SUDS – Sustainable Drainage Systems

To explore the effectiveness of different pathway options in slowing down the flow of surface run-off and trapping sediment from different farm and field locations.

A joint project between the Environment Agency and LEAF – Linking Environment And Farming

Interim report October 2010

LEAF
LINKING ENVIRONMENT AND FARMING
Integrated Farm Management

Environment Agency

SUDS – Sustainable Drainage Systems

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Project objective:

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Summary

The Environment Agency has been working with LEAF (Linking Environment And Farming) to put science into practice by trialling new types of measures on farm that intercept run-off from fields. These measures are known as Sustainable Drainage Systems or SuDS. This interim report demonstrates the relative ease and simplicity of constructing these measures and recognises that it is a two step operation:

1) choose the right site on the farm and
2) choose the right sustainable drainage option to suit the site.

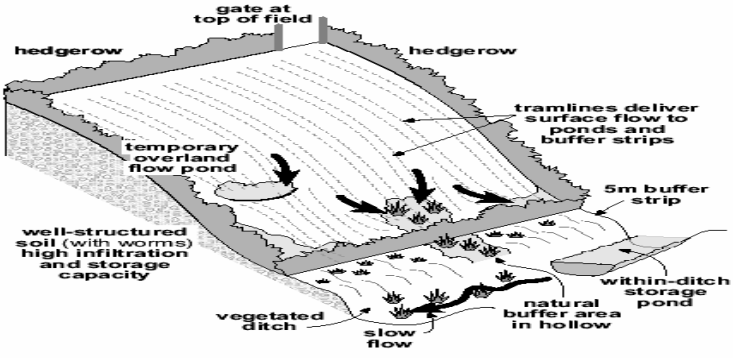
This study showed the costs to the farmer for implementing a suite of sustainable drainage measures on the farm were relatively low. It also shows how these measures could be scaled up across the wider catchment, and could potentially contribute to a significant reduction in the loads of a range of diffuse pollutants.

The study is intended to assess the ease of construction and effectiveness of the measure at farm scale with the intention to introduce these measures into England's Higher Level Scheme and the Welsh Glastir scheme within environmental stewardship.

Some of the measures were not always implemented at the right scale, but this is very much part of the trial and error that is required at the experimental farm scale.

Introduction

Sustainable Drainage Systems (SuDS) provide a sustainable approach to draining surface water and are needed to better manage the future likelihood of flooding and water quality issues caused by these pressures. SuDS do this through mimicking natural drainage and managing water above-ground with the characteristics of storage and slowing down flows of water into water courses as well as improving water quality and amenity.



SuDS are physical barriers that can intercept the pathways of surface run-off and drainage

Measures to create SuDS are not a new concept and are frequently installed by developers. In recent years, there have been several Environment Agency science projects on intercepting measures to control run-off by intercepting water pathways. These include the Proactive report from Newcastle University 2007 and the Macauley report on Measures for Rural Sustainable Drainage (2009). Whilst previous measures have tried correctly to reduce the source of diffuse pollution, SuDS intercept the pathway of run-off through physical barriers such as ponds, scrapes and vegetation.

SuDS have multiple benefits in the agricultural landscape:

- **Water quality.** In part, SuDS are very efficient sediment traps. In reducing the amount of sediment in run-off, there is good evidence to suggest that phosphorus, pesticides and faecal organisms are captured before they enter main water courses. In December 2009, the Environment Agency published its Water Framework Directive (WFD) river basin plans. More than 15,000 kilometres of waterways in England and Wales will be upgraded to good ecological status over the next five years. There are still big risks to achieving these objectives. 74% of our rivers are failing WFD standards.
- **Reducing flood risk.** By capturing field run-off or intercepting the farm ditch network, the flow of water to a catchment can be manipulated to reduce peak flows at a local scale. The evidence on farmer's ability to do this is still sketchy but there have been some interesting studies in the uplands through blocking drainage grips.
- **Adapting to climate change.** Water availability and management will be a key need as we adapt to climate change. Wetter winters and drier summers will be a challenge for all of us but especially farmers who are at risk of losing crops or livestock with these extremes of weather. Suds encourage infiltration of water to recharge groundwater and with the creation of micro-wetlands can also create a network of habitat for biodiversity to also adapt.

