Protecting water from agricultural run-off: water retention measures

Water retention measures protect watercourses from pollution and can help prevent flooding incidents and silt being deposited on roads and in ditches. They may also provide opportunities for wildlife. This note has been written for farmers and land management advisers. It provides guidance on various types of soft engineering works that can help retain water and advises on how Higher Level Stewardship (HLS) can help fund these. See also TIN098 *Protecting water from agricultural run-off: an introduction* and TIN100 *Protecting water from agricultural run-off: buffer strips*.

Key points

- Large volumes of surface water can run-off farmland during heavy rain and this can cause soil erosion, water pollution and flooding.
- Water retention measures can help prevent these problems by holding back surface water flows and allowing them to dissipate into the soil or to slowly flow into a watercourse.
- They are suitable for land at moderate, or greater, risk of causing soil erosion or run-off.
- Slowing the water allows the sediments carried in the moving water to drop out of suspension thus preventing the sediment and any associated chemical pollutants from entering the watercourse.
- Water retention measures include temporary storage ponds, seepage barriers, in-ditch wetlands, swales and grassed waterways.
- Any water retention options should be implemented as part of a wider programme of good land management practices such as alleviating soil compaction and creating buffer strips beside water bodies.
- Specialist advice should be used when designing and constructing measures. Some water retaining features may require planning permission.

Photo 1 Agricultural run-off after heavy rainfall

- These measures should not be used near houses and premises as they may increase the risk of localised flooding.
- The EA should always be consulted for works within a ditch or water course as a licence maybe required.

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- Where land is within an Internal Drainage Board (IDB) district contact the IDB as some activities may require their consent.

Environment Agency consents and licenses

Any work or structures that occur within a watercourse, including stage 1 and 2 ditches, as identified in figure 1 below, will require an Environment Agency - Flood Defence consent. This is to ensure that any change to the watercourse does not impede the flow of water and increase the risk of flooding, especially to the property of other land owners.

The Environment Agency has a risk based approach to the issue of such consents and the fee for minor works is normally waived if funded by Defra. This guidance will change once consenting responsibilities are transferred to Lead Local Flood Authorities.

Barriers should not impede the passage of eels. Eels can travel over land and around some barriers, but the risk of obstructing their free passage will need to be considered as part of the application.

If soil from excavation works is being reused for other works, for example, embankments or soil bunds, this would not be considered a waste provided it is clean and fit for purpose. Material brought onto the farm from elsewhere to build bunds embankments and structures is waste and U1 exemption would be required.

Surplus spoil generated by the construction or maintenance of a sediment trap, dredging or widening of existing ditches can be disposed of by spreading it thinly over adjacent land. Any excavated material may be classified as a ‘waste’ and it’s use may need a waste exemption (U10 and /or U11) from the Environment Agency.

You should contact your local Environment Agency office to discuss what exemptions you may require before carrying out the works. See *Further information* below for details of how to contact your local office and links to further guidance on exemptions.

Temporary storage ponds

Temporary storage ponds retain water during periods of high rainfall. They can be placed in either grass or arable fields. They should not be located on sites with existing semi-natural habitats or historic features because they can damage these features.

Photo 2 Temporary storage pond

New ponds should be located at the bottom of shallow slopes to intercept run-off before it enters a ditch or an existing pond.

New shallow ditches may be needed to channel surface flows into the pond. Where possible these should use the natural topography to minimise construction and excavation costs and reduce disturbance and associated run-off/erosion risks. Flows between tracks, roads, gateways and fields should all be properly linked to the storage pond.

Access maybe required to de-silt the pond and this should be considered when selecting the site. The frequency of de-silting will be dependent on size of the pond and of the contributing catchment. If the appropriate in-field practices are followed, de-silting of the pond should not be necessary or at least, it should be minimal.

Temporary storage ponds design and construction

The exact dimensions, location and constructional requirements should be agreed with your Natural England adviser and, where appropriate, any other relevant bodies.

The size of the pond will depend on the volume of run-off that needs to be intercepted. A pond should have sufficient retention time to allow the soil particles to settle out of the water, this may be from several hours to days, depending on soil type and other factors.

Ideally run-off should not be turbulent when it enters the pond so that sediments can quickly sink to the bottom. Typically the minimum pond volume should be 10 m x 3 m x 1 m. Ponds can be created by:

- excavating directly into the ground;
- by the construction of an embankment; or
- by a combination of the two.

