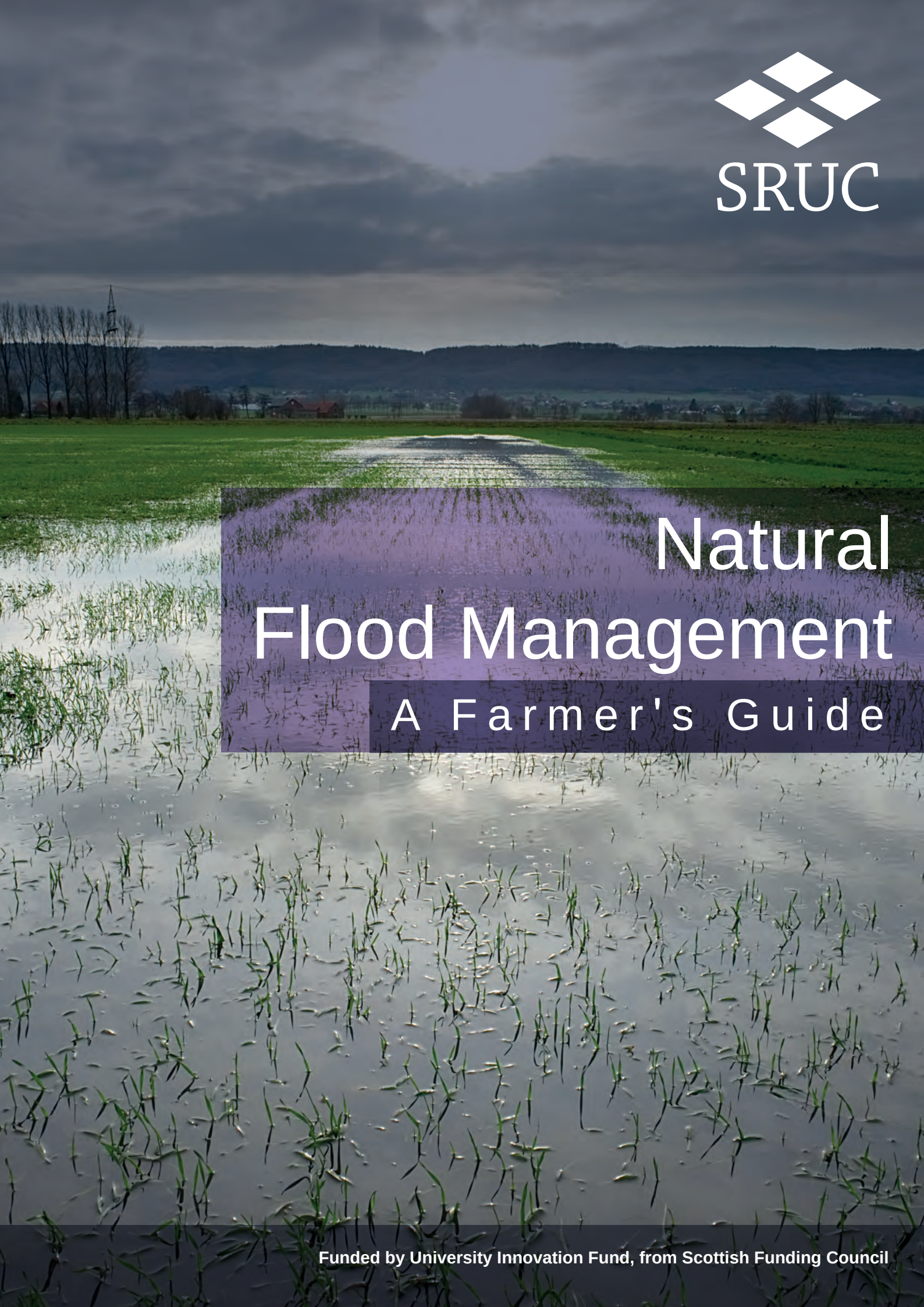


SRUC

Natural Flood Management

A Farmer's Guide

Funded by University Innovation Fund, from Scottish Funding Council

This guide has been developed to provide information on natural flood management for landowners and farmers in Scotland.

Acknowledgements:

This document was produced by SAC Consulting and the Tweed Forum funded by the University Innovation Fund from the Scottish Funding Council.

With thanks to SEPA for information and guidance in producing this document.

All information contained in this publication is believed to be correct at time of going to press.

What is Natural Flood Management?

Natural Flood Management is a process whereby systems are put in place, which work with the natural environment to store and slow down the flow of water running through the catchment.

What Natural Flood Management Can Do For You?

Natural Flood Management (NFM) schemes on farmland can help reduce catchment flooding, increase biodiversity and reduce diffuse pollution. NFM has the potential to offer many benefits to the farm, with increasing biodiversity, maintaining soil, reducing compaction and many more. However, uptake of NFM schemes on farmland throughout Scotland has not been high. This may be because farmers fear loss of land with no benefit to their farming business. However, while NFM schemes can collectively help reduce the impact of flooding downstream this document has been produced with the intention to show the immediate **direct benefits NFM schemes can offer the farm** in which they are located.

This guide aims to provide an overview of the suite of small and large scale NFM schemes available, which with sufficient design and guidance may be of benefit to help your farm and neighbouring land owners.

Contents

1 Case Study: Eddleston Water, Tweed Forum

Farming and Natural Flood Management; can they work together?

The Eddleston Water project looks at the contribution that natural flood management features in the landscape can make to reduce the risk of flooding and of habitat degradation. From an initial scoping study in 2009, it has developed into a long-term national research project funded by the Scottish Government. To date, it has worked with over 20 farmers, foresters and land managers to re-meander over 2 km of river, planted some 207 ha of native trees, created 28 flood ponds, 116 log structures and is on track to restore the river from Bad to Good Ecological Status.

The project has three main objectives:

1. To investigate the potential to reduce the risk of flooding to downstream communities through the utilisation of natural flood risk management (NFM) features;
2. To improve habitats for wildlife and fish, and raise the ecological status of the river; and
3. To work with landowners and farmers in the local community to maximise the benefits of the work, whilst sustaining farming livelihoods and practices.

In seeking to deliver these objectives, the project aims to generate robust evidence of the impact, cost and benefits of working with natural processes at a catchment scale. The role of Tweed Forum is to manage the project and to act as a facilitator to farmers to discuss what they could do to help the project.

How does this type of work fit with farming?

Farmers are key to making the project work, as they control land use. All the works carried out have been on a voluntary basis and each NFM feature has been made to benefit the farm in a small way, without a cost to the farmer. Some farmer reactions include;

'although I have lost a small bit of rough grazing, the new fence and the strip of trees beside the burn means that the burn is protected from poaching, so SEPA will not be concerned.'

'all the paperwork, felling, replanting and fencing was done by Tweed Forum, and we got the felled timber value, as well as better land drainage, a duck flight pond and a secure boundary fence.'

'the trees and new hedges will give a bit of shelter for the sheep, and keep them out of the wettest areas where fluke can be a problem. The farm looks better with some more trees too.'

The Eddleston Water Project; An Example of How Natural Flood Management Might Work

The Eddleston Water is a tributary of the River Tweed in the Scottish Borders, with a catchment of 70 km2 draining south to join the main river at Peebles. It is typical of rural Scottish catchments of this size, with a mix of forestry, rough grazing and improved grassland. The river was severely straightened at the start of 19th Century to enable the building of a toll road to Edinburgh which, together with land drainage and use of modern fertilisers, led to improved agricultural production. However, in combination with the subsequent building of a railway embankment and further changes in farming and forestry, this resulted in increased flood risk downstream and habitat degradation.

Currently, SEPA's flood risk assessment shows some 582 properties at risk of flooding in Eddleston and Peebles under a 1:200 year scenario; the most recent floods being in 2016. Farmers are also affected by flooding, where vital silage fields can become inundated and unusable.

Figure 1-1 Flooded farmland near Eddleston, Valuable silage ground becomes too wet to work and gravel and debris is deposited on the land.

Figure 1-2: An example of new native woodland planting along a watercourse. This protects the watercourse from poaching by livestock.

Figure 1-3 Cutting a more natural channel on the floodplain.

Facilitation

Tweed Forum has worked with farmers to plant native trees, dig flood storage ponds, plant transverse hedges and install leaky barriers along streams. These features all hold water in the landscape and so contribute to reducing the height of flood peaks. Each farm and farmer is different, so the key was to discuss at length what would be acceptable and desirable on each farm, and then for Tweed Forum to come up with the funds to make it happen. The summer of 2012 was particularly wet and saw a great increase in the incidence of liver fluke among livestock. Many of the riparian woodlands and ponds are located in wet areas, so with these areas fenced off, the incidence of fluke and the medication needed to treat animals, should reduce. The incidence of livestock drowning will reduce too. Farmers have also benefited from new fences where ponds and woodlands have been created.