Field run-ff could increase with climate change. Buffer strips are an excellent last line of defence but can only capture some of the larger soil particles. It does not slow the flow of water for long enough to allow smaller soil particles with associated nutrients and pesticides to be captured before they enter the surface water system.

Diffuse pollution is often invisible to the naked eye, but in time of intense rainfall, we often see the adverse effects of run-off, for example gullies in fields, erosion of tracks and sediment in ditches. This has direct cost implications for the farmer and the surrounding environment. It is possible to get funding through Natural England's Higher Level Scheme for resource protection management options. However, the areas in England that are accessible to these funds are limited. Similar options will be available in Glastir in Wales from 2013. There is considerable interest in Catchment Sensitive Farming, where sediment traps are already a feature on some farms.

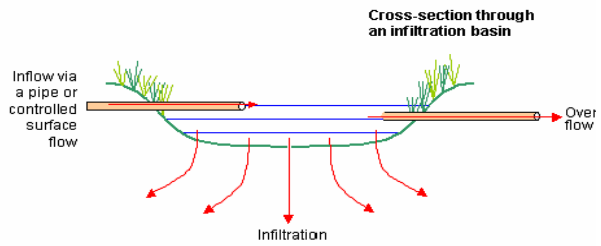
The LEAF SuDS project

For this pilot, different SuDS measures were established at three different farms – Midloe Grange Farm (Cambridgeshire), Church Farm (Somerset) and Green Hall Farm (in Wales). These farms represent different farming types and more importantly, they differ in rainfall, soil type and topography.

The project started in March 2009 with Midloe Grange Farm and Church Farm having their options in place by the summer 2009. Green Hall Farm is behind the other two due to joining the project later and weather conditions preventing construction of the options until March 2010.

Each farm was given a suggested design criteria for possible measures are intended to be introduced into agri-environment. However, individual farmers were able to choose options that best suited their locations. In all cases the basic principle was the same. Run-off is piped or collected into a retention basin. As much water as possible infiltrates the soil profile and where appropriate water flows out after some retention and has allowed sufficient time for suspended solids to settle out.

Fig 3 – illustration showing the principle of surface flow being intercepted and slowed down



LEAF farm findings

Grassland sediment trap in ditch (Midloe Grange Farm)

Grassland can become badly compacted especially from livestock in the autumn and winter months. Grassland fields can be just as prone to run-off as cultivated fields with the additional risk of loss of faecal organisms.

On Midloe Grange Farm in Cambridgeshire a sediment trap was installed in a ditch that was open to livestock during the grazing season (see photographs below). The bottom of the ditch was scraped out with a digger and lined with paving stones to form a base to the ditch where subsequent accumulated sediment could be easily removed. The barrier is a recycled plastic called ‘Aquadyne’. This is porous to water, but holds back sufficient flow to allow soil particles to settle out.

The same grassland ditch started flowing in December 2009. The flow was rarely over half capacity. The small drop into the silt trap acted as a settlement tank, and within

weeks there was a build up of sediment and detritus. In retrospect, no barrier should be so close to a culvert that it may block it in high flows. This sediment trap is easily accessible for a loader and bucket to allow for frequent clearing if necessary.

Cost to the farmer …Aquadyne slab, digger and paving slabs ….about £75

Arable silt trap (Midloe Grange Farm)

The arable silt trap at Midloe Grange Farm is a similar construction to the grassland sediment trap. Again the benefits are to trap silt in single locations that are easily accessible to clean.


The silt trap is about 6" deep and is lined with paving stones to give it a defined level. Marker sticks can be an added refinement. The trap was carefully positioned between the last pipe outfall and the end of the ditch. The silt trap works by slowing the flow of water, allowing soil particles and attached nutrients or pesticides to filter out.

The silt trap works by slowing the flow of water, allowing soil particles and attached nutrients or pesticides to filter out. A tray placed at the bottom of the silt trap in December 2009 demonstrates the amount of material collected in just one month and after 52 mm of rainfall. Amongst the sediment was an abundance of fresh water invertebrates.

Cost to the farmer….hire of digger and paving slabs £75

Arable field buffer or scrape (Midloe Grange Farm)

Run-off is not just a problem for farms with slopes. In 2008, Midloe Grange Farm recognised a field where the slope is less than 2 degrees was collecting water. This was at the bottom of the field where tramlines joined the headland, the normal access to the field. The field already had a 4 m buffer strip, however a soil scrape was created by a digger to hold back water in large rainfall events.

