Risk, Liability and Maintenance

Taking a proportionate approach to reducing risk & liability and designing for minimum maintainance.

Chris Uttley

Environment Agency

Assessing the Risk

Assessing the Potential Hazards of using Leaky Woody Structures for Natural Flood Management

ADEPT

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Forestry Commission

Forest Research

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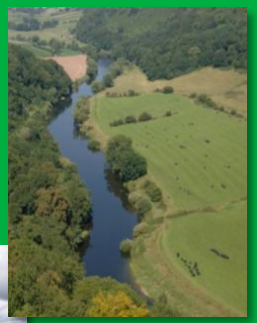
Working with Natural Processes on rivers & their tributaries

Grip blocking



Woodlands in wider catchment & as flow interception

Gulley Stuffing

Woody dams

River & floodplain woodlands

Flow interception

Land /soil management

Natural Flood Management

Environmental Engineering

River restoration

In-channel measures to restore river floodplain connection

River & floodplain reconnection

Floodplain & wetland restoration

Urban Flood storage areas

Green/blue infrastructure

Suds

Headwaters/steep slopes | **In-channel** | **Floodplain** | **Urban**

Who is going to build NFM?

Farmers and woodland owners? Crucial partners

Community groups and NGOs?

Contractors: Skills resource and valuable advocates?

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The Basics of the Risk Assessment.

- **Part A:** Summarises the risks that need to be considered to ensure any LWS scheme will be safe and effective.
- In **Part B**, we consider the potential severity of impact or hazard and how to manage these through site selection right at the start of the process. This is intended to ensure that NFM schemes are only developed in suitable catchments where they can be most effective.
- **Part C** examines what mitigation measures can be applied to minimise the likelihood of loss of woody material from LWS and therefore reduce the risk of downstream blockage of structures. While LWS is not encouraged for sites that have a high blockage impact or hazard, if such sites are chosen, it will be essential that mitigation measures are put in place.

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Key Risks:

- **There are four risks that need to be considered when installing LWS:**
- 1. Woody material breaking loose and flowing downstream resulting in a blockage of a bridge or culvert, increasing flooding of another person's property or land, or direct injury to people and damage to infrastructure.
- 2. Flood water damage to property downstream as a result of a surge of flood water due to the failure of multiple LWS.
- 3. Water levels rising upstream of a structure – the "backwater" effect, causing inadvertent flooding of land or property outside of the ownership boundary or onto rights of way.
- 4. People injuring themselves on LWS.

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Basic Principles of Using Wood and LWS

- The main purpose of LWS is to increase hydraulic roughness, add channel diversity, divert flows out of channel and slow the flow by attenuation.
- The principle should be to establish many smaller, wider, low features rather than few, large, deeper ones.
- Permeability is key to stability The more permeable a structure, the less hydraulic pressure will be exerted on the upstream face during high flows
- Go big or go home. Larger, longer and more complex elements of wood are safer & less mobile in flood flows. Use large timbers, relative to the width of the channel (approx. 2.5 times channel width)
- (The influence of geomorphology on large wood dynamics in a low gradient headwater stream Dixon. S & Sear.D 2014)

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Longevity and maintenance.

- Designed well, there is little need for maintenance of most Leaky Woody structures. They may need replacement in the longer term rather than specific maintenance. Where appropriate, natural replenishment is the preferred method, but re-construction may also be necessary. Desilting is not feasible. Observation and inspection is needed.
- Utilising naturally occurring materials enables structures to be constructed with minimal cost, maximum flexibility and to be added to or repaired with ease. In some locations live trees should be used.

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Risk is reduced with a good Governance structure

- It is good practice for projects involving LWS to have a governance structure that sets out who is responsible for the design, construction and ongoing maintenance. The responsibility for maintenance and repair will depend upon formal or informal agreements put in place between the landowner and the commissioning / constructing organisation. It is likely that LWS installed in locations where they pose little or no hazard will require no ongoing maintenance other than observation and potential replacement.
- Responsibility for any unintended damage caused by LWS, including inadvertent flooding, will be determined by a large range of project and site specific factors. Responsibility could rest with the landowner, commissioning body, designer or contractor unless there is a specific agreement in place that transfers liability to a particular organisation or person.

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Part B

Assess and mitigate the potential severity of impact.

The potential severity of the hazard/Impact should be assessed first and where ranked as potentially moderate or high, action taken to mitigate this. In the case of potential impact on downstream property or infrastructure, consideration needs to be given to placement and design factors in **Part C** to minimise the likelihood of washout and risk posed. All the design factors should be interpreted in relation to each other, assessing the location, type of land use and the level of certainty required.

If the potential impacts identified in Part B are low, no further action need be taken.

If the potential impacts identified in Part B are moderate or high, mitigate these or reject site. See (Part C).

