FIRM Plan features tested at Nafferton Farm

Sediment flow from roads is redirected into ponds

Interception ponds capture fast polluting flow paths before they reach the ditch, the pond then stores and strips sediment from the runoff.

The range of sediment depth in the pond was 7-17 cms in May 2008 (Approx wet accumulation rate of 50 m3 p.a.)

How much is this sediment worth to a farmer as a resource?

Combined sediment trap and P stripping zone

Barriers retard flow and induce rapid sedimentation; this process is so efficient we would advise frequent sediment removal. Average sediment depth was 37 and 21cms in June 07 and May 08 respectively, equating to an approximate wet volume of 2.8m3 and 1.6m3 p.a.

Sediment can be recovered on farms!

The evidence for efficient P-stripping and sediment removal is shown opposite respectively. Up to 77% total phosphorus removal has been observed during storm events. (95% suspended sediment removal has been observed). Recovering the sediment is now the major question: who, how and when?

Within-ditch wetlands

The sedge wetland and a willow wetland will store and retard flow even in winter and will also help to denitrify flow and strip fine material. However over 25m very little nitrate was removed. Although, typically P and sediment are removed in the flow, the large storm showed evidence of P and sediment remobilisation. Sediment traps and wetland should be used in combination. The wetland must be managed and willow must be cut each spring.

Benefits all round

Implementation of a runoff management strategy or FIRM plan has been shown to have multifunctional benefits for not only reducing nutrient delivery to water courses but also reducing flood peaks (Quinn et al., 2007, Wilkinson et al, 2008) as well as ecological benefits such as protecting sensitive spawning grounds from sedimentation or creating habitats for aquatic invertebrates.

A supplementary benefit to FIRM plans have been to create a framework for holistic thinking that has brought an essential and diverse team of scientists and policy makers together to agree on a strategy that could potentially be up-scaled in the future to help implement the WFD.

Conclusions

All features physically store flow and attenuate peak flow rates. Large amounts of nutrient-rich sediment are being produced. This sediment is a valuable resource to the farmer. A large amount of saturated land will be needed to denitrify flow. Ditches and Buffer zones should be put to better work through planned runoff management strategies. Controlling flow during storms events, at source is a visible means to reduce environmental problems which can fully engage with farming officers and farmers through innovative forward thinking stewardship schemes.

Full reports on both nutrient management and flood storage on farms are available at:
www.ncl.ac.uk/iq/Proactive/Firm.html

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www.ncl.ac.uk/iq

www.youtube.com/proactivefarms

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ESL earth systems laboratories

Newcastle University

Civil Engineering and Geosciences

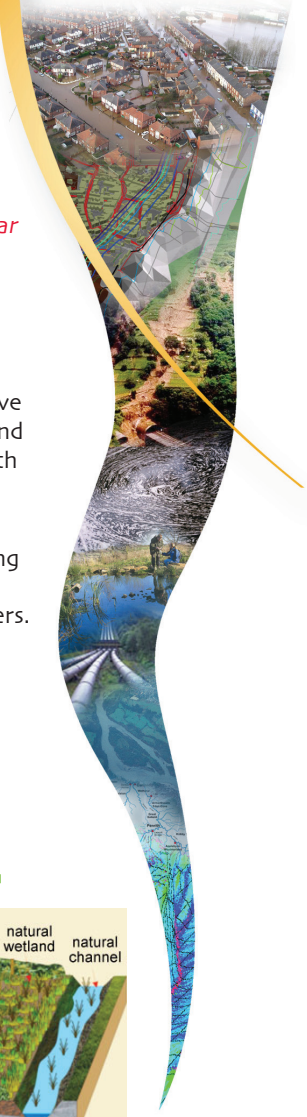
Nutrient trapping and recycling on farms

A landscape scale sustainable soft engineering option

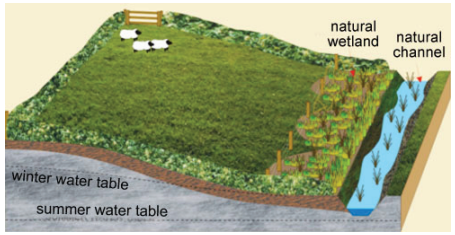
'A scheme that must have clear benefits to farmers and the Environment'

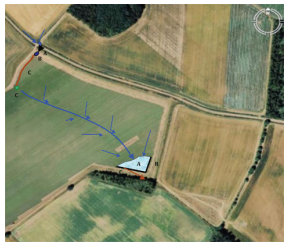
The PROACTIVE approach to farm environmental management is a joint initiative of the Environment Agency and the Newcastle University Earth System Laboratory iniative.

firm Plans are based on experience and evidence arising from full scale applications on farms and supported by farmers.



