highways england

Mersey Rivers Trust

DON CATCHMENT RIVERS TRUST

Natural Flood Management **Measures Booklet**

GET STARTED

2021 scheme

Contents

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How to use this Measures Booklet

This booklet has been developed to provide information on the **natural flood management (NFM)** measures available for implementation as part of the Highways England **Natural Flood Management Fund** (hereafter **NFM Fund**).

For NFM measures to successfully support flood risk management and deliver multiple benefits they need to be technically robust, effective and simple to deliver.

Whilst it is recognised that the measures available under the NFM Fund do not reflect the full range of interventions available under the umbrella of NFM, they have been selected from the long-list as those most likely to provide effective and quantifiable flood risk reduction to the highways network and other receptors within the target catchments and focus areas.

This booklet is to be read in conjunction with the complementary documentation listed on the back cover.

The information in this booklet provides an overview of NFM measures available under the NFM Fund to support farmers and landowners in identifying appropriate opportunities for NFM delivery on their landholdings.

The NFM measures have been broadly grouped to reflect the primary mechanism by which they reduce flood risk. Each has its own summary section in this booklet, that includes an overview of the measure, and signposting to more detailed **Design Specification Sheets** within the **Design Specification Catalogue.**

FR02.1: Offline Storage Pond

Purpose of Measure

Offline storage ponds are designed to provide additional areas for water storage within the landscape that fill during a flood or heavy rainfall event. This acts to reduce the volume and/or rate at which water enters the river network. As an offline measure the ponds do not include within their design a direct connection to an existing watercourse (small ditch, stream or river) or waterbody (pond/lake), through for example, an open channel or a piped connection.

They may be constructed adjacent to a watercourse or outside of the floodplain, to intercept water moving along an overland flow route. They can be designed to permanently hold some water, or as temporary flood storage feature which is dry for most of the time. Ponds, both permanent and temporary, can add considerable biodiversity value to the local area. As such, consideration should be given to the ecological design of ponds to maximise opportunities for wildlife where this does not compromise the flood management function of the measure.

Design Parameters

Offline ponds shall be designed on a site-specific basis according to factors such as land use, soil type, existing drainage, local habitats, catchment setting and future maintenance requirements. Ponds may be designed as a single feature (**Figure 1** and **Figure 2**) or as a connected chain of ponds (**Figure 3**). Ponds may require an outlet structure or spillway to convey flow out of the pond or between individual pond features should overtopping be a strong possibility. This outlet feature or spillway shall include scour protection.

Pond sizes vary, however are most commonly between 100 - 400 m^2 with a depth up to 1.5 m. Size will be governed by access, available space, volume needed for water storage and ease of build. Where filled in pond features are present in the landscape their reinstatement should be considered. Ideally, reinstated ponds should not be excavated beyond their original size and depth profile for historical and ecological reasons.

Pond design shall ensure safe egress in the event of entering the pond through provision of appropriate bank slopes (no steeper than 1:3). Ponds potentially accessible to the public (i.e. near to footpaths) may need further measures such as warning signs and/or exclusion fencing. Ponds can either permanently or temporarily hold water. Ponds designed to hold water throughout the year must provide additional capacity to hold storm water. Temporary ponds are typically designed to drain within a short-term period, to ensure their storage space becomes available for longer duration rainfall events over multiple days. Lining of ponds is best avoided, especially for temporary ponds as infiltration to ground is an important flood reduction feature. An assessment of the suitability of the ground to retain water should be undertaken.

Additional storage can be created through bunding around a pond that ties into higher ground levels. Should bunding be undertaken (as shown in **Figure 1**) it must not result in more that 200 m^3 of additional above ground storage.

The ability for ponds to provide additional biodiversity to the local area should be considered in the design e.g. provision of variable depths, slopes and islands. Excavation of the pond will generate spoil material. Any design will need to consider how and where this material will be managed. The preference should always be local re-use, as this is often the most sustainable and cost effective option. Spoil re-use opportunities will be dependent on the material's properties and potential for contaminants to be present; both should be investigated as part of the design process.

Complementary measures— A complex system can be implemented, in which both offline and online storage ponds (**FR02.2**) combine to manage flood water. Spoil from pond excavation can be used to build a flow pathway bund (**FR01.2**) around the pond to increase storage capacity and reduce disposal costs. In-channel leaky barriers (**WC01.1**) may also be constructed in proximity to an offline storage pond to encourage water spill from a watercourse channel for storage within the offline storage pond. Planting cross-slope woodland & hedgerows (**LM01.2**) adjacent to offline storage ponds can also be beneficial to roughen the surface and further attenuate flow.

Maintenance Requirements

Offline storage ponds typically have a 10 year design life at optimum functionality, without the need for significant maintenance.

A medium level of maintenance is required for storage ponds, including regular checks for sediment build-up in the base of the pond (especially where unfenced and open to poaching) as this can reduce storage capacity and effectiveness over time. Occasional desilting and appropriate disposal of accumulated sediment may be required. This may be of higher importance if the pond design includes an outlet feature, to ensure blockages do not occur. Typically, maintenance is low whilst the pond feature is establishing, through vegetation growth and water filling.

Permanent storage ponds typically have a greater maintenance requirement than temporary storage ponds.

Cost

Construction of offline storage ponds is costed between £10 and £50 per m^3 of excavation (including equipment, materials and labour costs). However, in most examples the construction cost will be towards the lower end, assuming simplistic pond design, limited removal/disposal of soil and limited consenting requirements. There will be additional costs associated with any requirements to spread or remove spoil.

The above cost estimates therefore cover a 'fair weather' construction. If construction is undertaken in a particularly difficult location or planned for a time of year when weather may be inclement a contingency should be added. In addition an allowance should be made for pre-construction activities and maintenance. The cost of design, planning and consenting before construction can be 60% of construction cost. A typical allowance for maintenance costs is 10% of construction cost for each year a structure is in operation. For an example of typical maintenance requirements, see the "Maintenance Requirements" section.

Equipment and Materials

The following is a list of equipment and materials that are typically required in the construction of an offline storage pond.

Equipment:

- Tracked excavator—preferably with a toothless tilting bucket head to allow for more complex contouring
- Tracked dumpers—for spoil movement and tipping
- Lorries—should off site spoil disposal be required
- Water pumps—for dewatering excavations

Materials:

- Pipes—for outlet and inlet structures (**Figure 3**)
- Outlet scour protection—to protect against erosion downstream of the measure
- Pond liner (sheeting/clay)—should the pond be required to permanently hold water and infiltration to ground undesirable
- Seeding/planting—to facilitate vegetation re-establishment in working area

Figure 1. *A newly constructed offline storage pond as part of the River Soar NFM pilot scheme (© Atkins Ltd)*

Figure 2. *A single offline storage pond before vegetation establishment (© Evenlode Catchment Partnership)*

Figure 3. *A series of offline storage ponds forming a wetland habitat and benefits for NFM (© Tweed Forum, Hugh Chalmers)*

Consents and Permissions

Consent is often required for offline storage ponds, with exact requirements depending on the pond size, storage volume and location.

Large ponds may require planning permission from the local planning authority, with the permission request accompanied by environmental reporting e.g. an Environmental Impact Assessment (EIA) and a waste management plan.

A flood-risk activity permit from the Environment Agency will be required for works adjacent to or in the floodplain of main rivers. Ponds located adjacent to and/or alter the flow of an ordinary watercourse may need land drainage consents from the Lead Local Flood Authority (LLFA) or Internal Drainage Board (IDB)

Permissions may be needed from relevant historical and archaeological bodies e.g. Historic England to control for any potential disruption to heritage features. A waste management plan and exemption agreement or licence may be required for management of spoil generated by excavating a pond.

Further Reading

For further information on offline storage ponds refer to the following sections within the References (**REFS.X**) specification sheet:

General—references 2, 3 and 7

Measure Specific—FR02.1: Offline Storage Pond—reference 1

Consents and Permissions—references 6, 7, 8, 9, 10, 11, 13 and 14

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Member of the SNC-Lavalin Group

Notes

This Design Specification Sheet is to be read in conjunction with the Natural Flood Management Measures Booklet, Design Specification Catalogue, the Natural Flood Management Fund Handbook and the Fund website (https://catchmentbasedapproach.org/learn/HE-NFM-Fund).