Funding

Funds came from a variety of sources, including; Forestry Grant Scheme, Scottish Rural Development Programme, carbon capture funds, Woodland Trust, quarry offsite mitigating funds, Borders Tree Planting Grant, Scottish Government Flood team and farmer contributions.

Figure 1-4 A new more natural sinuous channel, with duck pond, and protecting existing silage fields.

Results

Monitoring is being led by Dundee University, who have set up a dense network of rainfall and river depth gauges, as well as a whole range of biodiversity indicators, such as river invertebrates. At this stage, the project is past the initial set-up stage, and now we await the occurrence of a flood, so that our NFM features can be tested and measured. In the meantime, farmers are content that they have contributed to a landscape scale experiment, which has not adversely affected how they farm, and which has also brought tangible benefits to how they farm. Other benefits of the project include biodiversity, landscape and as an educational resource.

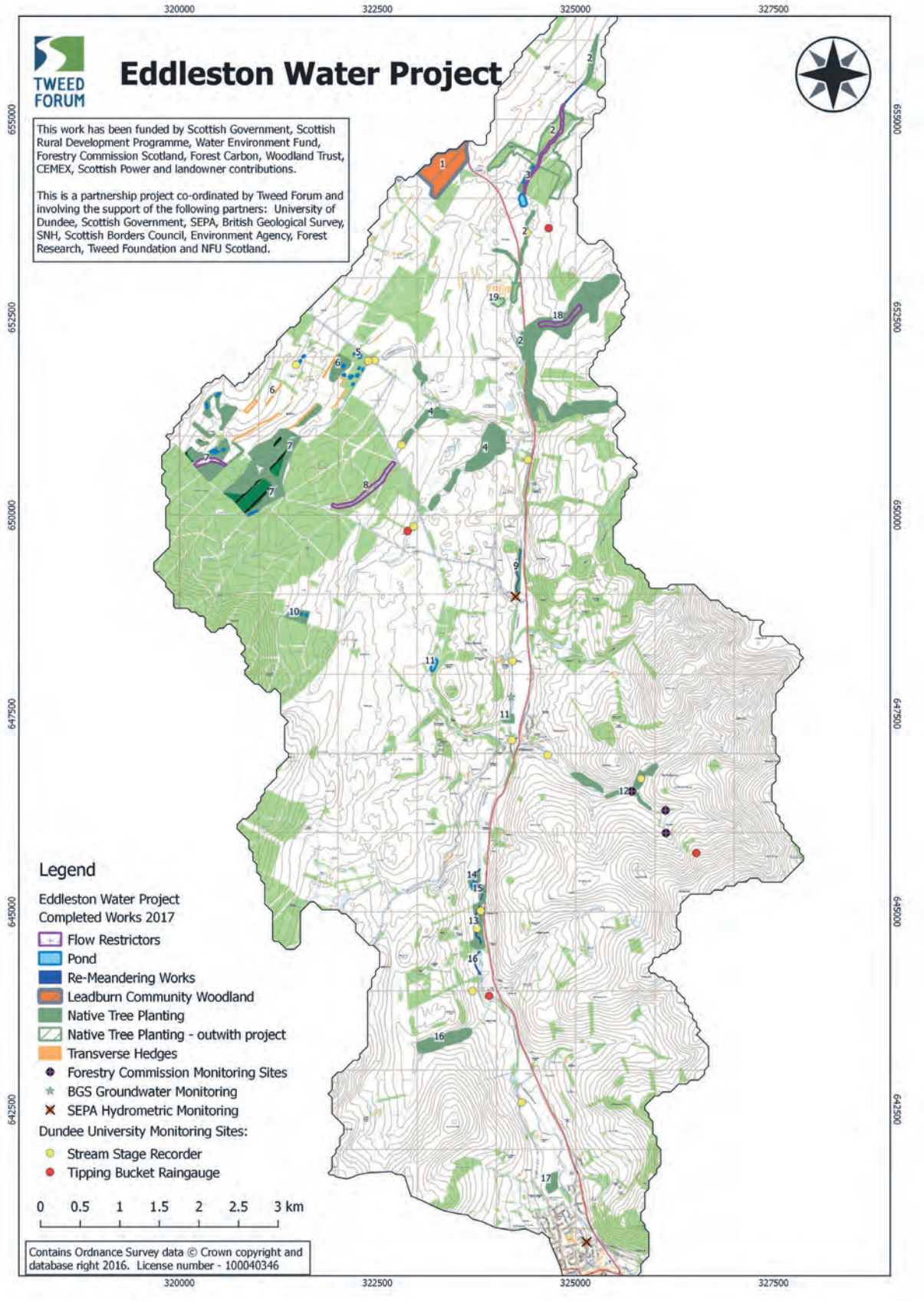


Figure 1.5. NFM features which have been constructed in the Eddleston Catchment Natural Flood Management Map

2 Natural Flood Management Map

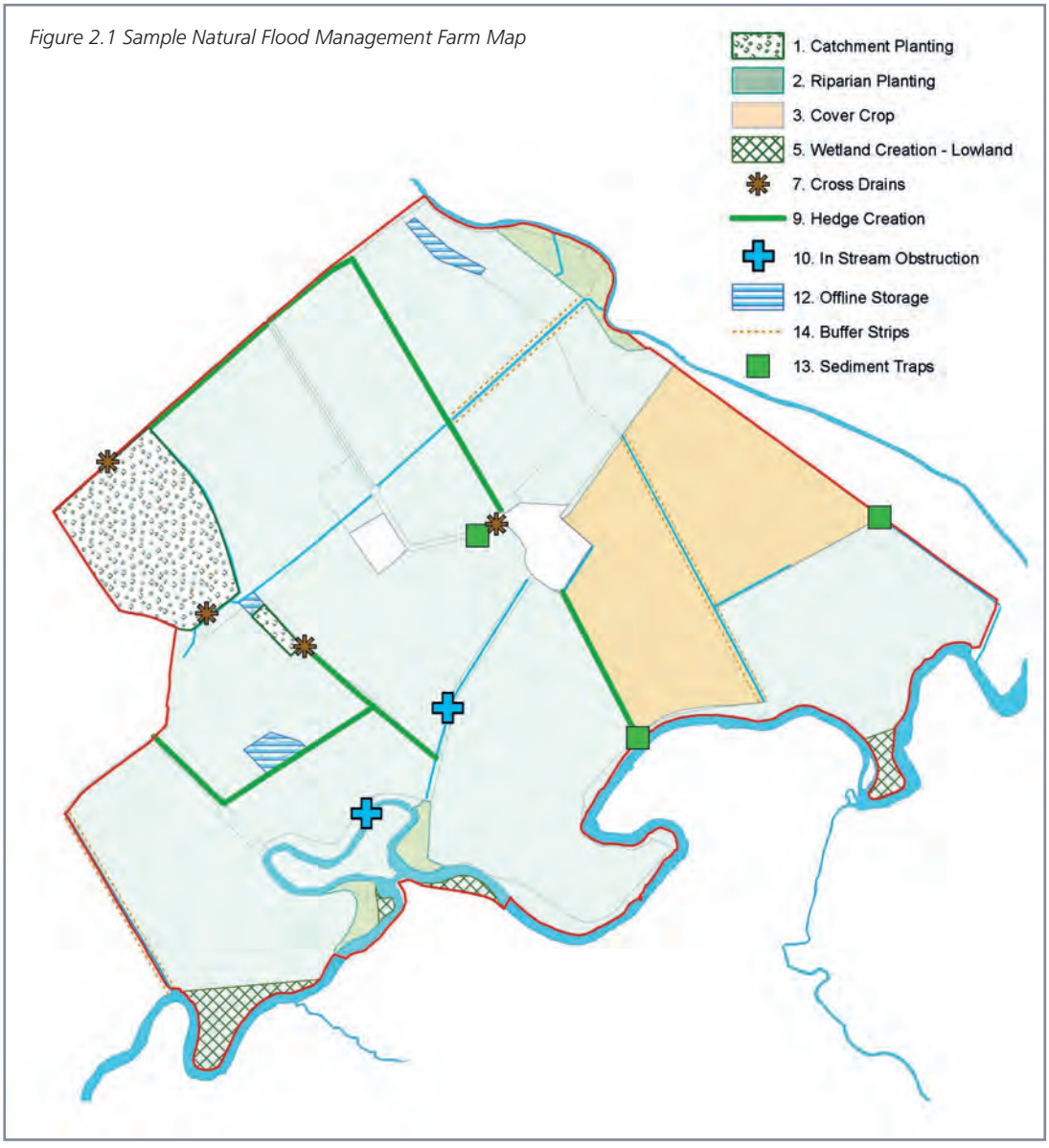
Every farm is individual with diverse requirements, issues and management practices. When initiating plans to introduce natural flood management (NFM) schemes on farm having a visual tool can be really useful. Producing a map, which can focus on areas that could be significantly improved by introducing NFM practices, will highlight areas that should be targeted and techniques that can be used on farm. Risk maps can be found at http://soils.environment.gov.scot/maps/risk-maps/. These maps offer observations of what could be happening on the ground and can be an excellent base to start investigating whether natural flood management would be beneficial to you farm. However, a detailed analysis could show you the areas to focus on more specifically on your farm and suggest what would be best for you and your farm.