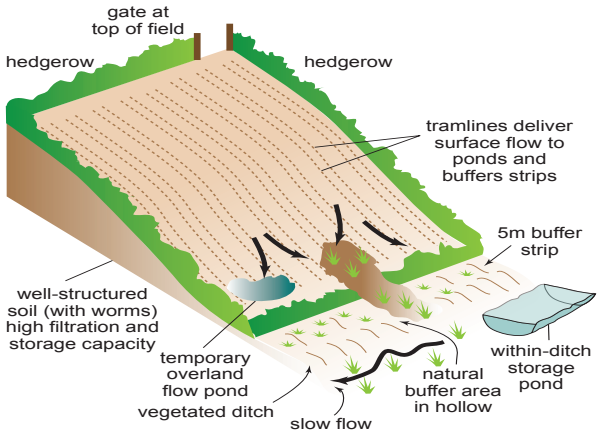
farm Integrated runoff management plans





If a typical farm or small catchment can sacrifice 2-10 % of the landscape to runoff storage and mitigation features then the properties of the runoff regime can be radically altered.

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**.

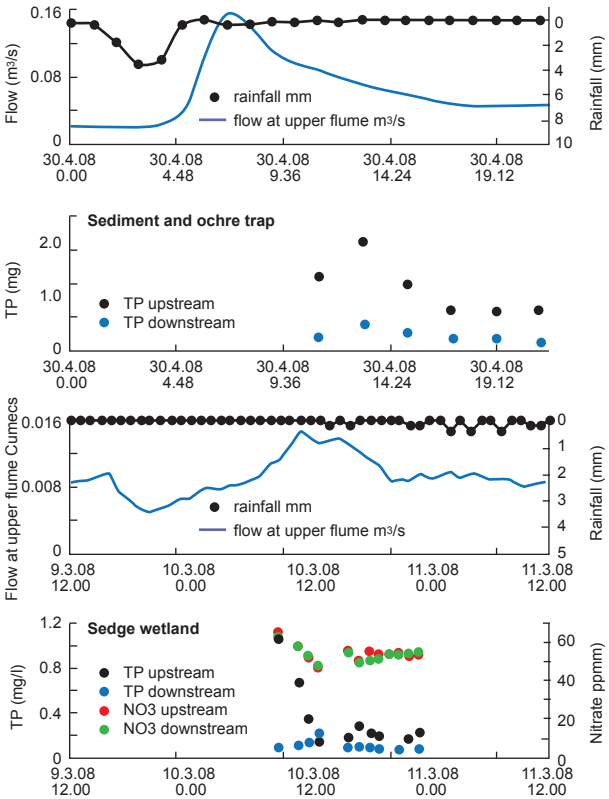


Best options to reduce phosphorus, nitrate and flood risk:

- A small temporary storage pond in most field, to slow flow and capture sediment and phosphorus
- Barriers within ditches
- Wetlands and sediment traps in ditches
- Buffer strips that are put to effective work

Changes to planning/policy needed for effective **firm plans**:

- 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



Total phosphorus concentrations before and after sediment and ochre trap during a larger storm

Why FIRM plans are necessary?

Initial analysis on pressures regarding diffuse pollution, carried out by The Environment Agency, stated that, 'diffuse pollution (especially from agricultural nutrients) will make it very difficult for the UK to achieve the Water Framework Directive's objectives' (EA, 2006). Recent figures have estimated that, 87 % of rivers, 50 % of lakes, 35 % of estuaries, 20 % of coastal water, and 68 % of groundwater are at risk of not achieving WFD objectives, (EA, 2007).

Agri-environment schemes have gone some way to addressing conservation needs of farming but are making little impact on pollution and high runoff rates from economically viable farms. The FIRM Plan approach could offer another wider range of options to control pollution and flood risk from farms, IF they were adopted by policy.

Flume

A 400m long within-ditch experiment is quantified at each end with flow and nutrient loading data. ISCO samplers are used to test each individual feature's efficiency.

Leaky barriers made from wood

Barriers in the ditches at Nafferton have been constructed from wood, willow and a recycled plastic material.

A willow hurdle

Recycled plastic material

What will they cost and who should construct them?

It has been estimated that the cost of installation and maintenance of mitigation features such as infiltration ponds, sediment traps and wetlands would be approximately **£750-1000 per feature, or up to £10,000/ km2** (Quinn et al., 2007). This will provide drastic reduction in nutrient pollution and sediment losses in most storms. A full FIRM plan requires the farmer to take an active part in the plan and for sound advice/ training to be given.

Where should they be sited?

Each farm is different and local modifications to FIRM plans are needed. However the basic premise to control, store, slow, and filter all flow during storms is common to all FIRM plans. Some sacrifice of land is needed (2-10 % of total land) and ditches need to be managed in a radically different way.

Tools to help and example FIRM plans can be found on www.ncl.ac.uk/iq