Design Considerations

This sheet is for design information only and is NOT to be used as a "fit for construction" final design specification. Where specific design parameters are stated for the measure, these shall be adhered to.

Maintenance and Liability

The landowner shall be responsible for the implementation and maintenance of any NFM measure on their land and will hold the liability for said measure during its design life. Refer to the Natural Flood Management Fund Handbook for Terms & Conditions governing participation in the Fund.

Cost

Costs are based on available information from a range of sources relating to the measure. Costs should therefore be treated as a guide only. For further information and additional reading, see references detailed in the "Further Reading" section.

Equipment and Materials

The list provided within the "Equipment and Materials" section is typical for the measure type. Equipment and materials usage will vary by design, site characteristics and material availability, therefore, the list should NOT be taken as exhaustive.

Consents and Permissions

The information provided is NOT an exhaustive list but includes guidance on common requirements for the measure. For further consenting and permissions advice, please make contact with the Catchment Advisor who will assist in identifying site specific requirements for the measure.

Health and Safety Considerations

The Construction (Design and Management) Regulations (CDM) 2015 provide a helpful reference for identifying the roles and responsibilities for people involved in the design and construction process and what is needed to protect them from harm. Further specific information on health and safety in agriculture is available from the Health and Safety Executive (HSE) Farmwise booklet.

Design

A design risk assessment is required to identify the hazards and evaluate the risks that may arise from the design. Dependent upon the hazard, the designer shall implement appropriate controls to minimise or remove the risk. Considerations include, but are not limited to, location of services and public rights of way, UXO risk, accessibility for machinery, waste management, consenting requirements, presence of protected species/habitats, invasive non-native species presence and future maintenance needs.

Construction

Working method statements, risk assessments, biosecurity procedures and environmental/site management plans shall be produced and adhered to at all times. Ensure all construction staff are fit for work, appropriately trained, hold the correct tickets/permits for machine operation and have access to appropriate PPE and on-site welfare.

Operation/Maintenance

Post-construction activities will also need to be considered in project planning to ensure that specified inspection and maintenance requirements can be undertaken safely. As with the construction phase, inspection and maintenance activities shall only be undertaken by appropriately trained individuals. During operation ensure that any interfaces with the public are appropriately controlled and maintained.

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Client
Highways England

Project title
Highways England NFM Pilot

Drawing title
FR02.1: Offline Storage Pond

Scale	Drawn	Check	Review
A3	SR	MH	IPM
	Date 25/11/20	Date 15/03/21	Date 16/03/21

Drawing no: 5158157/7.9.2.1/DG/FR02.1 (v3.0)

Figure 1 – Example Design Specification Sheet housed in the Natural Flood Management Design Specification Catalogue

1 How to use this Measures Booklet

The Design Specification Sheets (example provided as **Figure 1**) include more detailed information on key design parameters, machinery and material needs, cost, maintenance and health and safety requirements. In addition, the specification sheets signpost to both general and measure specific supporting documents and guides. **Figure 2** shows the process of NFM Fund measure selection and interactions with key processes leading to design, implementation and maintenance.

NFM measure delivery will be supported by a Rivers Trust local **Catchment Advisor** and there are number of reports and guides that contain useful information on the measures presented in this booklet, that have a focus on working within agricultural landscapes. These include:

- Yorkshire Dales River Trust. 2019. Lowland Natural Flood Management Measures – a practical guide for farmers
- West Cumbria Rivers Trust. 2018. Natural Flood Management Measures – a practical guide for farmers
- Environment Agency. 2017. Working with Natural Processes to Reduce Flood Risk
- Transition Monmouth & Monmouthshire County Council. 2018. RECS Handbook

Within each of the measure summaries and design specification sheets the requirement to obtain appropriate **consents and permissions** that will ensure compliance with various regulations and act to protect the environment. Please note that the list is not exhaustive, and that requirements often vary for the same measure depending on its location within the catchment and its size. Further information on the more commonly required consents and permissions and the relevant consenting authority is provided at the back end of this booklet.

Where existing **Countryside Stewardship, Environmental Stewardship or Basic Payment Schemes (BPS)** are in place on landholdings that are being targeted for NFM, the implications on agreements will need to be considered. Often NFM measures will complement, not conflict, with agreements that may be in place (refer to individual scheme agreements). However, in certain situations works may be prohibited, or a derogation required to facilitate measure implementation. Whilst the local Catchment Advisor can support, the following references provide a useful guide:

- GOV.UK. 2021. Countryside Stewardship
- GOV.UK. 2021. Basic Payment Scheme (BPS)
- GOV.UK. 2018. Farming Rules for Water from April 2018

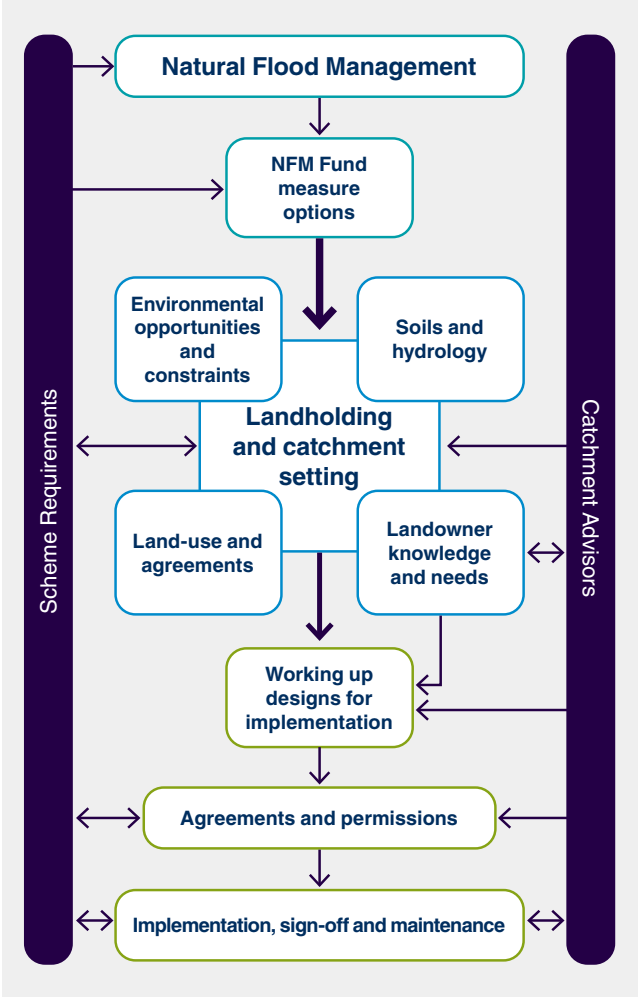

Figure 2 – NFM measures implementation process

2

Natural Flood Management Measures

The natural flood management interventions included in this booklet have been organised into a hierarchy as shown in **Figure 3**. Each Measure is first ordered under an Intervention Type which, apart from Landowner Innovation, aligns with the mechanism by which NFM is predominantly achieved.

The four NFM Intervention Types are as follows:

- **LM: Land-use Management –** measures that involve changes to, or improvements in, existing land management practices that typically act to intercept water and encourage infiltration. These measures are typically best suited to arable and grassland areas.
- **FR: Overland Flow Route Measures –** the construction of attenuation measures to store overland flow. These measures are often discrete and temporary and need not significantly affect existing land-use.
- **WC: Watercourse Measures –** measures that involve works in small permanent or temporary flowing watercourse channels to increase roughness and slow the rate of downstream transfer of water.
- **LI: Landowner Innovation –** as previously acknowledged the NFM measures presented in this booklet are not an exhaustive list. The NFM Fund recognises the importance of flexibility in NFM design and the value that can be achieved through application of local knowledge in the development of innovative ideas. The Landowner Innovation measure facilitates the development of bespoke measures outside of those prescribed in the booklet.

