



# Nature-based Solutions for reducing flood risk – a Scottish perspective

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Tweed Forum

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# Outline of presentation

- a) **Nature-based solutions, Natural Flood Management and the development of a risk-based, catchment approach to Sustainable Flood Risk Management in Scotland**
- b) **The Flood Risk Management (Scotland) Act 2009 and the requirements of Section 20 (assessment of the potential role of Natural Characteristics)**
- c) **The developing science evidence base for Natural Flood Management (NFM) effectiveness and value for money**
- d) **Mainstreaming NFM within Scottish Flood Risk scheme appraisal and funding**

## a) Why is there an interest in Nature-based Solutions and Natural Flood Management (NFM) in Scotland?

*This is part of a much wider interest in land use and land management*

*Interest in 'restoring catchments' is being driven by four main factors:*

- **High profile flooding events**
- **Biodiversity loss**
- **Poor Ecological status of rivers**
- **Climate Change**

*Other drivers for nature-based policy solutions include:*

- **Woodland expansion targets**
- **Land Use Framework strategy**
- **Natural Capital and Ecosystem services**



# Policy and Context for Flood Risk Management

Nature-based Solutions are part of a **risk-based, sustainable policy** approach to flooding - delivered at **catchment scale**

Policy recognises cannot only build walls downstream where floods do most damage, but need to also manage **sources** and **pathways**.

**Restore – enhance - protect**

Key: It is not NFM vs Traditional flood defences

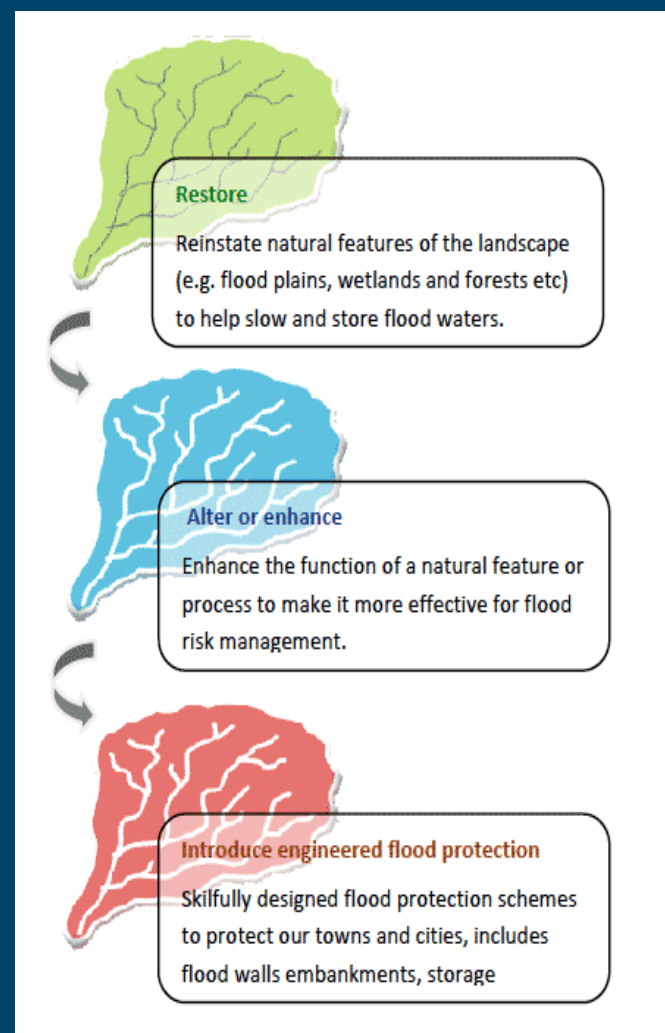
NFM consists of different types of ‘natural’ measures within a catchment, which can deliver multiple benefits

**Integrated with delivery of related policies:**

Climate change adaptation and Resilience

Biodiversity (and WFD) benefits

Improving cost benefit of public investment in protecting people & property



## b) Approach encapsulated in the 2009 legislation which promotes the potential role of NFM


Flood Risk Management (Scotland) Act 2009  
– a New approach to reducing flood risk

**Opportunity to re-think whole approach** came with EU Floods Directive – Parliamentary Inquiry and very effective lobbying from NGOs