Through Integrated Land Management Plans (ILMPs)[1], which are funded through the Scottish Government's Farm Advisory Service, land managers can apply for funding to employ expert consultants to develop management maps for farms. There are many different areas ILMPs can cover, which include[2]:

- water pollution, prevention and control
- soil and nutrient management
- biodiversity, habitat and landscape management
- woodland management and conservation

The target areas above are encapsulated in NFM schemes and can be shown on a map similar to Figure 21, which can be produced using ILMPs funding. This map is an example of what can be highlighted on your farm, representing vulnerable areas and offer solutions to issues, which could be implemented on farm.

Figure 2.1 Sample Natural Flood Management Farm Map



A map created specifically for a farm can focus attention and ensure that target areas that are most vulnerable and cost effective to the farm are concentrated on.

[1] Further information on ILMPs can be found here https://www.fas.scot/integrated-land-management-plans-ilmps/
[2] Full list can be found at https://www.fas.scot/integrated-land-management-plans-ilmps/

3 Catchment Woodland Planting

What Catchment Planting Can Do

Planting woodlands within farms can potentially have great effect on the rate of water that passes through the farm.

Woodlands can offer:

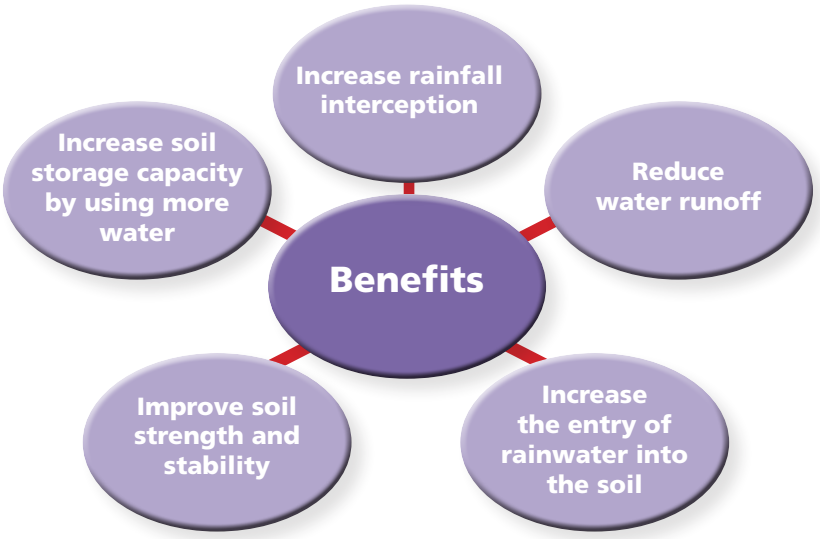
- Wind breaks and land roughness
- Protect soil from disturbance
- Improved soil structure
- Tree roots bind soil together, while the woodland provides high organic matter

3.2 What Catchment Woodlands Can Offer Your Farm

- Well sited woodlands can slow peak flows reducing flood peaks downstream
- Reduced erosion
- Reduced silt entering waterbodies

3.3 What Woodland would suit you?

Both broadleaved and conifer woodland can help with Natural Flood Management on a catchment scale. Deciding what would be most suitable for your farm depends on the issue you are hoping to resolve:



Broadleaf - can Increase infiltration rates

Coniferous - can have highest water use

This increased ability of the soil to receive and store rain water is often referred to as the forest 'sponge effect'.

There are limitations to this effect, however, as most major floods occur following periods of exceptionally heavy and/or prolonged rainfall. On these occasions the forest soils which will be intercepting water, however, are generally fully rewetted with a reduced capacity to receive and store storm water.

Catchment Woodland Top Tips

Economics	The cost effectiveness of woodland planting together with the forest 'sponge effect' can be maximised by increasing the scale of planting. If access is good, productive conifer planting could be considered to provide a good economic return. If well designed, for instance incorporating native broadleaved planting along riparian corridors they can also deliver benefits in terms of NFM.
Shortage of Land	Where suitable planting land is limited, strategically plant narrow, fenced shelterbelts of trees across slopes. Mixed broadleaved planting has been shown to be particularly effective at increasing infiltration rates even when in narrow strips. This allows capture of surface run-off from the pasture land above and run-off to soak more rapidly into the soil. (Grants may not be available for widths under 15m).
Water Courses	Observe Forest and Water guidelines with regard to buffer strips when planting coniferous woodland. Keep conifers 20m back from streams over 2m wide and 10m back from narrower streams. Use native riparian woodland in these buffer strips to maximise the NFM and water quality benefits. Extend buffer strips to include wet and boggy areas.
Forest Cultivation & Drainage	There should be no cultivation within 2 m of a water course. Limit cultivation to hinge mounding if planting native woodland within the 10 or 20m buffer strips given above. Consider opportunities to enhance floodwater storage through restoring forest wetlands, creating ponds and other storage features. Run forest drains at a gradient of no more than 2 degrees and lead them towards the head of the valley. Stop all drains well short of any water course.
Erosion:	New woodland on soils vulnerable to structural degradation by agricultural activities can increase soil infiltration rates and reduce rapid run-off and local flood flows.
Woodland	It is very important to follow the guidelines in the UK Forestry Standard, which will help maximise the benefits in terms of NFM. See the specific examples given above for buffer areas, cultivation & drainage.

Estimated costs/Funding Options

Under current Forestry Grant Scheme, planting grants for diverse conifer woodland planting are:

Grant Scheme	Non-Target Area (per ha)*	Target Area (per ha)*
Initial Planting Grant	**2160**	**2430**
Annual Maintenance Payment (for 5 years)	**336**	**378**

*Figures correct September 2018

Sample capital grants:

- new stock fence £4.40/m
- new deer fence £6.80/m
- rabbit net overlay £1.60/m

Further Information Online:

https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf

https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf

https://scotland.forestry.gov.uk/

https://scotland.forestry.gov.uk/supporting/strategy-policy-guidance/soil-and-water-management/flood-risk-management

http://www.tweedforum.org/

https://www.nfm.scot/about-us

https://www.sruc.ac.uk/info/120603/farming_and_water_scotland

http://www.pontbrenfarmers.co.uk

http://www.confor.org.uk/media/79557/1208-confor-productive-woodlands-plus-water-12pp-aw-sml.pdf

http://www.confor.org.uk/resources/uk-forestry-standard-2017/

4 Riparian Planting

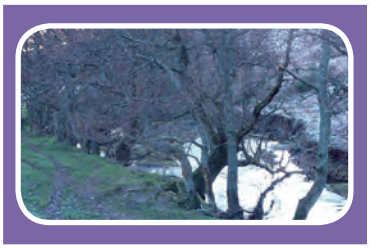
What is Riparian Planting

This is planting woodland along riverbanks and areas of wet woodland extending beyond the riparian zone across the flood plain. Such woodland, if containing appropriate trees and well managed, can provide numerous benefits for natural flood management:

Standing trees, fallen logs, branches and leaf litter form a very dynamic and complex network of multiple channels and dams, help to disperse and slow down flood flows.

Woodland increases rainfall Interception and infiltration of water into the soil profile. This means that rainwater will run-off the hill more slowly. This can reduce flood peaks downstream, reduce erosion and as a result the amount of silt in the river system.

Riparian woodlands trap sediments, nutrients and pesticides draining from adjacent land.



