenuation_Features_Handbook_final.pdf**

WADER SCRAPES

Wader scrapes are constructed adjacent to watercourses to be recharged during periods of high flows and rainfall. They can be combined with leaky woody dams to divert water out and into the scrapes. Not only are these scrapes incredibly important habitats for declining wader species, they can reduce the extent of flooding and protect valuable land/crops.

Scrapes can be designed to hold some water all year round for ecological benefits or they can be dry and kept in production, only coming into use during certain conditions.

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Natural flood management purpose

- Floodwaters are directed out of the channel into the wader scrape. The water then slowly infiltrates or is released back into the channel via an outlet point once the flood peak has passed.
- Captures runoff and creates controlled release.
- Traps sediment which can reduce the function of neighbouring watercourses and drainage systems.

Agricultural and environmental benefits

- Sediment is removed from the flow which improves water quality.
- The depth and the speed of drainage can be manipulated according to the site.
- Create a dynamic and important habitat for multiple declining species of waders.
- Guide the location of flooding and prevent dirty flood water contaminating land.
- Scrapes can be designed to respond to events of varying severity.

WADER SCRAPES

Ecosystem Service

Provisioning Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply.

Regulating Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events.

Supporting Soil formation, Photosynthesis & Nutrient Cycling.

Cultural Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

Methods

- 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 1 metre and grass cover should be established as quickly as possible.
- Scrapes can be constructed in combination with other NFM measures such as leaky woody dams giving more flexibility to the location of the features.

Considerations

- Test pits will be needed to see how well the scrape will hold water, if a permanent source of water is desired.
- Scrape 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.
- Dependent on the scale and design.
- Arrangements for on-going maintenance may need to be submitted as part of any planning application.
- Any in-channel features will also need to be maintained.

WADER SCRAPES

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: Medium to High (dependant on scale)** **Maintenance: Low**
Funding	■ Countryside Stewardship (CS) scheme. ■ The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
Additional information	Floodplain Scrapes **therrc.co.uk/MOT/Final_Versions_%28Secure%29/7.1_Skerne.pdf** **sussexflowinitiative.org/uploads/1/6/3/1/16313516/woodsland_farm_case_study_final.pdf**

SWALES

Swales are shallow, vegetated drainage features that convey and store surface water, providing the opportunity for infiltration and water treatment through encouraging settlement of sediment.

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 leaky dams within the swale.

They can be installed next to tracks, helping to prevent loss of the track material and the development of ruts on the tracks therefore saving on the cost of track maintenance. Swales can also be used to direct runoff into other Natural Flood Management measures or woodlands where the ground is rougher and the water has more opportunity to infiltrate.

Natural Flood Management purpose	■ Reduce runoff rates by slowing runoff flow. ■ Reduce volume of runoff by increasing the opportunity for infiltration and evaporation. ■ Trap sediment and polluntants, which can reduce the function of neighbouring watercourses and drainage systems.
Agricultural and environmental benefits	■ Reduce soil loss and surface scour. ■ Provide pollutant treatment by allowing settlement. ■ Protect access tracks and other surfaces from scour.

SWALES

Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.
Methods	■ 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. ■ Consider vegetation cover once established, and future maintenance e.g. access for mowing. ■ Swales are best constructed along a contour or, if down a slope on a gradient of no more than 2 degrees. ■ They can be wet or dry (on a day to day basis) depending on land use – good for grazing animals.
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).

SWALES	
Key locations	■ Shallow slopes prone to runoff during flood events. ■ Areas where runoff with a heavy sediment load is known to compromise local drainage. ■ Next to farm tracks.
Cost	**Set up: Medium** **Maintenance: Low**
Funding	■ Countryside Stewardship (CS) scheme. ■ The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
Additional information	**Swale design** **adlib.everysite.co.uk/adlib/defra/content.aspx?id=000HK277ZX.0HCIIG33ALM59DZ** **susdrain.org/resources/ciria-guidance.html** **Basic Payment Scheme (BPS) criteria** **gov.uk/government/collections/basic-payment-scheme**

5. Natural Flood Management Measures: Level 3

FLOODPLAIN RESTORATION

While Natural Flood Management (NFM) measures associated with interventions in land management seek to reduce flood water generation, measures in the river channel , on its banks or floodplain can improve the ability of rivers to manage those floodwaters.

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

5.1 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.