**Ethos of FRM** – Catchment & Risk Based Approach to Sustainable and Natural Flood Management

Major / complex flood protection works to be advanced as Flood Protection Schemes

*Flood Risk Management (Scotland) Act 2009 (asp 6)*



Flood Risk Management (Scotland) Act 2009  
2009 asp 6

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**Basis for Natural Flood Management (NFM) to be used as an effective and integrated catchment measure to reduce flood risk and adapt to climate change**

## Section 20 of the FRM (Scotland) Act requires that one must:

*'assess whether alteration (including enhancement) or restoration of natural features and characteristics of any river basin.... could contribute to the management of flood risk...'*

### **BUT to do so needs better Scientific information on:**

- What is the effectiveness of different NFM measures
- How can you assess the costs and benefits of NFM measures, including the other benefits delivered alongside flood damages avoided
- How to integrate NFM within major Flood Defence Schemes
- How can one work with land managers to help implement NFM measures in the best locations

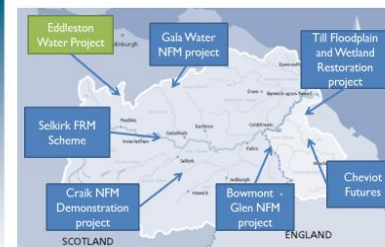
➤ **Scottish Government set up the Eddleston Water study in 2010**

## c) The emerging NFM science evidence base

# Eddleston Water - Scottish Government's long-term study of *Natural Flood Management*



Natural Flood Management projects in the Tweed catchment

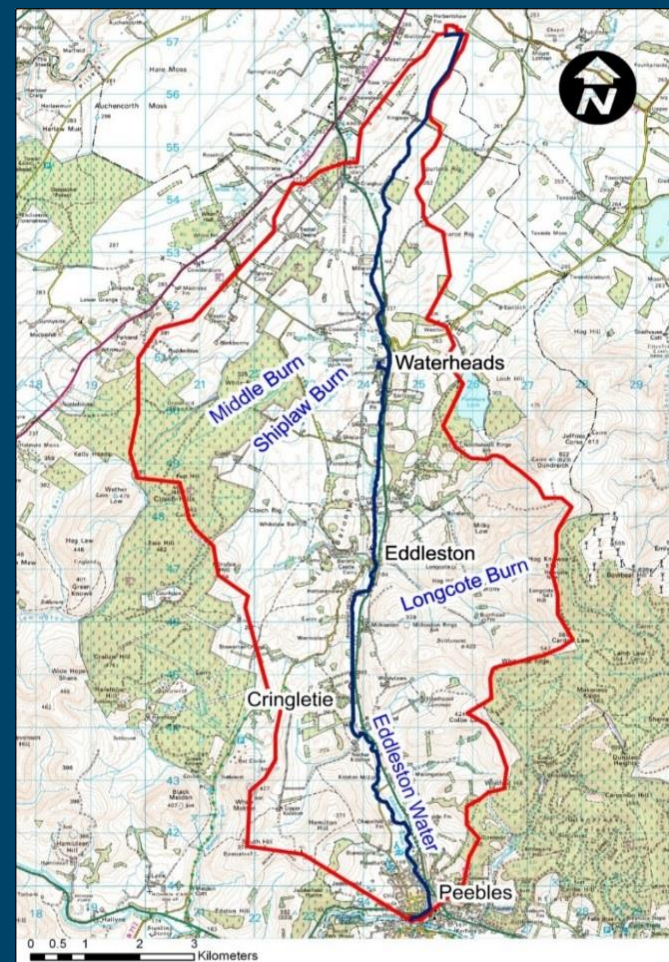


### PROJECT AIMS

- To assess the *effectiveness of NFM measures* to **reduce flood risk**
- To assess the *impact of NFM restoration* on **habitats and species**
- Work with landowners* and communities to maximise the benefits to them, **while sustaining farm businesses**