As far as possible use the natural topography and flow paths to reduce the need for excavation or embankments. When excavating remove vegetation and overburden from the site and stockpile top and subsoil separately for re-use. The subsoil can be re-used if it is necessary to construct an embankment.

The risks of erosion and the need for erosion control need to be taken into account during the construction and vegetation establishment. In particular, do not undertake work when it is wet.

Grassed waterways

What is a grassed waterway?

A grassed waterway is a constructed shallow channel covered with a grass sward. They are designed to intercept flows of surface water and to increase percolation into the soil. This can prevent gullying and soil erosion as well as water pollution. They are normally used within arable fields but can also be valuable in intensive grassland. They can be created along natural drainage pathways.

During normal rainfall the flows should infiltrate into the ground in the waterways, but during heavy rain they may not be able to absorb all the flow. Where this is likely they should be designed so that they drain towards an area that can accommodate additional flows, such as a temporary storage pond or a wide buffer strip.

Grassed waterway design and construction

Specialist advice should be sought to help design these.

Cease arable production and construct a shallow channel. This channel should be graded so that side slopes do not exceed 1 in 2, ideally 1 in 4. During construction stockpile any top and sub-soil separately. Sow a grass seed mixture to stabilise the slopes of the grass waterway. See table 2 at the end of this note for a suggested seed mixture.

Photo 3 Grassed waterway under construction

If managing under ELS option EJ/OJ5 *In-field Grassed Waterways to Prevent Erosion and Run-off,* in order to meet the prescriptions, the waterway should at least 10 m wide along its entire length. Another important prescription for EJ/OJ5 is the need to ensure that there are no bare areas within the grassed waterways as these will be especially vulnerable to further erosion.

Grassed swales

What is a grassed swale?

Grassed swales, or out-takes are linear areas of grass generally designed to convey run-off from one location to another. The main purpose of the swale, in addition to conveyance, is to trap suspended solids.

Swales are commonly used adjacent to roadways and farm tracks, in conjunction with cross-drains, where run-off is allowed to collect and soak away. Occasionally in grassland below yards they can be used as a receptor for lightly

fouled water. On steeper slopes check dams may be needed within the swale to slow down the water flows.

Grassed swales design and construction

The work should consist of site preparation, excavation of the swale and the installation of dams to check the flow of water as necessary (known as check dams).

Specialist advice is needed to identify the specific requirements of a particular site and to develop appropriate design specifications. In general swales will be constructed on the contour of the slope or at a longitudinal slope of no greater than 2°. The layout will be marked on the ground and the swale excavated to a depth of 750 mm. Side slopes should be graded to no more than 1 in 3. The topsoil should be stockpiled and replace once the swale has been excavated.

Dams to check the flow of water should be located at regular intervals along the swale, the distance between check dams should be shorter the steeper the swale gradient. Check dams can be soil bunds or seepage barriers, for further information see below.

Establish a dense grass sward on the sides and floor of the swale. For details of a suitable mixture see table 2 below.

The down-stream end of the grassed swale must be able to absorb any surface water flow from storm events by directing them into low areas such as temporary storage ponds or areas of rough grassland such as wide buffer strips.

In-ditch wetlands

In-ditch wetlands are ditches that have been widened and re-profiled to create areas where wetland vegetation can develop. This vegetation slows water flows, increases sediment deposition and helps remove some pollutants from the water. These wetlands may also develop into valuable wildlife habitats in their own right.

They can be created close to known risks of pollution, for example in a seasonal ditch which takes run-off from a cattle yard. Alternatively they can be created within a network of seasonal ditches to improve general water quality. Specialist advice must always be sought before constructing wetlands.

The impact of the in-ditch wetland on the landscape needs to be considered. In many, but not all cases it will be positive, but this will depend on a number of factors.

The location and design of the in-ditch wetlands must be tailored to a particular site. This will be dependent on:

- the catchment area;
- the volume of run-off;
- the steepness/length of field slopes;
- soil types;
- location;
- depth/width and gradient of the ditch; and
- space available for construction works.

Normally new in-ditch wetlands should be created in ditches with shallow gradients and which do not have continuous flow year round. In-ditch wetland should only be located in stage 1 and 2 ditches as identified in figure 1 at the end of this note.

In-ditch wetlands design and construction

See figure 2 below for details of an in-ditch wetland with a soil bund. The wetland should be at least 10 metres long and no more than 3 metres wide. The cross-section of the ditch should be varied to provide wide shelves for the development of emergent plants. The depth of water across the majority of the ditch should be around 50 cm deep and no more than 75 cm deep.