(© Chloe Palmer)

2 Natural Flood Management Measures

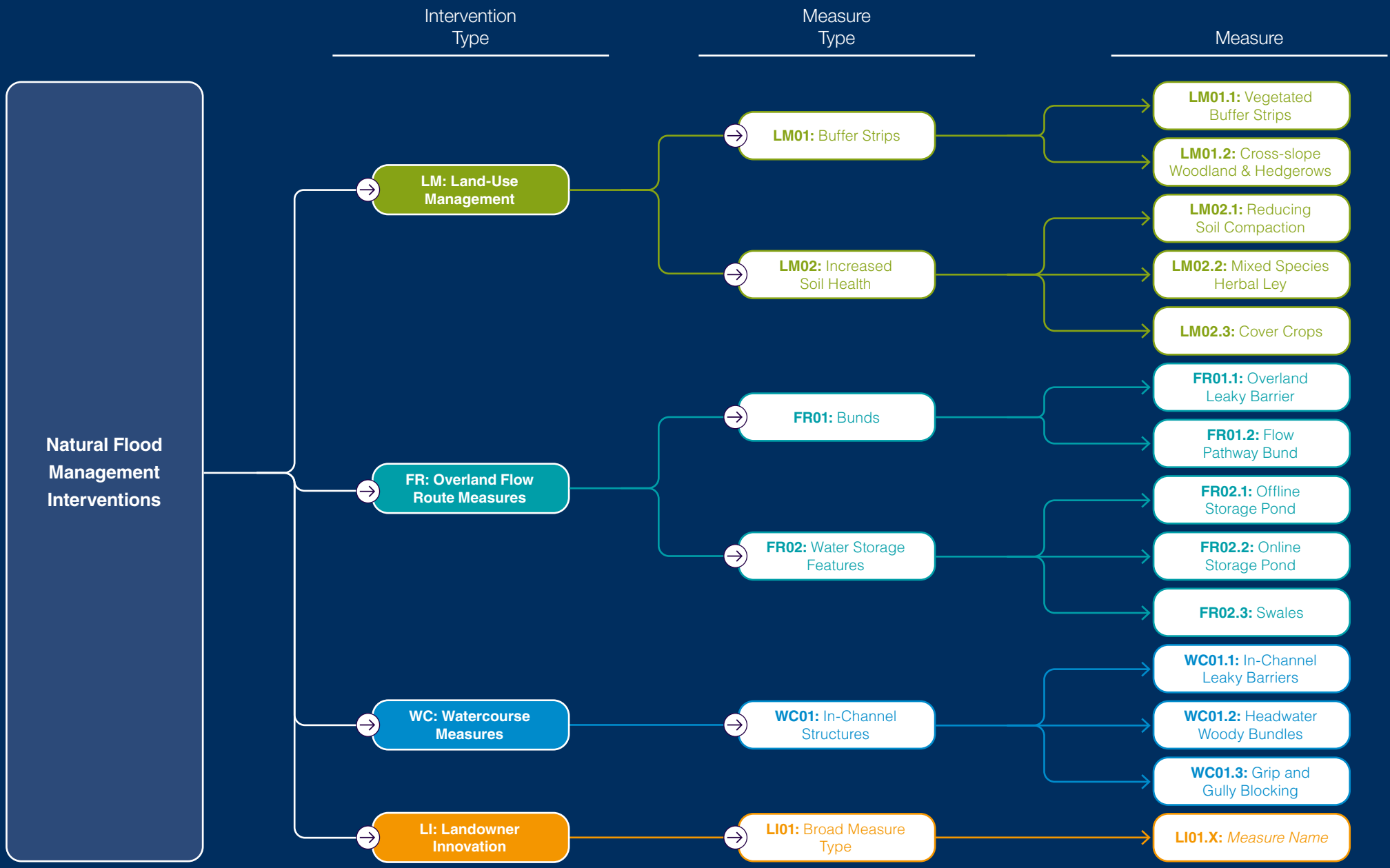

Figure 3 – Natural flood management measure grouping

2 Natural Flood Management Measures

The Intervention Type is further divided into Measure Type and specific Measure. For example, NFM interventions along overland flow routes (FR) are divided into those measure types that act to either bund (FR01), or store flow (FR02), with specific Measures such as overland leaky barriers (FR01.1) and offline ponds (FR02.1) grouped accordingly. At each division within the measure hierarchy a specific alpha or alpha-numeric code has been applied for consistency and ease of reference across the NFM Fund documentation and application process.

The NFM measures can be applied to a range of catchment settings, where they can be targeted at source (upland areas), along flow pathways (overland flow routes) and at specific receptors such as watercourses and their riparian zone. To support decision making around appropriate location of the NFM measures described in this booklet, an indicative location map is provided as **Figure 4.**

Certain NFM measures are more effective when implemented in combination with other measures. One example, as presented on the front cover of this booklet, is the use of earth bunds to increase the above ground storage potential of ponds designed to intercept and store overland flow. The re-use of spoil from the pond excavation is likely to act to reduce construction and material costs, disposal requirement, environmental disturbance, the measure and NFM Fund's carbon footprint and potentially consenting effort.

To support the sustainable implementation of NFM measures as part of this NFM Fund, the Measure summaries presented in this booklet and the design specification sheets contain information on complementary measures and wider benefits to the environment.

Source:

River Soar NFM Scheme
Croft offline storage pond and flow pathway bund immediately after construction.

1. **LM01.1 –** Vegetated Buffer Strips
2. **LM01.2 –** Cross-slope Woodland & Hedgerows
3. **LM02.1 –** Reducing Soil Compaction
4. **LM02.2 –** Mixed Species Herbal Ley
5. **LM02.3 –** Cover Crops
6. **FR01.1 –** Overland Leaky Barrier
7. **FR01.2 –** Flow Pathway Bund
8. **FR02.1 –** Offline Storage Pond
9. **FR02.2 –** Online Storage Pond
10. **FR02.3 –** Swales
11. **WC01.1 –** In-channel Leaky Barriers
12. **WC01.2 –** Headwater Woody Bundles
13. **WC01.3 –** Moorland Grip and Gully Blocking

Figure 4 – Indicative catchment locations for NFM measures (© Atkins Ltd)

3

The NFM Measures

LM: Land-Use Management

LM01: Buffer Strips
LM01.1: Vegetated Buffer Strips
LM01.2: Cross-slope Woodland & Hedgerows

LM02: Increased Soil Health
LM02.1: Reducing Soil Compaction
LM02.2: Mixed Species Herbal Ley
LM02.3: Cover Crops

FR: Overland Flow Route Measures

FR01: Bunds
FR01.1: Overland Leaky Barrier
FR01.2: Flow Pathway Bund

FR02: Water Storage Features
FR02.1: Offline Storage Pond
FR02.2: Online Storage Pond
FR02.3: Swales

WC: Watercourse Measures

WC01: In-Channel Structures
WC01.1: In-Channel Leaky Barriers
WC01.2: Headwater Woody Bundles
WC01.3: Grip and Gully Blocking

LI: Landowner Innovation

LI01: Broad Measure Type
LI01.X: *Measure Name*

LM: Land-Use Management

LM01: Buffer Strips

LM01.1: Vegetated Buffer Strips

Description
Buffer strips are areas of land that are permanently vegetated. Mixed species buffer strips are typically planted with grasses, herbs and wildflowers along field boundaries or adjacent to watercourses and ditches **(Figure 5)**. They provide a physical boundary between arable land or improved grassland and the drainage network, acting to reduce the amount of water and sediment runoff to watercourses, as well as reducing bankside livestock poaching.

Vegetated buffer strips increase surface roughness and therefore slow overland flow, encouraging infiltration to the soil. By slowing water movement, buffer strips also act to trap sediment before it enters watercourses, enhancing water quality and reducing channel sedimentation and nutrient enrichment.

Location Suitability
The optimal location for buffer strips is at the downslope edges of fields and following land contours. However, buffer strips encompassing entire field boundaries are still desirable. Implementing buffer strips in areas that experience high runoff that are well connected to the drainage network e.g. located next to a watercourse, is desirable.

Complementary Measures
Buffer strips may be implemented in conjunction with other land management (LM) or overland flow route (FR) measures. Buffer strips may aid with sediment management to improve performance and reduce maintenance requirements of other measures.

Considerations
The Basic Payment Scheme Handbook should be consulted for further guidance. This is particularly applicable if the buffer strip is being fenced off to exclude livestock as this may have implications for eligible land area for the Basic Payment Scheme.

Where buffer strips interact with public rights of way there may be a requirement to maintain grassland to facilitate access.

Consents and Permissions
It is unlikely that consents or permissions will be required for vegetated buffer strips.

