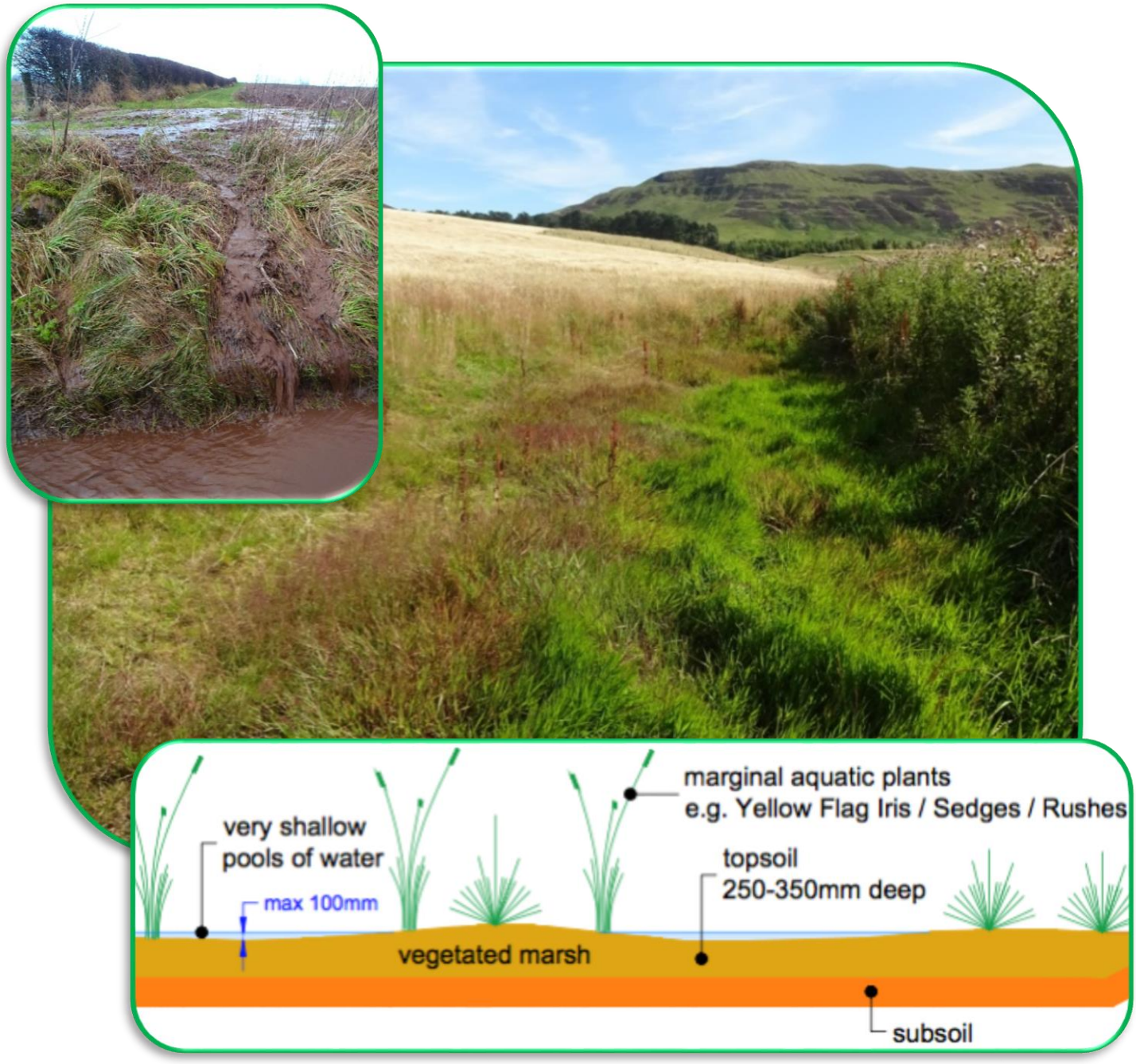
crew
Scotland's centre of expertise for waters

Abertay University

Rural Sustainable Drainage Systems

A Practical Design and Build Guide for Scotland's Farmers and Landowners



Helping to protect Scotland's most valuable resource

Published by CREW – Scotland's Centre of Expertise for Waters. CREW connects research and policy, delivering objective and robust research and expert opinion to support the development and implementation of water policy in Scotland. CREW is a partnership between the James Hutton Institute and all Scottish Higher Education Institutes supported by MASTS. The Centre is funded by the Scottish Government.

This document was produced by:

Alison Duffy[1], Stewart Moir[2], Neil Berwick[1], John Shabashow [1], Brian D'Arcy[1], Rebecca Wade[1]

[1]Abertay University,
Bell Street, Dundee
DD1 1HG

[2]Moir Environmental Ltd,
7 Alloway Place, Ayr
KA7 2AA

Please reference this document as follows: Duffy, A. Moir, S. Berwick, N. Shabashow, J. D'Arcy, B. Wade R. (2016). Rural Sustainable Drainage Systems: A Practical Design and Build Guide for Scotland's Farmers and Landowners. **CRW2015/2.2**. Available online at: crew.ac.uk/publications

Dissemination status: Unrestricted

Cover photographs courtesy of: Alison Duffy, UWTC, Abertay University and Stewart Moir, Moir Environmental Ltd.

Contents

PART 1 – INTRODUCTION

What are Rural Sustainable Drainage Systems (Rural SuDS)?

Soil cultivation, manure / fertiliser applications and chemical spraying can all contribute to diffuse pollution from agricultural land. Rainfall runoff from farm roads, tracks, yards and dusty roofs are also potential sources of diffuse pollution. Whilst many changes in farming practice have dealt with these sources of pollution there still remains instances where small amounts escape from a farmyard into a nearby ditch or where sediment laden overland field flows make their way into a ditch or burn, river or natural wetland and finally the sea. This not only has cost implications for a farmer but these incidents across a catchment have a huge impact on our water environment.

Rural Sustainable Drainage Systems (Rural SuDS) will reduce agricultural diffuse pollution impacts as they are physical barriers that treat rainfall runoff. They are low cost, aboveground drainage structures that capture soil particles, organic matter, nutrients and pesticides before they enter our water environment. Rural SuDS for steadings prevent blockages in drains and ditches. They contribute to good environmental practice and farm assurance schemes. In fields they can be used for returning fertile soil back to farmland and will help your business become more resilient to the impacts of climate change. **Trapping soils, organic matter and nutrients means that valuable assets can be reclaimed – recent studies indicate savings of £88 per hectare per year!**

This Design and Build guide can be used by farmers and land managers who wish to apply for an Agri-Environmental Climate Scheme (AECS) grant or not. You may have a diffuse pollution issue outwith AECS objectives but you should still consider using Rural SuDS to reduce diffuse pollution.

Image © Alison Duffy

A Rural SuDS Pond in South East Scotland

This guide will help you select, design and build the most suitable Rural SuDS for your farm and explains how to look after the systems. It also promotes the wider benefits such as coping with extreme weather related to climate change, localised flood prevention and enhancing biodiversity. Other sustainable land management options that you can consider are provided in Part 9. Case studies in Part 10 illustrate how these practices have been successfully applied around Scotland.

PART 1 – INTRODUCTION

How will Rural SuDS help my Business?

Where rainfall runoff enters slurry storage systems unnecessarily, then Rural SuDS can be used to collect and treat the runoff from roofs and general yards. Diverting roof and general yard runoff away from your slurry store means that not only will you increase slurry storage capacity but the slurry will have a higher dry matter content thereby increasing nutrient concentration and fertiliser value per volume spread on land.

Image © Stewart Moir

Soil erosion by water is a natural process. Recent changes in weather patterns have seen more rain falling over shorter periods, meaning that this is becoming more of an issue. More rainfall means that more soil is washed away, increasing the risk of diffuse pollution including the loss of valuable nutrients and organic matter. Rural SuDS slow down the flow and treat polluted runoff whilst helping to reduce the loss of soil, nutrients and organic matter. They can also help reduce local floods and provide valuable habitats for birds, plants and insects. Keeping soil on the land is not only beneficial for farming; it is more cost effective than managing soil build up in water bodies. Nutrient rich sediment can be recovered and returned to farmland. Rural SuDS can be installed without taking a large area of farmland out of production. There are also benefits for land owners as they will help you achieve Good Agricultural and Environmental Condition (GAEC), a stipulation for the single farm payment.

Rural SuDS should be the last stage in the defence against diffuse pollution and erosion if all other land management practices are in place upstream such as buffer zones, nutrient management and managing tramlines. They should be placed where they will naturally trap polluted and / or soil laden runoff before it enters a ditch or burn as these quickly transport runoff downstream which can make diffuse pollution problems worse in rivers. By capturing runoff, soil, nutrients and organic matter are held back and clean water can flow into rivers. Rural SuDS in fields trap pollutants and

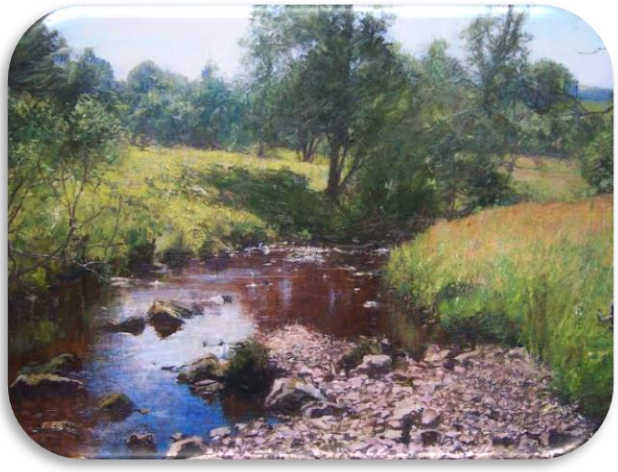


Image © Jonathan Mitchell

encourage groundwater recharge. Rural SuDS can also be beneficial during flash floods in the summer months' where polluted runoff can flow straight to a watercourse (due to compacted soil) or a road which may cause flooding of the local road and or flooding of a rural town or village.

Several studies have calculated what the savings may be to your farm business by reclaiming soil washed off land due to erosion. Two examples below show potential savings to a farmer in Fife who has installed a sediment trap bund.

Defra Study

In the publication *'Safeguarding our Soils'*, Defra estimates that 2.2 million tonnes of soil are eroded annually at a cost of £45 million (including £9 million for production loss) with the estimated value of soil being about **£20 per tonne**. If we apply this soil value to a farm in Fife that regularly traps and recovers soil using a sediment trap bund we can calculate what the annual savings are to this farm business. The farmer recovered 200 tonnes following the first crop of potatoes (see image below) and has recovered approximately 800 tonnes during seven years of operation. This means that the savings to the farmer are in the region of £4,000 for the year that potatoes were grown with a total saving of £16,000 over seven years. This farm business therefore has an estimated saving of £2,286 per year by reclaiming and putting this nutrient rich soil back on the land.

Durham University Study

This study looked at the cost of agricultural diffuse pollution to a farm business. The cost per hectare of the **loss** of nitrates is estimated as £63.84, the **loss** of phosphorous as £2.81, the **loss** of potassium as £1.04 and the **loss** of soil as £20.50 – a total cost of £88.19 per hectare per year (2014 costs). If we again apply this to the same farm in Fife where the sediment trap bund serves a 13-hectare field, then we can estimate that the farmer saves an average of **£1,146 for the 13-hectare field per year**.

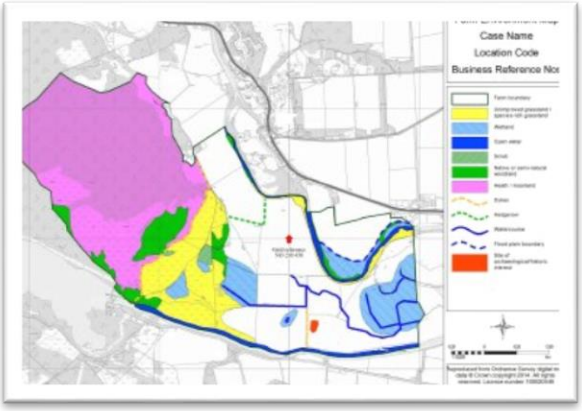
Image © Brian D'Arcy

PART 2 – RURAL SuDS EXPLAINED

Rural SuDS - Funding Opportunities for Scottish Farmers

Agri-Environment-Climate Scheme (AECS)

Current details and eligibility can be found on the *Management options and capital items* section of the Agri-Environment Climate Scheme website. **100% funding** is potentially available through this scheme if your land is within a target area for the following Rural SuDS options: *Swale, Sediment Trap / Sediment Trap Bund, Pond* and *Wetland*. As part of your AECS application you will need to undertake a *Farm Environment Assessment*. This will include a *Diffuse Pollution Risk Assessment*. If you intend to apply for the Rural SuDS capital items, then you need to carry out a steading assessment as well as an assessment of diffuse pollution risks in fields. Guidance for a steading assessment can be found at *Supporting Guidance for Managing Steading Drainage.*



Environmental Co-operation Action Fund (ECAF)

The *Environmental Co-operation Action Fund* (ECAF) promotes the delivery of landscape-scale environmental projects between groups of farmers, foresters and other land managers. ECAF supports the costs of planning and facilitating co-operative projects but will not fund building Rural SuDS. Applications to fund the build of a Rural SuDS may subsequently be made to AECS, the *Forestry Grant Scheme* and / or other public funding incentives such as Scottish Water's Land Management Incentive described below that also supports the delivery of Rural SuDS projects.

Sustainable Land Management Incentive (SLM)

Scottish Water's SLM team is working with land managers to protect drinking water sources from diffuse pollution within *priority areas*. Farming practices can affect source water quality which increases the use of energy and chemicals for water treatment. Land managers can apply to the *SLM Incentive Scheme* to cover up to **100% of costs** for swales and in ditch measures (see page 49 of this guide) that protect drinking water sources where the action required to do so is above pre-existing legal requirements (e.g. General Binding Rules (GBRs), cross compliance, Nitrate Vulnerable Zone (NVZ) rules). *The SLM incentive booklet* describes the scheme and Rural SuDS that can be funded including how to apply.

For other potential funding opportunities see Chapter 8 of the SEPA *Natural Flood Management Handbook.*

PART 2 – RURAL SuDS EXPLAINED

Rural SuDS – Funded Measures that reduce Diffuse Pollution

This design and build guide supplements the information provided in the *Managing Water Quality and Flood Risk Options* section of the Scottish Government Rural Payments AECS website. Rural SuDS that can be **100% AECS grant funded on a standard cost basis** include:

✓ ***Swale*** (see pages 25-28)

A dry shallow, vegetated channel that collects, treats and transfers runoff from a steading or field to a downstream Rural SuDS or discharges directly to a watercourse if appropriate (e.g. roof runoff).

Image © Farming and Water Scotland

✓ ***Sediment Trap*** *(steading,* see pages 29-32*)*

✓ ***Sediment Trap Bund*** *(field, see pages* 42-45)

A dry, vegetated basin that temporarily fills up during a rainfall event and traps sediments and pollutants. A sediment trap / bund helps reduce sediment loading in ponds and wetlands when constructed directly upstream.

Image © Michael McDaid

✓ ***Pond*** (see pages 33 to 36)

A basin with a permanent pool of water that stores runoff providing high level treatment including nutrient removal before discharge to a watercourse. A pond can also provide flood storage and valuable wildlife habitats.