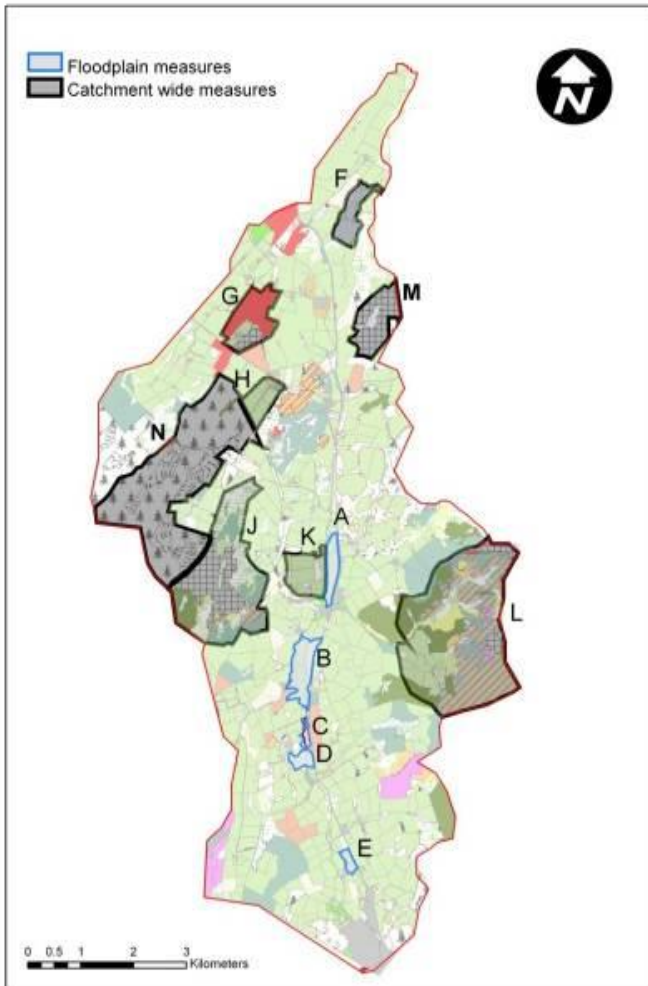
### Empirical and Modelled evidence

- Long-term partnership study **2010** →
- Scottish Government & EU funding, with public & private sector support **£2.8m +**
- Managed by Tweed Forum**, with Scottish Government, SEPA, BGS & University of Dundee
- Typical catchment 69 km
- Detailed Hydrological & Ecological monitoring network**



# Worked with the character of the landscape to identify potential locations for NFM to 'slow the flow', temporarily store floodwaters and improve river habitats