Agricultural and other Benefits
Buffer strips intercept and attenuate sediment, chemical runoff and reduce soil loss. The reduction in sediment delivery to watercourses will also aid compliance with the Farming Rules for Water. Reduced siltation may also reduce any local watercourse maintenance requirements and flooding. Nitrate leaching may also be reduced through buffer strip root systems absorbing nitrogen and preventing transfer directly to watercourses, therefore further improving local water quality.

Buffer strips may be effective at enhancing farmland biodiversity. They can create safe wildlife corridors and provide habitat for ground-nesting birds, small mammals and beneficial pollinating insects.

Crop management operations may be simplified by straightening irregular field edges through buffer creation. Where planted alongside a watercourse, bank stability may also be improved by roots, helping to reduce bank erosion and reduce risk of bank failure.

Costs
Set up: **Low**
Maintenance: **Low**

Level of Maintenance
Low

Design Specification Sheet
Drawing title: LM01.1: Vegetated Buffer Strips
Drawing number: 5158157/7.9.2.1/DG/LM01.1

Figure 5 – Buffer strip with fencing, separating crop from a river (© Dave Gasca-Tucker)

LM: Land-Use Management

LM01: Buffer Strips

LM01.2: Cross-slope Woodland & Hedgerows

Description
Cross-slope woodland & hedgerows involves the planting of trees or hedge species in strategic locations to intercept overland flow **(Figure 6)**. The measure is designed to reduce flooding by slowing the movement of water downslope towards and into watercourses. This occurs through the interception of rainfall and overland flow, encouraging evapotranspiration, increasing infiltration through soil improvements (due to enhanced root growth), and increased surface roughness which can slow overland water flow.

Location Suitability
Cross-slope woodland & hedgerow planting has proven NFM effectiveness and is particularly useful where large areas can't solely be given over to woodland planting. Cross-slope woodland is typically located along land contours and in locations where there is high overland flow during rainfall events. Cross-slope woodland can also bridge gaps within, or form extension of, pre-existing woodland and hedgerows. Cross-slope woodland may also be applicable on slopes adjacent to a watercourse, to reduce direct input of overland flow.

Complementary Measures
Cross-slope woodland & hedgerows may be planted alongside swales **(FR02.3)** or adjacent to vegetated buffer strips **(LM01.1)** to further enhance local infiltration rates and intercept overland flow.

Woodland planting can also be beneficial where planted adjacent to storage ponds **(FR02.1 and FR02.2)** to roughen the surface and further attenuate flow and improve riparian biodiversity.

Considerations
To qualify for funding all tree/hedge species will need to be native and sourced from nurseries which can prove provenance. Any tree or hedgerow planting should be appropriately fenced/protected to remove grazing pressure and allow for successful establishment. Livestock exclusion may also facilitate the development of a woodland understory which can add greater benefit.

Consents and Permissions
Consents are unlikely to be needed for small-scale tree or hedgerow planting, however, there may be some exceptions where large areas are being converted to woodland, or if the area is within a protected landscape or immediately adjacent to a watercourse.

Agricultural and other Benefits
Woodland and hedgerows add considerable biodiversity benefit to the landscape acting as wildlife corridors and providing habitat and food sources for birds and mammals.

Cross-slope woodland may protect against soil erosion and crop damage from wind and rain impacts, as well as slowing overland flow across fields.

Tree planting can provide additional provision for game shooting on farmland and established hedgerow and woodland edges can act as areas of shelter and shade for livestock.

Costs
Set up: Medium
Maintenance: Low

Level of Maintenance
Medium

Design Specification Sheet
Drawing title: Cross-slope Woodland & Hedgerows
Drawing number: 5158157/7.9.2.1/DG/LM01.2

Figure 6 – Newly planted cross-slope woodland, protected by guards and fencing (©Tweed Forum, Hugh Chalmers)

LM: Land-Use Management

LM02: Increased Soil Health

LM02.1: Reducing Soil Compaction

Description
Soil compaction can occur across whole fields but is often most focused around vehicle access routes, gateways and areas such as livestock troughs, where high pressures exerted on to the soil surface by machinery and livestock reduces soil pore space.

The compaction reduces the infiltration which can lead to an increase in overland flow and flooding during a storm event. Reducing the compaction of soils through aerating **(Figure 7)**, subsoiling or sward lifting can be a very effective technique.

Other ways to reduce soil compaction include crop and livestock rotation, mob grazing and avoiding the use of heavy machinery on wet soils.

Location Suitability
Soil de-compaction measures are widely applicable, although are typically undertaken in fields below the moorland line, particularly those that are used for winter grazing, experience repeated trafficking e.g. fields used for multiple silage cuts, and/or are seen to experience overland flow events.

Complementary Measures
Vegetated buffer strips **(LM01.1)**, mixed species herbal leys **(LM02.2)** and cover crops **(LM02.3)** with deep rooting species may be used to improve the soil structure and de-compact the soil. A mix of species is key to provide the soil with a diverse range of root growth. These measures may be applied after initial efforts are made to de-compact the soil.

Considerations
Soil compaction and its mitigation can be highly site-specific; therefore, it is recommended that the local Catchment Advisor be consulted regarding the best approach before commencing any work. If inappropriately applied, soil de-compaction measures can exacerbate the problem, therefore, an assessment of the existing compaction levels are required.

Consents and Permissions
Typically, consents are not required for reducing soil compaction, although consultation may be needed with the local Catchment Advisor for use of subsoilers and sward lifters.

Agricultural and other Benefits
The creation of more pore space allows for greater movement of air and nutrients through the soil column, improved root and crop development and enhanced fertiliser uptake.

Such improvements in soil health and structure can act to reduce soil erosion and waterlogging and allow for easier access to fields and an increase in the number of available grazing days throughout the year.

Improved local water quality may be observed due to less soil erosion and therefore less sedimentation of watercourses. This may also improve local biodiversity.

Costs
Set up: Low
Maintenance: Low

Level of Maintenance
Low to medium

Design Specification Sheet
Drawing title: LM02.1: Reducing Soil Compaction
Drawing number: 5158157 /7.9.2.1/DG/LM02.1

Figure 7 – Soil aerator in operation (© Chloe Palmer)

LM: Land-Use Management

LM02: Increased Soil Health

LM02.2: Mixed Species Herbal Ley

Over-seeding or re-seeding with a mixed species herbal leys, including deep rooting species **(Figure 8)**, can aid with improving overall soil structure. This is particularly useful in fields that have previously been compacted by extensive grazing and would benefit from more diverse crop and enhanced soil health.

A mixed species herbal ley aims to increase water infiltration. Through the establishment of a diverse range of species, including deep rooting species, the soil can be enhanced with greater amounts of carbon, soil organic matter and therefore greater water storage potential. Developing root systems will also aid with reducing soil bulk density (compaction).

A range of species including grasses, legumes, herbs and wildflowers may be used to form the mixture and should contain species that can support growth year-round to provide a protective soil cover.

Location Suitability
Mixed species herbal ley can be used on grassland or previously used arable land. Land parcels with known pest problems are best avoided to reduce maintenance requirements.

Complementary Measures
Prior to cultivation of herbal leys, measures to reduce soil compaction **(LM02.1)** may be used to improve the soil structure and allow better establishment of grasses and herbs. Herbal leys may therefore continue to improve and maintain good soil health after initial improvements have been made.

Considerations
Pesticide-use should be avoided (apart from herbicides to spot-treat injurious weeds) once mixed species herbal ley is sown.

Mixed species herbal leys cannot be established on land with high-risk of soil erosion, as highlighted in the Farm Environment Record (FER). They may also not be permitted to establish on land with historic features, as highlighted in the Historic Environment Farm Environment Record (HEFER).

Consents and Permissions
Consents and permissions for implementing mixed species herbal leys may be required, depending on the size of land and prior land-use.

Agricultural and other Benefits
The mixture of species can be highly productive for livestock and will allow for an extended grazing season. Moreover, deep-rooting species are effective in bringing minerals to the surface, increasing livestock health.

If legumes are included in the mixture, these are highly effective in removing atmospheric nitrogen and storing it in the soil. Drought resistance can be improved due to deep rooting species storing and maintaining greater soil moisture levels through the dry summer months.