Image © Stewart Moir

✓ **Wetland** (see pages 37 to 41)

✓ **Constructed Farm Wetland (CFW)**

Wetlands operate in a similar manner as ponds but have additional shallow marshy areas. They provide enhanced treatment and wildlife habitat potential. ***Note: Wetlands and Constructed Farm Wetlands (CFW) have different designs. CFWs collect lightly contaminated runoff from outdoor FYM (Farm Yard Manure) middens all year or outdoor silage clamps in winter months (see Part 4 - Steading).***

Image © Stewart Moir

PART 2 – RURAL SuDS EXPLAINED

Rural SuDS - When to use them

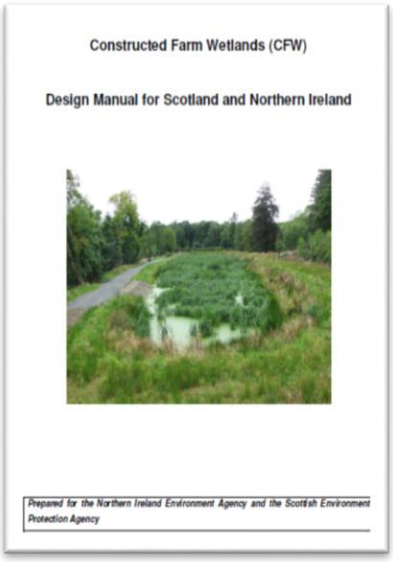
The main purpose of Rural SuDS is to improve water quality by reducing the impacts of diffuse agricultural pollution from rainfall runoff that currently discharge direct to a watercourse. Rural SuDS help to achieve this by:

- collecting and treating **steading rainfall runoff** from **roofs, clean yards** and **general yards**
- collecting and treating **lightly contaminated runoff** from **outdoor FYM middens** and **outdoor silage clamps** (in a Constructed Farm Wetland only, see below)
- intercepting and treating **field rainfall runoff** laden with **sediment** and **nutrients**

The table below illustrates what type of Rural SuDS to use on either a steading or in a field.

Steading Runoff	Field Runoff
✓ Swale **[1]** ✓ Sediment Trap **[1]** ✓ Pond ✓ Wetland ✓ Constructed Farm Wetland (CFW) **[2]**	✓ Sediment Trap Bund ✓ Pond ✓ Wetland ✓ Swale **[3]**
[1] To protect animal health, where swales and sediment traps are installed nearby to pig and poultry buildings, the design should ensure that they do not hold water for longer than a day. **[2] To be used for 'lightly contaminated runoff' as specified in the Steading Selection Table (see page 12).** **[3] For the transfer of runoff between sediment trap bunds, ponds and wetlands.**	

It is important to note that guidance has previously been published for **Constructed Farm Wetlands (CFW)** to be used to collect and treat steading runoff. If you wish to collect and treat **lightly contaminated runoff** from an **outdoor FYM midden** (all year) and/or an **outdoor silage clamp** (during winter months only) a **Constructed Farm Wetland** must be used. A **Wetland** should be used to collect and treat the **rainfall runoff** from **roofs, clean yards** and **general yards** that contain much lower levels of pollution (see Part 4 Steading). Therefore, reference **must** be made to the Scotland and Northern Ireland *CFW Design Manual* if after carrying out your Diffuse Pollution Steading Assessment you wish to build a **Constructed Farm Wetland**.



To assist assessment, selection and design of Rural SuDS this guide is split into: **Steading** (**Part 4**, pages 10-17) and **Field** (**Part 5**, pages 18-21).

PART 2 – RURAL SuDS EXPLAINED

Rural SuDS – Jargon

Four terms that you will regularly see in the specification sheets and example drawings in Parts 4, 5 and 7 of this guide are: **attenuation**, **sheet flow**, **pipe flow** and **emergency overflow**.

Attenuation - the temporary storage of runoff to reduce the risk of pollution and flooding.

Pipe flow - runoff collected from a roof or yard that is discharged from a single point via a pipe.

Sheet Flow - runoff that flows freely over the yard or field into a Rural SuDS.

Emergency Overflow / Spillway - an open grassed lowered section in the bank or rock armoured weir and channel that directs excess flow away from farm buildings, roads / tracks, or other areas of risk during heavy storms to a watercourse or other area that will not cause a problem.

Image © Alison Duffy

Sheet flow into a sediment trap bund

Image © Stewart Moir

Piped flow into a pond

Rural SuDS – Treatment Train

It is a requirement for AECS funding to use a Treatment Train approach.

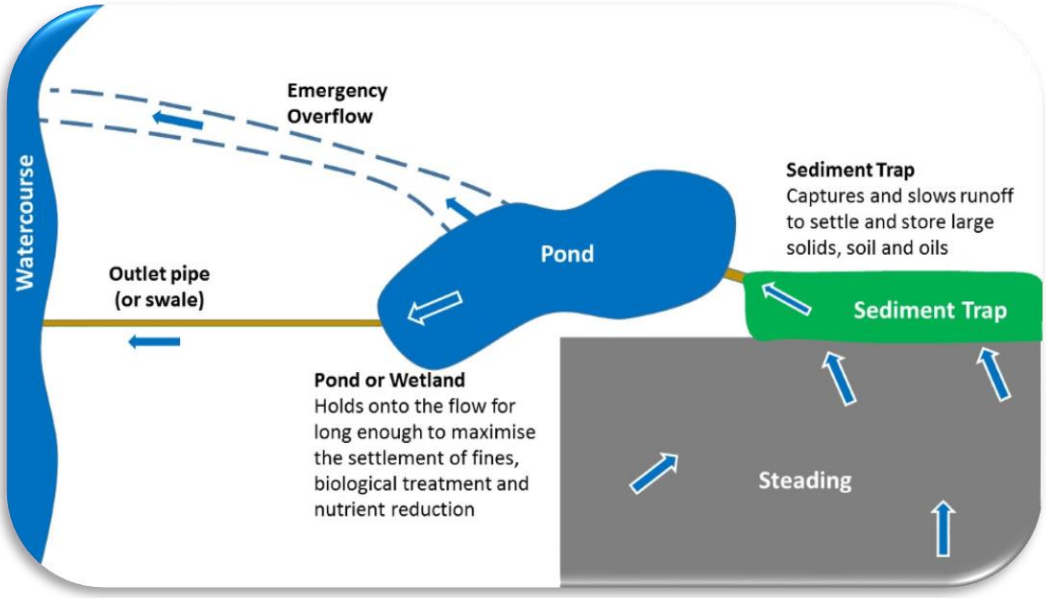
To get the best benefits from your Rural SuDS, you should consider the **Treatment Train** approach – using a combination of Rural SuDS. The treatment train approach will help reduce the impacts of diffuse pollution in stages before reaching the watercourse. As a rule, for your steading, Rural SuDS that collect rainfall at source (where the rain falls) using sheet flow into a swale or sediment trap followed by a pond or wetland provides the most pollutant removal benefits. The lifespan of each connecting system depends on the treatment train functioning correctly. This involves following the basic maintenance schedules outlined in this guide such as checking that inlet and outlet pipes are not blocked and managing vegetation to ensure storage volumes are retained particularly if you intend to use your Rural SuDS to manage a localised flood risk.

Treatment Train – Rural SuDS measures arranged in series to reduce pollutants by controlling runoff flow rates and volumes in at least two stages.

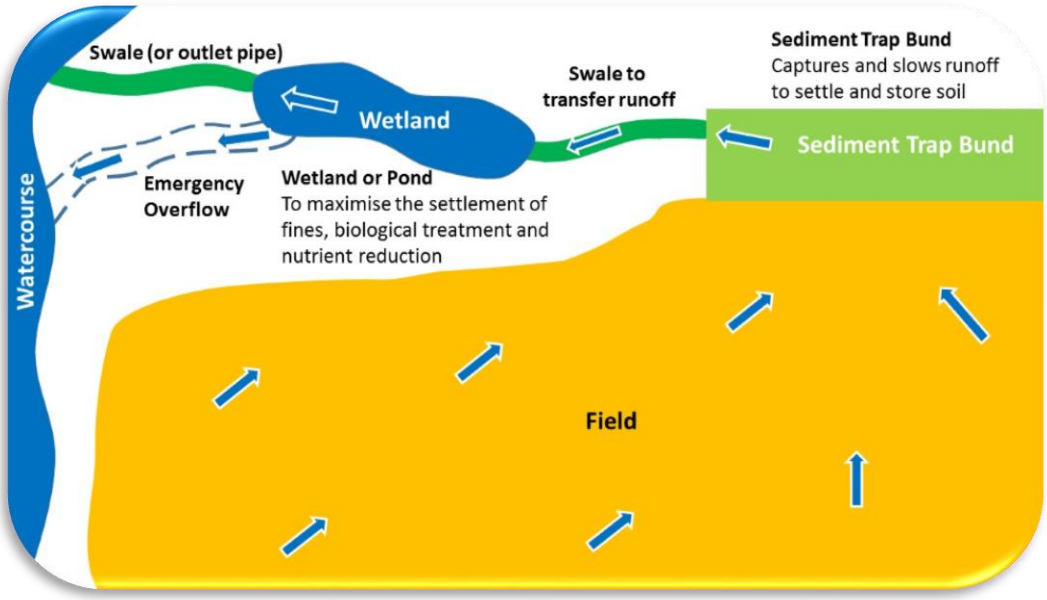
PART 2 – RURAL SuDS EXPLAINED

As stated earlier in this guide, **Rural SuDS should be the last stage in the defence against erosion and diffuse pollution** if all other land management practices are in place upstream such as buffer zones and managing tramlines (See **Part 9**, page 48 for more details). In general, the pollution risk is greater the closer the erosion problem is to a watercourse and steepness of slope. When selecting Rural SuDS preference should be made for using a combination of measures to collect, transfer and treat runoff. The **Treatment Train** examples below illustrate where the use of Rural SuDS may be beneficial if combinations of measures are used at the steading or in field.

Example 1 - Steading Treatment Train



Example 2 - Field Treatment Train

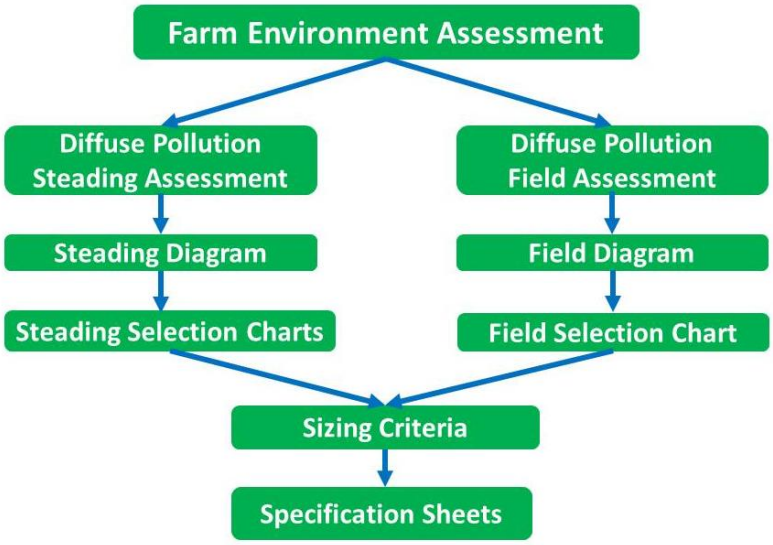


The illustrations also show the placement of the emergency overflow / spillway. If there is no watercourse nearby, or if for example, situations where some intensive animal farming practices such as pig or poultry that often operate in landlocked situations, then it is acceptable for a Rural SuDS that receives roof runoff to overspill to an existing open area of grassland.

PART 3 – ASSESSMENT SELECTION DESIGN

Rural SuDS – How to Assess, Select and Design

Farmers and advisors should follow the steps below to assess, select and design Rural SuDS.



Farm Environment Assessment and Identification of Issues

1) Carry out a holistic farm assessment of both steading and field areas to identify problem areas such as field erosion, dirty water running off a yard or roof runoff entering a slurry store.
2) Prepare reports along with steading drainage drawings and field maps highlighting locations of diffuse pollution. These reports are typically called:
    - Diffuse Pollution Steading Assessment
    - Diffuse Pollution Field Assessment

Identification of Solutions

3) Use the Steading Diagram (page 13) and Field Diagram (page 19) to determine sources and solutions to the problems reported. **Note,** it may not always be a Rural SuDS that is the best course of action (See **Part 9** - Other Management Options).

Selection of Rural SuDS

4) Use the Steading (**Part 4,** pages 14-15) and Field (**Part 5,** page 20) Selection Charts to determine the Rural SuDS best suited to the diffuse pollution issue on your farm.

Design and build of Rural SuDS

5) Use the Sizing Criteria provided in this guide (pages 16-17 for steading and page 21 for field) to determine the volume of runoff to be captured in each Rural SuDS.
6) Use the Specification sheets and example drawings provided in **Part 7** of this guide to help you design and build your Rural SuDS.

Note if you are applying for AECS grant funding some Rural SuDS combinations are compulsory such as a pond or wetland must be combined with a sediment trap. A pond must have a perimeter stock fence. For other current Agri-Environment Climate Scheme (AECS) eligible funding requirements, please see the *Scottish Government Rural Payments and Services Website*

PART 4 – STEADING

Where to use Rural SuDS at the Steading

Steadings can present a wide range of pollution risks to the water environment that will vary depending on farm use such as arable, livestock or mixed, rainfall and the health or sensitivity of the receiving watercourse. Runoff can range from relatively clean roof water to lightly contaminated runoff to highly polluting slurry.

It is accepted that clean and general yards will build up some contamination over time from passing machinery and occasional livestock movements. In the majority of cases this runoff will be suitable for treatment via a Rural SuDS or alternatively could discharge to an existing local grassed area if available.

The images below provide some examples of steading areas that can be drained into a Rural SuDS and steading areas that must be collected and stored and therefore not suitable for Rural SuDS.

Allowed	Not Allowed
 Image © Stewart Moir	 Image © Stewart Moir
Roof runoff	Livestock standing yards
 Image © Stewart Moir	 Image © Stewart Moir
Clean yard runoff	Yards with regular livestock access

PART 4 – STEADING

Allowed	Not Allowed
 Image © Stewart Moir	 Image © Stewart Moir
General yard runoff	Dairy and parlour washings
 Image © Stewart Moir	 Image © Stewart Moir
Outdoor FYM midden runoff (CFW only)	Outdoor feeding area runoff
 Image © Stewart Moir	 Image © Stewart Moir
Outdoor silage clamp winter runoff (CFW only)	Silage effluent

PART 4 – STEADING

Steading - Selection Table

It is important to recognise that different Rural SuDS measures should be used to collect and treat different types of runoff. The table below shows when and where Rural SuDS measures can be used within a steading storage and management hierarchy to prevent pollution incidents.