*block upland ditches, high-flow log restrictors, woodlands*



*remove embankments, riparian woodland & wetlands*



*re-meander channel*



*create floodplain ponds*



# NFM Measures implemented



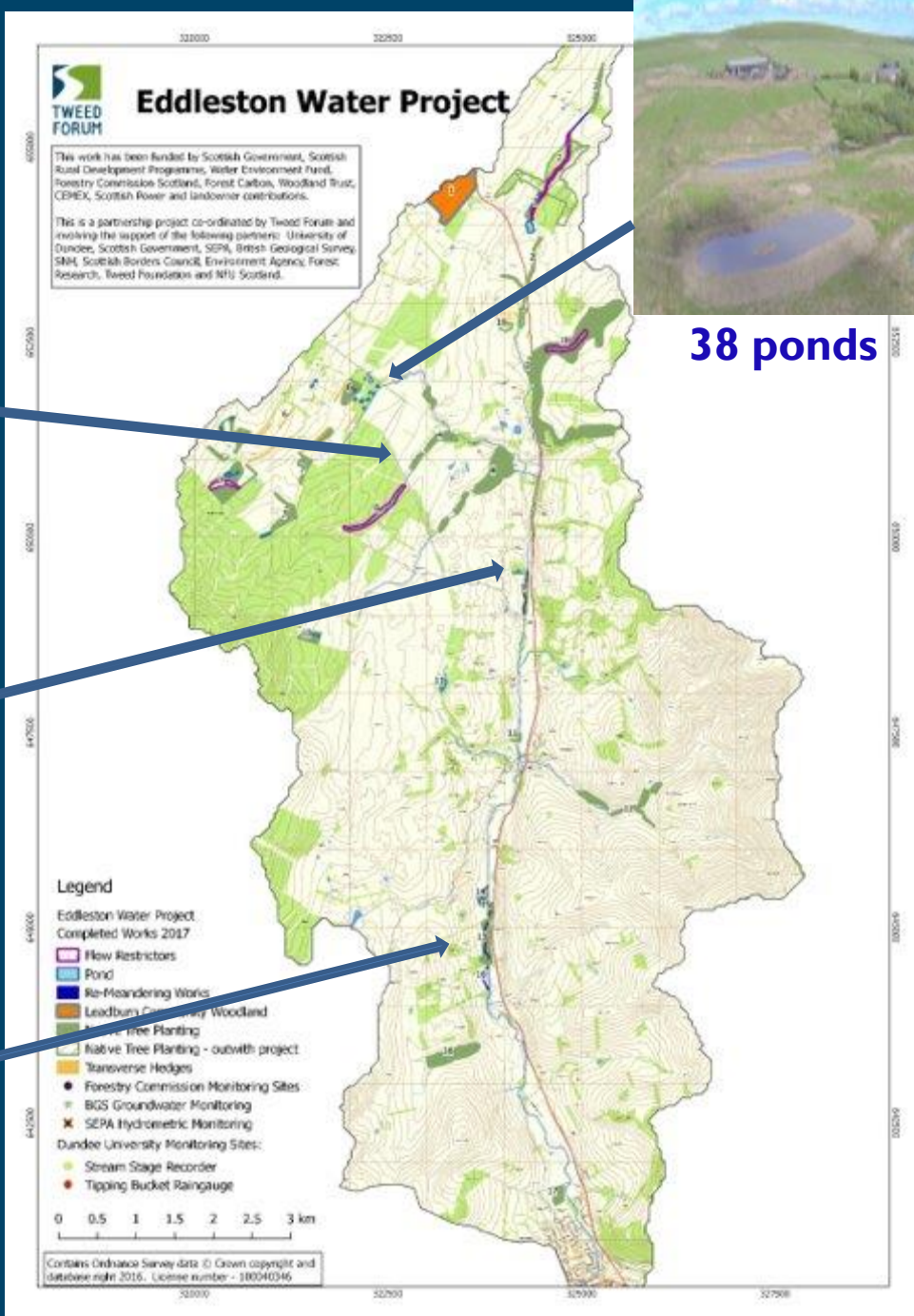
116 high-flow log restrictors



340k native trees (210ha)



3.5km new meanders



38 ponds

Cringletie

## Re-meandering on the Eddleston Water

Exact channel design and location depends on hydrological analysis, historical analysis and landowner agreement