The binding action of tree roots can increase the stability of river banks, thus preventing or slowing bank erosion.

By lowering the input of excessive coarse sediment into the water course riparian woods can help protect against bank erosion.

Would Riparian Planting be right for Your Farm?

Care is required to avoid sites where the backing-up of floodwaters upstream could affect local properties, or the washout of large woody debris could block downstream bridges or culverts. Access may be needed to maintain flood protection measures. Ensure that Forest and Water Guidelines are followed throughout the whole process.

Groups of conifers produce heavy shade. This reduces the biodiversity and productivity of a water course and should be avoided. The lack of ground vegetation that results from the heavy shade can also lead to increased soil erosion. Finding the right species for the woodland is important for the success of the project.

Riparian woodland often involves long thin strips of woodland on fertile ground. These can be expensive to establish with high protection costs (long lengths of fencing per area planted) and high weeding costs. Fencing can also be difficult along flood plain areas and will need to be replaced if damaged by a flood Consider flow pathways during flood events and avoid fencing transverse to these, alternatively use specially designed fences, which are easy to reinstall.

Why Natives Broadleaves?

- Use native broadleaved species for riparian planting.
- Plant at variable spacing with areas of open ground. This allows a diverse ground flora to develop, which will help with water infiltration. The dappled shade produced helps maintain suitable water temperatures for fish and the mixed leaf litter provides a good source of food for invertebrates.

Bank Stability

- Mature trees or fast growing willows on river banks can exert a large lever force and lead to bank destabilisation. Management of riparian woods is important with pollarding or coppicing of trees such as willow and wych elm being an effective way of preventing this issue and allow the desired levels of light to reach the river.

Bank Stability/Wildlife habitats

- Plant some native trees on, rather than away from, the bank in treeless rivers so that eventually the tree roots will create physical structures, which may be used by wildlife such as otters.

Biodiversity

- Do not plant in areas that are already important for wildlife such as certain wetlands, species-rich grassland, reedbed and tall herb communities.
- Link new native broadleaves planting with existing fragments of riparian woodland.

Shade

- Too much shade can lead to bare eroding banks and result in wider shallow channels.
- Too little shade can result in a lack of shelter and more extreme water temperatures.

Livestock poaching and eroding riverbank

- Fence off the area to plant riparian woodland using the Forestry Grant Scheme to help reduce the fencing costs.

What Should You Consider When Planning Riparian Planting?

Target areas	**In order to get the higher area payment for native woodland, the planting needs to be in areas that have been identified as 'woodland for water areas'. These are where there are clear benefits to be gained from the planting in terms of both natural flood management and water quality. However, this is currently under review as not all beneficial areas are targeted or covered.**
Grant for capital items	**Grant for capital items: Be aware that the grants for capital items are nearly always capped at 150% of the initial planting grant. This is very significant for riparian planting with its high protection costs. If tree shelters are used then there is usually no capital grant left to cover fencing. For long narrow stretches of riparian planting the fencing grant alone is often greater than 150% of the initial planting grant. However, it is worth discussing your project with the Forestry Commission.**
Minimum block size	**The minimum block size for a native woodland planting grant is 0.25ha with a minimum width of 15m. However, to score enough points to be eligible for the grant larger planting blocks may be necessary depending on the location.**
Scale of planting	**For small areas of riparian planting the grant will rarely cover much more an 50% of the costs involved unless you undertake a lot of the work yourself. If the scale of planting is increased by including significant areas of floodplain woodland or larger areas of catchment woodland then the grant becomes much more attractive and can cover most of the costs involved in establishing the woodland.**

Estimated costs/Funding Options:

Under current Forestry Grant Scheme, planting grants for native broadleaved woodland planting are:

Grant Scheme	Non-Target Area (per ha)*	Target Area (per ha)*
Initial Planting Grant	1840	2070
Annual Maintenance Payment (for 5 years)	272	306

*Figures correct September 2018

Sample capital grants:

- new stock fence £4.40/m
- new deer fence £6.80/m
- 1.2m tree shelter £2 each

4.6 Competitive Funding

FGS funding is now highly competitive for high cost woodlands (over all grant funding of over £6000/ha). Riparian planting is likely to fall into this group and so it will be very important to demonstrate the NFM benefits when making an application.

Further Information Online

https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf

https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf

https://scotland.forestry.gov.uk/

http://www.tweedforum.org/

https://www.nfm.scot/about-us

https://www.sruc.ac.uk/info/120603/farming_and_water_scotland

5 Soil Management Measures

The management of soil runoff is an ongoing battle of the farming industry. The cost to the farm and the surrounding area from the movement of soil can be vast. This section explores different methods to reduce the soil loss from the farm, trying to keep the soil and nutrients as close as possible to their origin.

Relieving Compaction

What is Soil Compaction and Why is it an Issue?

Soil compaction is one of the biggest problems modern farmers face when managing their soil resource. Increased use of heavy machinery, stocking densities and high rainfall winters has led to it becoming a hot topic among arable and livestock alike. The role compaction can play in increasing the amount of runoff from farms also contributes to the total amount of water reaching the burn when there is heavy rainfall, thus impacts on potential flood waters. During a rainfall event un-compacted soil will soak up water until it fills its pore space and becomes saturated, a compacted soil will soak up less water and will reach saturation slower allowing more water to flow into the burn, as shown in the figures below.

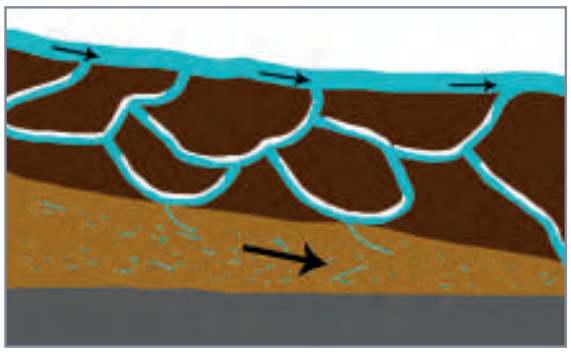


Figure 10.1 Water movement in a freely drained soil, water moved quickly through the soil.

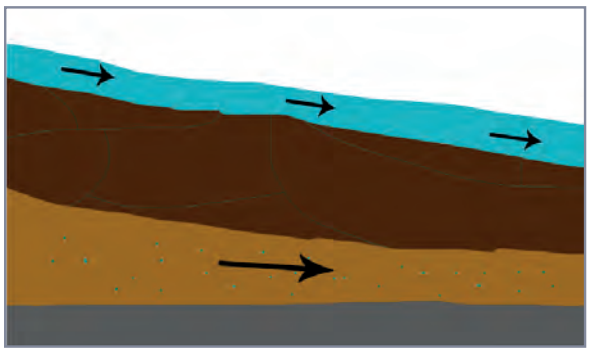


Figure 10.2 Water movement in a compacted soil, water travels slowly through the soil resulting in increased runoff.

What can you do to avoid soil compaction

To try to avoid soil compaction on farm make simple changes that can have huge benefit.

Avoid entering the field when the soil is waterlogged

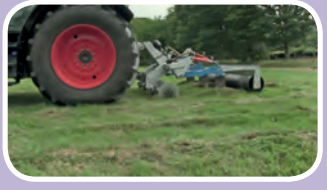
Change or vary tillage practices on the field e.g. minimum tillage or vary ploughing depths

Reducing the overall amount of heavy machinery driving over the land and controlling the traffic that does

Regularly moving water troughs and feeders to avoid compaction

Use lighter machinery with wider tyres and minimum inflation when possible

Cover crops can be used to break through compacted soil and improve its structure



Sward lifters and other machinery can also be used to help alleviate

Reducing soil compaction will not only help to reduce run off and flood waters it can also help to increase grass and crop yields and reduce fertiliser loss.

Increase yields, crops and grass -

Increase grass competitiveness against rushes -

Reduce soil erosion, keeping a valuable resource where it should be -

Reduced loss of fertilisers and pesticide into nearby ditches and burns, saving you money -

Better soil infiltration, reducing waterlogging so the field may be accessible earlier in the season

Tram Lines

Why is Tramline Management Important in NFM?

Tramlines are a recognised practice in arable farming allowing for simpler field operations. If tramlines become compacted they can encourage the channelling of water and potentially increase diffuse pollution. Making small changes to tramlines can make a huge difference to the surface runoff.