Source of Pollution	Definition	Rural SuDS Option?	Rural SuDS Measures or other Management Options
Runoff from roofs [1]	Relatively clean water with a low level of pollution	✓	Swale Sediment Trap Pond Wetland Soakaway Rainwater Harvesting
Runoff from roofs [1] on intensive pig and poultry units	Runoff with a low to moderate level of pollution primarily caused by dust	✓	Swale Sediment Trap Pond / Wetland (if there is space and only when appropriately sited)
Runoff from clean and general yards [1]	Runoff with a low to moderate level of pollution caused by vehicles and occasional livestock movements	✓	Swale Sediment Trap Pond Wetland
Runoff from lightly contaminated areas	Runoff with a higher level of pollution from outdoor FYM middens (all year round) and outdoor silage clamps (winter months only)	✓	Constructed Farm Wetland [2] Effluent Tank
Slurry, Manures and Effluents	Slurry	✗	Above Ground Ring / Lagoon / Underground Tank
	Dairy & parlour washings	✗	Slurry storage
	Silage effluent (summer months)	✗	Effluent Tank
	Sheep dip effluent	✗	Application to land [3]
	Chemical sprayer runoff	✗	Biobeds and biofilters
	Veg & fruit processing wastewater	✗	Bespoke treatment facilities

(1) It is a statutory requirement that all farm buildings and yards constructed since 1st April 2007 have appropriately designed sustainable drainage systems installed.

(2) Constructed Farm Wetlands (CFW's) can be used for runoff from all areas as well as unroofed FYM middens and silage clamps (winter months only). Roofed structures must drain to an effluent tank at all times.

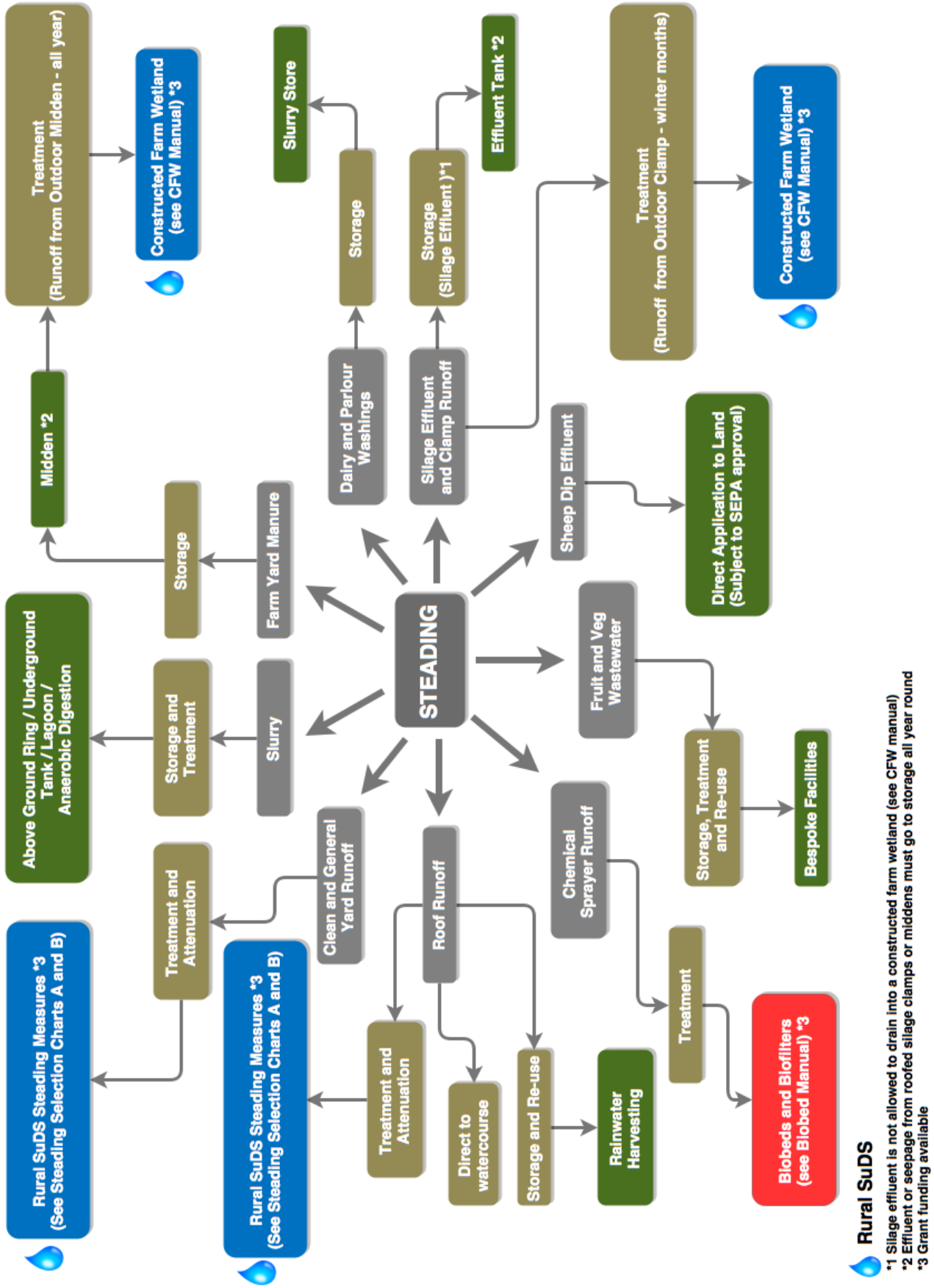
(3) Subject to land assessment and SEPA authorisation.

High risk sources of pollution (in red above) are not suitable for Rural SuDS and should be managed by other measures in accordance with existing guidance and legislation. See *Farming & Water Scotland, General Binding Rules 10, 11, 18-24, PEPFAA Code, 4 Point Plan, Farm Soils Plan,* SSAFO *Regulations, PPC (Scotland) Regulations.*

PART 4 – STEADING

Steading Diagram - Sources of Pollution and Management Solutions

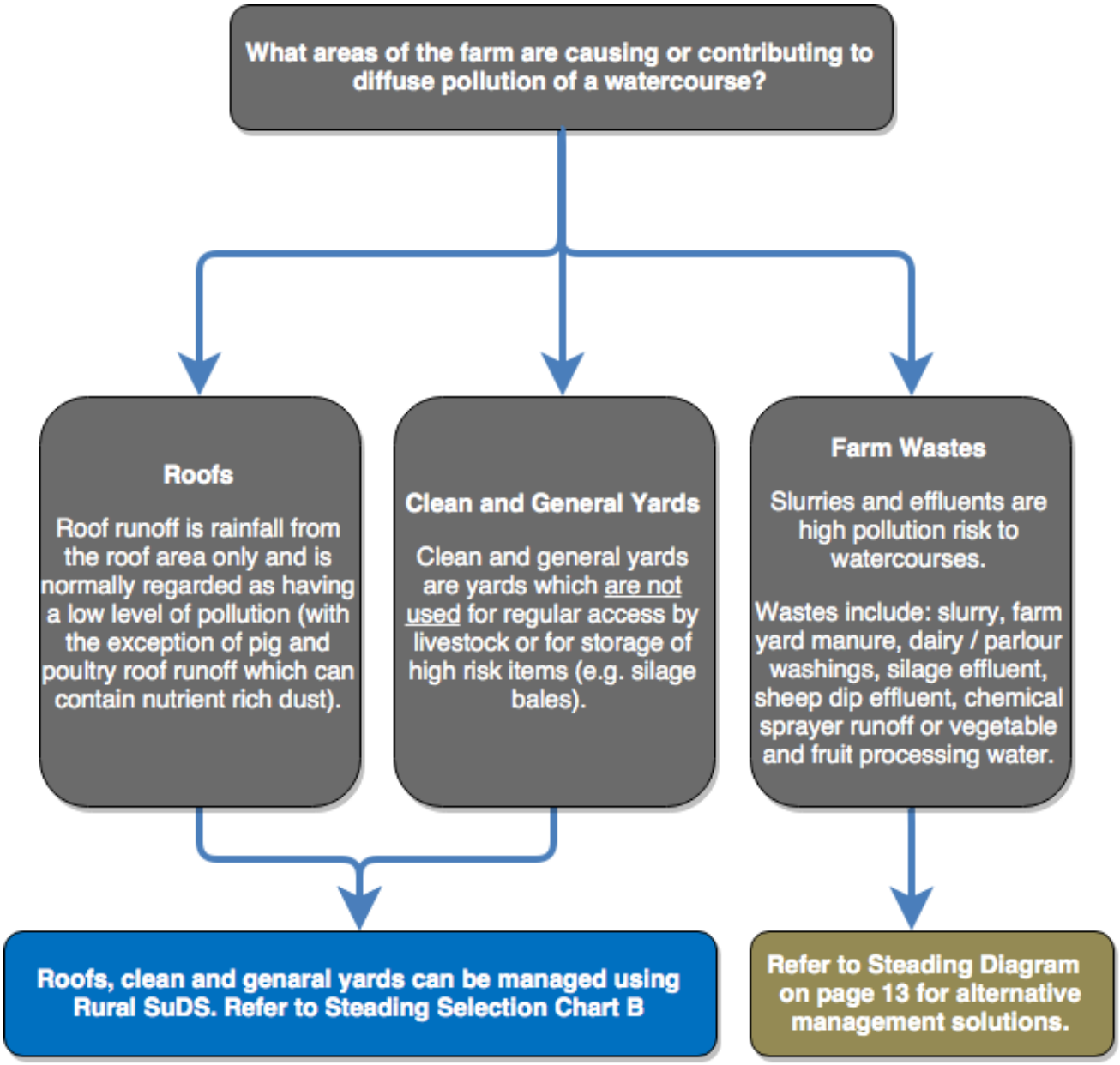
Use this diagram to identify best practice for steading waste, effluent and runoff problems.



PART 4 – STEADING

Steading - Selection Chart A

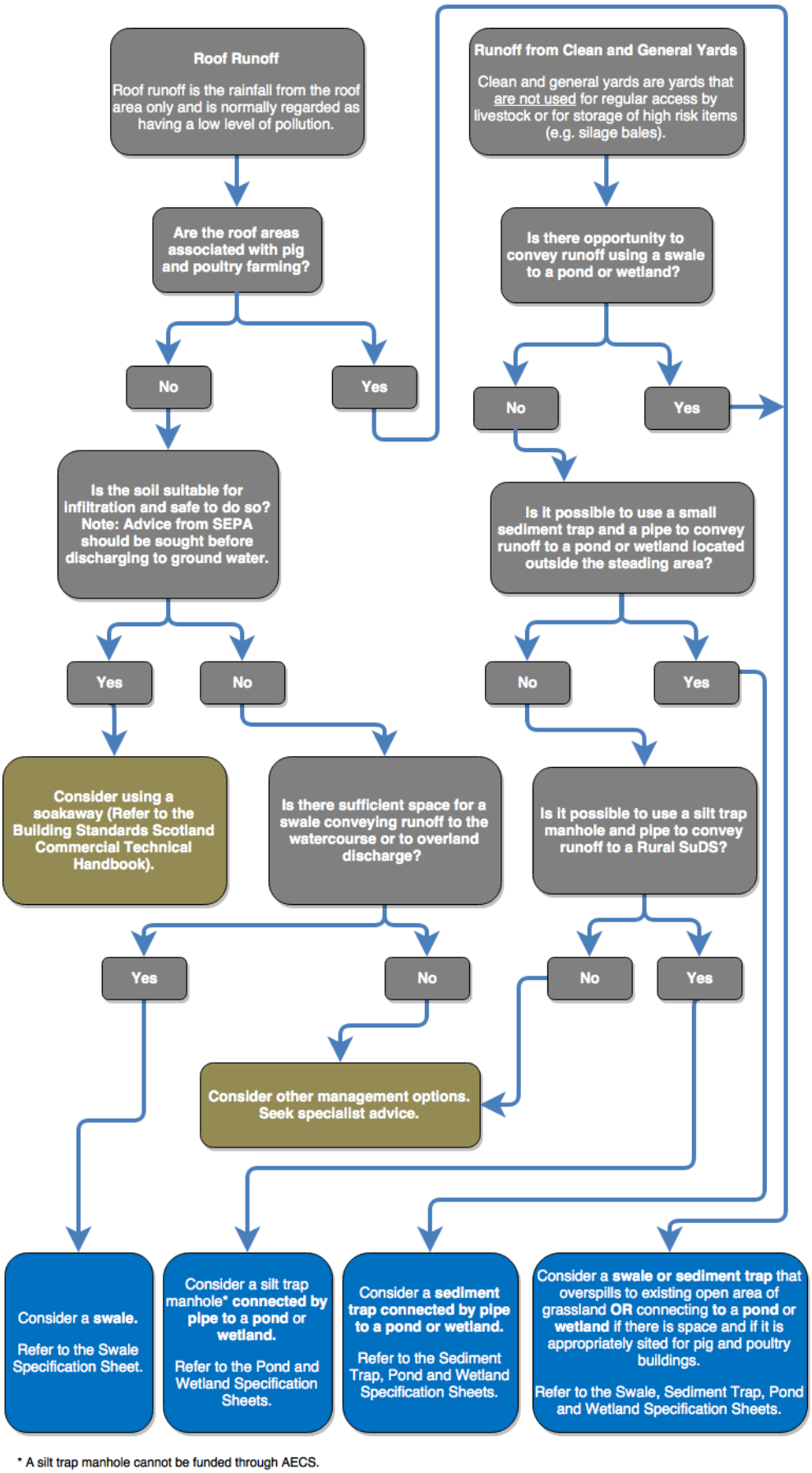
Use this chart to determine the suitability of Rural SuDS.



PART 4 – STEADING

Steading - Selection Chart B

Use this chart to determine the Rural SuDS best suited for the type of runoff.



* A silt trap manhole cannot be funded through AECS.

PART 4 – STEADING

Steading - Sizing Criteria

Important Note: If you wish to collect and treat runoff from an outdoor FYM midden or outdoor silage clamp please refer to the *CFW Design Manual* for guidance on how to size a Constructed Farm Wetland.

How do I calculate the Treatment Volume for runoff draining to my Rural SuDS?

Treatment Volume (Vt) is the amount of runoff draining from the yard that needs to be cleaned (or treated) during a design rainfall event.

1. Complete your Steading Drainage Assessment and identify the area(s) suitable for draining to Rural SuDS.
2. Calculate the surface area(s) to be drained. You should at this stage decide if different areas are to be treated separately or if they are to be combined.
3. Establish the rainfall value for your location (see ***What is my Rainfall Value?*** map, page 17).
4. Determine the Treatment Volume for each surface area using the following design equation.

Steading Design Equation **Area Drained (A) x Rainfall (R) = Treatment Volume (Vt)**

Where:

(A) = Area Drained is measured in square metres (m^2) and is obtained from your Steading Drainage Assessment.

(R) = Rainfall Depth is measured in metres (m) and is obtained from your location within Scotland (see the ***What is my Rainfall Value?*** map, page 17).

(Vt) = The calculated Treatment Volume (Vt) is measured in cubic metres (m^3) and determines the size of your Rural SuDS

If you have two or more Rural SuDS draining different areas of your steading then calculate the Vt for each Rural SuDS.

If you have doubt about any aspect of Rural SuDS design seek specialist advice.