Milkieston

Lake Wood, Wormiston

dotted line denotes the old course



# Underpinned by comprehensive Monitoring

## Hydrology – Dr Andrew Black



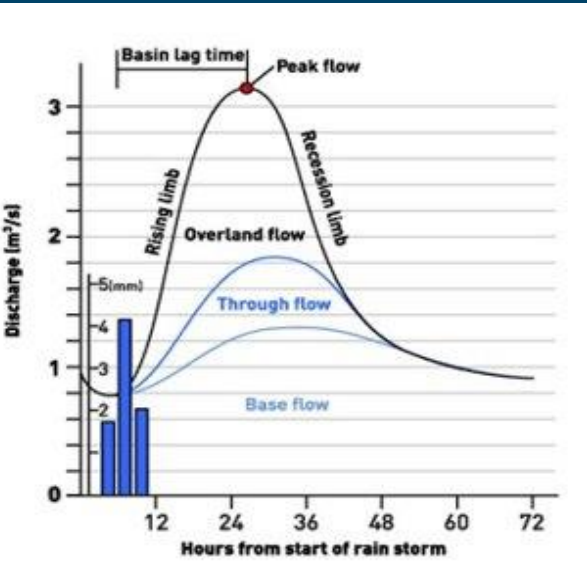
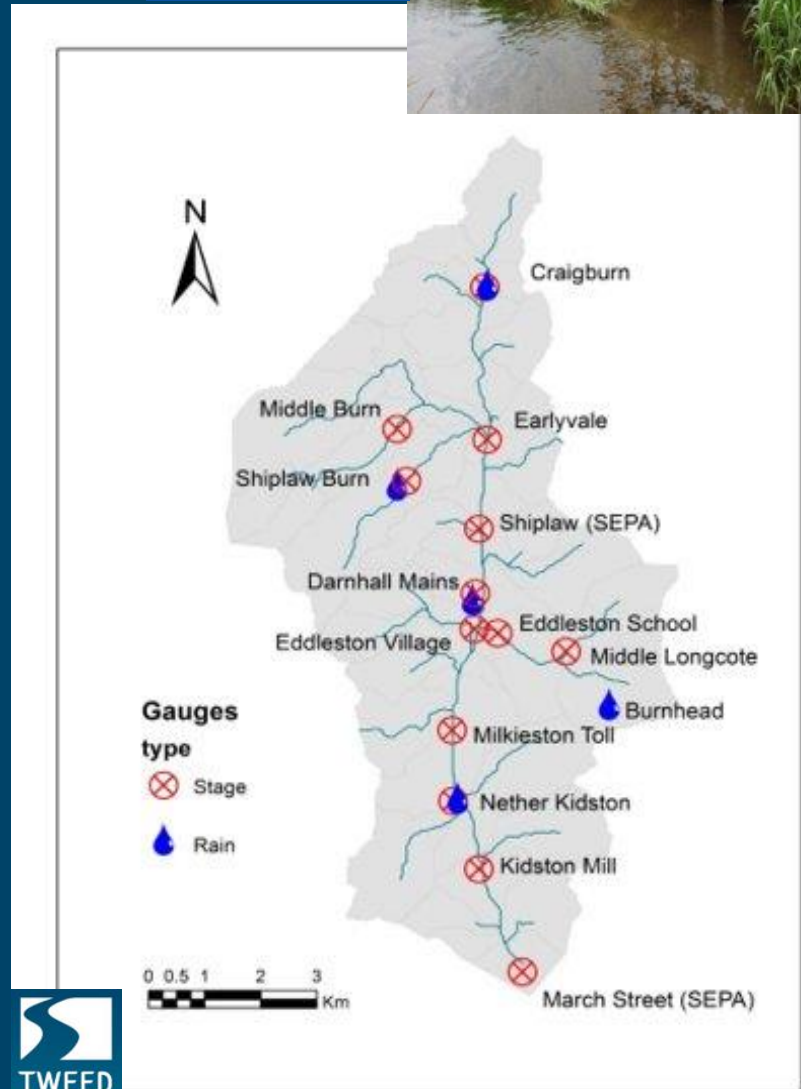
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**Aim:**  
to identify how and where flood runoff is initiated and how floods then move downstream, causing flooding

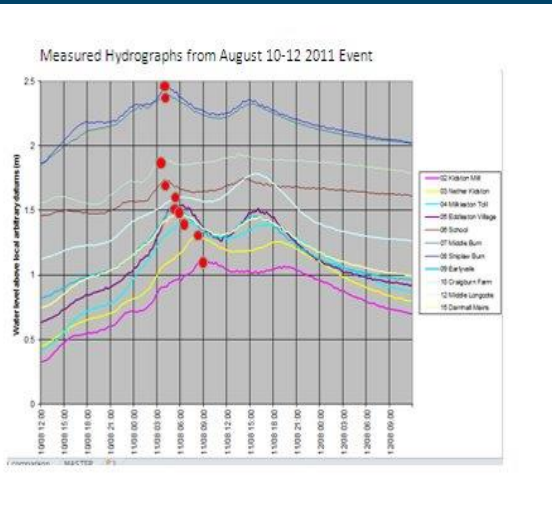
**Installed:**  
Very detailed Hydrometric network in 2010 to record river and pond levels and flood flows.