Tramlines are a potential flood risk on sloping ground

Tyres on left of trailer demonstrating less compaction

Tramlines in winter wheat at harvest

Tramline Management – Top Tips

Regularly moving water troughs and feeders to avoid compaction from livestock.	**Create tramlines that follow contours rather that up and down slopes. Taking into account slope gradient.**	**In high risk fields an extra headland tramline (not connected to other tramlines) at the lowest end of the field will act as an additional buffer.**
Use GPS without tramlines or consider sporadic tramlines.	**Roughening the soil within the tramline helps control runoff, soil erosion and the loss of nutrients from fields, e.g. using a tramline trickler.**	**Use low ground pressure tyres – ensure correct tyre inflation pressure for the tyre, filed operational land axel load – don't over inflate.**
Increase tramlines spacing e.g. 18m to 24m – reduces number of tramlines and include 6m buffers to reduce run-off.	**Autumn spraying can be high risk compaction points – consider timing, alternatives and take extra care on high risk fields.**	**Avoid establishing tramlines when soils are wet or on loose fluffy seedbeds.**

Cover Crops

5.3.1 What are Cover Crops and Why Grow them

A cover crop is grown between main crops to protect soils and the environment, reduce flood risk and improve subsequent crop yields. They have a number of agronomic and environmental benefits such as:

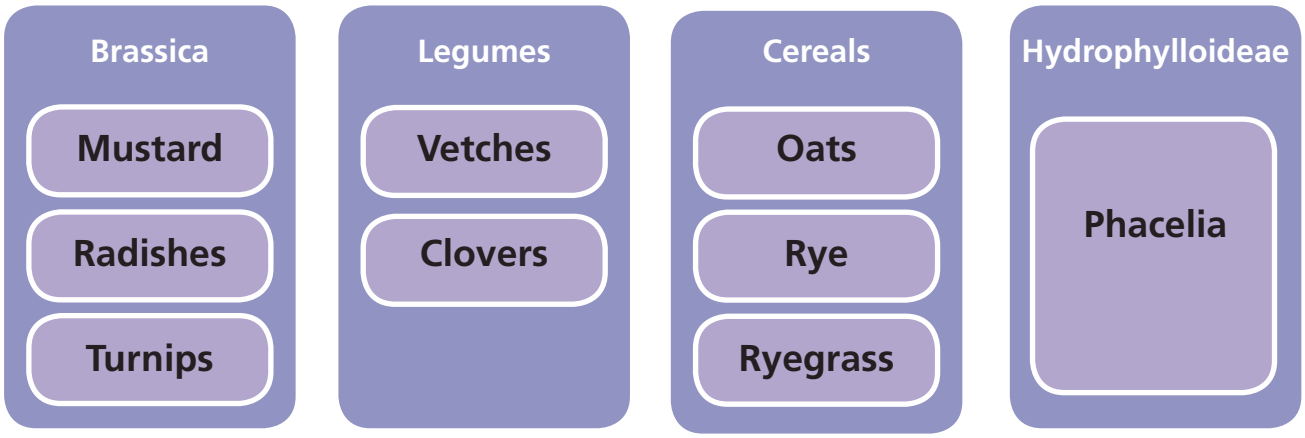
- Stabilise soils and reduce erosion
- Reduce leaching through run off
- Improve soil structure and organic matter
- Improve water quality
- Retain and potentially increasing soil nutrients - using legumes
- Can be used as part of Ecological Focus Area (EFA) to satisfy farm support payments.

Studies carried out in 2017 demonstrated the importance of early sowing of cover crops post-harvest. Results showed that August sowings were vastly superior to September sowings. By ensuring that your fields are in crop you can protect your field from harsh weather conditions and improve soil quality.

Figure 5-1 Mix cover crop

What Cover Crops Can You plant:

Cover crops are generally fast growing and mixes of different crop families such as:



5.3.3 Top Tips for Cover Crops

Sow cover crops after harvest in flood prone areas to protect soils and nutrients losses

Select a suitable cover crop for the system

When choosing cover crops consider other crops in the rotation e.g. brassica cover crops increase clubroot risk, green bridge effect of cereals

If soil structure improvement is an aim choose fast growing crops with a long tap root such as fodder radish

Consider sowing date when choosing cover crop

Choose species that establish quickly to avoid erosion

Consider biodiversity and pollinators for earlier sowings

Cover crops can be a cost effective method to protect your soil stability and subsequently reduce sediment runoff from farm. This in turn reduces the soil and nutrients loss from farm, which can save money. By having the field in crop, the soil is able to retain moisture, therefore, reducing the rate of water runoff from the farm. This can help reduced flood peaks further downstream.

Buffer Strips and Fencing

What are Buffer Strips

Buffer strips are vegetated strip(s), generally consisting of grassland, wetland, scrub or trees, lying alongside watercourse and ditches. The width of strips varies depending on site, however, a minimum 2m is required to comply with Good Agricultural and Environmental Conditions (GAECs).

What Can Buffer Strips Offer Your Farm

Act as a barrier to nearby water course

Offer security to farmers by complying with GAECs

Protect watercourses

Buffer strips are a low cost, relatively low maintenance option for farmers.

Benefits to Farm

Reduce Runoff Sediment	Reduce Diffuse Pollution	Stabilise River Banks	Increase Biodiversity
By creating a barrier between field and watercourse, runoff sediment can remain within fields and reused on farm, which can reduced soil and nutrient loss.	The creation of buffer strips, offers 'peace of mind' by providing a barrier from unexpected/ unavoidable accidents.	Buffer strips help stabilise banks, which reduces erosion = prevent potential field loss.	The wider the buffer strip the better, especially for creating wildlife habitats, where a minimum of 10m should be set aside.

Controlled Traffic Farming

Ploughed fields, especially up and down a slope increase the soil loss during a flood event. Minimum tillage and cultivating across slopes creates ridges running with the contours so reducing the risk of flooding.

Controlled traffic farming (CTF), identified by GPS, aims to keep machinery on set tracks for all machinery. This avoids soil compaction and so improves soil structure in the majority of the field. However, it still remains important that good tramline management practices are carried out on the tracked areas. This is relevant on grassland and arable.

Soil compaction increases the potential for surface water runoff by reducing the ability of soils to hold water; it can also have a major effect on grass growth. Work at Crichton Royal Farm, Dumfries, showed that after three years of regular compaction by a tractor, in the autumn, dry matter yield of silage had been reduced by 14%. Keeping machinery off the majority of your fields through CTF will help increase yield and reduce flood risk. Further information on relieving compaction can be found on page 10.

Figue 5.2 Tractor Compaction at Crichton Royal Farm.

Further Reading Online

https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf
https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf
http://www.tweedforum.org/
https://www.nfm.scot/about-us
https://www.sruc.ac.uk/info/120603/farming_and_water_scotland

6 Sediment Trap and Bunds

What are Sediment Traps and Bunds

Sediment traps are small vegetated basins, which allow surface runoff to be guided through. The systems work by retaining water, which allows sediment to settle before entering watercourses. The traps can offer a 'security blanket' for preventing runoff entering nearby watercourses and retaining soil on the farm. To ensure they are most effective they should remain 'dry' until a rain event whereby they can be used to collect runoff.

Sediment trap bunds are excavated mounds of earth, which act as a block in the waters path. The systems work best in-field, generally at the bottom of slopes. The bund can 'trap' water reducing the flow to nearby watercourse, hence reducing the impact and allowing for soil to be retained on farm.

Why install sediment traps?

Improve Water Quality
Runoff water is collected and stored whereby sediment and nutrients can be deposited and prevented from entering nearby water courses.

Settlement store
Runoff water is slowed, which allows sediment to be deposited and collected for reused on farm.

Big & Small
Settlement traps can be small or large to fit farm size and requirement.

Support other NFM schemes
Sediment traps are best when working in conjunction with other NFM schemes. They are excellent at filtering out sediment and beginning slowing down flow.

As with most schemes, sediment traps with the largest surface area are more efficient, however, smaller schemes are still beneficial.

Further Reading Online

https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf
http://www.tweedforum.org/
https://www.nfm.scot/about-us
https://www.sruc.ac.uk/info/120603/farming_and_water_scotland

7 Hedge Creation

What can hedges offer your farm

Hedges can be used as a tool for natural flood management as they can help reduce and slow runoff from your farm, thus reducing the volume of water reaching nearby watercourses. This in a high flow scenario can help to reduce the risk of flooding downstream. The chaotic nature of branches in woody hedges furthermore helps to reduce the flow of water during a flood event, further reducing flooding risks. The benefits, however, of planting or maintaining hedges on farm go beyond NFM.

