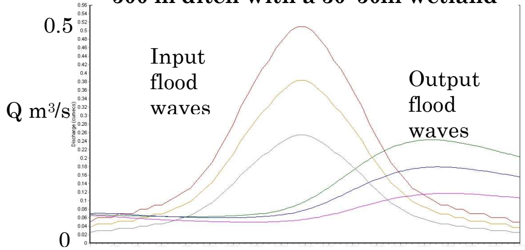
Conclusions

For storms that are of a magnitude of 1 in 1 year or less, we can observe storage and attenuation effects of differing degrees, dependent on the antecedent conditions and the storm magnitude. However, the observed hydrographs suggest that more temporary storage features could have a significant effect.

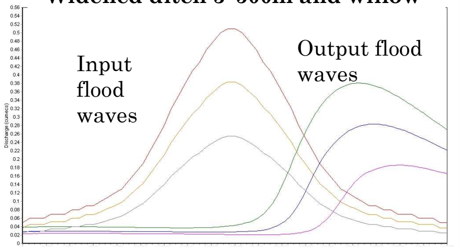
To upscale the effect of the smaller features to a larger scale – to the whole farm scale, we carried out hydraulic simulations for a range scenario using the Noah 1D hydraulic model. A simulation of a 500 m ditch witch included a wide area of low gradient land with high roughness (such as a pond or wetland) greatly shifted a the pattern of a theoretical flood wave. Equally, a scenario of a widened ditch (3m wide) with high roughness, running for 500m (such as the within ditch willow wetland), then the reduction in Qp could be significantly altered (see below). N.B. the Time of travel of the flood wave with not features was determined as 7 minutes. Here we see that the time of travel is also greatly effected when simulated.

500 m ditch with a 30*50m wetland



Simulation duration of 1 hour

Widened ditch 3*500m and willow



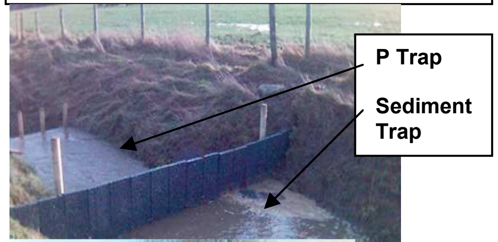
Simulation duration of 1 hour

More Features at Nafferton Farm - Interception Ponds

Capture fast polluting flow paths before they reach the ditch, the pond then stores flow and strips sediment from the runoff. Ideally ponds should capture runoff from roads and small ditches.

Sediment Traps and a Sedge wetland for nutrient pollution management

Barriers retard flow and induce rapid sedimentation thus reducing phosphorus losses. The wetland can further remove nutrients.



The Sedge Wetland

The usual V shape of the ditch is altered to be flat and wide (here the ditch is now 3m across).

www.ncl.ac.uk/iq • www.youtube.com/proactivefarms

Paul Quinn, Sean Burke (EA), Jennine Jonczyk, Caspar Hewett, Mark Wilkinson, David Rimmer

ESL Earth Systems Laboratories FIRM Plans

Newcastle University Civil Engineering and Geosciences

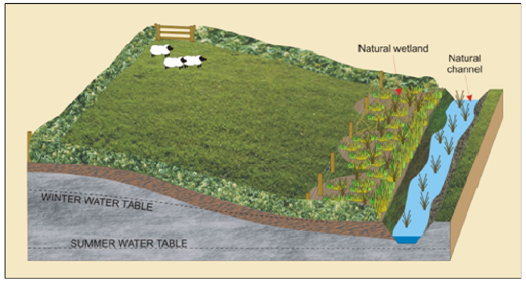
Farm Integrated Runoff Management Plans

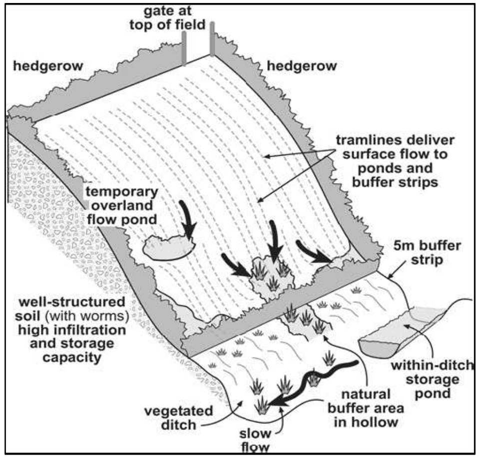
The **PROACTIVE** approach to farm runoff management is a joint initiative of the Environment Agency and the Newcastle University Earth Systems Laboratory initiative. FIRM Plans are based on experience and evidence arising from full scale applications on farms working closely with farmers and farm advisors.

Flood Storage and Attenuation on Farms

A landscape scale sustainable soft engineering option

If a typical farm or small catchment can sacrifice 5-10 % of the landscape to temporary runoff storage and mitigation features then the magnitude and properties of the runoff regime can be greatly altered.