Groundwater boreholes

Weather stations



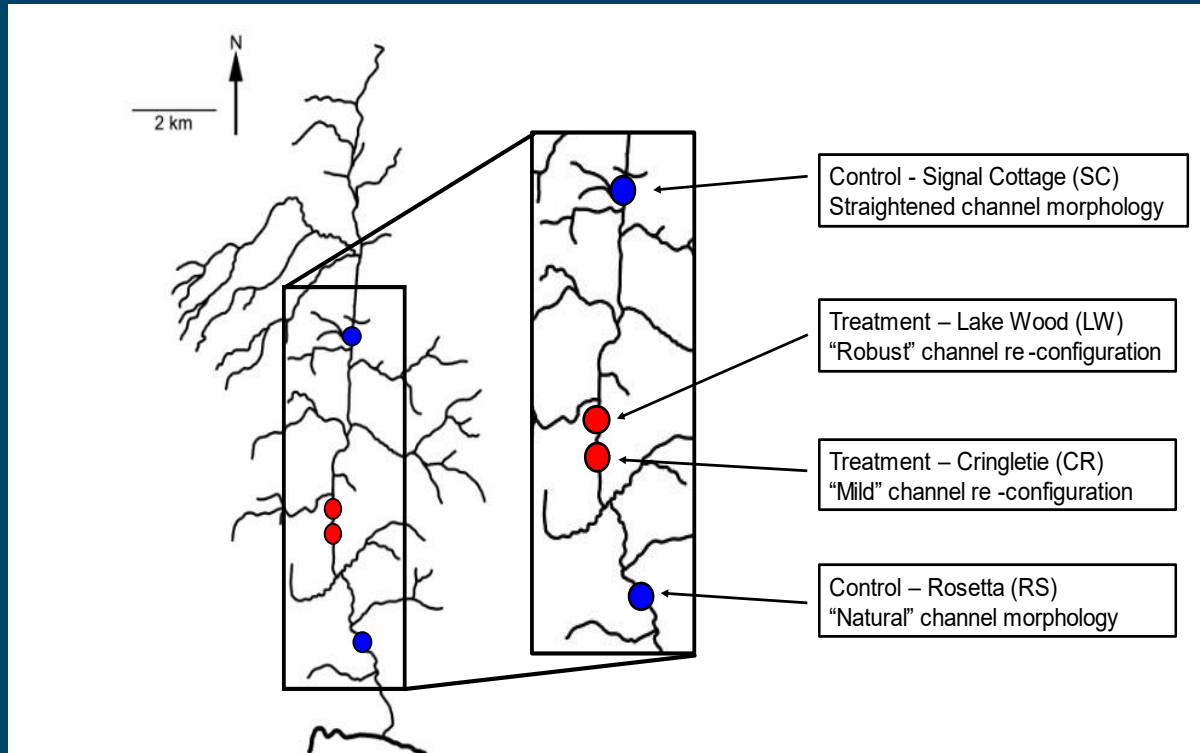
*Aim to lower the peak flow*



*Tracking a single storm down the catchment*

# Monitoring changes in Ecology and River Habitats

*Before / After / Control / Impact* survey design used to assess the impact of re-meandering once straight channels on geomorphology, macroinvertebrates and fish



Channel re-configuration completed in July at Cringletie & Sept at Lake Wood 2013

Before-After-Control-Impact design

**Sediment and Ecological** sampling undertaken at same locations

2012 - pre works  
2013 - pre works  
*meanders*  
2014 - post 1  
2015 - post 2  
2017 - post 4  
2019 - post 6  
2021 - post 8  
(2021 - e-DNA trial)  
2023 - post 10 in progress