Mixed leys provide greater local biodiversity, including habitat and food supply for invertebrates.

Costs
Set up: **Low**
Maintenance: **Low**

Level of Maintenance
Low

Design Specification Sheet
Drawing title: LM02.2: Mixed Species Herbal Ley
Drawing number: 5158157/7.9.2.1/DG/LM02.2

Figure 8 – A mixed species herbal ley
(© Chloe Palmer)

LM: Land-Use Management

LM02: Increased Soil Health

LM02.3: Cover Crops

Description

Cover crops **(Figure 9)** are non-cash crops that are grown to protect and improve the soil over periods where the soil may otherwise be bare and prone to erosion. Cover crops are typically used in rotation with cash-crops and should be sown early in the rotation where possible, typically in autumn to allow time for establishment before the winter period when run-off from the land can be at its highest.

Cover crops directly intercept rainfall and further protect soils by increasing the rate of infiltration, thus reducing water runoff and soil erosion. Cover crops should have the ability to grow throughout the winter period, or at times when cash-crops are not present i.e. at times where the land would otherwise be sparsely vegetated.

A mixture of species, including legumes, grasses and brassicas are recommended and are typically combined to enhance soil health and development of complex root systems. Plants with varying development/growth forms should be considered to remove the risk of undesirable competition.

Location Suitability

The use of cover crops is suitable on any arable land that is usually left bare for long-periods of time in-between cash-crop growth. This measure may work particularly well where soil compaction is present and where soil is in poor health. This may also be more applicable on sloping land where overland flow is more commonly observed. In contrast to mixed species herbal ley which is most favourable to grassland land-use, cover crops are typically for use on arable land.

Complementary Measures

Cover crops can be implemented alongside other changes to land management, such as reducing soil compaction **(LM02.1)**, involving measures such as soil aeration, subsoiling and sward lifting. Reducing soil compaction using mechanical methods prior to cover crop sowing may increase the likelihood of successful cover crop development and will also aid with improving soil health.

Considerations

The use of cover crops and/or the early sowing of these may require altering cropping cycles. However, after initial setup cover crops can be used repeatedly as part of a long-term strategy for arable land.

Cover crops must be suited to the specific soil characteristics e.g. soil type, pH and moisture content to maximise the benefit of this measure. Grazing of cover crops can be beneficial through addition of organic matter to improve soil structure and soil health.

Consents and Permissions

Consents are not likely to be needed for the implementation of cover crops.

Agricultural and other Benefits

Through the use of cover crops over recurring cycles, the soil structure and health will likely improve, which in turn can increase nutrient content and increase soil productivity. This can enhance crop yields and reduce the need for fertilisers, herbicides and pesticides.

An improved soil structure and a permanent soil cover reduce the likelihood of soil erosion and sedimentation of the local drainage network and watercourses, subsequently improving local water quality. Cover crops can also act to provide cover for game birds and other wildlife.

Further habitat value can be provided from cover crops and provide options for livestock feeding opportunities.

Costs

Set up: Medium
Maintenance: Low

Level of Maintenance

Low

Design Specification Sheet

Drawing title: LM02.3: Cover Crops
Drawing number: 5158157/7.9.2.1/DG/LM02.3

Figure 9 – Cover crops containing radish, black oat and spring oats (© Peter Cartwright, Revesby Estate)

FR: Overland Flow Route Measures

FR01: Bunds

FR01.1: Overland Leaky Barrier

Description
Overland leaky barriers are discrete measures that are strategically located and fixed on a floodplain or preferential flow route to intercept and temporarily store water. They are typically constructed from wood, including whole tree trunks laid perpendicular to the flow pathway **(Figure 10).**

They are designed to slow and attenuate the flow of water by roughening the ground surface and providing a barrier that acts to increase the time it takes water to move downstream.

Location Suitability
Overland leaky barriers can be used in both lowland and upland settings. Key locations may be within floodplain woodland, where there are local sources of materials for ease of construction and where measures will complement the environmental setting.

Complementary Measures
In-channel leaky barriers **(WC01.1)** may be used in the adjacent watercourse to promote water-spill from the channel on to the floodplain where it can be attenuated by overland leaky barriers. In certain situations, e.g. where the floodplain is constrained, an overland barrier can simply be an extension to an in-channel barrier, such as shown in Figure 10.

Storage ponds **(FR02.1 and FR02.2)** may be constructed to temporarily store water that has been intercepted by the overland leaky barrier.

Considerations
Locally available trees should be used wherever possible, which will reduce costs of sourcing and transportation of materials.

Protected species in the area may constrain implementation and the use/felling of local trees is likely to trigger the need for appropriate protected species surveys.

All felling activities should be undertaken by a qualified tree worker, to ensure safe practices are followed. Felling may also involve soft-felling upper boughs and branches prior to the full felling works.

Consideration of construction locations and the requirement for fixings is needed where there is risk of blockages to downstream structures should wood become mobile.

Consents and Permissions
Consents may be required for overland leaky barriers, depending on where they will be constructed. This may include flood-risk permits from the Environment Agency or Lead Local Flood Authority if they are situated on a floodplain of a main river or an ordinary watercourse, respectively.

Further specific consents may be required for tree felling (if applicable), in the form of a tree felling license from the Forestry Commission. Protected species licences may be required in relation to measure implementation and more specifically tree works.

Agricultural and other Benefits
Overland leaky barriers may provide valuable habitat for plant and animal species. The provision of wood habitat and increased wetting of the surface can act to improve biodiversity in the area.

Floodplain surface erosion and subsequent sediment transport may be reduced as a result of lowered floodplain flow velocity.

Costs
Set up: Low
Maintenance: Low

Level of Maintenance
Low to Medium

Design Specification Sheet
Drawing title: FR01.1: Overland Leaky Barrier
Drawing number: 5158157 /7.9.2.1/DG/FR01.1

Figure 10 – Overland leaky barrier on the upper Pip Brook NFM scheme, Dorking, Surrey (© Jay Neale)

FR: Overland Flow Route Measures

FR01: Bunds

FR01.2: Flow Pathway Bund

Description
Flow pathway bunds are typically made from earth and can be located catchment-wide to target known overland flow pathways. These measures are also termed 'contour bunds', 'cross-slope bunds', 'flow-route bunds' or simply 'bunds'.

Overland flow can occur following periods of heavy or prolonged rainfall, directing water (and sediment) rapidly downslope towards a watercourse. Constructing bunds **(Figure 11)** across these pathways aims to capture, slow and store water strategically in the landscape.

Location Suitability
Typical locations may be across steep sloping fields where channels/gullies/furrows act as/indicate water flow pathways, or in field corners where overland flow may concentrate prior to discharging to the local drainage network or road network. Bunds located near to hard surfaces such as tracks may also be particularly useful due to these surfaces promoting rapid runoff.

Complementary Measures
Offline storage ponds **(FR02.1)** may be constructed alongside flow pathway bunds to provide additional water storage during a storm event. Water intercepted by a bund may be channelled into a temporary storage pond.

Considerations
Bund placement should be considered carefully as water will pond on the land behind ('upstream' of) the bund. This flooded land may still be eligible for the Basic Payment Scheme should the flooding be temporary.

The design will need to consider the requirement for water storage control, such as through pipes and spillways, and the potential for new flood-risk areas and erosion of the flow pathway 'downstream' of the bund.

Consents and Permissions
As the size of a flow pathway bund increases, there is a greater likelihood that consents will be required. For large bunds, planning permission may be required from the local authority, whilst a flood risk activity environmental permit may be required from the Environment Agency, should the bund be constructed adjacent to a main river or in a floodplain. Permits may be required from the Lead Local Flood Authority if located adjacent to ordinary watercourses.

Furthermore, a waste exemption may be needed from the Environment Agency if spoil spreading is taking place due to bund construction.

Agricultural and other Benefits
Depending on design, bunds can create temporary wetland habitats of value to species such as wading birds. Bunds may also act as sediment traps, intercepting soil being washed from the land and allowing it to be placed back on to fields should this be deemed beneficial. The interception of sediment may also improve local water quality, by intercepting pollutants and reducing sedimentation of watercourses.