5.2 Initial advice as to a site's suitability can be given by local Rivers Trusts (RT), Environment Agency (EA) staff, and early contact is highly recommended.

5.3 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.

© Anne Purkiss

WETLAND CREATION

Wetlands are normally shallow ponds and marshy areas covered almost entirely in vegetation. Wetlands will hold some water all year round to support the plants and species found in these habitats and are designed to hold extra water in a flood event.

They are designed to accept water run-off that might otherwise discharge into a watercourse and to hold it for long enough to allow sediments to settle and for pollutants to be removed through plant uptake and breakdown in the soil. Wetlands also provide significant biodiversity benefits and vary dramatically depending on the local conditions and the species they include, from fen and reed beds to saltmarsh. Each wetland habitat has a unique design criteria.

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Natural flood management purpose	■ Retention of some water all year round but with greater capacity in flood events. ■ Reduce flood peak downstream/upstream for saltmarsh. ■ Reduce sediment load.
Agricultural and environmental benefits	■ Reduction in soil loss. ■ Effective removal of water contaminants including suspended sediments and pathogens. ■ Retention of year-round water. ■ Increase in biodiversity.
Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

WETLAND CREATION

Methods	■ Design and dimensions are entirely site dependent and will need detailed specialist advice. ■ Wetlands should be designed with a significant storage capacity.
Considerations	■ Requires land. ■ Wetlands 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. ■ Wetlands should not be created in areas where they may pose a flood risk to nearby property.
Level of maintenance	**Low**
Key locations	■ Throughout catchments. ■ Low lying areas that are already wet or often hold water. ■ Simple wetlands are more suited to a small-scale intervention plan on a single farm. ■ Complex multi-stage wetlands can be designed on larger areas and across estates where they can provide additional recreational benefits.
Cost	**Set up: Low to High (dependant on scale)** **Maintenance: Low to high (dependant on scale)**
Funding	■ Countryside Stewardship (CS) scheme. ■ The ELM scheme will be based on 'public money for public goods', therefore it is likely there will be funding through the new scheme.
Additional information	**Design Guidance** **therrc.co.uk/MOT/Final_Versions_(Secure)/7.2_Pinkhill_Meadows.pdf**

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 streams have often been altered. These changes combine to disconnect rivers from their natural floodplain, speed up the flow of water and reduce the available area for water to storage, increasing the flood risk to downstream settlements.

Restoring meanders can be by physically digging out the meander or by encouraging the power of the water to form its own natural course. This can be enhanced with the installation of flow deflectors which can help to focus the flow to speed up the natural process. This can also create areas of still water which have benefits for fish and other aquatic species.

Natural flood management purpose	■ Restoring the shape (morphology) of the streams or river by re-creating meanders will increase the time taken for the floodwater to flow downstream. ■ Slowing the flow, it allows the river to carry a greater volume of water.
Agricultural and Environmental benefits	■ Potential benefits will be specific to the location chosen.
Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.

RESTORING MEANDERS

Methods	Dimensions are entirely site dependent and will need detailed specialist advice at an early stage.
Considerations	■ Reconstructed meanders usually substantially improve the fisheries of the stream or river. ■ The Rural Payments Agency (RPA) will need to be informed about changes to the land parcel area. ■ Environment Agency (EA) advice and consent will be required as part of the planning for this kind of project. ■ The Land Drainage Authority for the area will need to be consulted for advice and possibly consent during the planning of the project. The Lead Drainage Authority can be either the Internal Drainage Boards (IDBs) or the Local Authority depending on the area. ■ Planning consent will be required. ■ Another consideration is that these are long term vision projects. ■ Can meandering channel be restore within existing footprints of straight channels without the need to excavate anything, this approach is not only cheaper but can help to remove sediment from the channel.
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 streams and rivers have been straightened. It is most likely to be practical where the same landowner owns both sides of the channel. Small streams 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**

RESTORING MEANDERS

Funding	■ Specialist advice on funding is needed.
Additional information	Example re-meander projects **nationaltrust.org.uk/sheffield-park-and-garden/projects/river-ouse-restoration-project-at-sheffield-park** **therrc.co.uk/MOT/Final_Versions_%28Secure%29/1.9_Shopham_Loop.pdf**

WASHLAND RESTORATION

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, as well as the size of the water course in question.

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.