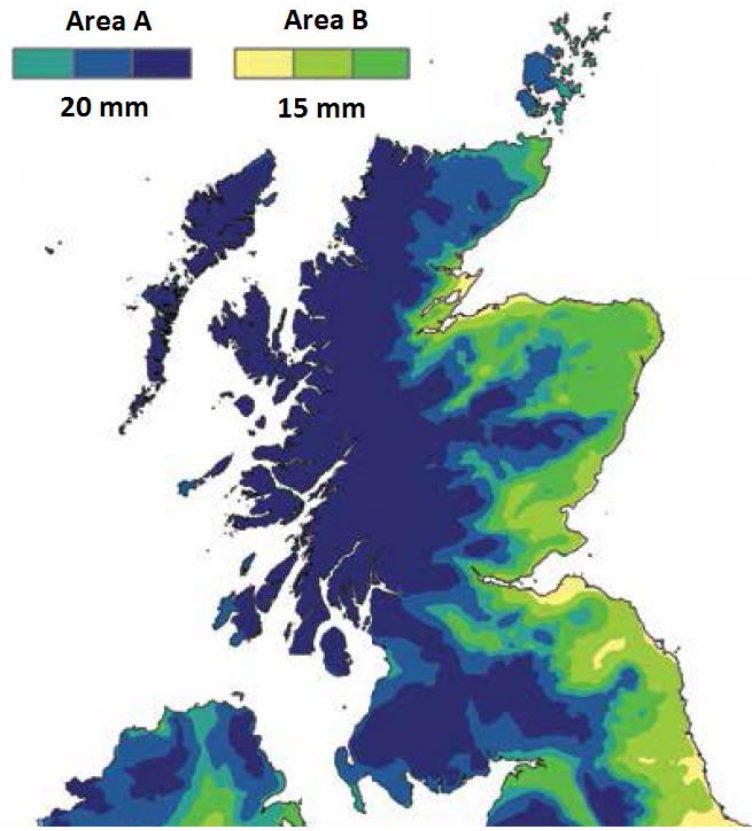
PART 4 – STEADING

What is my Rainfall Value?

Farms in Area A have a rainfall value of 0.02 m (20 mm)

Farms in Area B have a rainfall value of 0.015 m (15 mm)

NOTE: These values are approximations only. Data more specific to your location may be available from your local agricultural consultant.



Average annual rainfall for Scotland. Adapted from CIRIA C753 The SuDS Manual.

How do I know what size and volume my Rural SuDS should be?

Different Rural SuDS measures require different multiples of treatment volume to be stored. The minimum volume to be stored by each Rural SuDS is:

A **Swale** or **Sediment Trap** should hold 1 x Treatment Volume

A **Wetland** should hold 3 x Treatment Volume

A **Pond** should hold 4 x Treatment Volume

Worked Example 1:

The general yard area to be drained is 1,500 m^2. The farm is located in Ayrshire with a rainfall value of 0.02 m. The calculated Treatment Volume (1Vt) is 30 m^3 (1,500 m^2 x 0.02 m). The Rural SuDS chosen based on the pollution risk from the general yard and sensitivity of the local burn is a Pond that should be 4 x Treatment Volume (4Vt). The Pond should be designed to hold a minimum volume of 120 m^3 (30 m^3 x 4Vt). To receive AECS funding, you must apply the treatment train approach so the pond must have a sediment trap upstream. A sediment trap Treatment Volume is 1Vt, therefore the Sediment Trap volume is 30 m^3.

Now refer to **Part 6 General Design Guidance** and **Part 7 Specification Sheets** to design the shape and size of your Rural SuDS.

PART 5 – FIELD

Where to use Rural SuDS in the Field

Fields can present a wide range of pollution risks to the water environment that will vary depending on farm use, soil type, field slope, rainfall and health or sensitivity of the receiving watercourse. In fields, Rural SuDS should be the **last option**. Best Management Practices (BMP) such as riparian buffer strips, properly located feed sites and good practice spreading of slurry should always be implemented first. Farmers and landowners should ensure that they comply with *General Binding Rules 18-24* before considering Rural SUDS.

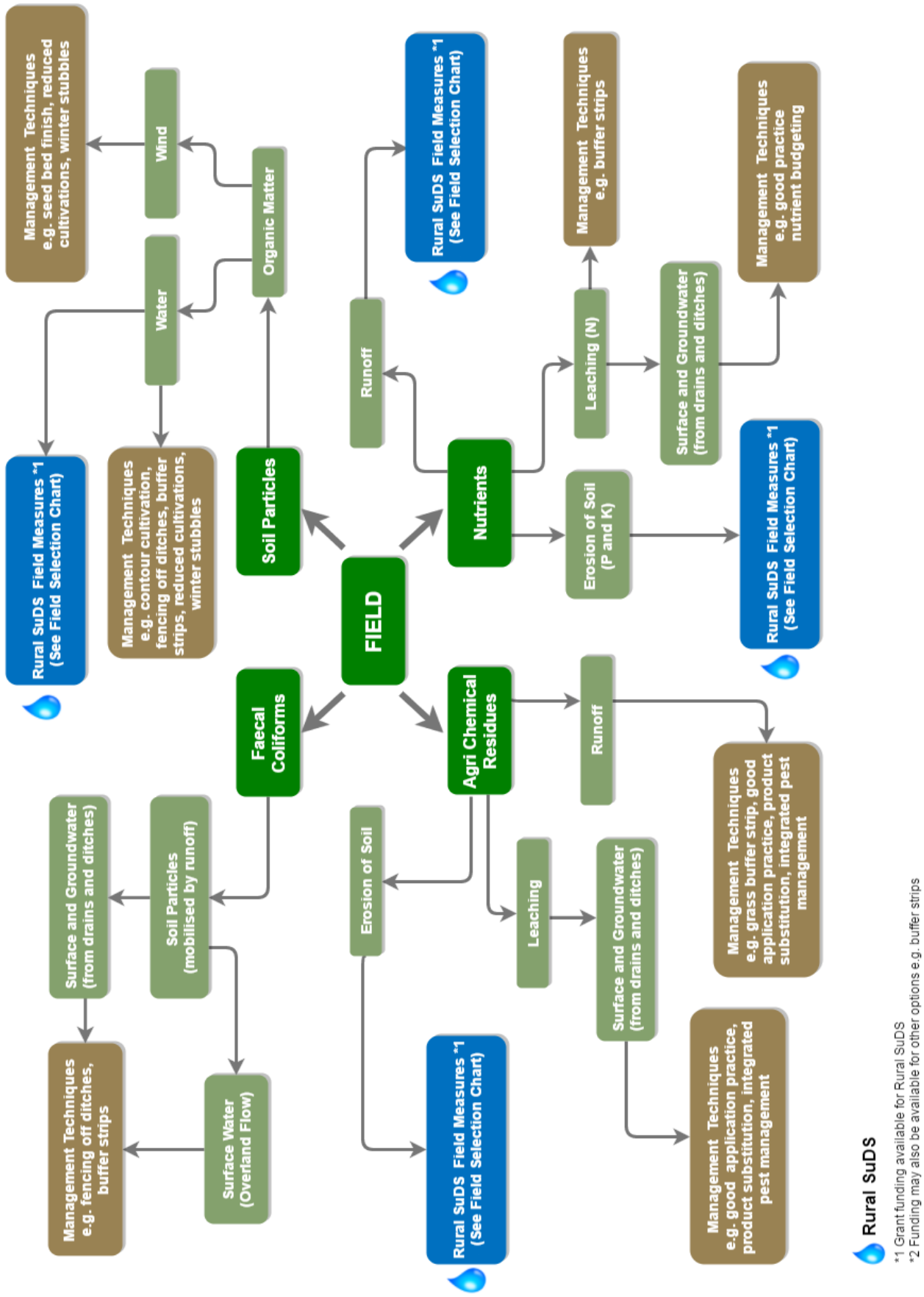
The images below provide some examples of field issues that can be directed through a Rural SuDS and those issues that should be solved by other management options.

Rural SuDS may be used	Use Other Management Options
 Image © Stewart Moir	 Image © Stewart Moir
Runoff from arable fields	Overland runoff from grass fields
 Image © Alison Duffy	 Image © Stewart Moir
Runoff from farm tracks and gateways	Runoff from poorly sited feed sites
 Image © Alison Duffy	 Image © Stewart Moir
Runoff onto rural public roads	Erosion of watercourse banks

PART 5 – FIELD

Field Diagram - Sources of Pollution and Management Solutions

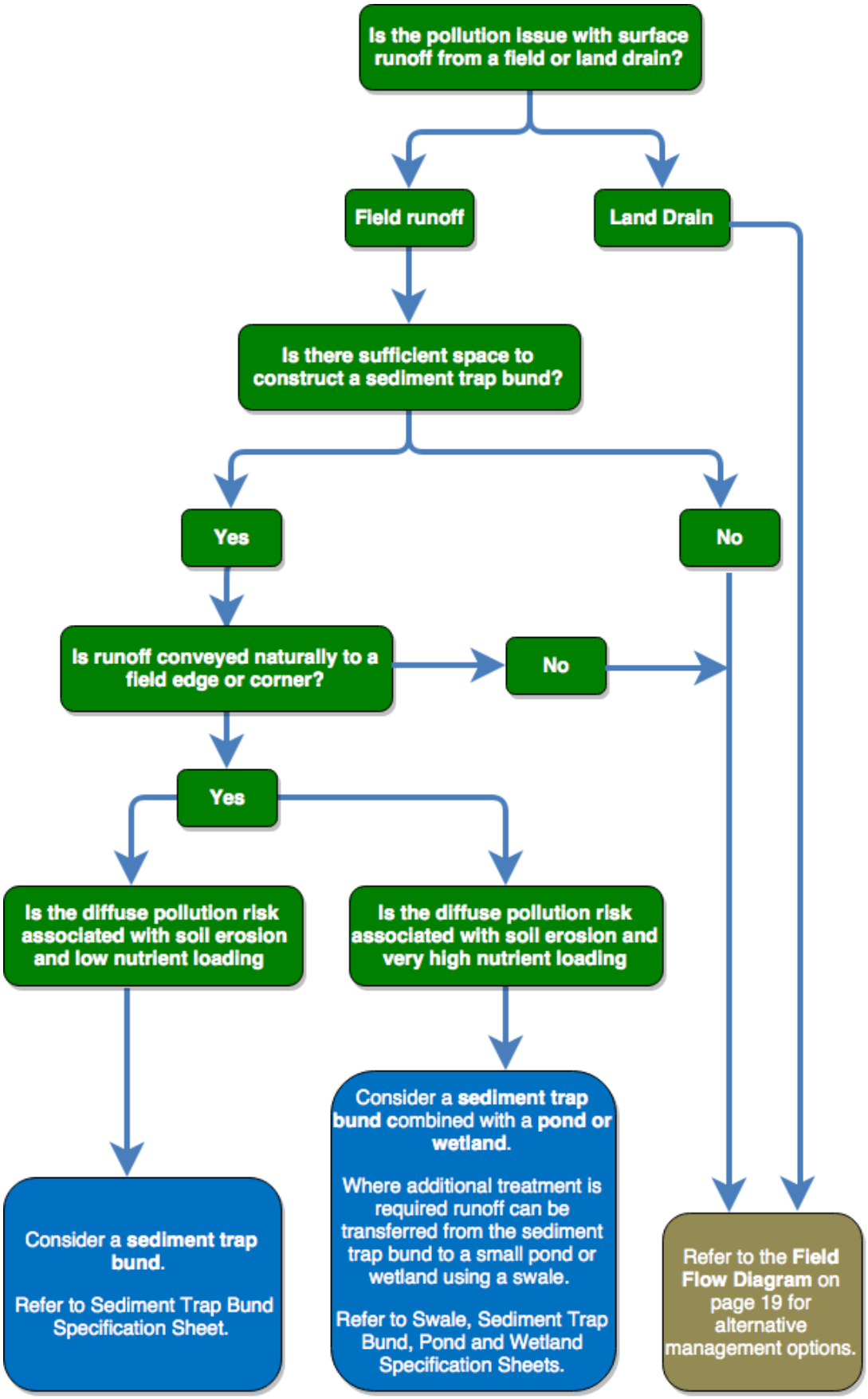
Use this diagram to identify best practice for field runoff problems.



PART 5 – FIELD

Field Selection Chart

Use this selection chart to determine the Rural SuDS best suited for the type of field runoff.



PART 5 – FIELD

Field Sizing Criteria

Sizing for field Rural SuDS differs from steading areas. They should be sized according to the following guidelines based on experience gained to date in Scotland and the UK. Please refer to the design tables in the relevant Rural SuDS specification sheets in **Part 7** of this guide for more detailed information and specific dimensions such as length, width, depth and side slopes.

Field runoff must be captured in a Sediment Trap Bund as a minimum. Where additional treatment is required, then a swale or pipe should be used to transfer runoff from a sediment trap bund into a pond or wetland. Ponds and Wetlands are recommended to capture and treat very high nutrient loads. It is also recommended that if you have doubt about any design aspect of in-field Ponds and Wetlands then you should seek specialist advice.

Each field measure has a separate design equation as listed below.

Sediment Trap Bund Design Equation

Base Area of a Sediment Trap Bund = 0.25% of field area

Wetland Design Equation

Total Wet Area of a Wetland = minimum 0.50% of field area

Pond Design Equation

Total Wet Area of a Pond = minimum 0.25% of field area

Worked Example 2:

A 13 ha arable field is adjacent to a watercourse in Fife. The field is in a rotation of root crops and winter wheat with frequent erosion of soil causing pollution of the watercourse.

Therefore:

Field area = 13 ha (equivalent to 130,000 m^2)

Percentage of field to be used for a Sediment Trap Bund = 0.25% (equivalent to 0.0025)

Sediment Trap Bund plan area = 325 m^2 (130,000 x 0.0025)

Sediment Trap Bund depth = 1.0 m

Sediment Trap Bund volume = 325 m^3 (325 m^2 x 1.0 m)

Now refer to **Part 6 General Design Guidance** and **Part 7 Specification Sheets** to design the shape and size of your Rural SuDS.

PART 6 – GENERAL DESIGN GUIDANCE

Collection and Transfer of Runoff

For current Agri-Environment Climate Scheme (AECS) eligible funding requirements, please see the *Scottish Government Rural Payments and Services Website.*

The design guidance below contains important principles for the construction of **all** Rural SuDS whether you wish to apply for an AECS grant or not.

1. If there is insufficient area at the edge of the steading to transfer runoff into a swale, to a sediment trap, pond or wetland then pipes and manholes can be used. Silt trap manholes should be used in the pipe routes to trap sediment close to the source of the pollution.

   Note 1. Pipes and silt trap manholes require regular sediment removal to remain effective.

   Note 2. Silt trap manholes have a sump beneath the outlet pipe to catch sediments. Whilst silt trap manholes are reasonably effective they do not provide the same level of treatment as a swale or a sediment trap.

   Image © Stewart Moir

   Note 3. Silt trap manholes cannot be funded through AECS.

2. Piped inlets and outlets are detailed in this guidance with large stones under the pipe. This slows and reduces runoff energy at the inlet and limits erosion on the base of the Rural SuDS. The stones also prevent re-suspension of settled sediments. Stones at the outlet also reduce plant overgrowth that can cause blockage and limit visibility for inspections.

3. Diameter of pipes used for inlets and outlets are a function of area and rainfall. They should be sized in accordance with the tables provided below.

INLET PIPES	
Area Drained (m^2)	**Pipe Diameter (mm)**
Up to 400	100
500	150
1,000	150
2,000	225
3,000	225
4,000	300
5,000	300

OUTLET PIPES		
Pipe Diameter (mm)	**Pipe Gradient**	**Discharge Rate (litres/second)**
100	1 in 150	5
100	1 in 100	6
100	1 in 60	8
150	1 in 150	15
150	1 in 100	18
150	1 in 60	23

Note 1 Inlet and outlet pipes should be plastic pipes with a smooth inner wall.

Note 2 Inlet pipes should be laid no shallower than 1 in 100 fall.

Note 3 Outlet pipes should never be laid shallower than 1 in 150 fall.