Costs
Set up: Medium
Maintenance: Low

Level of Maintenance
Medium

Design Specification Sheet
Drawing title: FR01.2: Flow Pathway Bund
Drawing number: 5158157/7.9.2.1/DG/FR01.2

Figure 11 – A cross-slope bund with fence for added protection against livestock poaching (© Cumbria County Council)

FR: Overland Flow Route Measures

FR02: Water Storage Measures

FR02.1: Offline Storage Pond

Offline storage ponds **(Figure 12)** are measures designed to store water during a storm or flood event. Water is captured and stored temporarily before slowly infiltrating to ground, evaporating or being conveyed as a controlled discharge from the pond (via pipes for example) after the storm event, to the nearby watercourse or additional water storage feature. They can be designed to permanently hold some water, or as temporary flood storage feature which is dry for most of the time. Offline storage ponds are not directly connected at their downstream end to watercourses but may receive flow from the local drainage network.

Ponds can be constructed as single features or as a connected chain of ponds. Ponds may require an outlet structure or spillway to convey flow out of the pond or between individual pond features should overtopping be a strong possibility.

Location Suitability
Offline storage ponds are typically located in an optimal location for attenuating water. Therefore, storage ponds are suitable for positioning on a floodplain or on flow routes within land holdings. These are offline features so not directly connected to a watercourse by natural flow pathways. Typical locations may therefore include at field corners where water ponding may regularly occur or leave the field, or in areas adjacent to impermeable surfaces that promote large quantities of overland water flow.

Complementary Measures
A complex system of storage ponds can be implemented, in which both offline and online storage ponds **(FR02.2)** combine to manage flood water.

Flow pathway bunds **(FR01.2)** may be constructed from the spoil generated through the construction of an offline storage pond. These bunds may be used to capture and attenuate overland flow after flooding from the watercourse, as well as provide additional storage.

In-channel leaky barriers **(WC01.1)** may be constructed within the watercourse adjacent to the desired pond location. An in-channel leaky barrier can encourage water flow to the floodplain and into an offline storage pond for temporary storage.

Cross-slope woodland **(LM01.2)** may also be planted adjacent to offline storage ponds to roughen the ground and further attenuate surface water flows.

Considerations
Biodiversity and heritage features must not be negatively impacted through the construction of a pond; therefore, relevant surveys e.g. protected species surveys, may be needed before work commences to determine any risk.

Where historical pond features are present in the landscape reinstatement should be considered as their location is likely to indicate water accumulation points. A plan for dealing with spoil that would be generated from the construction of a pond is required and an assessment may be required to determine its quality for re-use and or/ disposal. Wherever possible, the spoil should be reused on site as the cost of transporting spoil off site is high and may require a waste transfer permit.

If a permanent pond is desired, an assessment will be needed into the suitability of the ground to hold water for long periods, and to set the maximum permanent water level to leave enough spare storage volume for flood events.

Consents and Permissions
Consents may be required for the construction of an offline storage pond, including flood risk activity permits from the Environment Agency, drainage consents from the Lead Local Flood Authority, planning permission from the local authority may be required.

Protected species licences may be required in relation to measure implementation and more specifically excavation works in sensitive habitats.

Agricultural and other Benefits
Offline ponds can provide many benefits in addition to NFM. These include the entrapment of sediment and pollutants as well as providing valuable habitat for aquatic flora and fauna where ponds are designed to retain a permanent body of water.

Costs
Set up: Medium
Maintenance: Low

Level of Maintenance
Medium

Design Specification Sheet
Drawing title: FR02.1: Offline Storage Pond
Drawing number: 5158157/7.9.2.1/DG/FR02.1

Figure 12 – A newly constructed offline storage pond as part of the River Soar NFM pilot scheme (© Atkins Ltd)

FR: Overland Flow Route Measures

FR02: Water Storage Measures

FR02.2: Online Storage Pond

Description
Online storage ponds provide additional water storage areas incorporated into existing watercourse alignments, or adjacent to them. Online ponds are hydraulically connected to the drainage network, which can be via pipes or open cut channel connections **(Figure 13).**

They are designed to provide additional storage capacity within a channel or to intercept water heading towards a watercourse via the existing drainage network. Both approaches act to attenuate flow and reduce the flood peak. Once the event has passed, the connection/s between the storage ponds and the watercourses facilitates emptying of the pond so that storage is available for the next event.

Location Suitability
Online ponds are typically constructed within small watercourse systems (2 – 3 m wide) or adjacent to larger watercourses (up to 10 m wide). Where constructed along an existing watercourse alignment online storage ponds are typically small features which can be installed in sequence to increase storage potential. Construction on land adjacent to a watercourse often facilities the provision of much larger online pond features.

Complementary Measures
A complex system of storage ponds can be implemented, in which both online and offline storage ponds **(FR02.1)** combine to manage flood water.

Overland leaky barriers **(FR01.1)** or flow pathway bunds **(FR01.2)** may be complementary depending on the location within the catchment/channel. These measures may support the development of an online storage pond by backing up flows during storm events. These barriers should be leaky to allow passage of flow during normal flow conditions and allow for drainage of the pond back to the downstream watercourse once the storm event has passed.

Considerations
Biodiversity and heritage features must not be negatively impacted through the construction of a pond; therefore, relevant surveys e.g. protected species surveys, may be needed before work commences to determine any risk.

Attention must be paid on the level of sediment build-up within the pond as this may impact the capacity of water storage over time and increase the likelihood of the pond overtopping.

Consideration is needed of the spoil that would be generated from the construction of a pond. A plan must be devised of where this will be placed. Wherever possible, the spoil should be reused on site as the cost of transporting spoil off site is high.

If a permanent pond is desired, an assessment will be needed into the suitability of the ground to hold water for long periods, and to set the maximum permanent water level to leave enough spare storage volume for flood events.

Where installed along high energy systems within the watercourse channel there may be the need to provide armouring of the outlet to protect against erosion.

Consents and Permissions
Consents will be required for the construction of an online storage pond, including flood risk activity permits from the Environment Agency, drainage consents from the Lead Local Flood Authority, planning permission from the local authority may be required.

Protected species licences may be required in relation to measure implementation and more specifically in-channel and bankside works. A waste transfer permit may be required if spoil is being removed from site.

Agricultural and other Benefits
Online ponds can provide many benefits in addition to NFM. These include the entrapment of sediment and pollutants as well as providing valuable habitat for aquatic flora and fauna where ponds are designed to retain a permanent body of water. Where constructed along existing channel alignments, online ponds can be very effective in managing fine sediment loads in the watercourse.

Costs
Set up: Medium
Maintenance: Low

Level of Maintenance
Medium to High

Design Specification Sheet
Drawing title: FR02.2: Online Storage Pond
Drawing number: 5158157/7.9.2.1/DG/FR02.2

Figure 13 – Online storage ponds with adjacent tree planting as part of the Evenlode scheme (© Evenlode Catchment Partnership)

FR: Overland Flow Route Measures

FR02: Water Storage Measures

FR02.3: Swales

Description
Swales are shallow depressions/channels that act to capture, store or intercept water during heavy rainfall events **(Figure 14).**

Swales are designed to slow, store and encourage infiltration of water to ground and can be installed on any land susceptible to overland flow e.g. adjacent to impermeable surfaces such as tracks and paths or areas with direct transfer to a watercourse. Vegetation within the swale acts to increase channel roughness and therefore slow the flow of water within the channel, whilst encouraging greater amounts of infiltration and evapotranspiration. Through the storage of water and infiltration, swales can promote sediment settling and reduce the transfer of pollutants to watercourses.

Location Suitability
Swales may be created along land contours, on any land that experiences overland flow. Example locations may be at field boundaries, particularly those that border drainage channels, watercourses and roads, or adjacent to impermeable surfaces where large quantities of overland flow occur. Spoil generated from swales may be used to create a downslope low-level bund to improve storage capacity.

Complementary Measures
Swales can link to offline storage ponds **(FR02.1)** and spoil generated from their excavation can be used to create flow pathway bunds **(FR01.2)** (assuming appropriate water retention properties) to reduce the need for material movement/disposal.

Cross-slope woodland & hedgerows **(LM01.2)** may be implemented alongside swales to roughen the ground surface, encourage greater water infiltration and intercept greater amounts of water should overtopping of the swale occur.