The style of water control structure will need to be selected for each site, but in most cases simple soil bunds with pipes to control water flows should be sufficient. Water control structures need to be carefully designed so that storm flows can be accommodated.

Ensure that the in-ditch water-control structure is not located too close to a field drainage outlet to ensure that water is conducted away from the

structure; typically there should be at least 3 metres between the structure and the nearest drain outlet.

Allow the in-ditch wetland bed to naturally re-vegetate. If you wish to plant the bed use wetland species typical of the local area. Willow beds can also be considered.

Work should be carried out during a dry period to avoid any unnecessary soil damage. In some cases, it may be necessary to pump out or divert the water flow to allow 'dry' working at the site.

Soil bunds

This specification is only a guide and may not be appropriate for all sites.

If the subsoil from the excavation contains sufficient clay it can be used to construct the bund. The soil should have minimum clay content greater than 20% and ideally above 30%. Where the clay content of the soil is not known you can send representative soils samples for analysis at an accredited laboratory.

A key trench should be excavated at least 450 mm into the bottom and sides of the ditch. Using selected soil with at least 20 to 30 per cent clay content, back fill and consolidate the key trench and build up the bund in thoroughly compacted 150 mm layers until the required height is achieved.

Side slopes should generally be no steeper than 1.5:1. The height of the bund should always be finished slightly proud of ground level to allow for minor settlement. The top should be at least 2 m wide. Trim the bund faces to a smooth finish.

To control water levels, a 200 – 250 mm diameter pipe should be used as in most circumstances this should be enough to prevent overtopping of the bund. An un-perforated land drainage pipe or rigid plastic pipe can be used. The crown of the pipe should be set at least 30 cm below the top of the bund.

Photo 4 A bunded ditch

To reduce the risk of bund erosion in the event of a storm, the pipe should be extended beyond the base of the earth bund on the downstream side. In some circumstances a spillway may need to be constructed to prevent erosion of the bund face and the ditch downstream.

A right angled bend can be attached to the upstream end of the pipe, so that it can be twisted to control the water level in the wetland area.

Any accumulations of rubbish or silt must be removed from under the pipe where it enters the bund. To further help stabilise the bund sow a grass seed mix at 25 g/m^2. For details see table 2 below.

Embankments

To build an embankment compact the sub-soil in 150 mm layers. Thorough compaction of the subsoil is required to ensure the embankment is stable. Continue building up in 150 mm layers until the required height is achieved.

When building an embankment you need to allow for settlement and ensure slope gradients are not in excess of 3:1.

Any surplus topsoil can be spread onto the embankments and their outside slopes to help stabilise slopes and prevent erosion. To further help stabilise the embankment sow a grass seed mix at 25 g/m^2. See below of suitable mixture.

To allow for overflow during periods of heavy rain install an outflow discharge pipe at 0.5 to 0.75 m below the bank top.

Discharge flows should fall on to a stable outlet such as a grass buffer or waterway ideally it should not be directly to the ditch. In some cases you may need to provide protection, for example, stone pitching, slabs or concrete spillway around the outflow.

Failure to install a safe outfall could lead to embankment failure with potential serious sediment problems downstream.

Seepage barriers

A seepage barrier is a dam that allows the slow passage of water through it. They are normally made of timber, but can be made of other materials that allow water to percolate at a suitable speed.

They can be installed in ditches that only flow during flood events, in-ditch wetlands as described above and even across low parts of grass fields to create temporary storage ponds.

Site selection

An assessment of the risk of soil erosion, run-off and the catchment area should be made as this will help inform the size and location of the seepage barrier. The design and frequency of installations will have to be tailored to a particular site. This will be dependent on:

- catchment area;
- volume of run-off;
- steepness/length of field slopes; and
- soil type.

Design

Seepage barriers should only be located in Stage 1 ditches as described in figure 1 below as no obstruction should be placed in a watercourse where free fish movement is required. Although in some circumstances the Environment Agency may approve them in stage 2 ditches.

Photo 5 A seepage barrier

Further information

Natural England Technical Information Notes are available to download from the Natural England website: **www.naturalengland.org.uk**. In particular see:

- NE230 *Farming for cleaner water and healthier soil*
- TIN098 *Protecting water from agricultural run-off: an introduction*
- TIN100 *Protecting water from agricultural run-off: buffer strips*
- TIN081 *Illustrated guide to watercourses beside grassland*
- TIN093 *Shelter woods to prevent wind erosion*

For further information contact the Natural England Enquiry Service on 0300 060 0863 or e-mail **enquiries@naturalengland.org.uk**.