PART 6 – GENERAL DESIGN GUIDANCE

4. Situations where Rural SuDS should be surrounded by a fence include:
    - To protect people and the structure from livestock poaching or vehicle over-run.
    - To protect livestock from the risk of diseases such as Liver-fluke and Cryptosporidium.

5. Grass buffer strips should be used prior to all field Rural SuDS to slow the flow and remove a proportion of coarse solids prior to entering the structure.

6. Emergency overflows or spillways should be included in the design of all Rural SuDS to manage exceedance flows. Emergency overflows prevent overtopping during extreme rainfall events that can cause embankment erosion and prevent outlet failure (See page 8 for more information about emergency overflows).

Landscaping, Habitat and Biodiversity Enhancement

7. When implementing Rural SuDS Ponds or Wetlands, these should be new structures and not existing wildlife ponds or natural wetlands. This is because existing habitats (plants and wildlife) could be damaged if used to treat potentially polluted water from a steading or field. Whilst Rural SuDS are designed to mimic natural processes and may create habitats, they are primarily designed for the treatment of rainfall or lightly contaminated runoff.

Image © Alison Duffy

8. Ways that you can maximise biodiversity potential of your Rural SuDS are provided below. This information including more useful tips can be found in *WWT Constructed Farm Wetlands Guide* and Part 3 of the *RSPB / WWT Sustainable Drainage Systems Guide*.

    ✓ Excavated top soil can be used to create variation in topography to increase habitat diversity and wildlife potential in swales, ponds and wetlands.

    ✓ Encourage digger operators to leave rough bank profiles rather than over-perfecting.

    ✓ Permeable check dams in swales using stones to slow, but not impede flow provides shallow pools that benefit wildlife while increasing sedimentation and infiltration. You could replace stones with woody debris or willow hurdles to enhance natural aesthetics.

    ✓ Where possible, allow natural colonisation of plants.

    ✓ Avoid cutting vegetation between spring to late July-August, to provide habitat for pollinators (birds / insects etc.) and cover for breeding wildlife.

    ✓ Gentle slopes ensure valuable wildlife habitat, as well as acting as a safety feature.

PART 6 – GENERAL DESIGN GUIDANCE

9. All Rural SuDS should be planted with native species. See the table below for examples of suitable planting schemes.

Rural SuDS	Location	Plant Species
Swales and Sediment Traps	Base and side slopes	Hardy, low maintenance grass seed mix For example 70% creeping red fescue, 20% smooth-stalked meadow grass and 10% creeping bent
Ponds and Wetlands	Margins	Bulrush (*Typha latifolia*) * Common Reed (*Phragmites australis*) * Yellow Flag Iris (*Iris pseudacorus*) Branched Bur-reed (*Sparganium erectum*) * Greater Pond Sedge (*Carex riparia*) * Lesser Pond Sedge (*Carex acutiformis*)
	Vegetated marsh	Yellow Flag Iris (*Iris pseudacorus*) Reed Sweet-grass (*Glyceria maxima*) Reed Canary-grass (*Phalaris arundinacea*) Lesser Pond Sedge (*Carex acutiformis*) Marsh Marigold (*Caltha palustris*) Marsh Woundwort (*Stachys palustris*) Rushes (*Juncus spp.*)
	Side slopes	Wildflower, low maintenance grass seed mix

Note 1 * Vigorous species that will form dominant stands – do not mix vigorous plant species.

Note 2 Plants should be sourced from nursery stock and not gathered from the wild.

The following Specification Sheets provide information to assist you to design and build Rural SuDS. Details include an overview of function, construction specifications, and example drawings. Basic maintenance activities are also provided.

If you have doubt about any aspect of Rural SuDS design, please seek specialist advice.

What is a Swale?

A swale is a linear, dry, grass channel laid with a shallow fall on its base. Swales are designed to collect and transfer runoff during rainfall events. Swales are dry channels and water is only normally found in them following rainfall. Swales are cheaper to construct than piped systems.

What does a Swale do?

At the steading a swale captures rainfall runoff from roofs, yards and areas draining onto yards. They attenuate runoff and slow down the rate that runoff reaches a downstream grass strip (if appropriate), Rural SuDS or watercourse. The grass surface of a swale helps to filter coarse sediments and pollutants in runoff allowing them to settle out and be retained within the swale. On permeable sandy and loamy soils runoff will also infiltrate into the soil below the base of the swale. In fields swales are used as above ground pipes to transfer runoff between two Rural SuDS or from a Rural SuDS at the end of a treatment train to a burn, river, loch or the sea.

What can I use a Swale for?

- ✓ Collect and attenuate steading runoff from clean roofs, before discharge to a watercourse.
- ✓ Collect and attenuate steading runoff from roofs on pig and poultry farms and / or transfer into a pond or wetland for further treatment.
- ✓ Collect, attenuate and transfer steading runoff from clean and general yards into a sediment trap, pond or wetland for further treatment.
- ✓ A lined swale can collect, attenuate and transfer steading runoff from lightly contaminated areas into a Constructed Farm Wetland (CFW).
- ✓ Transfer runoff in fields between sediment trap bunds, ponds and wetlands.

What does a Swale look like?

Image © Stewart Moir

Sheet flow off a yard into a swale

Image © Farming and Water Scotland

Swale on a slope with stone check-dams

Useful Tip: **Use stone check dams to slow down runoff in swales on steeper slopes.**

PART 7 – SPECIFICATION SHEET SWALE

What makes a good Swale?

- ✓ Swales work best when runoff flows directly off the yard surface (sheet flow) and down the swale side slope into the base; swales can also receive runoff in pipes from roofs or yards.
- ✓ The longer the better, a long swale gives more time for filtration and settlement of sediments.
- ✓ A swale should have no sharp bends; swales should curve gently around buildings and yards.
- ✓ Swale base gradients should be shallow and no greater than 5 degrees (1 in 20). Swales can be built on steeper ground if designed to slow flow and reduce the risk of erosion.
- ✓ Suitable measures for steep sites include stepped swales, following contours so that the swale curves to and fro across the slope to achieve a shallower gradient, or use of check-dams.

Best Practice Construction Guidance for a Swale

- ✓ Divert runoff during construction and establishment phases until a grass sward is established on the base and side slopes.
- ✓ Finish construction by the end of the growing season to promote a healthy grass sward.
- ✓ Stockpile the stripped topsoil nearby for use later. Make sure that the topsoil is not washed into the structure during construction.
- ✓ Excavate and form base and side slopes as required.
- ✓ Install pipes and erosion protection areas where required.
- ✓ Replace the stripped topsoil over the base and side slopes at a maximum depth of 150 mm (6 inches). The placement must be done when the topsoil is dry to avoid compaction.
- ✓ If the slope is steep, form stone check dams at regular intervals along the swale base. Check dams should be at least 10 m (30 feet) apart.
- ✓ Sow an appropriate hardy, low amenity, low maintenance grass seed mixture (see part 6 General Design Guidance, page 24 for details) that can withstand sediment loading over the topsoil to establish a healthy grass sward. Sow at 25 g/m^2 (grams per square metre).
- ✓ If required, fencing should be erected at least 600 mm (2 feet) off the top edge of side slopes.

Best Practice Maintenance for a Swale

- ✓ A long grass sward should be maintained on a swale base at all times (max 100 mm) as this encourages sediments to settle out. This is achieved by regular cutting (in the growing season).
- ✓ Inlet / outlet pipes should be checked for blockages, vegetation build-up and debris (at least twice per year and following heavy rainfall) and cleared as necessary.
- ✓ If in place, perimeter fencing should be checked for integrity / holes and repaired as required.
- ✓ Significant accumulated sediment and debris on the base of a swale to be removed as required – a sign will be ponding on the swale base e.g. if water remains in sections of the swale following rainfall. As a rule of thumb, if sediment levels are above the bottom of the inlet or outlet pipe then you should remove the accumulated sediment.
- ✓ Repair eroded or damaged areas of grass as required to restore design performance.

If Rural SUDS are not maintained in accordance with the above basic guidelines, they will no longer treat runoff and may release their pollutants to the watercourse they are protecting.

PART 7 – SPECIFICATION SHEET SWALE

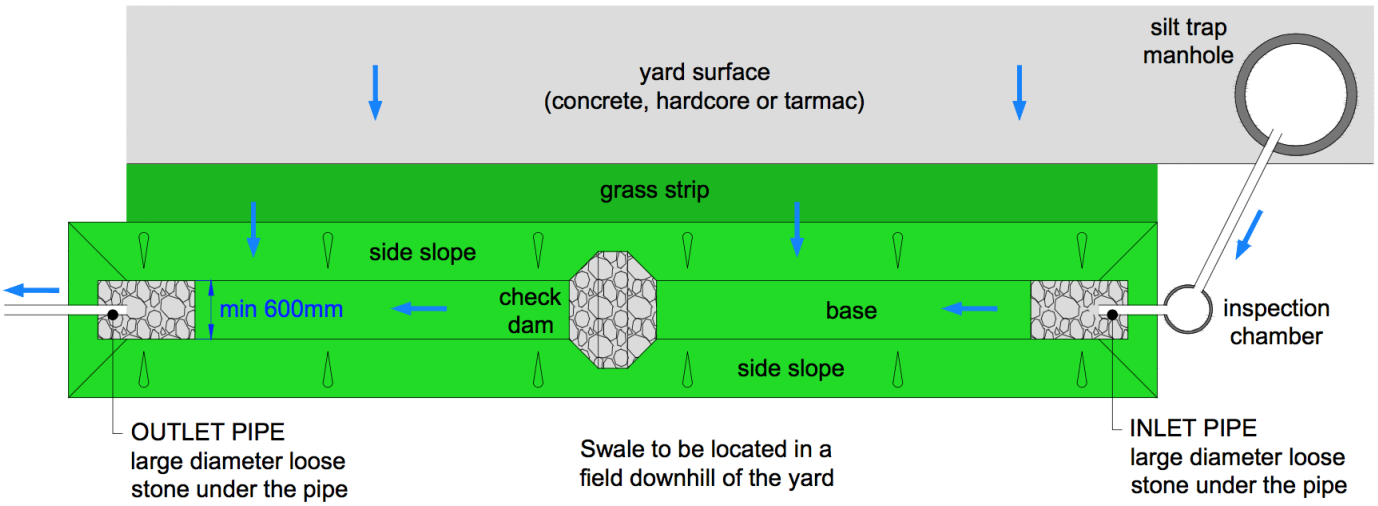
Recommended Specifications and Example Drawings for a Swale

The table below provides recommended minimum and maximum dimensions for a swale. This will help you choose the most suitable swale for your steading. The table should be read in conjunction with the example drawings that show the general layout of a swale and how it should be constructed. The actual dimensions of a swale will depend on its location, the natural fall of the ground, how runoff enters the structure (across the surface as sheet flow or from a pipe), and the volume of runoff to be collected.

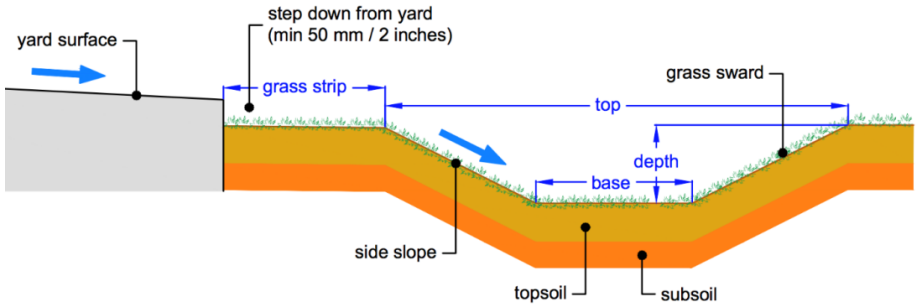
Description of Feature	Minimum		Maximum	
	(millimetres)	(feet)	(millimetres)	(feet)
Grass Strip Width	600	2	1,200	4
Base Width	600	2	2,000	6½
Depth	300	1	1,000	3½
Top Width	2,400	8	varies according to base width and depth	
Side Slope	1 in 3 *		1 in 4	
Topsoil Depth	150 mm (6 inches)			
Base Fall (optimum)	1 in 200 to 1 in 300 (3 to 5 mm fall every 1 m)			
Base Fall (maximum)	1 in 100 (10 mm fall every 1 m)			

* **Note**: Steeper side slopes may be used in swales that receive only pipe flow or where space is limited. Side slopes should never be steeper than 1 in 2. It is feasible where space is limited to design a sheet flow swale with the far slope (away from a path or steading) with a 1 in 2 gradient.

Swale: Typical Plan

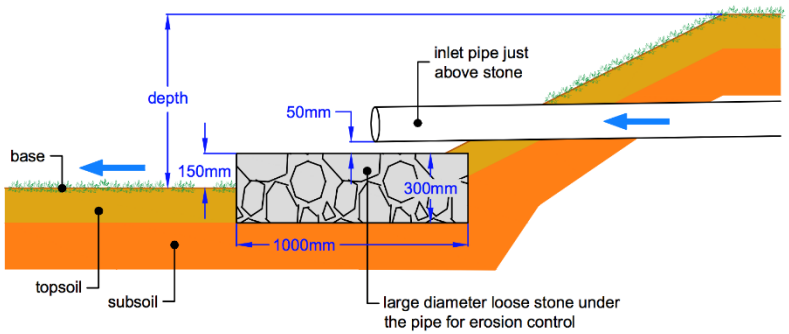


Swale: Typical Cross-Section



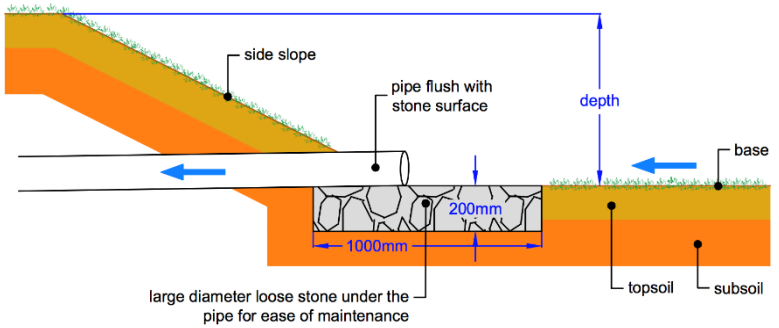
Note: Swales used to convey lightly contaminated runoff from a silage clamp or FYM midden into a Constructed Farm Wetland must have a waterproof liner installed between the subsoil and topsoil layers to prevent infiltration of the lightly contaminated runoff into the soil.