Veritas Ecology

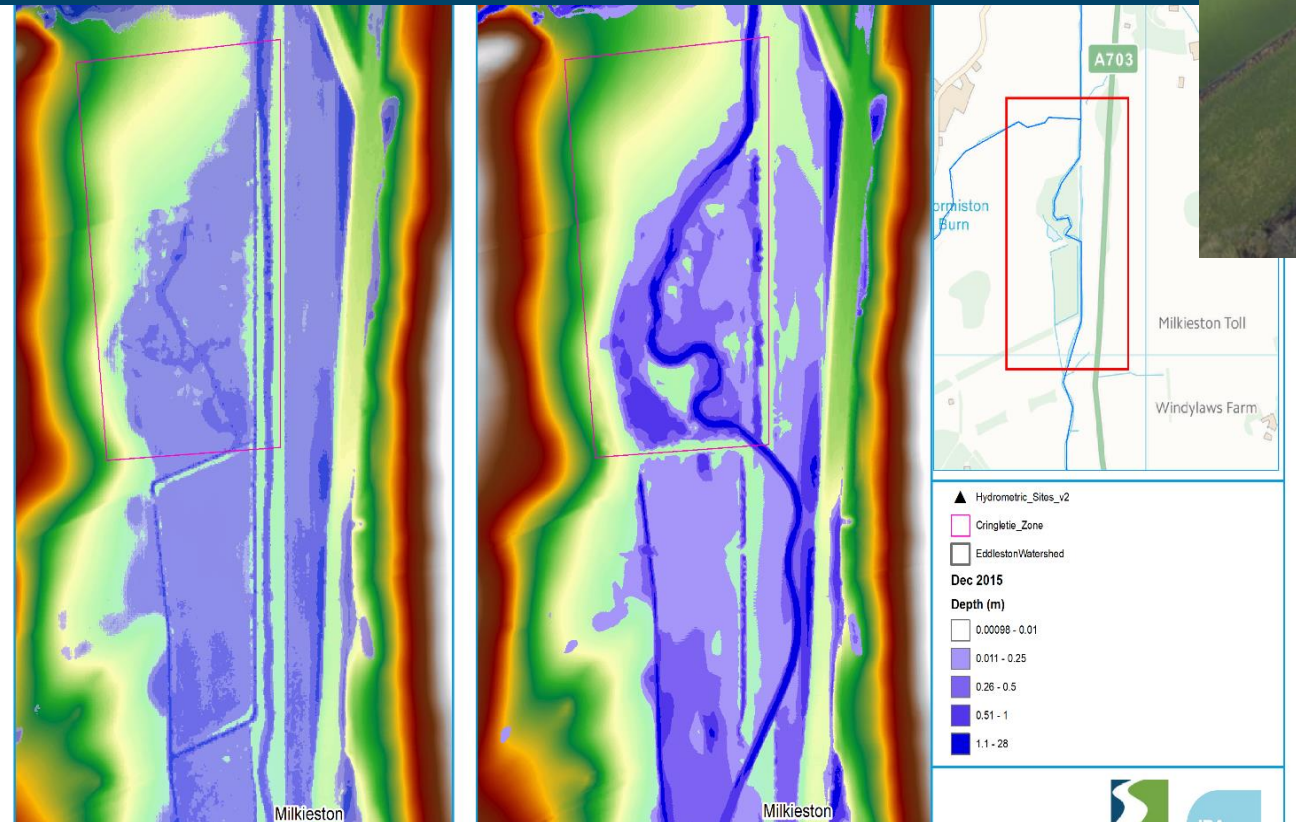
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APEM





# Re-meandering previously straightened channels and re-connecting to the floodplain, even locally can improve flood storage



Cringletie NFM  
Remeander  
2012-2015

Storage on  
Floodplain  
increases 6%  
(8,700m<sup>3</sup> to  
9,216m<sup>3</sup>)

*Calculated impact of NFM re-meandering on floodplain storage*

**However, meandering alone staying within high embankments and with no temporary storage on the adjacent floodplain only adds c 2% extra storage**

# 'Upstream' ponds can effectively store flood waters in small upper sub-catchments

*We have created 36 Ponds in upstream 'source areas'*

- Measurements of pond levels show ponds in the *upper catchment can readily store water, providing 'quick wins'*
- Ongoing research shows this is only effective in small sub-catchments
- Modelling shows that this will have only a *relatively small effect on total sub-catchment runoff* at this scale

*Ponds in the upper catchment at Ruddenleys*

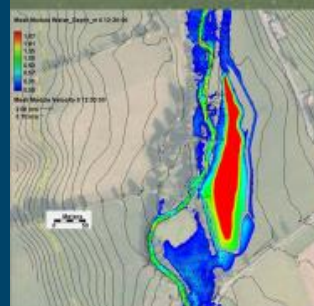
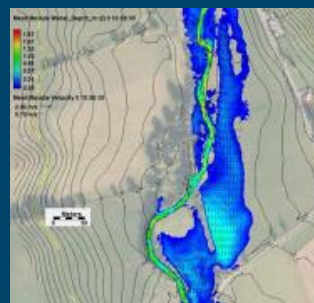


Ponds are designed to always hold some water, but also have a large 'freeboard' enabling them to temporarily store greater volumes in times of flood