Environment Agency

Customer services can identify your local Environment Agency office from your postcode, telephone 08708 506 506. For further information on waste exemptions see:

- U1 exemption **www.environment-agency.gov.uk/business/topics/permitting/116299.aspx**
- U10 exemption **www.environment-agency.gov.uk/business/topics/permitting/116322.aspx**
- U 11 exemption **www.environment-agency.gov.uk/business/topics/permitting/116324.aspx**

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This note has been written by Natural England staff in conjunction with the Environment Agency and contributions from Cranfield University, Pond Conservation Trust and Defra. Editor Susie Smith. Photo1 James LePage, photo 2 Susie Smith, photo 3 Rob Simmons, Cranfield University, photo 4 Pond Conservation Trust photo 5 Tom Holland. Figures Paul Lacey.

Table 1a Some HLS and Upland ELS capital items that can be used to protect soil and water

Title	Code	Measure
Pond creation options	PC and PCP	Temporary storage ponds
Creation of temporary ponds options	SCR and SCP	Temporary storage ponds, grassed waterways, swales
Soil bund	S1	Temporary storage ponds, in-ditch wetlands
Timber sluice	S2	Seepage barriers
Brick, stone or concrete sluice	S3	In-ditch wetlands
Water penning structures	WPS	In-ditch wetland, temporary storage ponds
Ditch creation	WDC	In-ditch wetlands, Grassed waterways, Swales
Ditch restoration	DR	In-ditch wetlands, Grassed waterways, Swales
Silt trap	STP	Temporary storage ponds
Cross-drains under farm tracks	RPD	Grassed waterways
Gutters	WGC	Grassed waterways, Swales
Post and wire fencing along watercourses	UOJ3	Preventing pollution (only available on SDA land below the moorland line.)

Table 1b Some of the ES options that can be used to protect soils and water

Title	Code	Measure	
Management of maize crops to reduce soil erosion	EJ/OJ02	Preventing pollution at source	
In-field grass areas to prevent erosion and run-off	EJ/OJ05	Preventing pollution at source and waterways Temporary storage ponds	Grass swales
12m buffer strips for watercourses on cultivated land	EJ/OJ09	Protecting the receptor	
Enhanced management of maize crops to reduce soil erosion and run-off	EJ10	Preventing pollution at source	
Maintenance of watercourse fencing	EJ/OJ11	Protecting the receptor	
Winter cover crops	EJ/OJ13	Preventing pollution at source	
Arable reversion to unfertilised grassland to prevent erosion or run-off	HJ03	Preventing pollution at source	
Arable reversion to grassland with low fertiliser input to prevent erosion or run-off	HJ04	Preventing pollution at source	
Preventing erosion or run-off from intensively managed improved grassland	HJ06	Preventing pollution at source	
Seasonal livestock removal on grassland with no input restriction	HJ07	Preventing pollution at source	
Winter livestock removal next to streams rivers and lakes	UOJ12	Preventing pollution at source (only available on SDA land below the moorland line.)	

Table 2 Grass mix

Suggested Grass mix	% by weight
Red Fescue *Festuca rubra*	30
Common bent *Agrostis capillaris*	25
Meadow fescue *Festuca pratensis*	20
Timothy *Phleum pratense*	15
Meadow Foxtail *Alopecurus pratensis*	10
Sow at a minimum seed rate of 25kg/ha	**100**