Reconnecting a river with its floodplain can be carried out on a variety of scales. When looking at re-connecting the floodplain consideration needs to be given to the size of the watercourse and the expected affect that the work will have on flood characteristics, not only at the site but also downstream. Other considerations should include the effect on peak flow, the flows in other tributaries, the velocity of water leaving and entering the system and the impact on neighbouring land. For larger water courses and flood plain areas flood modelling is necessary.

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.

WASHLAND RESTORATION

Agricultural and environmental benefits	■ Potential benefits will be specific to the location chosen. ■ Flooding water able to reenter river once the flood event has passed, thereby reducing time water is sitting on land and damage to crops. ■ Over winter water storage options for livestock meaning less abstraction is required in summer.
Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.
Methods	■ Design and 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. ■ The Land Drainage Authority for the area will need to be consulted for advice and possibly consent during the planning of the project. The Lead Drainage Authority can be either the Internal Drainage Boards (IDBs) or the Local Authority depending on the area.

WASHLAND RESTORATION

Level of maintenance	**Medium** Ongoing monitoring.
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] ■ This could also be coastal realignment, which would require liaison with the Environment Agency.
Cost	**Set up: Medium to High (dependant on scale)** **Maintenance: Medium**
Funding	■ Specialist advice on funding is needed.
Additional information	Example floodplain project **therrc.co.uk/MOT/Final_Versions_%28Secure%29/6.3_Long_Eau.pdf** **therrc.co.uk/MOT/Final_Versions_%28Secure%29/6.4_Burn_of_Mosset_Forres.pdf** **therrc.co.uk/sites/default/files/general/MOT/final/6.1_cole_apr2019.pdf** **Managed realignment at Medmerry: ice.org.uk/knowledge-and-resources/case-studies/managed-realignment-at-medmerry-sussex**

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BEAVERS

Beavers are a native UK species which were made extinct at least 400 years ago. Beavers are the ultimate natural flood managers, they can help to reduce (the water volume in) flood peaks by around 30% and delay the arrival of flood peaks (the time it takes a flood to move through the landscape) by upwards of an hour. Evidence shows that beavers can also play an important role in helping to improve water quality, enhance biodiversity and buffer against drought.

Re-introductions **in Scotland**, and an **enclosed site in Devon** have shown the multiple benefits of beavers to flooding and other natural services. The first free living population of beavers in England for 400 years, on the **River Otter in Devon**, was **licenced to remain by Defra** in 2020, paving the way for beavers to become a free living native species once more.

© National Trust/Nick Upton

Natural flood management purposes	■ Instinctive damming of watercourses and water flows, helping to slow and store vast amounts of flood water. ■ Buffering against drought by mitigating historic land drainage. ■ Creating wetland habitat and managing wetland vegetation which acts as a natural barrier to flood water. ■ Creating natural barriers and leaky dams which capture storm debris.
Agricultural and environmental benefits	■ Varies dependent on land use type and proximity to watercourses (beaver activity tends to be <30 metres from any watercourse). ■ Trapping and storing soil and sediment run off. ■ Mitigating flooding downstream. ■ Increase resilience to drought conditions. ■ Creating biodiversity havens with benefits for many species including fish. ■ Improve water quality.

BEAVERS

Ecosystem Service	**Provisioning** Food, Raw materials, Medicinal Resource, Biodiversity & Water Supply. **Regulating** Air quality regulation, Climate regulation, Carbon sequestration and storage, Water regulation, Erosion regulation, Water purification, Pollination & Moderation of extreme events. **Supporting** Soil formation, Photosynthesis & Nutrient Cycling. **Cultural** Spiritual experience and sense of place, Aesthetic value, Recreation and ecotourism & Mental and physical health.
Methods	■ Partnering with your Lead Local Flood Authority, the Environment Agency, your local Wildlife Trust, National Trust and/or Rivers Trust is recommended. ■ Liaise with neighbouring landowners and local community groups prior to releasing beavers. ■ Monitor the wellbeing of beavers and the impact they are having on their environment. ■ Decide who is going to be the licence holder (you or another organisation) and apply for a licence via the .gov website.
Considerations	■ A government licence is required to release beavers, although this may change in the future. ■ Beavers in certain locations may back up water and affect agricultural operations or infrastructure. Prior to releasing beavers, clearly identify potential issues, and put in place beaver management measures. Consultation with surrounding landowners, as well as with local wildlife group is crucial.
Level of maintenance	**Medium**