B1. Potential severity of impact on downstream property or infrastructure

NFM projects are designed to reduce the risk of flooding to people, property and infrastructure downstream. However, the washout of woody material could potentially block or damage downstream culverts and bridges in and around residential properties and infrastructure, increasing flooding. Increased flooding could also result from the failure of multiple LWS causing a surge/release of stored flood waters.

Potential severity of Impact	Negligible / Low →	Moderate	High
Hazard Property or infrastructure downstream is at risk from inadvertent flooding	No vulnerable culverts or bridges downstream at risk of blockage that would cause flooding. The nature of the river system (presence of ponds, non-critical pinch-points or dense vegetation) and features (appropriately sited and managed trash screens or other trapping structures) prevent woody material reaching them. Total volume of water designed to be attenuated behind LWS is small in relation to flood peaks affecting downstream communities or property.	Mobile trees and timber would be able to reach vulnerable culverts and bridges, but no history of blockage or flooding. Blockage would only result in flooding of land and not property. Moderate volumes of water attenuated, the release of which would have a limited effect on downstream flood levels and potential flood damage.	Mobile trees and timber would be able to reach vulnerable culverts and bridges located directly downstream. This infra-structure has a history of blockage causing flooding. Total volume of water attenuated is large in relation to downstream flood peak and its release would have a significant effect on flood levels and damage to property.
Potential mitigation	N/A	Select appropriate placement and design to minimise the risk of LWS failure/washout. (Part C)	Avoid site or ensure placement and design will secure structures. (Part C)

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Part C

Assess and mitigate the likelihood of impacts occurring.

The tables in part "C" focus on how the placement and some design elements of LWS can be used to minimise the likelihood of washout of woody material or sudden release of attenuated waters thereby reducing the risk of flood damage. These elements act as mitigation for each other and where the potential severity of impact is moderate to high.

C1. Landscape or habitat setting of the constructed LWS

Installing LWS within a woodland or riparian woodland setting will usually reduce the risk of failure. There is often scope for bracing structures against trees and for any released material to be trapped within the woodland or by existing natural woody structures. The presence of riparian trees and woodland will also act to slow down and mitigate the release of flood waters in the event of a structure(s) failing.

Likelihood	Low	Moderate	High
Hazard Timbers can travel further in a landscape without riparian trees	In woodland or riparian corridor where other trees will help secure structures and impede movement of loose material.	In water course flowing through open farmland.	In urban or public environment.

C2. Width of the watercourse and length of timbers

Wider watercourses present a greater risk of structure failure due to length of span and increased discharge. While the mobility of woody material in a watercourse is largely determined by the ratio of length of wood to channel width (at ratio's over 2.5: 1 timber lengths are functionally immobile, even without fixings), the risk of breakage/snap increases with width.

Likelihood	Low	Moderate	High
Hazard Energy is greater and risk of washout greater in wider watercourses. Shorter timbers are more mobile	**Less than 3m** Headwater streams providing high stability of structures due to ability for bracing or capture of woody material by close spacing of trees between opposite banks. Timbers are 2.5xs channel width.	**3 – 5m** Wider spacing between banks and longer structures at greater risk of breakage and washout. Timbers are >1.5xs channel width.	**5+m** Higher risk of breakage and washout due to width of span and greater discharge. Also less opportunity for trapping of released material. Timbers are the same or less than the width of the channel.

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C4. Height of LWS above bank

The higher the LWS above bank height, the greater the depth of water and therefore potential weight of water attenuated. This will add hydraulic pressure and can increase likelihood of structural failure. As a general guide, the higher the structure, the more frequent the need for inspection and potential for maintenance. Higher structures will need more fixings and other mitigation measures.

Likelihood	Low	Moderate	High
Hazard Increased depth is generally associated with an increased risk of failure	Height above bank <50 cm.	Height above bank between 50 cm – 1.0 m.	Height above bank >1 m.

C5. Permeability of the structures

There is a correlation between permeability and risk of LWS mobility and breakage. More permeable structures (letting normal flows pass unhindered) allow more water and sediment through which will reduce the force exerted on the face of the LWS structure. The desirable level of permeability will depend upon the project objectives, but higher permeability does not always reduce effectiveness and can increase longevity.

Likelihood	Low	Moderate	High
Hazard Less permeable structures may be more likely to fail in high flow events	Very permeable. Large gaps within or below the structure, allowing leaves and small branches to pass through.	Permeable. Smaller gaps that are more likely to become filled over time.	Low permeability. An increased risk of siltation/deposition causing infill and sealing.