Hedge, providing a habitat for pollinators and wildlife

Planted and maintained hedge to provide a habitat for beneficial insects, pollinators and provide a shelter for livestock

What can Hedges bring to Your Farm

Shelter Belt	**Hedges can provide a shelter belt to protect livestock from wind and rain while reducing the risk of soil erosion from wind.**
Reduce Runoff	**Hedges can greatly reduce runoff, therefore, reduce the amount of soil and fertilised that is lost to rivers. This retains valuable nutrients in your field and reduces diffuse pollution from your farm.**
Biodiversity	**Hedges can provide habitats for beneficial insects like pest predators, which may help to reduce pesticide use.** **Biodiversity will increase on farm with increased populations and variety of birds and mammals.**
Pollinators	**Certain species of hedges can become a hub for pollinators and flower earlier in the season attracting pollinators to your farm for when they are needed.** **Hedges can act as corridoes for beneficial insects and pollinators.**
Shade	**Hedges grown alongside rivers can also provide shade in the summer months for juvenile fish and other aquatic species improving the water environment.**

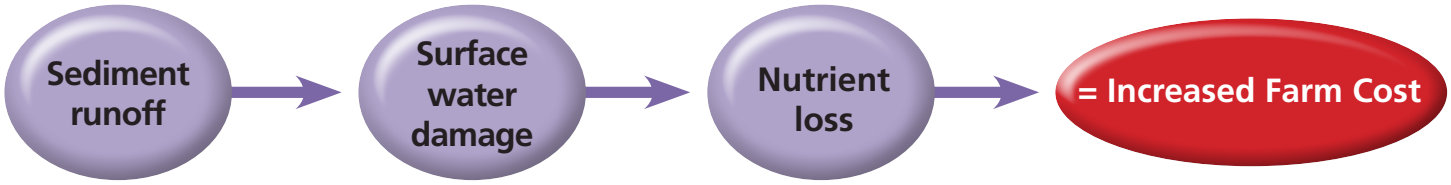
Further Reading Online

https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf
https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf
http://www.tweedforum.org/
https://www.nfm.scot/about-us
https://www.sruc.ac.uk/info/120603/farming_and_water_scotland

8 Cross Drains for Forestry/Farm Tracks

Road and tracks are essential infrastructure within a farm. However, when discussing movement of water they can operate as a passage for water to run through farms at speed. This can have damaging effects to existing infrastructure and the surrounding environment.

The impact of heavy rain falls have been observed in recent years throughout Scotland. The increase in flash flooding, as a result of heavy downpours, impacts the longevity of farm tracks.



What issues arise from water erosion on farm tracks

Potholes

Water seeps into the road surface, reducing the stability of the structure leading to accelerated wear and tear of tracks, which need to be maintained and restored.

Stone Removal

Tracks constructed of loose stones can quickly lose their structure during a flash flood. Water accumulates stones and transfers them down stream, leaving the need for repair.

Nutrient Loss

Tracks act as a stream transferring nutrients in runoff into nearby waterbodies.

Sediment Loss

Tracks act as a runway for sediment, which has been caught in the flow of water. This is then transported until the water slows and sediment is deposited.

Increased flows carry vital sediment and nutrients from farm, accelerating the speed to which they reach nearby waterbodies. As a result, the fields remaining can experience soil damage and loss of important nutrients.

Protecting tracks from the offset can significantly save you money in maintenance and soil damage.

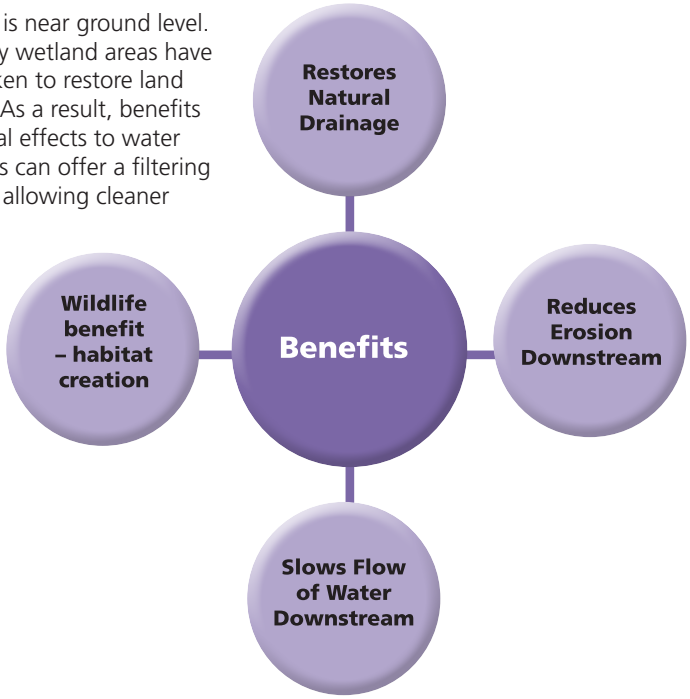
Where to Install Cross Drains

Installing cross drains strategically along tracks can helps minimise water damage. Focus on 'hot spots', which are more liable for flooding, for example by gates, at watering points, bottom of steep slopes. Trying to reduce the momentum of the water can significantly help reduce the impact on tracks. Setting cross drains tactically could increase the life time of road infrastructure and save money. Additionally combining drains with sediment traps (see page 15) can catch run off and protect nearby waterbodies, while maintaining material on farm.

9 Wetland Creation

What are Wetlands

Wetland areas are naturally saturated areas of land whereby the water table is near ground level. They offer great havens for biodiversity, water purification and storage. Many wetland areas have been drained throughout the years, however, great effort has been undertaken to restore land to its natural state and encourage the rewetting of areas that were drained. As a result, benefits of these systems have shown that creating wetlands can have huge beneficial effects to water quality and slowing the effects of flooding downstream. In addition wetlands can offer a filtering operation, in which nutrients and sediment can be absorbed and deposited, allowing cleaner water to reach nearby waterbodies.



What is Upland Wetland Creation

Holland, J. Stone Dam, Meall Buidhe

Wetland creation largely commences in the uplands and begins with blocking drainage grips to increase water storage capacity of peatland. During peak rainfall it is the acceleration of water from the open channels, and collection of debris, which leads to flooding, scouring and sediment deposition in the lower sections of water course. This causes environmental degradation, destruction and displacement.

Upland drain blocking consists of a manmade dam, depending on size, using impermeable peat, robust wood, stone or plastic. Dam blockers are installed slightly elevated from any existing dams to allow overflow water to be distributed to the surrounding area. The dams then work as a barrier and the water must then dissipate to the surrounding ground.

Additional water storage capacity can be created by breaking in-field drainage, in fields with a naturally occurring high water table. This serves to store additional water and helps encourage sphagnum regeneration, which aids slowing the flow during floods, and essentially acting as a flood plain.

What is Lowland Wetland Creation

The creation of lowland wetland is established through a similar method to upland wetland creation. Barriers are installed, reducing the flow of runoff from the farm, which in turn aid sediment deposition and increased infiltration rate.

As with upland wetlands, creating wetlands can be to increase water storage capacity, filter runoff water and offer habitats for biodiversity.

The systems can offer:

An area for water to be retained, where sediment and nutrients can settle in the vegetation → **Water is then slowly dissipated through wetland area** → **Runoff water decreases in velocity, reducing volume of water entering nearby watercourse during heavy rain periods**

Why is there a need for Wetland Creation?

Large scale draining for agricultural improvement began in the 1840s. Draining was introduced for various reasons, however, following the Second World War there was an initiative to improve and increase land for food production. Since the 1980s, however, growing evidence has suggested that draining certain areas of land may increase the likelihood of flooding downstream.

Emphasis has now moved to removing/blocking appropriate farm drains, which can allow land to return to an improved state and can help reduce flooding downstream.

What is Farm Drain Blocking

For fields, which have high water tables or suffer from saturation, blocking drains and converting some part of a field to a wetland area may be beneficial. The process involves breaking in-field underdrainage and allowing runoff water to accumulate. If fields continuously suffer from saturation altering the land use to allow wetland formation could be more financially viable and offer more benefits than trying to drain the area.

Drain blocking is a relatively low cost, low maintenance management tool depending on scale.

How Drain Blocking could benefit your Farm

Increase Biodiversity

Blocking ditches creates a moist environment where biodiversity can thrive. Drained land reduced the variety of species that lived in this environment, by blocking ditches these species can return. Vegetation binds soil together while acting as a sponge. This can increase water tables and reduce the rate of run off.