# Large floodplain ponds can effectively store flood waters downstream

*We have created one much larger pond on the floodplain at Kidston Mill*

- **Downstream:** modelling of the potential impact of a series of large floodplain ponds linked to the river suggests that, for a 1.5-year return interval flow event, five such ponds in series could *locally reduce the discharge peak by c.20% and delay it by up to 6 hours.*
- **But floodplain ponds occupy some of the best farmland**





# Impacts of Woodland Planting

Planted c 340,000 native trees  
over 210 hectares

→ Model of landscape-scale tree  
planting shows up to 20%  
reduction in peak flood flows



Infiltration of rainfall under mature broadleaf woodland  
5-8 x that under grazed pasture or conifers

# Summary: Emerging results from Eddleston

- **Different NFM measures can reduce flood risk** by temporarily storing surface waters and *delaying peak floods*, as well as by increasing surface roughness and groundwater connectivity
- **NFM measures work best in small catchments and in response to lower level flooding**. They will not stop flooding in major events
- Appreciable flood risk reduction through NFM is likely only to be achievable through *the widespread application of many types of approach throughout the whole catchment*
- NFM measures can also **deliver important biodiversity gains** by restoring habitats for wildlife and fisheries
- Nature-based Solutions can provide a wide range of **additional benefits and ecosystem services**
- The **economic value** of the multiple benefits of nature-based solutions can be **demonstrated**



# Are nature-based solutions good value for money?

*We can assess the impact of NFM measures as flood damage avoided*

Flood risk reductions due to NFM measures can be valued in terms of Flood Damages avoided to downstream properties and communities using standard HM Treasury Green book methods

NFM measures implemented by 2021 show a positive net present value (NPV) of **£950k** from flood damages avoided

For a hypothetical maximum use of NFM in the catchment this could increase to £2,850k (NPV taken over 100yrs).



## *We can also assess the value of other benefits (ecosystem services) these same measures provide*



Using best practice methods, the total value of other benefits (ecosystem services) delivered by the NFM measures is **estimated at £4.2 million (NPV)**

Benefit category	Actual NFM implemented (£k)	Additional NFM (£k)
Amenity	1,489	3,724
Biodiversity and ecology	627	4,594
Carbon sequestration	717	4,857
Education	383	383
Flows in watercourse	365	2,678
Water quality and pollution	628	1,424
Total	4,201	17,660



For a hypothetical maximum use of NFM in the catchment this could **increase to approximately £17.7 million NPV.**

**One take home message is that:**

**The total value of other benefits delivered by NFM across the catchment are 4x larger than the flood damages avoided benefit alone.**



## d) Mainstreaming NFM within Scottish Flood Risk scheme appraisal and funding

In Scotland, flood risk funding is direct to Local Authorities as part of the general capital grant (*different to England*)

**Two ways in which NFM can be funded by the flooding component of the L A general capital grant:**

- If NFM is an integral part of a flood protection scheme and provides flood risk reduction then it is ***fundable as part of that scheme*** (80% is allocated to prioritised schemes)
- 20% is for LAs to use to fund other actions to reduce flood risk - so they ***can choose to use this for standalone NFM measures*** if they wish

# Flood Risk scheme options appraisal - review

Scottish Government are looking at the existing funding of flood protection schemes to understand if this delivers the most effective outcomes and whether the range of interventions which are eligible for funding should be widened.

**Options appraisal can incorporate the benefits of NFM.**

**Scottish Government's options appraisal guidance is currently being updated.**

- New guidance will provide advice on how to develop good business cases at different stages of project development in line with HM treasury's green book.
- Economic appraisal section contains much more advice on assessment of the environmental and social benefits of an option, and use of tools like Ciria's Benefits Estimation Tool (BEST), Defra's Enabling a Natural Capital Approach (ENCA) etc.

**This should enable holistic assessment of options and their benefits/disbenefits.**

# Thank you

With thanks to the funders, supporters and communities involved in the work on Natural Flood management on Eddleston, on Tweed and elsewhere covered in this presentation, including Scottish Government, Tweed Forum, Scottish Environment Protection Agency and University of Dundee  
*and*  
EU Interreg North Sea Region *Building with Nature*

**For further information, please contact:**

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For information on the **Eddleston Water Project** see:  
<http://www.tweedforum.org/projects/current-projects/eddeleston>