The concept was to maximise the use of a field corner but enabling alternative access of farm machinery where appropriate. The area within the bund would ideally be grassed to allow maximum infiltration of water and to create a diverse habitat.

The scrape proved to be highly effective at holding back 'muddy' water and retaining a number of diffuse pollutants. A small overflow of water filters through the grass buffer strip for a final polish before entering the watercourse system. Ideally the water in the scrape should slowly drain over 24 hours to be ready for the next rainfall event. The crop should not be unduly affected and if grassed could be retained as a micro wetland feature.

Cost to the farmer. Hire of digger and compaction of scrape walls….£200

Arable field buffer or scrape (2) (Church Farm, Somerset)

Church Farm in Somerset, has a number of sloping fields with sandy soils, known to be of high risk of soil erosion and run-off. The loss of soil is a considerable cost to the farm including, prevention, clear up operations and the loss of soil as a resource.

This particular field has a history of run-off from tramlines and onto the road. This acted as a direct pathway to the surface water network. The normal mitigation measures such as buffer strips have not been sufficient to intercept the pathway. This is a common problem in some parts of the UK.

The solution devised by Church farm was to move the field entrance away from the tramline and dig out an 8m x 8m x 1m scrape as a run-off trap. Although the picture shows a cuboid type pit, the intention was to grade the sides and plant grass seed to stabilise the bank and base. However, unpredictable spring weather put work on hold.

Although some of the sediment is from erosion of the banks, at least two inches (6cms) of soil, about a cubic meter in total was retained within this. Soil has a value of about £5 / mt^3. Over the course of a season this single measure might attract retain several cubic meters of soil.

Off line or 'blind'ditch wetland (Church Farm)

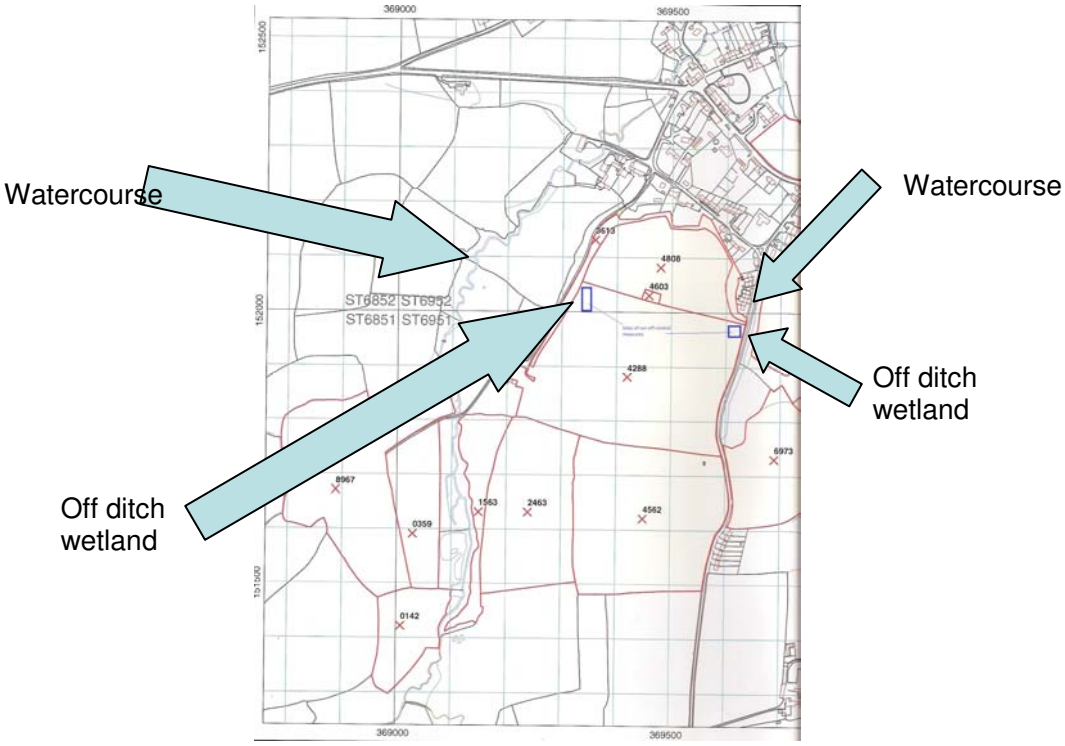
Church Farm also had a sloping field where more diffuse run-off was observed. That is to say that water leaves the field boundary over a wider area and not just at one point.