Swale: Typical Inlet Cross-Section (Pipe Flow)



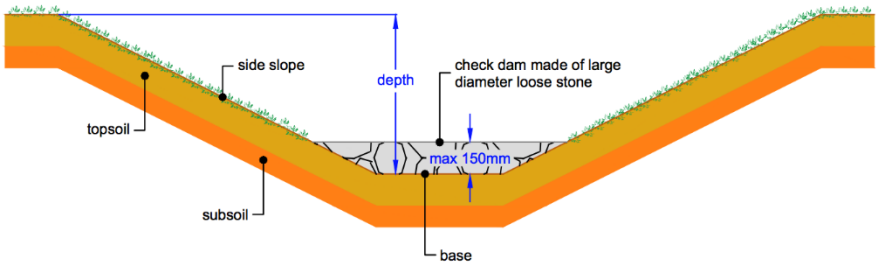
Note: The internal diameter of the inlet pipe should be designed for the area drained (see page 22)

Swale: Typical Outlet Cross-Section

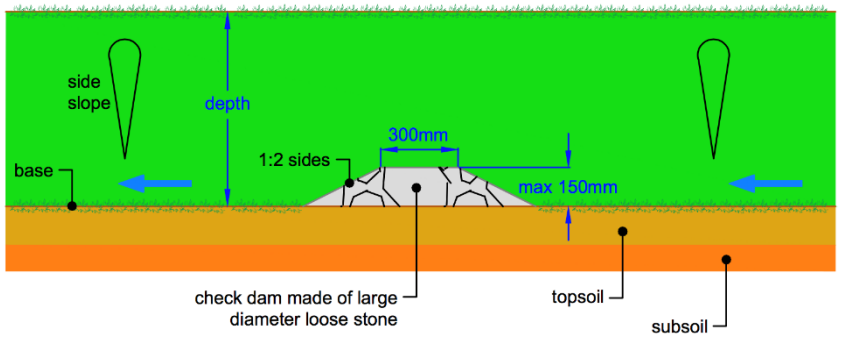


Note: The outlet pipe must be a minimum of 100 mm (4 inches) internal diameter

Swale: Check Dam Cross-Section



Swale: Check Dam Long-Section



What is a Sediment Trap?

A sediment trap is a dry, shallow, grass basin laid with a shallow fall on its base. Sediment traps collect, retain and treat runoff during rainfall events. Sediment traps are dry structures that temporarily fill with water after rainfall events.

What does a Sediment Trap do?

A sediment trap captures rainfall runoff from roofs, yards and areas draining onto yards. Sediment traps attenuate runoff and slow down the rate that it reaches the local watercourse. The grass surface of the trap helps to filter sediments and pollutants (such as grit, sand, soil and oils) within runoff retaining them within the trap. On permeable sandy and loamy soils runoff will also infiltrate into the soil below the base of the sediment trap. Whilst a sediment trap in this guide is designed for treating rainfall runoff they will always provide some flood storage. Their use in flood management scenarios should be considered at the design stage and sized appropriately.

What can I use a Sediment Trap for?

- ✓ Collect and attenuate steading runoff from clean roofs before discharge to a watercourse.
- ✓ Collect, attenuate and transfer steading runoff from clean and general yards into a pond or wetland for further treatment.
- ✓ To collect, attenuate and treat steading runoff from roofs (and yards) on pig and poultry units if site conditions are suitable

What does a Sediment Trap look like?

A newly constructed sediment trap with established grass on the base and side slopes Note: surrounds have yet to be grassed over

Pipe flow discharging across loose stone to reduce the energy of the flow and manage erosion of the inlet area

PART 7 – SPECIFICATION SHEET SEDIMENT TRAP

What makes a good Sediment Trap?

- ✓ The larger the surface area of a sediment trap the better; large surface areas gives more time for the filtration and settlement of sediments.
- ✓ Sediment traps work best if runoff can flow directly off the yard surface (sheet flow) and down the side slope of the sediment trap into the base. If sheet flow is not feasible, they can also receive runoff via pipes.

Best Practice Construction Guidance for a Sediment Trap

- ✓ Divert runoff during construction and establishment phases until a grass sward is established on the base and side slopes.
- ✓ Construct during the growing season to promote establishment of a healthy grass sward.
- ✓ Stockpile the stripped topsoil nearby for use later. Make sure that the topsoil is not washed into the structure during construction.
- ✓ Excavate and form base and side slopes as required.
- ✓ Install pipes and erosion protection areas where required.
- ✓ Replace the stripped topsoil over the base and side slopes at a maximum depth of 150 mm (6 inches). The placement must be done when the topsoil is dry to avoid compaction.
- ✓ Where slopes are steep, construct sediment trap basins in series linking them by pipes, swales or a cut away in the bank between each basin.
- ✓ Sow an appropriate low amenity, low maintenance grass seed mixture that can withstand sediment loading over the topsoil to establish a grass sward. Sow at 25 g/m^2 (grams per square metre).
- ✓ A sediment trap should have a shallow fall across the length of the base. Gradients should be shallow and no greater than 5 degrees (1 in 20). Sediment traps can be built on steeper ground if they are stepped in series.
- ✓ If required, perimeter livestock fencing should be erected at least 600 mm (2 feet) off the top edge of all side slopes.

Best Practice Maintenance for a Sediment Trap

- ✓ A long grass sward should be maintained on a sediment trap base at all times (max 100 mm). This is best facilitated by regular strimming or mowing (at least twice per growing season).
- ✓ Inlet and outlet pipes should be checked for blockages, vegetation build-up and debris (at least twice per year and following heavy rainfall) and cleared as necessary.
- ✓ If in place, perimeter fencing should be checked for integrity / holes and repaired as required.
- ✓ Significant accumulated sediment and debris on the base of a sediment trap to be removed as required – a sign will be ponding on the base e.g. if water remains in sections following rainfall. As a rule of thumb, if sediment levels are above the bottom of the inlet or outlet pipe then you should remove the accumulated sediment to restore design performance.
- ✓ Repair eroded or damaged areas of grass as required to restore design performance.

If Rural SUDS are not maintained in accordance with the above basic guidelines, they will no longer treat runoff and may release their pollutants to the watercourse they are protecting.

PART 7 – SPECIFICATION SHEET SEDIMENT TRAP

Recommended Specifications and Example Drawings for a Sediment Trap

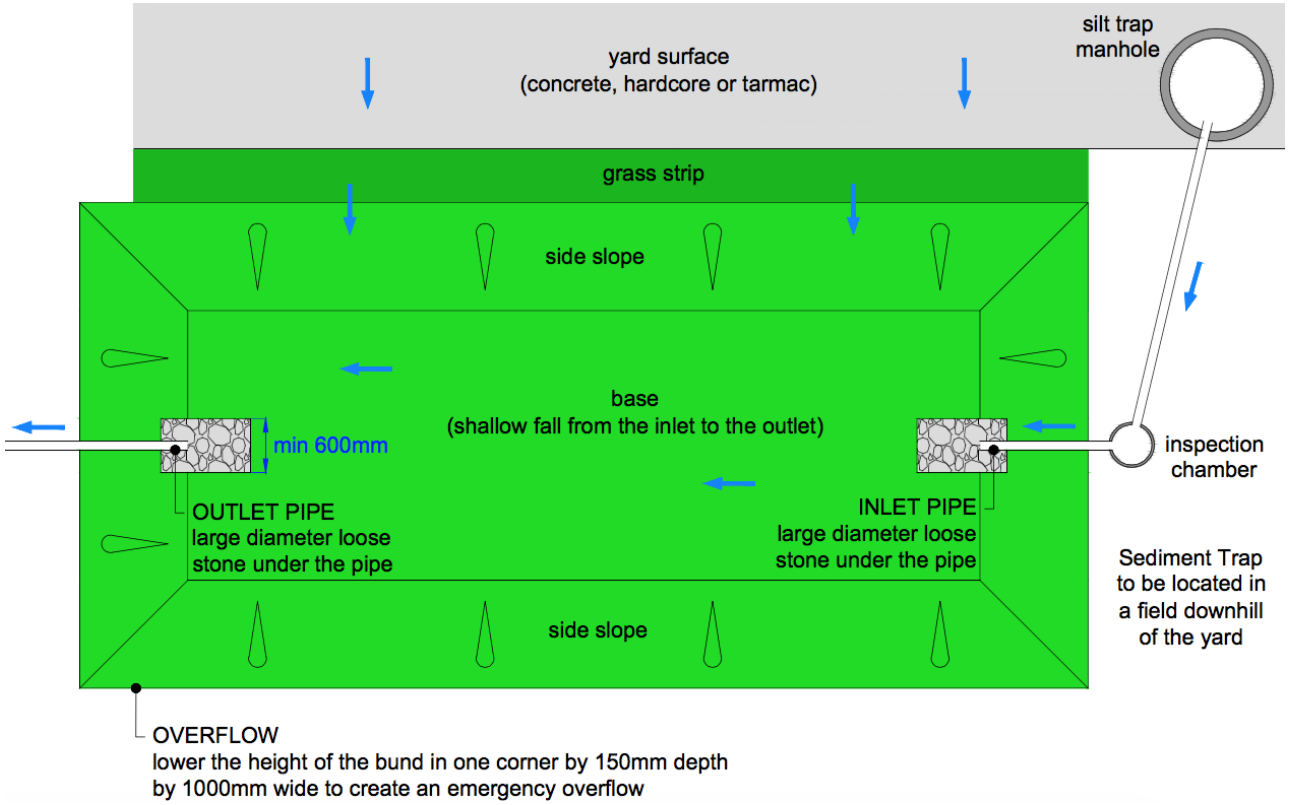
The table below provides recommended minimum and maximum dimensions for a sediment trap. The range of dimensions will help you choose the most suitable sediment trap for your steading. The table should be read in conjunction with the example drawings that show the general layout of a sediment trap and how it should be constructed. The actual dimensions of a sediment trap will depend on its location, the natural fall of the ground, how runoff enters the structure (across the surface as sheet flow or from a pipe), and the volume of runoff to be stored.

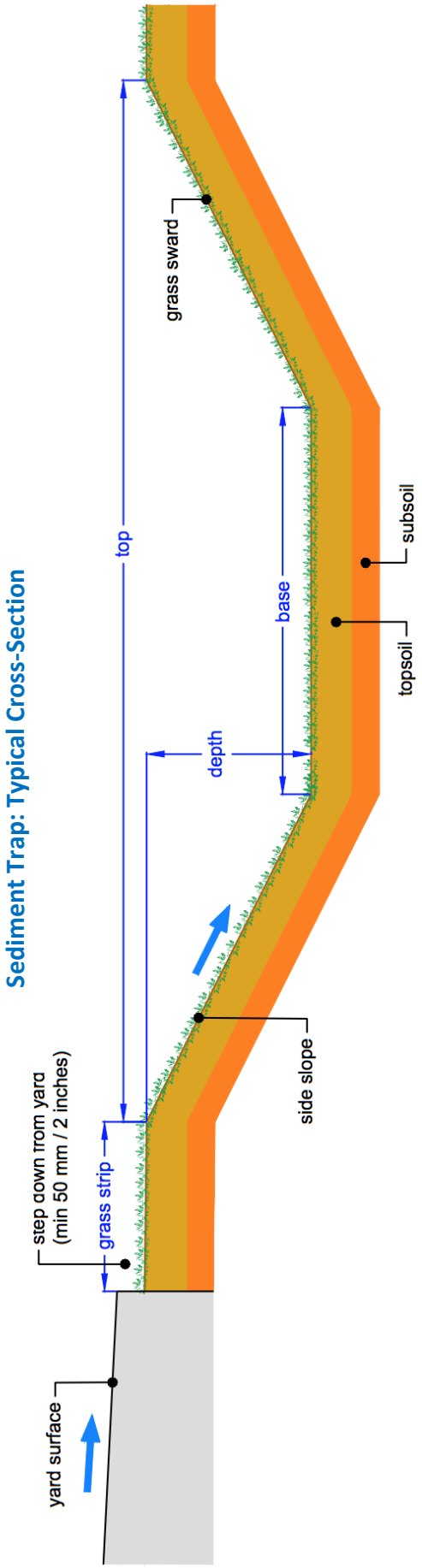
Description of Feature	Minimum		Maximum	
	(millimetres)	(feet)	(millimetres)	(feet)
Grass Strip Width *	600	2	1,200	4
Base Width	3,000	10	10,000	30
Base Length	10,000	30	30,000	100
Depth	600	2	1,000	3½
Top Width	6,600	22	varies according to base length & depth	
Side Slope	1 in 3 **		1 in 4	
Topsoil Depth	150 mm (6 inches)			
Base Length Fall	1 in 100 to 1 in 300 (3 to 10 mm fall every 1 m)			

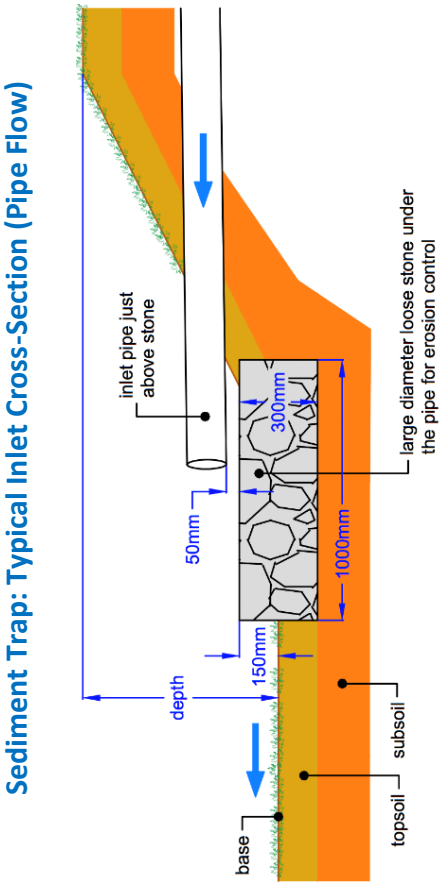
* **Note**: Grass strips are only required where runoff enters the sediment trap as sheet flow.

** **Note**: Steeper side slopes may be used in sediment traps that receive only pipe flow or where space on site is limited; side slopes should never be steeper than 1 in 2.

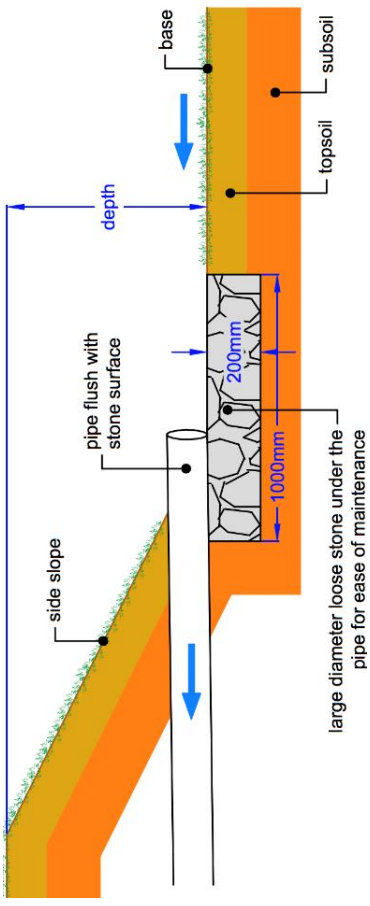
Sediment Trap: Typical Plan







Note: The internal diameter of the inlet pipe should be designed for the area drained (see page 22)



Note: The outlet pipe must be a minimum of 100 mm (4 inches) internal diameter

PART 7 – SPECIFICATION SHEET POND

What is a Pond?

A pond is a permanent water basin with shallow planted margins. Ponds are designed to collect, retain and treat runoff during rainfall events.

What does a Pond do?

A pond captures rainfall runoff from roofs, yards and areas draining onto yards or constructed as part of a Rural SuDS treatment train in fields. Ponds attenuate runoff and slow down the rate that runoff reaches the local watercourse. The forebay at the inlet of a pond allows sediments and pollutants to settle out and be retained. The permanent pool of water and planted margins facilitate further treatment by a range of natural processes including sedimentation, biological breakdown and nutrient uptake. They can also help in flood risk management situations if sized appropriately.

What can I use a Pond for?

- ✓ To collect, attenuate and treat steading runoff from roofs, clean and general yards
- ✓ To collect, attenuate and treat steading runoff from roofs (and yards) on pig and poultry units if site conditions are suitable and if combined with a swale or sediment trap
- ✓ For enhanced treatment (if required) of field runoff downstream of a sediment trap bund

What does a Pond look like?