Improve Water Quality

Land, which was previously wet, has the opportunity to return to its original state, whereby land can act as a wetland, allowing water to slow and deposit key nutrients on the land, where they can be of marginal benefit to the farm. Additionally the land can acts as a sponge, reducing the speed at which water enters the watercourses.

Reduce Erosion

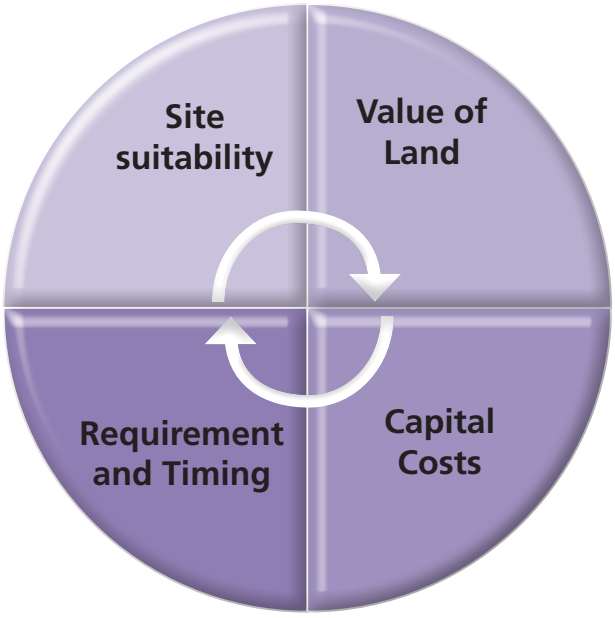
Encouraging peatland to be restored encourages vegetation growth, which binds soil together. Peat is vulnerable to erosion, by allowing vegetation to return the soil structure can be protected and enhanced.

Would Wetlands Work For You?

When considering installing wetlands into a farm the financial cost of the project needs to be considered.

- Is there land that is frequently wet that could be productive to turn into a wetland?
- By converting the land would the benefits outweigh the loss of potential arable land?

It is important to discuss projects with SEPA as soon as possible. Advice can be sought on many issues that may arise from installing a scheme on farm.



Wetland

- Install at the bottom of slopes, side of fields prone to flooding or generally wet areas.
- Water table should be close to the surface.

Note: Size of scheme dependent on size of intake, larger areas may be more effective, however, smaller schemes can have huge benefits.

Wader Scrapes

- Temporary features designed as feeding site for wader birds.
- Scrapes offer a strip of land where water can be stored.

Note: Cannot be installed near woodland or drains.

Constructed Farm Wetland

- Designed to absorb runoff from farm steadings.
- Treat contaminated water to try and ensure clean water enters local waterbodies.

Note: Ensure that you have an area large enough for the volume of runoff from steading.

Further Reading Online

http://www.therrc.co.uk/manual-river-restoration-techniques

https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf

https://www.crew.ac.uk/sites/default/files/sites/default/files/publication/CREW_NFMProject_Land_Drainage-FINAL.pdf

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http://www.tweedforum.org/

https://www.nfm.scot/about-us

https://www.sruc.ac.uk/info/120603/farming_and_water_scotland

10 Bank Restoration

What is Bank Restoration?

Bank erosion is an important natural process in river systems, however, when human activities result in accelerating and exacerbating the natural erosion process problems can arise. Erosion on watercourses is often exacerbated by heavy rainfall events, and influenced by agricultural and forestry activities. The issues created by rainfall events include diffuse pollution, caused by sediment and phosphate loss from soil erosion, all of which affect the water ecosystem and the species it supports, including salmon and fresh water pearl mussel. Damage to the edges of watercourses is often historic, however, remedial action is possible in the form of bank restoration.

River Avon – Example of Bankside Erosion

What could you do on your farm:

Setback Fencing

- Reduces opportunity for poaching.
- Reduces bankside erosion.
- Cost
- Approx. £2300/100m*

Riparian Planting

- Woody plants will enhance bank stability.
- Slows the flow of water on floodplains.
- Cost
- Approx. £2300/100m*

Willow Spilling

- Captures and store smaller sediment
- Slows the flow of water on floodplains
- Cost
- Approx. £25000/100m*

Engineered Log Jam

- Captures and stores coarse sediment
- Reduce flow of water
- Divert or encourage away from eroding banks
- Improves habitat diversity
- Provides spawning pools
- Natural materials
- Increases bank stability
- Cost
- Approx. £35000/100m*

*All work costs include Pre-works surveying; CAR licensing/consents; and Tendering and project management

Site Suitability

- Do you have good access?
- Is the site large enough to accommodate the restoration works?
- Will the works have significant benefit to soil erosion for your farm, what is your risk?

Value of Land Affected

- Installing schemes may remove land from agricultural production so the cost of this needs to be evaluated
- Will other users be affected and have you initiated consultation with them?

Capital Cost

- Do you have a method to raise funds for work or do you need to examine funding options?
- Is there possibility to collaborate with neighbours on a restoration project-spread the cost and benefit?

Access to Watercourse

- Are there restrictions in accessing your watercourse?
- Can you access all year round?

Material Availability

- Do you have access to material to reduce costs, i.e. willow or woody debris?
- Can you source locally to reduce costs?

All these questions need to be answered before beginning your project to ensure that these schemes would be best for you and your farm. Ensure that you contact SEPA in the initial feasibility stage for advice and allow any potential concerns to be raised.

Further Reading Online

https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf
https://jprenvironmental.co.uk/erosion-control-willow-spiling-checklist/
https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf
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https://www.nfm.scot/about-us
https://www.sruc.ac.uk/info/120603/farming_and_water_scotland
https://vimeo.com/263476790 **Scottish Rural Network (2018) SRDP on Film: River Margins Enhancement Project**

11 Instream Obstruction

What is Instream Obstruction

Instream obstructions, usually in the form of woody debris, are used in natural flood management to disrupt and slow the flow of a river and reduce the risk of flooding downstream. They can come in many shapes and sizes and consist of a log or bunch of logs crossing a bank either under or over the surface of the water. They can occur naturally in rivers through trees falling across a river.

However, the benefits felt in and around the watercourse are far more than just from flood management.

Engineered log jam in river, helping to alter river flow, stabilise the bank and creating a habitat for wildlife.

Naturally occurring obstruction, slowing flow and acting as a silt trap.

What Instream Obstructions Can Offer Your Farm

Increase biodiversity on farm, which can help reduce pests by increasing populations of beneficial insects and predators.

Improve fish habitats in rivers, providing shelter and food for young fish and improve spawning habitats.

Improve river ecosystems providing food for river birds and mammals, such as kingfisher and otter.

Provide bridge for wildlife, increasing habitat connectivity.

To install instream obstructions consultation with SEPA is required and beneficial. SEPA can advise of issues and support the plan for the most appropriate and suitable scheme for the farm. It is important to ensure that any obstruction is sited in a suitable location, which SEPA can advise on. For example, if a potential location is on steep gradients above a bridge the structures could cause a washout and flooding/ blockage, therefore, making situations worse. This highlights the importance of finding a good location for these schemes to ensure the greatest benefit can be reached.

Further Reading Online

https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf
https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681411/Working_with_natural_processes_evidence_directory.pdf
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https://vimeo.com/263476790 **Scottish Rural Network (2018) SRDP on Film: River Margins Enhancement Project**

12 Offline Storage

What is Offline Storage

Offline storage is a section of land designed to store overflow water from heavy rain/flood events. The areas, which lie adjacent to watercourses, are designed to suit the environment offering relief to the volume of water coming through your farm by increasing retention time.

Where is the Most Favourable Site?

The most suitable sites for these systems are large areas alongside watercourses, bottom of slopes, near field drains. This ensures that during high rainfall the water can be diverted to storage ponds and then released to the river or drain when flows recede.

What Benefits can offline storage bring to your farm

To install offline storage systems on farm, land is required; ensure that calculations are made, if necessary, to account for the loss of agricultural land. This is prevalent if the land is not intend to return to agricultural activity, e.g. it is not a temporary feature/no grazing will occur on the land.

Offline storage can offer many farm benefits, especially if it is found that they may prevent other areas of the farm from flooding. The schemes do require a substantial volume of land and regular maintenance is required to ensure that the structure can withhold the water and no damage has been done after a flood period. The systems are designed to slowly release water so at times they may be dry, however, you can design the systems to retain water if you wish to provide habitats for wildlife.' Otherwise, combining the schemes alongside other NFM options may be an option.