A narrow depression, at the bottom of the slope, not much larger than a plough furrow, acted as a collector of run-off over several hundred metres. At several points in the field, a pipe was installed to channel the effluent (water + soil particles nutrients or pesticides) under a track to a blind ditch approximately 2m x 6m.

The picture shows the amount of soil collected over the course of one month that would have otherwise entered the surface water network. The water collected slowly drains

through the profile. Overtime, this ditch will grow vegetation and the top layers will help to break down any pesticides or faecal organisms collected. The soil and associated nutrients will be returned to the field.

Map of Church farm showing options in relation to watercourses



Total cost to the farmer of both options -

JCB digger hire	12 hrs @ £ 25/ hr = £ 300.00
Tractor and dump trailer	10 hrs @ £ 20/ hr = £ 200.00
6metres 225mm pipe	@ £ 40.00
10 metre 4" perforated land drain	@ £ 9.50
1 tonne clean stone	@ £ 10.50
Total cost……	£560 + VAT £658.00

Track drainage to scrape (Midloe Grange Farm)

Farm tracks are renowned carriers of water during rainfall. They can also act as temporary carriers of field run-off, causing direct damage to tracks as well as fast access of potential pollutants to the main river.

The principle is to construct a French drain or 'sleeping policeman' to divert this flow to a field corner for retention and slow percolation.

Cost to the farmer Hire of digger and French drain….£250

In- ditch barriers – (Midloe Grange Farm) The principle of in- ditch barriers are to slow and hold the flow of water. This can serve two purposes:

(i) to allow soil particles to settle out and

(ii) hold back water within the drainage network to reduce peak flows in the main river. The concept could be scaled up at sub-catchment level and with some spatial planning, could contribute to a reduction in flood risk.

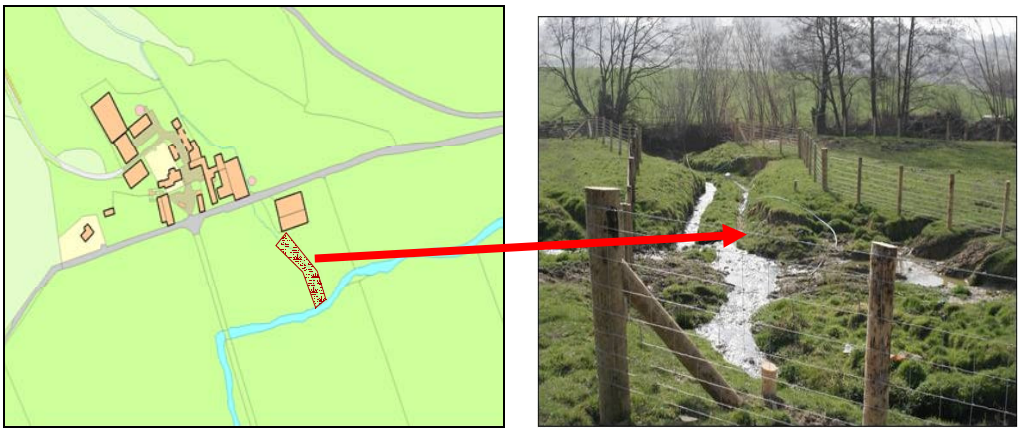
This pilot at Midloe Grange Farm shows a freshly excavated ditch which has collected considerable sediment over the years. Construction is using a mixture of natural features. For example stumps of felled trees to act as an anchor for the barrier. The barrier has gaps that allow normal flow of water but can hold back the force and flow in heavy rainfall periods. Even during normal flow, it is apparent that the speed of flow has been reduced to allow sedimentation.

Cost to the farmer…..Poles, posts and construction £50 + Digger hire £50

An alternative variation to a ditch barrier, is to use local resources that can be used to do a similar job. This barrier uses felled willow growing beside the ditch network. These pictures demonstrate how natural debris is being trapped by the willow barrier and will naturally degrade and settle out. The pilot study will test the resilience of the construction and how much sediment is trapped by this feature. Further up this same ditch, Midloe Grange Farm has coppiced natural willow where the root network is being monitored for its effectiveness of sediment filtration and retention.