BEAVERS

Key locations	■ Small- to medium-sized floodplains, not on main rivers or IDB watercourses. ■ Non-essential drainage networks. ■ Upland areas with minor stream networks. ■ Stream networks with at least 30% tree cover, and good availability of other wetland vegetation.
Cost	**Set up: Medium to High** Currently the requirement is for beavers to be released into fenced enclosures (which can be expensive) – though this may change in the future **Maintenance: Medium to High**
Funding	■ Specialist advice on funding is needed.
Additional information	**Beaver Trust** **exeter.ac.uk/creww/research/beavertrial** Sussex Beaver Projects: **sussexwildlifetrust.org.uk/what-we-do/living-landscapes/partnerships/the-sussex-beaver-trial** **nationaltrust.org.uk/press-release/national-trust-re-introduces-beavers-to-south-east--england-site-after-somerset-success**

6. Consent and approval

Some Natural Flood Management (NFM) measures may require consent prior to construction.

LAND DRAINAGE CONSENT

ON MAIN RIVERS

6.1 A Flood Risk Activity Permit (FRAP) will be required from the Environment Agency (EA) for any works within 8 metres of a main river or 16 metres if tidal.

ON ORDINARY WATERCOURSES

6.2 Works in or near an ordinary watercourse (non-main river) may require ordinary watercourse land drainage consent from your Lead Local Flood Authority.

6.3 For activities near an ordinary watercourse in Hampshire please see the Hampshire County Council's website **www.hants.gov.uk/landplanningandenvironment/environment/flooding/changewatercourse**

6.4 For activities near an ordinary watercourse in West Sussex please see the West Sussex County Council's website **westsussex.gov.uk/fire-emergencies-and-crime/dealing-with-extreme-weather/flooding/flood-risk-management/ordinary-watercourse-land-drainage-consent**

6.5 For activities in East Sussex please visit East Sussex County Council's website **eastsussex.gov.uk/environment/flooding/ordinarywatercourseconsent**

PLANNING CONSENT

6.6 This may be required for larger structures, and a discussion about proposed works should be held with the local planning authority. Standard Methods are recommended for each measure to enable quicker approval.

NEW WOODLANDS

6.7 An Environmental Impact Assessment (EIA) enquiry should be undertaken if more than 2ha of woodland planting is being planned. This will allow the Forestry Commission (FC) to make a judgement on whether your project will need to undertake an EIA or not. For projects outside of the agri-environment schemes this is done by completing an EIA opinion form for afforestation projects. If applying for a woodland creation grant via the agri-environment scheme the process is undertaken as part of your grant application. For further information visit **www.gov.uk/government/organisations/forestry-commission**

SPECIALISED CONSENT

6.8 In some cases, a higher level of consent would be required before any measure can be put in place – for example, where Scheduled Monuments,

Sites of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), Special Protection Area (SPA) or Public Rights of Way are involved.

PUBLIC RIGHTS OF WAY

6.9 Public footpaths, public bridleways and byways are managed by the Local 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

6.10 Almost all chalk grassland and lowland heathland within the South Downs 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	0207 973 3700
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	Hampshire County Council West Sussex County Council East Sussex County Council	

7. Summary of consents

7.1 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]	
Natural Flood Management Measure	Planning permission GPDO*, full planning permission	Land drainage or ordinary water course consent	Historic environment (Local authority)	Wildlife (Local authority)	Hydrological specialist support	Available	What/who	BPS	ES, CS
Level 1									
Planting Hedgerow	N	Y[2]	N	N	N	Y	CS, WT	Y	Y
Woodland planting and Natural Regeneration	N	Y[2]	N	N	N	Y	CS, WT	Y	Y
Healthy Soils	N	N	Y[3]	N	N	Y	LWC[4]	N	N
Riparian and In-field buffer strips	N	N	N	N	N	Y	CS	Y	Y
Ditch Naturalisation	N	Y	N	Y	N	Y	CS	Y	Y
Level 2									
Leaky woody dams	N	Y	N	N	N	Y	CS	N	N
Pond creation and enhancement	Y	Y[5]	Y	Y	Y	N		Y	Y
Sediment traps	Y	Y2	Y	N	N	Y	CS	Y	Y

1 Applies if you receive payment from the schemes listed
2 If within 8m of main river or 16m if tidal, or within flood plain
3 Depends on which machinery is used – yes, for subsoiler and sward lifter
4 Contact your Catchment Officer for more information
5 Depending on location and scale of works