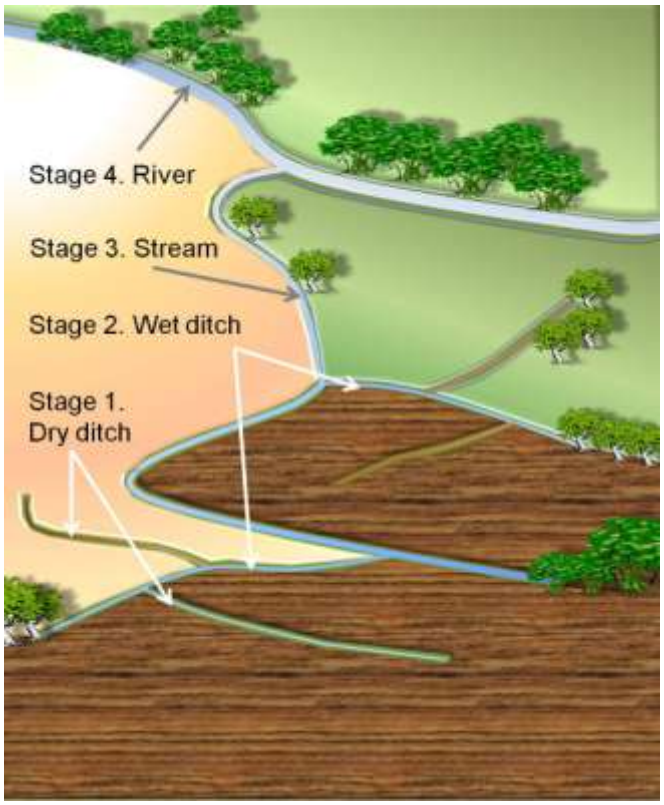

Figure 1 Water course stages

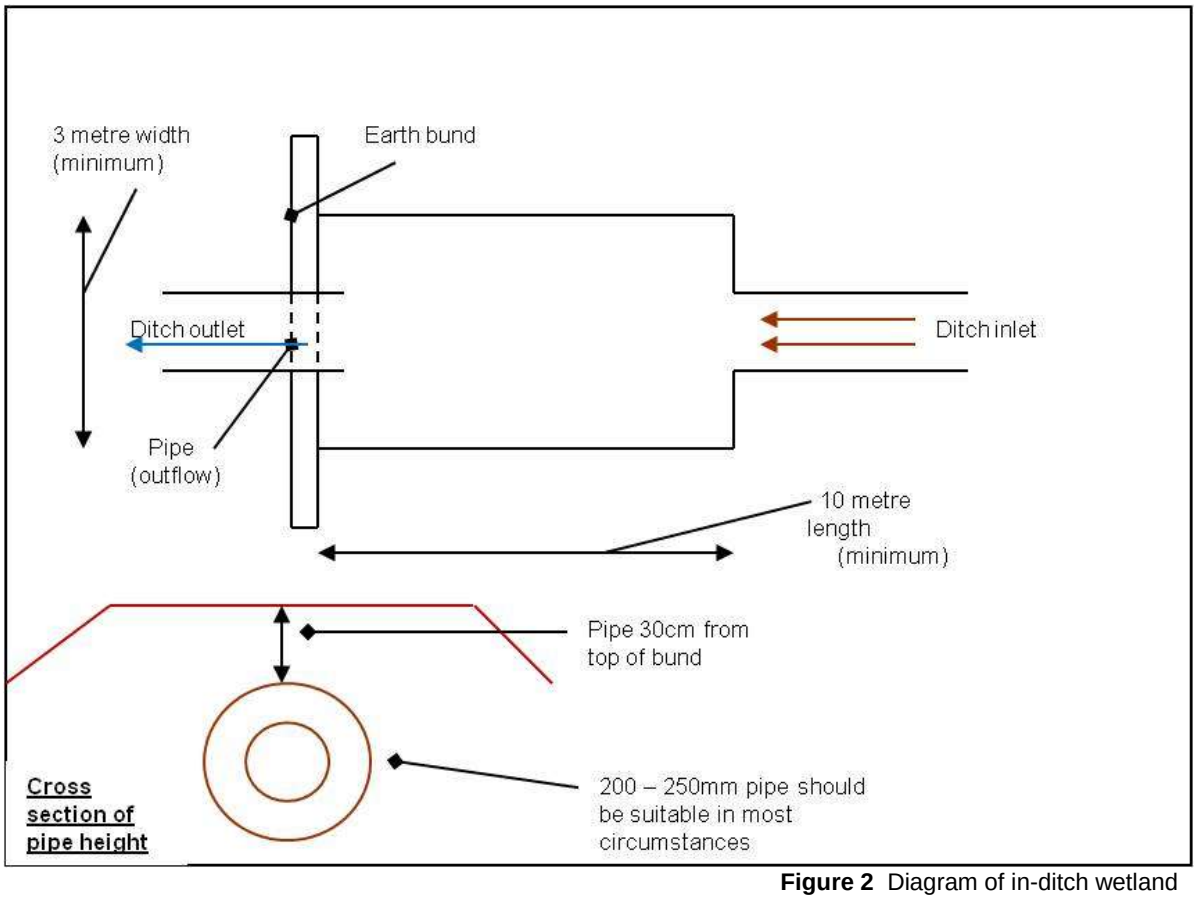

Figure 2 Diagram of in-ditch wetland