Image © Stewart Moir

A new pond for a farm steading.

Image © Stewart Moir

A well established pond with planted margins after 2 years.

Useful Tip: **Plant the topsoil margins prior to filling up the pond with water.**

PART 7 – SPECIFICATION SHEET POND

What makes a good Pond?

- ✓ A sediment trap upstream of a pond as part of the Rural SuDS treatment train is an AECS requirement. The sediment trap extends the operational life of the pond and will reduce the frequency of maintenance tasks such as sediment removal.
- ✓ The permanent pool should be 1.2 m – 2.00 m deep as this prevents encroachment of plants.
- ✓ Ponds should have planted margins as they provide additional treatment for nutrients and habitat benefits as well as a safety barrier around the body of water.

Best Practice Construction Guidance for a Pond

- ✓ Divert runoff during construction and establishment phases until such time that topsoil has been placed on perimeter margins.
- ✓ Ponds should be constructed during the growing season to promote establishment of marginal aquatic plants and grass on side slopes.
- ✓ Stockpile the stripped topsoil nearby for use later. Make sure that the topsoil is not washed into the structure during construction.
- ✓ Excavate and form base, forebay and berm, aquatic margins and side slopes as required.
- ✓ On sandy soils lay 300 mm (12 inches) of clay or a plastic impermeable membrane (minimum 1 mm thick) up to the underside of the outlet pipe to ensure the pond retains water.
- ✓ The forebay base area should be approximately 20% of the pond base area with a minimum length of 2.00 m (6.5 feet). The berm should extend across the entire width of the Pond.
- ✓ Install inlet / outlet pipes and erosion protection areas.
- ✓ Inlet pipe(s) should be placed as far away as possible from the outlet. This reduces the potential of flows to short circuit by maximising flow detention times e.g. increases the time flow takes to reach the outlet allowing sediments and associated pollutants to settle.
- ✓ Replace stripped topsoil at a maximum depth of 300 mm (12 inches) on aquatic margins and 150 mm (6 inches) over the side slopes. Do this when the topsoil is dry to avoid compaction.
- ✓ Plant appropriate aquatic marginal plants in the topsoil margin. Planting density to be 4 plants / m2 (per square metre).
- ✓ Sow a low amenity, low maintenance grass seed mixture that can withstand sediment loading over the topsoil to establish a grass sward. Sow at 25 g/m^2 (grams per square metre).
- ✓ If required, perimeter livestock fencing should be erected at least 600 mm (2 feet) off the top edge of all side slopes.

Best Practice Maintenance for a Pond

- ✓ Inlet and outlet pipes should be checked for blockages, vegetation build-up and debris (at least twice per year and following heavy rainfall) and cleared as necessary.
- ✓ Perimeter stock fencing should be checked for integrity / holes and repaired as required.
- ✓ Significant accumulated sediment at the inlet / outlet pipes to be removed as required.
- ✓ Repair eroded or damaged areas of grass / plants as required to restore design performance.

If Rural SUDS are not maintained in accordance with the above basic guidelines, they will no longer treat runoff and may release their pollutants to the watercourse they are protecting.

PART 7 – SPECIFICATION SHEET POND

Recommended Specifications and Example Drawings for a Pond

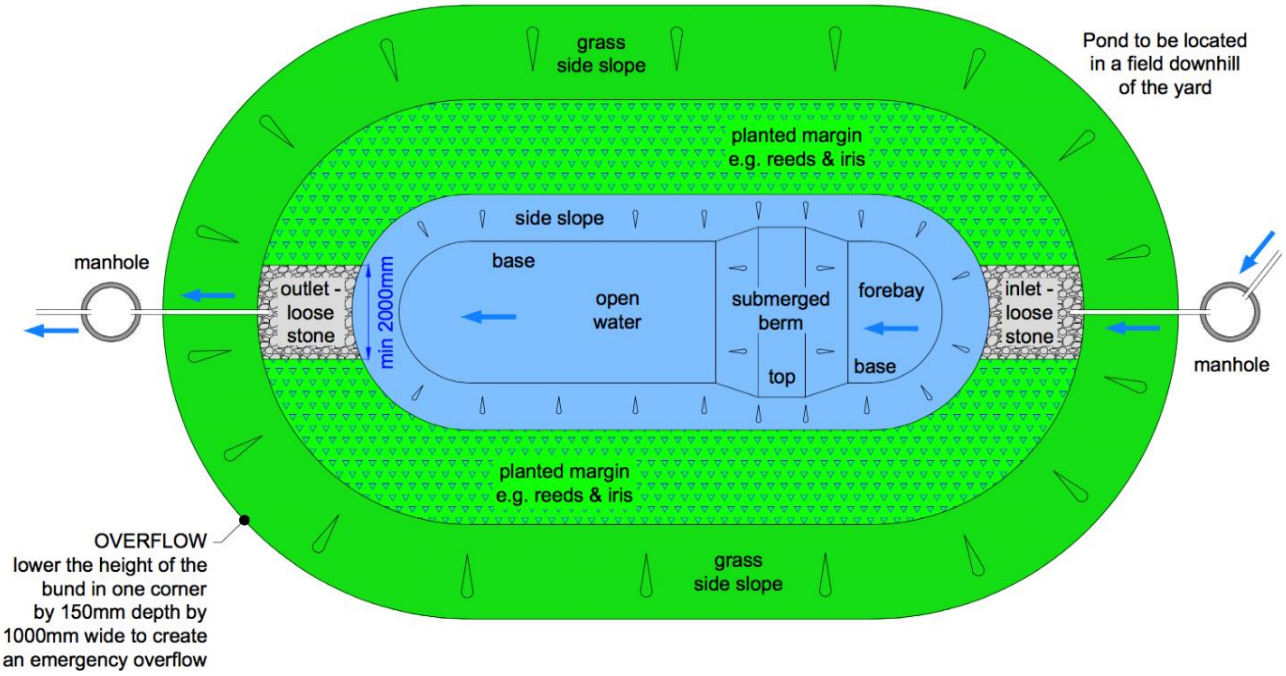
The table below provides recommended minimum and maximum dimensions for a pond. The range of dimensions will help you choose the most suitable pond for your steading or field location. The table should be read in conjunction with the example drawings that show the general layout of a pond and how it should be constructed. The actual dimensions of a pond will depend on its location, the natural fall of the ground, how runoff enters the structure (across the surface as sheet flow or from a pipe), and the volume of runoff to be attenuated and treated.

Description of Feature	Minimum		Maximum	
	(millimetres)	(feet)	(millimetres)	(feet)
Base Width *	3,000	10	10,000	30
Base Length *	10,000	30	30,000	100
Base Fall	Base to be level in all directions			
Depth of Water	1,200	4	2,000	6½
Planted Margin Width	2,000	6½	3,000	10
Planted Margin Depth	300 mm (1 foot) of topsoil			
Side Slopes (below water)	1 in 1		1 in 2	
Side Slopes (above water)	1 in 3 **		1 in 4	

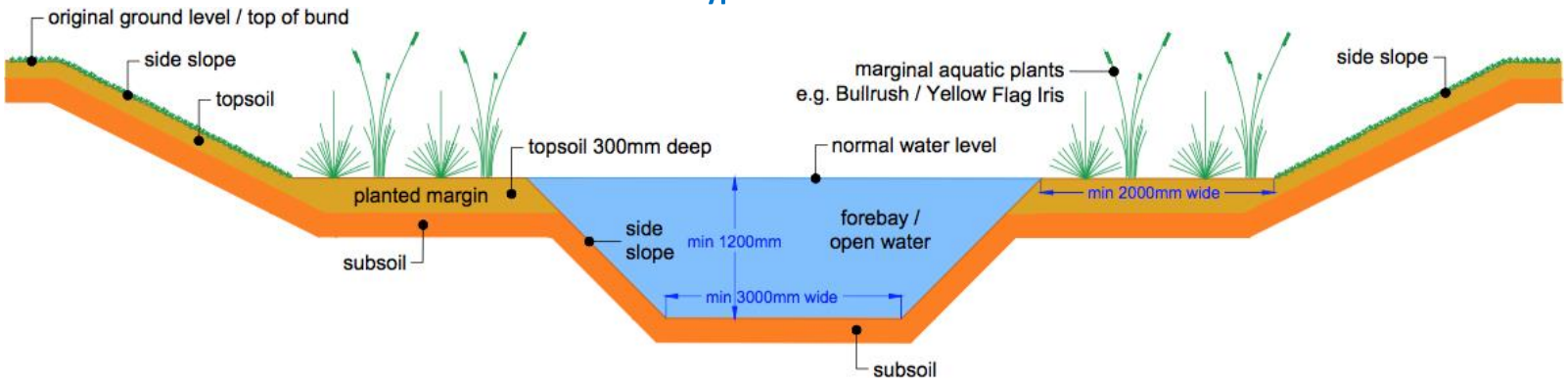
* **Note**: Base width to length ratio should always be a minimum of 1:3 and not exceed 1:5

** **Note**: Steeper side slopes may be used in ponds where space is limited; no steeper than 1:2.

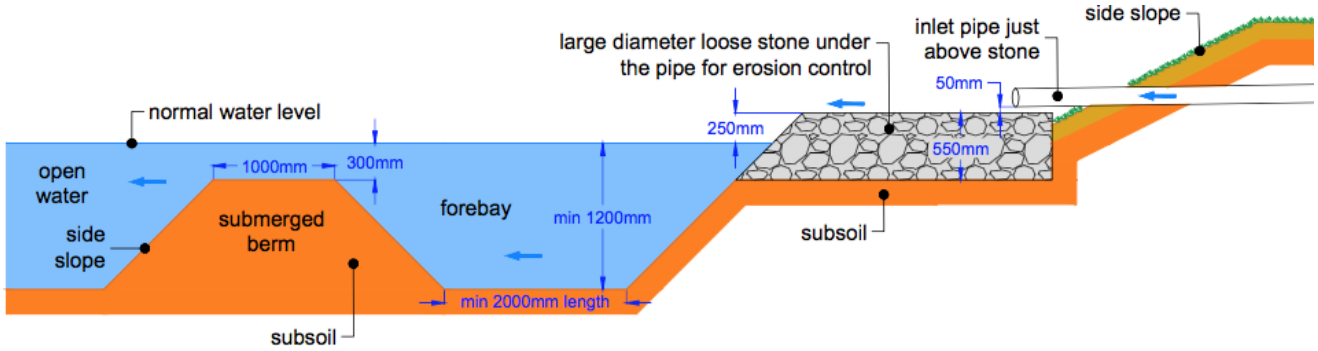
Pond: Typical Plan



Pond: Typical Cross-Section



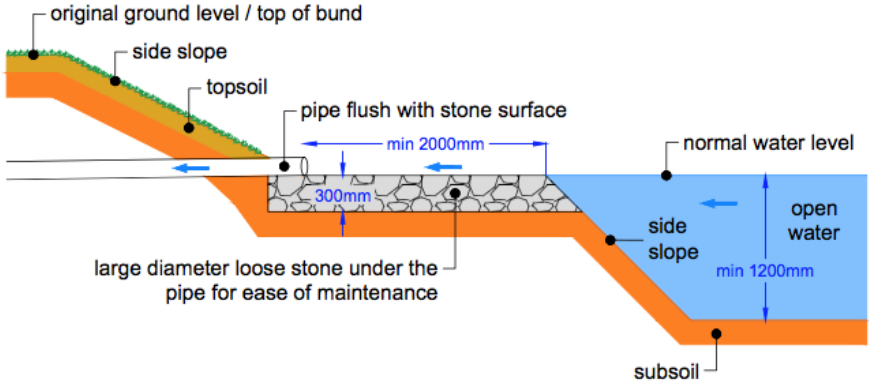
Pond: Typical Inlet Cross-Section



Note: The internal diameter of the inlet pipe should be designed for the area drained (see page 22)

Note: The inlet pipe can be replaced with a swale; the swale base should enter the pond at the same height as a pipe

Pond: Typical Outlet Cross-Section



Note: The outlet pipe must be a minimum of 100 mm (4 inches) internal diameter

PART 7 – SPECIFICATION SHEET WETLAND

Wetland Types

There are **two types of Rural SuDS wetland**: (1) a **Wetland** for the treatment of rainfall runoff from roofs and clean / general yards, from fields or from farm tracks; (2) a **Constructed Farm Wetland (CFW)** for the treatment of lightly contaminated runoff from an outdoor FYM midden or outdoor silage clamp as previously stated in this guide. **If you wish to build a CFW please refer to the** *Scotland and Northern Ireland CFW Design Manual.* This specification sheet is for a **Wetland**.

Note: a CFW can be used to accept combined steading rainfall runoff (clean and lightly contaminated). The surface area of a CFW can be reduced by using Swales, Sediment Traps, Ponds and Wetlands for rainfall runoff from roofs, clean yards and general yards.

What is a Wetland?

A wetland is a permanent water structure with at least three distinct zones each with different depths of water and vegetation density; deeper at the inlet, shallow in the middle and vegetated marsh at the outlet.

What does a Wetland do?

A wetland treats runoff by attenuating and slowing down the rate of flow before it reaches the watercourse. The forebay at the inlet allows sediments and pollutants to settle out. The shallow water and vegetated marsh sections facilitate enhanced treatment by a range of natural processes including sedimentation, nutrient uptake and biological breakdown of bacteria. They can also help in flood risk management situations if sized appropriately.

What can I use a Wetland for?

- ✓ To collect, attenuate and treat steading runoff from roofs, clean and general yards
- ✓ To collect, attenuate and treat steading runoff from roofs (and yards) on pig and poultry units if site conditions are suitable and if combined with a swale or sediment trap
- ✓ For enhanced treatment (if required) of field runoff downstream of a sediment trap bund

What does a Wetland look like?

Image © Stewart Moir

Forebay (inlet)
deep water with planted margins

Image © Stewart Moir

Vegetated marsh (outlet) very shallow water with a diverse plant habitat

PART 7 – SPECIFICATION SHEET WETLAND

What makes a good Wetland?

- ✓ Upstream treatment as part of the Rural SuDS treatment train (e.g. a swale or sediment trap / bund) can extend the operational life of the wetland. This can reduce future maintenance requirements.
- ✓ The forebay pool should be 1.2 m – 2.00 m deep in order to prevent encroachment of plants.
- ✓ Wetlands should comprise 25% of their surface areas as a forebay, 25% as shallow water and 50% vegetated marsh with very shallow water.

Best Practice Construction Guidance for a Wetland

- ✓ Divert runoff during construction and establishment phases until such time that topsoil has been placed on perimeter margins.
- ✓ Wetlands should be constructed during the growing season to promote establishment of marginal aquatic plants and a healthy grass sward on the side slopes.
- ✓ Stockpile the stripped topsoil nearby for use later. Make sure that the topsoil is not washed into the structure during construction.
- ✓ Excavate and form base, aquatic margins and side slopes as required.
- ✓ On sandy soils lay 300 mm (12 inches) of clay or a plastic impermeable membrane (minimum 1 mm thick) up to the underside of the outlet pipe to ensure the pond retains water.
- ✓ Install inlet / outlet pipes and erosion protection areas.
- ✓ Inlet pipe(s) should be placed as far away as possible from the outlet. This reduces the potential of flows to short circuit by maximising flow detention times e.g. increases the time flow takes to reach the outlet allowing sediments and associated pollutants to settle.
- ✓ Replace stripped topsoil at a maximum depth of 300 mm (12 inches) on aquatic margins and 150 mm (6 inches) over the side slopes. Do this when the topsoil is dry to avoid compaction.
- ✓ Plant appropriate aquatic marginal plants in the topsoil margin. Planting density to be 4 plants / m2 (per square metre).
- ✓ Sow a low amenity, low maintenance grass seed mixture that can withstand sediment loading over the topsoil to establish a grass sward. Sow at 25 g/m^2 (grams per square metre).
- ✓ If required, perimeter livestock fencing should be erected at least 600 mm (2 feet) off the top edge of all side slopes.