Considerations
Care must be taken when locating swales since sub-optimal placement of the measure may act to increase drainage connectivity and worsen downstream flooding contrary to the desired purpose.

Thought must be given to where water may flow should the swale overtop. A separate storage area may be an option for this to reduce the risk of flooding to undesirable locations, or creation of additional slower flow paths to watercourses.

Consents and Permissions
Consents may be required for the construction of a swale depending on where they are located and their size. These include a flood risk activity permit from the Environment Agency, or drainage consents from the Lead Local Flood Authority, should they be constructed close to a watercourse.

Agricultural and other Benefits
Swales can reduce soil loss by intercepting overland flow and therefore trap sediment and chemicals. Once sediment has settled, it can be removed and returned to the land. Through this process, swales provide treatment for pollutants, reducing sediment and pollutant transfer to watercourses and improving local water quality.

Local biodiversity can be improved as a result of the development of wetland vegetation.

Costs
Set up: Medium
Maintenance: Low

Level of Maintenance
Low

Design Specification Sheet
Drawing title: FR02.3: Swales
Drawing number: 5158157/7.9.2.1/DG/FR02.3

Figure 14 – A cross-slope swale with low-level bund on the downstream slope (© West Cumbria Rivers Trust)

WC: Watercourse Measures

WC01: In-channel Structures

WC01.1: In-Channel Leaky Barriers

Description
In-channel leaky barriers are constructed in small permanently, or intermittently flowing channels (2 - 3 m wide), through the placement and securing of woody material such as sections of tree trunks or large branches **(Figure 15)** or boards. These measures are also frequently termed 'leaky dams', 'woody dams' or 'in-channel barriers'.

Leaky barriers can be installed and secured individually, or as a series of barriers with the exact design and location dependent on factors such as channel form, flow character and proximity to local assets (bridges/culverts).

They are designed to temporarily impound and hold back flood water within the channel, which then leaks away once the flood peak has passed.

Location Suitability
In-channel leaky barriers are best suited to watercourses in locations where the temporary slowing and storage of flood waters will not create additional flooding issues. They should not be installed immediately upstream of structures e.g. culverts, outfalls or bridges and should always be secured to remove the risk of mobilisation of wood during high flows. In-channel leaky barriers shall not be installed within 30 times the channel width of a structure.

Implementing in wooded areas means that materials can be sourced locally to reduce cost and effort required to construct. Leaky barriers can be particularly effective in channels that have been historically straighten and are very responsive to rainfall events.

Complementary Measures
Overland leaky barriers **(FR01.1)** may form an extension to an in-channel barrier or be provided as a discrete measure alongside, flow pathway bunds **(FR01.2)** and offline storage ponds **(FR02.1)** on the adjacent floodplain to attenuate and temporarily store water pushed onto the floodplain by in-channel barriers.

Considerations
Protected species in the area may constrain implementation and the use/felling of local trees is likely to trigger the need for appropriate protected species surveys.

Consideration of construction locations and the requirement for fixings is needed where there is risk of blockages to downstream structures should wood become mobile.

The height and positioning of the barrier requires careful consideration as to not affect flood risk, or negatively impact low flows, impede fish passage or cause damage to local habitats/species. Surveys will be required at design stage to assess construction or operational impacts and to support any consent application.

If multiple measures are to be constructed, this will need additional careful planning to ensure that altered flood peaks do not coincide and thus cause greater risk from flooding.

Consents and Permissions
Planning permission is not usually required but a flood risk activity environmental permit from the Environment Agency, if within a main river channel, or a flood defence consent from the Lead Local Flood Authority, if within an ordinary watercourse, will be needed.

Further specific consents may be required for tree felling (if applicable), in the form of a tree felling license from the Forestry Commission. Protected species licences may be required in relation to measure implementation and more specifically tree works.

Agricultural and other Benefits
In-channel leaky barriers aim to strategically flood certain areas to reduce localised flooding, possibly within farm holdings or other land uses.

These measures can trap sediment and large debris and therefore improve local water quality and reduce undesirable blockages downstream.

In-channel leaky barriers can vary flow conditions within the channel, creating additional benefit to fish, aquatic mammals, plants and invertebrates, increasing biodiversity and habitat provisions.

Costs
Set up: Low
Maintenance: Low

Level of Maintenance
Medium

Design Specification Sheet
Drawing title: WC01.1: In-Channel Leaky Barriers
Drawing number: 5158157/7.9.2.1/DG/WC01.1

Figure 15 – Fixed large wood in-channel leaky barrier storing water during high flow event (© Dave Gasca-Tucker)

WC: Watercourse Measures

WC01: In-channel Structures

WC01.2: Headwater Channel Woody Bundles

Description
Headwater channel woody bundles are of a similar concept to in-channel leaky barriers (WC01.1). However, they are more typically associated with temporarily (ephemeral) flowing channels/gullies in the upper catchment and only become active during or following rainfall events. The purpose of these measures is to roughen the flow route within temporarily flowing narrow channels/gullies.

Bundles are typically designed and fixed where necessary to mimic naturally occurring woody accumulations that cause blockages within the catchment headwater setting. Multiple bundles **(Figure 16)** can be installed in sequence to maximise effectiveness, acting to slow smaller volumes of water per feature, rather than store a large amount of water behind a single feature.

Location Suitability
Since temporarily flowing channels/gullies are targeted, these measures are typically located in the upper catchment. They are ideally located within wooded headwater sections that lie naturally wet and are periodically flooded. Implementing in wooded areas means that materials can be sourced locally to reduce cost and effort required to construct.

Complementary Measures
Additional attenuation and storage may be provided in combination with overland leaky barriers **(FR01.1)**, flow pathway bunds **(FR01.2)** and offline storage ponds **(FR02.1)**. Downstream in permanent flowing section this measure can be replaced by in-channel leaky barriers **(WC01.1)**.

Considerations
Protected species in the area may constrain implementation and the use/felling of local trees is likely to trigger the need for appropriate protected species surveys. Re-use of fallen trees should be prioritised over fresh felling where there is an abundant local source.

Consideration of the risk of wood mobilisation and the requirement for fixings is needed where there is risk of blockages to downstream structures associated with the measure.

Consents and Permissions
Consents are unlikely to be needed unless measures target channels that fall under the Lead Local Flood Authority's ordinary watercourse consenting requirements. This measure shall not be targeted at main river habitat.

Further specific consents may be required for tree felling (if applicable), in the form of a tree felling license from the Forestry Commission. Protected species licences may be required in relation to measure implementation and more specifically tree works.

Agricultural and other Benefits
Through slowing the flow and encouraging spill of water to the floodplain, downstream flows can be reduced and may reduce localised flooding, potentially within farm holdings. The reduction in flow velocity may also reduce erosion and gullying within the headwaters.

Woody bundles may act as a sediment barrier, reducing sediment transport into channels downstream, which may in turn increase water quality. These bundles may also provide refuge for wildlife and provide habitat and increased local biodiversity.

Costs
Set up: **Low**
Maintenance: **Low**

Level of Maintenance
Low

Design Specification Sheet
Drawing title: WC01.2: Headwater Channel Woody Bundles
Drawing number: 5158157/7.9.2.1/DG/WC01.2

Figure 16 – Headwater channel woody bundles in wooded valley (© Dave-Gasca-Tucker)

WC: Watercourse Measures

WC01: In-channel Structures

WC01.3: Moorland Grip and Gully Blocking

Description

Grip and gully blocking **(Figure 17)** involve the constraining of flow with channels in peatland/moorland landscapes by the installation of small dams. These measures are largely aimed at storing water within these landscapes, rather than encouraging their drainage. These areas are usually highly responsive to rainfall and subsequent water runoff, and therefore can be key upland areas in which to target measures for reducing downstream flooding.

The measure aims to restore natural drainage and can encourage vegetation growth, which may reduce rapid drainage to downstream watercourses and reduce erosion. The pools created behind dams can provide additional temporary flood water storage and can therefore slow the rate in which water moves through the landscape. Dams can be constructed from locally sourced peat, or from other materials such as timber, stone or plastic. Despite this, timber and stone typically require airlifting in and therefore are more costly methods.

Location Suitability

This measure is specifically targeted at upland peatland areas with pre-existing grips and gullies. For ease of implementation, areas with good accessibility for machinery and equipment are favoured.