Cost to the farmer ……. Construction of willow barrier £50

In-ditch wetland – Green Hall Farm - an ' in-ditch ' wetland makes use of existing surface water features and enhances their ability to cleanse diffuse pollutants. Green Hall Farm in Wales has significant yard areas subject to occasional contamination from vehicle and animal movement. These areas drain to the Afon Cain via a tributary.



Cattle cross the public highway four times a day and though the road is cleaned daily - some diffuse pollution is inevitable.

A small tributary flowing through the farmyard was also fenced with the long term aim of creating an in-ditch wetland to 'polish' run off. Though this tributary primarily accepts clean water diverted away from the slurry store, the farms location on this small watercourse does mean that it occasionally receives small quantities of organic pollutants such as dirty water, slurries and silage effluent. Though any one discharge is insignificant the combined impact from similar discharges across the wider catchment can affect water quality in the Afon Cain. Sewage fungus has been seen in the tributary on at least one occasion.

The natural topography of the ditch meant very little profiling was necessary to create a wet area ready for planting and it was not necessary to use additional material to form the bund. However, water from the farm yard complex has been held back to allow more time for biological activity to polish the water as a final treatment. The groundwork's works were completed on the 22nd March 2010 and this area has now been planted with reeds. The Cain Valley Catchment Initiative will monitor the effectiveness of the in-ditch wetland using YSI automatic water quality data loggers. The alteration of surface water will require drainage consent.

The construction of a pilot in-ditch wetland on this tributary will slow, store, and filter nutrients and sediment run off before they enter the Afon Cain. However it may be necessary to tweak the design because of a slight gradient on the field. A suggestion that is being pursued is to construct two or three earth bunds at natural pinch points in the watercourse. This will ensure sufficient slowing of the flow to allow sediment to settle, and reeds to flourish whilst reducing the risk of causing overflow, wetting or flooding of the adjacent pasture.

Cost to the farmer ……..£895

- Flood Defence Consent Application £50.00
- Hire and operation of digger (4hrs) £225.00
- Pipe £200.00
- Phragmites australis £220.00
- Stone as substrate £200

Land drainage consents

At Green Hall Farm, initial consultation with colleagues within the Environment Agency confirms that there are no problems with restricting fish passage on this watercourse. However, a Flood Defence Consent under the terms of section 23 of the Land Drainage Act will be required as the bunds will interfere with the normal flow of the ditch. In this instance the application will need to include a location plan indicating location of works, and a typical cross section showing height of bund in relation to top of bank. Though no flow calculations are required as part of the application, a clear projection of the consequences of high flows should be stated. There is no cost to this application process and in this instance the Catchment Coordinator will assist the land manager in applying for the consent.

Observations

- The feedback from the farmers so far has been very positive in terms of cost and time involved to establish the options and the clear effects they are having in alleviating the problem areas.
- During and after heavy rainfall is when the options are at their most effective which is of course when the fields are at the highest risk of run off. The photographs clearly show this.
- The options are relatively inexpensive and straightforward to establish.
- Freshwater invertebrates were found in the sediment traps at Midloe Grange Farm which could show that the options have biodiversity benefits too.

Next steps

LEAF will encourage visits to farms where options are established for key industry people to see them working. Indeed the Environment Agency and LEAF would like to organise a workshop at Midloe Grange Farm for key industry contacts to see the options working during wet conditions.

Green Hall Farm will have more technically accurate results due to the project been overseen by Richard Dearing, catchment officer for the Environment Agency. Midloe Grange Farm and Church Farm are using more basic monitoring methods such as plastic trays and silt traps.

These are fairly dramatic results from measures that were only in place for a few short months of the winter. The features need a growing season to develop vegetation and a full winter to monitor their effectiveness. Each farm has agreed to have ongoing monitoring that can be recorded and reported back.

Camilla Puzey
LEAF – Linking Environment And Farming
Stoneleigh Park
Warwickshire
CV8 2LG

Tel: 02476 413911
enquiries@leafuk.org

www.leafuk.org

Jamie Letts
Environment Agency
Block 1 Government Buildings
Burghill road
Bristol BS10 6BF

Tel: 0117 915 2136
Email: james.letts@environment-agency.gov.uk
www.environment-agency.gov.uk