Design Matters!

The size, location, materials and vegetation used in the proposed features are the key to the practical, economical implementation and maintenance of the measures suggested by *FIRM* Plans.

Options to reduce pollution and flood risk are:

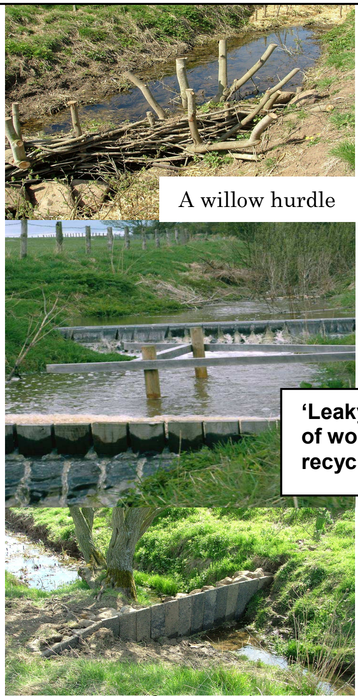
- Small temporary storage features in most fields, to slow and store flow and to capture sediment and phosphorus
- Features within small ditches to slow flow
- Wetlands and sediment traps in ditches, to radically alter the stream flow resistance
- Buffer strips that are put to effective work

Changes to planning/policy needed for effective *FIRM* Plans are:

- Temporary storage ponds, barriers, sediment traps and buffers to be made part of the stewardship regime on farms
- Construction, maintenance, and waste recovery (sediment and phosphorus) need to be funded activities.
- Agri-environment, flood risk management, carbon and renewable energy initiatives should be integrated together to create an incentive/payment scheme for farmers

A scheme that must have clear benefits to farmers and the Environment

Numerous features have been trialled at Nafferton Farm



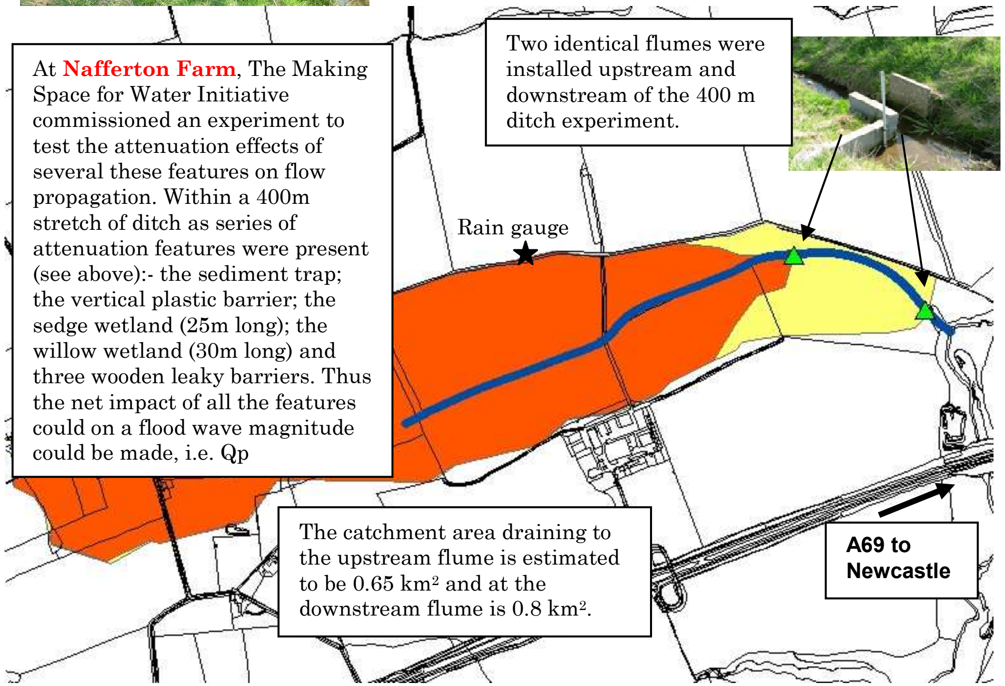
A willow hurdle

The channel is widened and flattened. Willow hurdles are constructed and willow is planted into the ditch bed. During storms flow is retarded and temporary ponds build up behind the features

'Leaky barriers' of wood and recycled plastic

Barriers must be firmly embedded into the banks and the ditch bed. Overflow and energy dissipation must be made part of the design