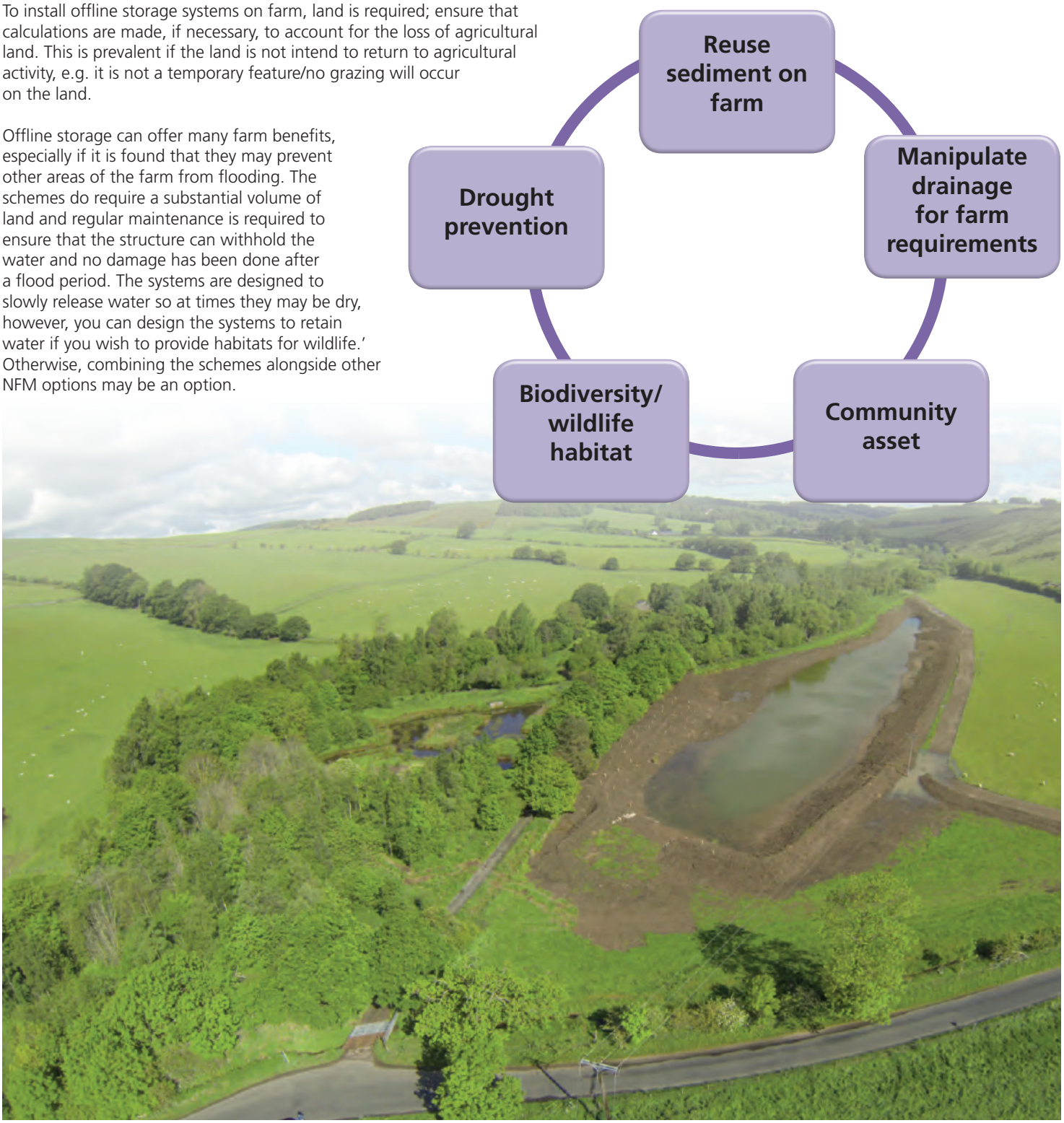

Figure 12.1 Tweed Forum, Kidston Mill Wildlife and Flood Water Storage Pond

Retained Sediment	Drainage	Biodiversity
Storage areas can retain sediment from runoff water from fields, which can then be extracted and reapplied to fields, therefore, important nutrients remaining within farm.	Water retained can be used for drainage, offering farmers' security in times of drought.	Offline storage areas increase the variety of biodiversity and can increase the number of pollinators on farm and offer an aesthetically pleasing area, which the local community can enjoy.

Further Reading Online

https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf

http://www.therrc.co.uk/manual-river-restoration-techniques

https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

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13 Meandering

Many rivers naturally meander, change course and have a natural floodplain ordinarily used to store floodwater. Working with the natural features of the river, to create a new meandering course or reconnect to previous cut-off meanders can aid flood management. Slowing down the flow by making it travel a greater distance allows the river to carry a greater volume of floodwater and reduces flooding risk.

What is the issue

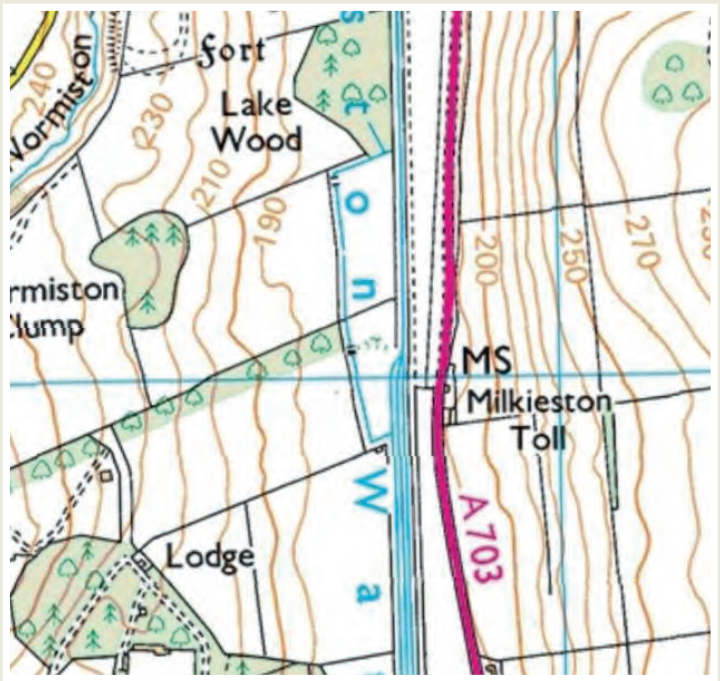
Rivers have been manipulated for human 'benefit' for years with river channelisation being a common river management tool. Artificially straightening rivers to speed up drainage and increase the land available for agriculture by restricting river channel movements was a very popular method of improving land for agriculture. However, this practice can have serious adverse consequences downstream, as water is conveyed more quickly through the catchment, and can create flooding in towns and villages.

What can be done - Farm Re-Meandering Projects

Benefits are very site specific and re-meandering involves significant ground work and planning. Initial setup costs can be high, however, once complete will require little maintenance costs as you have restored the river to its natural state. The aim is to reconnect with the floodplain, removing artificial flood banks where land can be allowed to flood if necessary, which can reduce flooding downstream.

Remeandering carried out on Eddleston Water

BEFORE - artificial straight channel



AFTER – meandering natural course

Re-meandering is a large catchment scale measure and should only be done in river sections that would naturally meander and that have been artificially straightened previously. Specialist advice should be sought before any re-meandering work is undertaken and discussion and consent from SEPA should be sought before carrying out any work as well as seeking permission from relevant landowners. As well as aiding NFM, re-meandering helps to recreate a more natural environment, which can bring further ecological benefits to the river system..

Further Information Online

https://www.sepa.org.uk/media/219450/bank_protection_guidance.pdf

http://www.therrc.co.uk/manual-river-restoration-techniques

https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

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14 Conclusion

As can be seen throughout this document there are many options that farmers and land owners can implement through NFM, which have the potential to offer added benefits to the Farm. One key measure to be taken from this document is that each individual NFM scheme has their own benefit, however, incorporating a variety of schemes onto your farm is intrinsic in designing for flood prevention and the success rate of on-farm benefit. For instance if installing cross drains, ensure that sediment ponds are located nearby to collect the runoff. Small changes can make big differences.

If you would like more information on potential ideas and how to start a NFM project on your land please contact your local farm advisor.

This guide has been developed to provide information on natural flood management for farmers and landowners in Scotland. The guide was put together by SAC Consulting, The Tweed Forum and The Scottish Environmental Protection Agency, funded by the University Innovation Fund from Scottish Council.

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.

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SAC CONSULTING

TWEED FORUM

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