	Pre application consultation & consents		Recommended consultation			Grant funding		Affect on schemes[1]	
Natural Flood Management Measure	Planning permission GPDO*, full planning permission	Land drainage or ordinary water course consent	Historic environment (Local authority)	Wildlife (Local authority)	Hydrological specialist support	Available	What/who	BPS	ES, CS
Modifying drainage grips	N	N	Y	Y	Y	Y	CS	Y	Y
Intercepting sub surface land drains	N	N	Y	Y	Y	Y	CS	Y	Y
Bunds and detention basins	Y	Y[5]	Y	N	N	Y	CS	Y	Y
Wader scrapes	Y	Y[5]	Y	Y	Y	Y	CS	Y	Y
Swales	Y	Y	Y	Y	Y	Y	CS	Y	Y
Level 3									
Wetland Creation	Y	Y	Y	Y	Y	Y	CS, EA	Y	Y
Restoring meanders	Y	Y	Y	Y	Y	Y	EA	Y	Y
Washland Restoration	Y	Y	Y	Y	Y	Y	CS[6], EA	N	Y
Beavers	Y	Y	N	Y	Y	N		Y	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 Water Company (LWC)
Wildlife Trust (WT)

6 CS grant funding available if river is designated SSSI

8. 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 0300 020 0301.

ENVIRONMENT AGENCY

Visit **apps.environment-agency.gov.uk/contact/** to find contact details for your area.

NATURAL ENGLAND

Guildbourne House
Chatsworth Road
Worthing
West Sussex
BN11 1LD
Telephone: 0300 060 3900
Email: **enquiries@naturalengland.org.uk**

FORESTRY COMMISSION

Forestry Commission
620 Bristol Business Park
Coldharbour Lane
Bristol
BS16 1EJ
Telephone: 0300 067 4000
Email: **info@forestryengland.uk**

RIVERS TRUSTS

Arun & Rother Rivers Trust
arrt.org.uk

Ouse & Adur Rivers Trust
oart.org.uk

South East Rivers Trust
southeastriverstrust.org

Wessex Rivers Trust
wessexrt.org.uk

ASSOCIATION OF DRAINAGE AUTHORITIES

ada.org.uk
Map showing the areas covered by each IDB: **ada.org.uk/member_type/idbs**

LOCAL AUTHORITY

Hampshire County Council
hants.gov.uk

West Sussex County Council
westsussex.gov.uk

East Sussex County Council
eastsussex.gov.uk

Brighton and Hove City Council
new.brighton-hove.gov.uk

WOODLAND TRUST

Kempton Way
Grantham
Lincolnshire
NG31 6LL
Telephone: 0330 333 3300
Email: **england@woodlandtrust.org.uk**

WILDLIFE TRUSTS

Hampshire & Isle of Wight Wildlife Trust
hiwwt.org.uk

Sussex Wildlife Trust
sussexwildlifetrust.org.uk

EXISTING NATURAL FLOOD MANAGEMENT PROJECTS

Sussex Flow Initiative
sussexflowinitiative.org
Email: **sussexflowinitiative@gmail.com**

CATCHMENT SENSITIVE FARMING OFFICERS AND ADVISERS

Please use the following link to find the contact details for the officers and advisers working in your catchment: **gov.uk/government/publications/catchment-sensitive-farming-officer-contacts**

9. References and further information

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

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

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

Farming for cleaner water and healthier soil (NE230) (2011), Natural England (NE)
publications.naturalengland.org.uk/publication/36016

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

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

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

Working with natural processes to reduce flood risk (2017) – Evidence base, Environment Agency, which includes 65 detailed case studies of NFM Schemes
gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk

Fully Interactive online WWNP maps
naturalprocesses.jbahosting.com/#6/54.188/-1.945

Natural Flood Management Toolbox – Guidance for working with natural flood management schemes
catchmentbasedapproach.org/wp-content/uploads/2018/08/EA-NFM-Toolbox-Final-Draft.compressed.pdf

Think Soils
adlib.everysite.co.uk/adlib/defra/content.aspx?id=263233

Reduce Flood Risk through Rewilding, Rewilding Britain
rewildingbritain.org.uk/blog/rewilding-flooding-report

Soils and NFM
wrt.org.uk/project/soils-and-natural-flood-management


Sussex Flow Initiative
River Ouse
SOUTH DOWNS
NATIONAL PARK