Willow planted in the ditch and a sediment trap during a storm

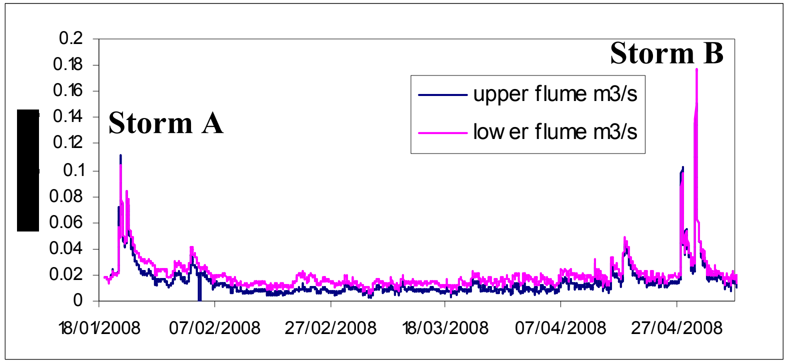


At **Nafferton Farm**, The Making Space for Water Initiative commissioned an experiment to test the attenuation effects of several these features on flow propagation. Within a 400m stretch of ditch as series of attenuation features were present (see above):- the sediment trap; the vertical plastic barrier; the sedge wetland (25m long); the willow wetland (30m long) and three wooden leaky barriers. Thus the net impact of all the features could on a flood wave magnitude could be made, i.e. Qp

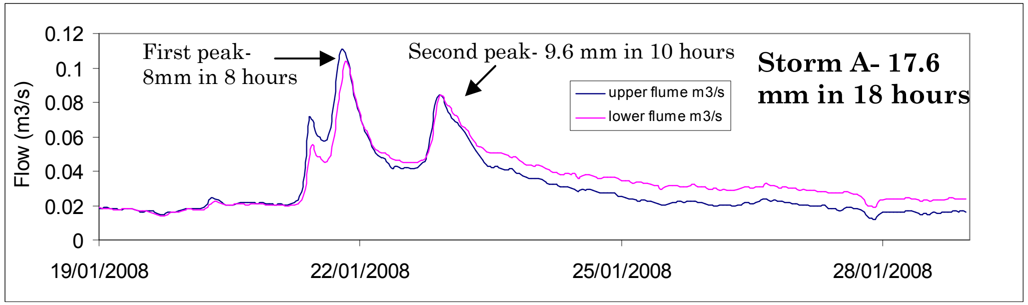
Two identical flumes were installed upstream and downstream of the 400 m ditch experiment.

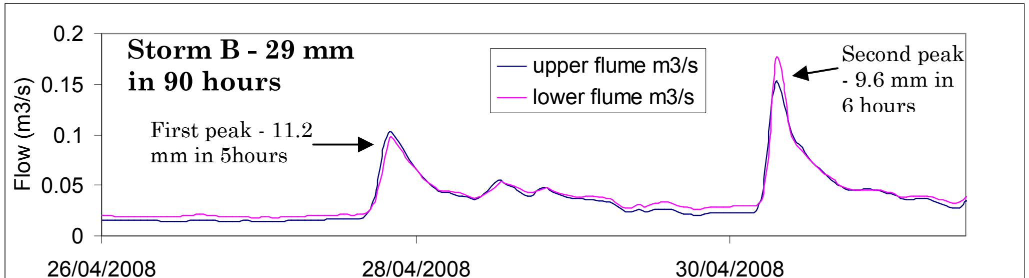
The catchment area draining to the upstream flume is estimated to be 0.65 km² and at the downstream flume is 0.8 km².

During 2008 both flumes recorded a series of storms for the 400m long within-ditch experiment



N.B. From the FEH software package – a 1 in 1 year storm event is estimated to be 12 mm in 5 hours or 26 mm in 1 day. During low flow periods the flow at the lower flume is 20-30% higher than at the upstream flume





Storm A had wet antecedent conditions. The first peak that passes through is much lower in flow at the lower flume than at the upper flume. The second flood wave is equal in flow to the upstream flume. We can postulate that the first food wave is being affected by the physical storage volume provided by the features. In the second wave much of this physical storage maybe in use but the flow is still being attenuated but to a lesser degree.

In **Storm B** the antecedent conditions were dry. The first peak to pass is reduced in flow at the lower flume. The second, larger flood peak, has a higher flow at the downstream flume, and has less attenuation. This second peak is the largest event recorded to date and is close to a 1 in 1 year storm event which has fallen on a wet catchment.

N.B the time of travel for the flood wave is 20-25 minutes for 400m of travel (see later)

If we assume that the flow should be higher at the lower flume (as suggested by the catchment area difference and the observed low flows) then we can estimate the impact on Qp. If we assume the first flow peak in **storm A** should be approximately 20% higher in flow than at the lower flume then the reduction in Qp is about 40%.

Attempts to upscale this work is now taking place in the EA Belford project (see Wilkinson, M., Quinn. P.F. and Welton, P. (2008), 'Belford catchment proactive flood solutions: storing and attenuating runoff on farms.' BHS symposium 2008, Exeter, U.K. [http://www.ncl.ac.uk/iq/download/BelfordBHSpaper.pdf]