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Example: *Design of Leaky Woody Structures for use for a Natural Flood Management project in Forestdale*

Potential severity of Impact to downstream infrastructure or property: Moderate
Potential impact to adjacent landowners – **Low**
Potential to harm people or rights of way – **Low**
Overall Risk Assessment after mitigation – LOW

Owner; Holly Woods | **Date of assessment** *15th January 2019*

Design Factors for Leaky Woody Structures	Characteristic	Initial risk level			Mitigation measures to reduce likelihood and risk	Residual risk level		
		Severity of impact of washout	Likelihood	Risk level		Severity of impact of washout	Likelihood	Risk level
Location & landscape	*Woodland setting*	M	L	L	***None required***	M	L	**L**
Water course width	*4m wide*	M	M	M	*Use timber lengths 1.5 x width. Increased frequency of monitoring.*	M	L	**L**
Tree species/materials used	*Alder*	M	L	**L**	*None required*	M	L	**L**
Height above bank	*75cm*	M	M	**M**	*Strengthen fixings, e.g. Using steel bar or reduce height of structure above bank. Increased frequency of monitoring.*	M	L	**L**
Permeability	*Permeable structure*	M	M	**M**	*Raise structure to allow base flows to pass unhindered. Increase permeability. More frequent maintenance.*	M	L	**L**
Fixings	*Non-degradable fixings*	M	L	**L**	*None required*	L	L	**L**

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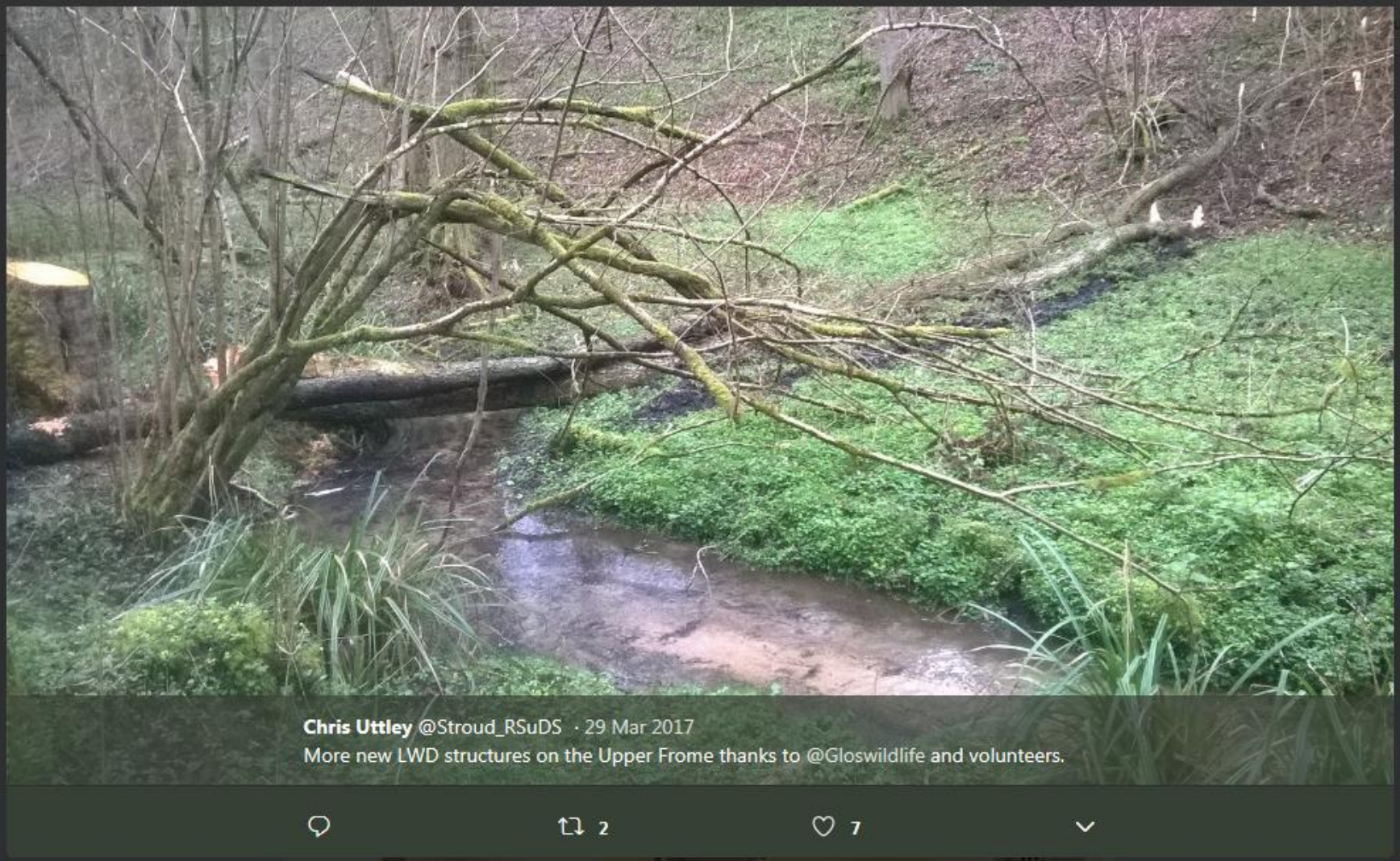
Chris Uttley @Stroud_RSuDS · 29 Mar 2017
More new LWD structures on the Upper Frome thanks to @Gloswildlife and volunteers.
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But these help abit too!

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