Complementary Measures

Grip and gully blocking can occur alongside other restoration techniques such as the re-introduction of vegetation, such as Sphagnum Moss. This would allow for a more broad-scale peatland restoration scheme as grip/gully blocking may support the growth of vegetation. This may be an idea proposed in the landowner innovation section if suitable.

Considerations

Research suggests that grip blocking can be effective in reducing flood-risk, however, careful placement may be needed to avoid creating coinciding flood peaks. Therefore, the local Catchment Advisor and planner will need to carefully advise on suitable location of measures.

Gully blocking can be implemented through peat, stone, timber or plastic dams. Despite this, all materials except peat must be transported in (typically via airlifting) and are therefore more costly to implement.

Consents and Permissions

Due to large areas of moorland being designated as open access land, Public Rights of Way and Open Access consents may be required from relevant authorities, which may include the National Park Authority, Unitary Authority or County Council. Further planning permissions from local authorities may also be required if very extensive work is being completed. Attention shall be paid to public risk and interface due to the potentially remote location of these measures.

Furthermore, many areas of moorland are designated habitats e.g. SAC, SSSI and local nature reserves and consent may be required from Natural England or the local authority, where appropriate.

Agricultural and other Benefits

Through the slowing of water movement, the erosion potential of runoff is reduced and therefore a reduction of sediment transport and water discolouration may be seen. Downstream water quality may also be improved through this.

Grip blocking can also reduce the rate at which peatland degrades, in turn reducing the rate at which carbon is released into the atmosphere as CO2.

Livestock can be harmed via falls into deep gullies and grips; blocking and re-vegetation may help to prevent this. When designing dams, allowing for safe egress is a primary consideration.

Costs

Set up: **High**
Maintenance: **Low**

Level of Maintenance

Low

Design Specification Sheet

Drawing title: WC01.3: Moorland Grip and Gully Blocking
Drawing number: 5158157/7.9.2.1/DG/WC01.3

Figure 17 – A series of constructed peat dams in a moorland setting (© Moors for the Future Partnership)

LI: Landowner Innovation

The landowner innovation option provides an opportunity for the landowner to present alternative measures to those listed in this booklet, that could contribute to NFM through mechanisms such as increasing infiltration, reducing water runoff and storing water. The innovation will need to provide a nature-based solution that acts to provide measurable benefits in term of reducing flood risk and shall avoid the need for hard engineering. Additional information is required to support this option, including the location of the measure and key design parameters, as well detailing costs and construction and maintenance requirements.

Some potential ideas include:

- River restoration
- Re-vegetation of moorland areas
- Minimum (conservation) tillage
- Adaptation of livestock management practices e.g. removal of livestock over autumn/winter
- Arable Reversion
- Coniferous plantation management
- Track cross-drains and sediment traps
- Rainwater harvesting
- Procedural/behavioural changes e.g. use/route of heavy machinery in certain areas

A blank Design Specification Sheet has been provided in the Natural Flood Management Design Specification Catalogue, allowing the landowner to record details of the innovation. For further guidance and support with detailing an idea, the local Catchment Advisor will be able to assist.

Design Specification Sheet
Drawing title: LI: add name of measure
Drawing number: 5158157/7.9.2.1/DG/LI01.1

4

Consents and Permissions

Throughout this booklet and the Design Specification Catalogue, the requirement for consents and permissions relevant to each measure have been identified.

However, these are not an exhaustive list and further advice from the local Catchment Advisor should be sought, especially where participants put forward bespoke landowner innovation measures. Where there remains uncertainty as to whether the implementation of an NFM measure will be permissible when considering agri-environment schemes, enquiries may be made to the Rural Payments Agency (RPA) for written clarification.

There are several consents that may apply across the measures in this booklet, a schedule of the more commonly required consents/permissions is provided in Table 1, including information on the consenting body and situations where they may apply.

Table 1 – A list of general consents that may need consideration for the measures detailed within this booklet

Consent/Permission	Consenting Body	Where consents may be required
European Protected Species (EPS) mitigation licence	Natural England	If any work could adversely impact any European Protected Species e.g. bats and otter, through for example tree works or works in and adjacent to watercourses
Wildlife Licences	Natural England	If work will disturb, remove or damage wildlife and habitats
Environmental Impact Assessment (Agriculture) Regulations 2006 (amended 2017)	Natural England	Applicable to rural land that is uncultivated or semi-natural, if work is: ■ Increasing productivity of land for agriculture ■ On land of 2 ha or greater ■ Impacting heritage features or within a protected status area ■ Restoring semi-natural grassland ■ Altering field boundaries over 4 km long ■ Moving/distributing over 10,000 m^3 of earth.
Protected Status Areas Consent e.g. SSSI consent, Habitat Regulation Assessment (HRA) under Conservation of Habitats and Species Regulations 2017 (as amended)	Natural England	If any land with protected status is being worked on, including: Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC) and Special Protection Areas (SPA), or there is potential for propagation of effects to a protected site
Main River Flood Risk Activity: Environmental Permit	Environment Agency	If any work is within the channel or floodplain of a main river

Table 1 Continued – A list of general consents that may need consideration for the measures detailed within this booklet

Consent/Permission	Consenting Body	Where consents may be required
Water Framework Directive (WFD) compliance assessment	Environment Agency	If applying for a bespoke flood risk activity permit as part of the NFM works, and i) the activity could affect a water body at high status or high morphology, or ii) you're applying for a flood risk activity permit for a specified type of activity on a main river
Ordinary Watercourse Land Drainage Consent	Lead Local Flood Authority or Internal Drainage Board	If works are within or adjacent to an ordinary watercourse
Planning Permission	Local Planning Authority	If large structures are being constructed e.g. bunds and ponds, or there is a material change of land use e.g. planting woodland over 2 ha, or constructing in the floodplain.
Public Rights of Way and Open Access Land Consents	County Council	If any works are being done that may impact the public's right of way (including the non-legal definitive route that people may use). Care must be taken to avoid blockage of any public rights of way, temporarily or permanently.
Scheduled Monument Consent (SMC)	Historic England	Heritage features will need to be considered, especially when breaking ground, including any legal designations (Scheduled Monument). If work is close to or involving a registered ancient monument Historic England will need to be consulted.
Tree Felling License	Forestry Commission	Felling licenses may be required depending on: ■ Location ■ Type of tree work ■ Volume and diameter of the tree/s However, even if a tree felling license is not required, other consents or permissions may still apply in relation to, European Protected Species (EPS) mitigation licencing, Tree Protection Orders (TPOs) and protection of landscapes and designated areas.

See References (REFS.X) Design Specification Sheet for links to consents and permissions guidance.

5

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highways england

Where to apply and how to find out more about the NFM Fund

NFM Fund Website

You can find everything you need to make an application to the NFM Fund on our website

https://catchmentbasedapproach.org/learn/he-nfm-fund

In particular, the website hosts links to the following key items:

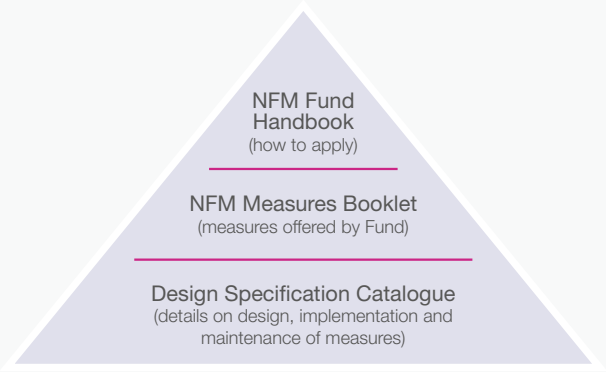
- NFM Handbook providing a summary of the entire Fund process
- NFM Measures Booklet giving an overview of the measures that can be implemented using the Fund
- Design Specification Catalogue detailing how to design, implement and maintain measures
- Application Page to the Fund: **https://highwaysengland.naturebid.org.uk**
- Step by step guide to making an application
- Terms and Conditions of the Fund

NFM Fund Helpline

If you need any assistance preparing or making an application to the NFM Fund please contact your local Catchment Advisor. Alternatively you can contact us on:

Telephone: (01332) 225901

Email: NFMadvice@atkinsglobal.com



Mersey Rivers Trust

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