Best Practice Maintenance for a Wetland

- ✓ Inlet and outlet pipes should be checked for blockages, vegetation build-up and debris (at least twice per year and following heavy rainfall) and cleared as necessary.
- ✓ If in place, perimeter fencing should be checked for integrity / holes and repaired as required.
- ✓ Significant accumulated sediment at the inlet / outlet pipes to be removed as required.
- ✓ Repair eroded or damaged areas of grass / plants as required to restore design performance.

If Rural SUDS are not maintained in accordance with the above basic guidelines, they will no longer treat runoff and may release their pollutants to the watercourse they are protecting.

Recommended Specifications and Example Drawings for a Wetland

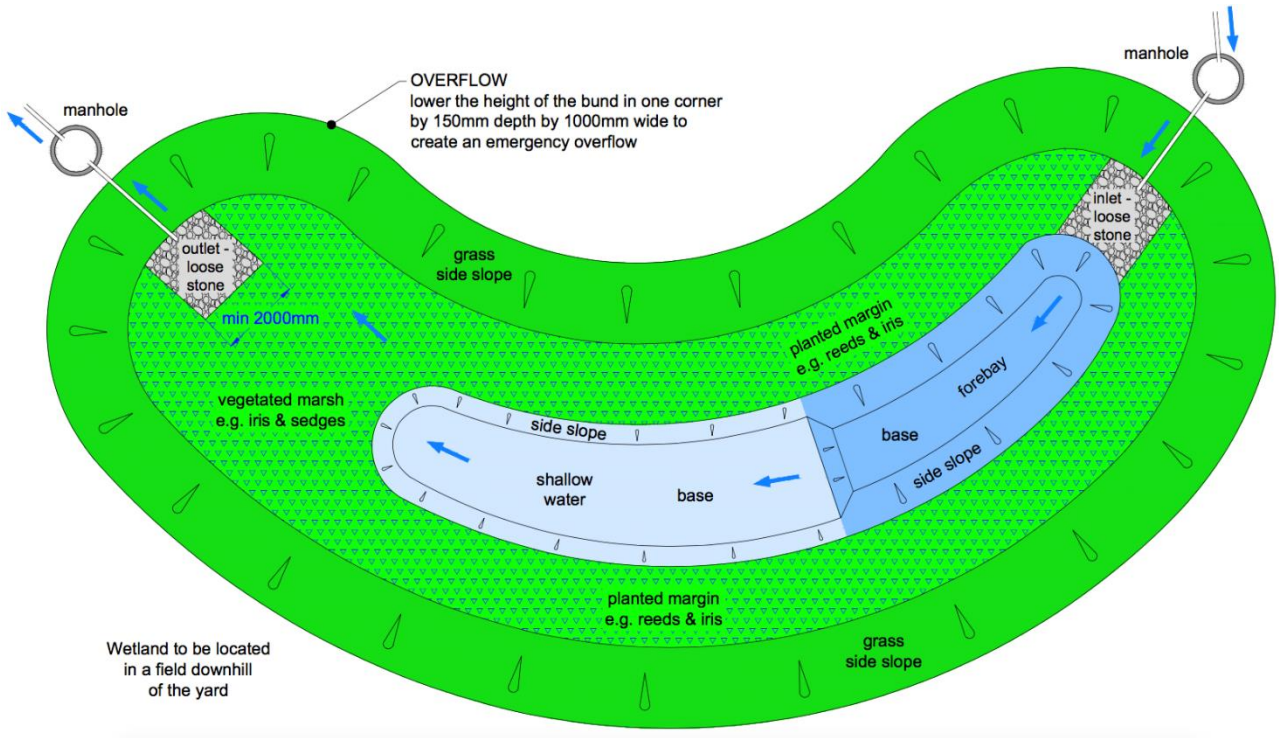
The table below provides recommended minimum and maximum dimensions for a wetland. The range of dimensions will help you choose the most suitable wetland for your steading or field location. The table should be read in conjunction with the example drawings that show the general layout of a wetland and how it should be constructed. The actual dimensions of a wetland will depend on its location, the natural fall of the ground, how runoff enters the structure (across the surface as sheet flow or from a pipe), and the volume of runoff to be attenuated and treated.

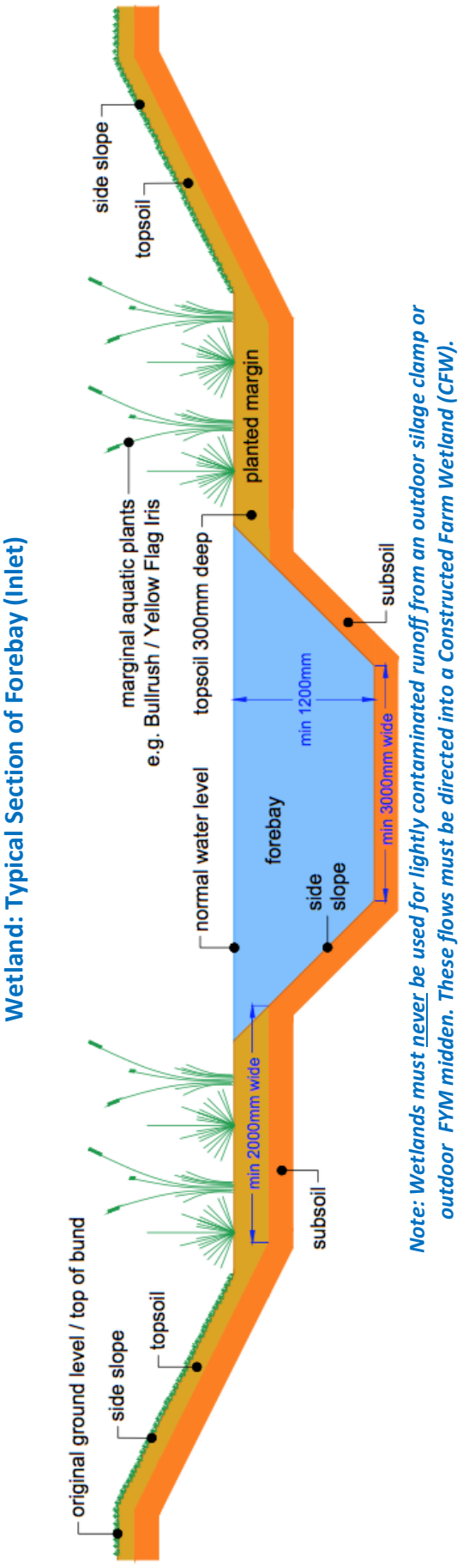
Description of Feature	Minimum		Maximum	
	(millimetres)	(feet)	(millimetres)	(feet)
Base Width *	3,000	10	10,000	30
Base Length *	10,000	30	30,000	100
Base Fall	Base to be level in all directions			
Depth of Water (forebay)	1,200	4	2,000	6½
Depth of Water (shallow)	450	1½	750	2½
Depth of Water (marsh)	0	0	100	4 inches
Planted Margin Width	2,000	6½	3,000	10
Planted Margin Depth	300 mm (1 foot) of topsoil			
Side Slopes (below water)	1 in 1		1 in 2	
Side Slopes (above water)	1 in 3 **		1 in 4	

* **Note**: Base width to length ratio should always be a minimum of 1:3 and not exceed 1:5

** **Note**: Steeper side slopes may be used in wetlands where space is limited; no steeper than 1:2.

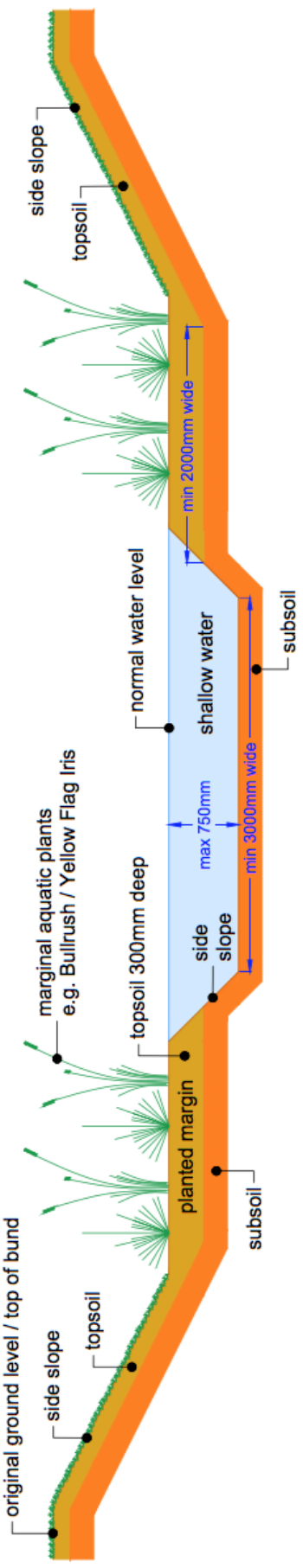
Wetland: Typical Plan





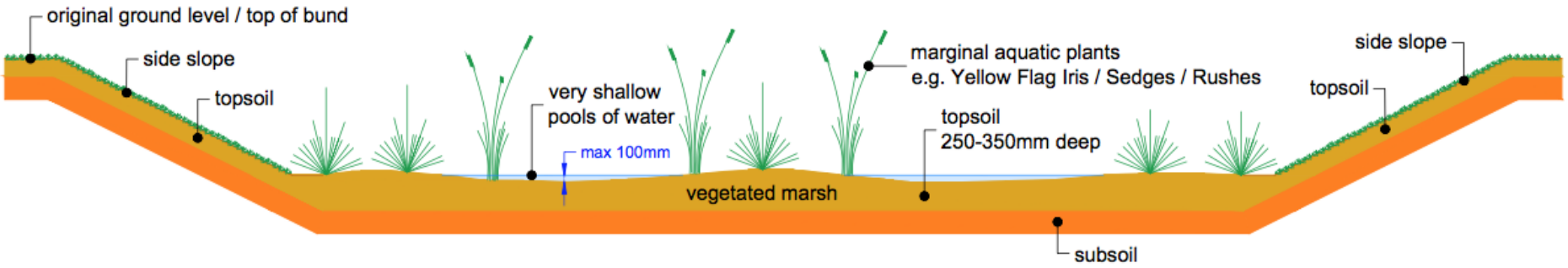
Wetland: Typical Section of Forebay (Inlet)

Note: Wetlands must <u>never</u> be used for lightly contaminated runoff from an outdoor silage clamp or outdoor FYM midden. These flows must be directed into a Constructed Farm Wetland (CFW).

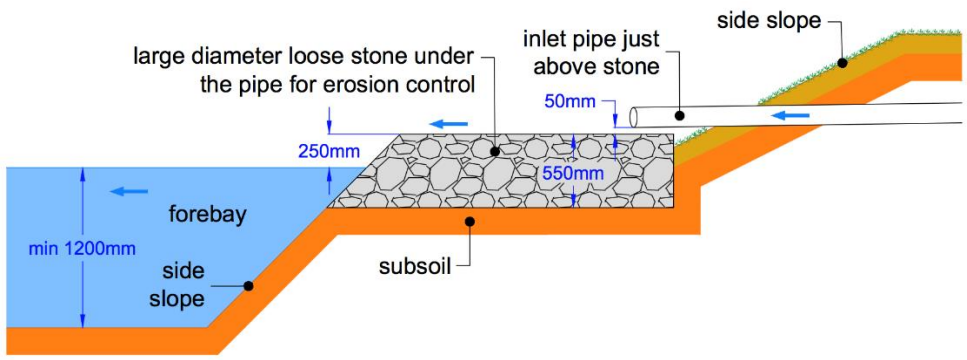


Wetland: Typical Section of Shallow Water (Middle)

Wetland: Typical Section of Vegetated Marsh (Outlet)



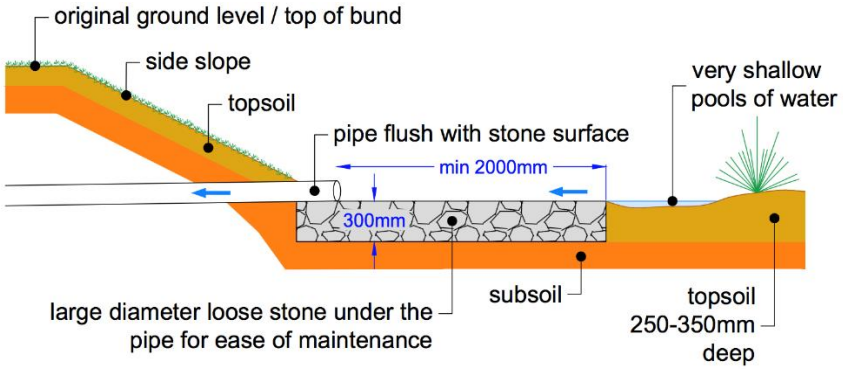
Wetland: Typical Inlet Cross-Section (Pipe Flow)



Note: The internal diameter of the inlet pipe should be designed for the area drained (see page 22)

Note: The inlet pipe can be replaced with a swale; the swale base Should enter the wetland at the same height as a pipe

Wetland: Typical Outlet Cross-Section



Note: The outlet pipe must be a minimum of 100 mm (4 inches) internal diameter

PART 7 – SPECIFICATION SHEET SEDIMENT TRAP BUND

What is a Sediment Trap Bund?

A sediment trap bund is an excavated in-field earth berm that intercepts and traps sediment laden flows and associated pollutants via sheet flow before discharge to a watercourse.

What does a Sediment Trap Bund do?

A sediment trap bund reduces the risk of pollution where the potential for soil erosion poses the greatest risk to a burn, river or loch. Sediment trap bunds are particularly useful on sloping fields where runoff tends to exit the field at a specific point e.g. low corners, a gateway or where slopes converge. On permeable sandy and loamy soils runoff will also infiltrate into the soil below the base. Whilst a sediment trap bund in this guide is designed for treating rainfall runoff they will always provide some flood storage. Their use as natural flood management measures should be considered at the design stage and sized appropriately (for more information see page 46).

What can I use a Sediment Trap Bund for?

- ✓ To attenuate in-field soil laden flows that currently discharge to a watercourse
- × Sediment trap bunds should not be used for the interception of runoff from field drains
- × Sediment trap bunds should not be used as a flood embankment

What does a Sediment Trap Bund look like?

Image © Richard Lockett

Excavation of a sediment trap bund

Image © Richard Lockett

Sediment trap bund in operation

PART 7 – SPECIFICATION SHEET SEDIMENT TRAP BUND

What makes a good Sediment Trap Bund?

- ✓ Sediment trap bunds typically receive runoff via sheet flow. The larger the surface area the better; large surface areas give more time for the filtration and settlement of sediments.
- ✓ A grass filter strip upstream of the bund is critical to help slow flows and reduce turbulence so that sediments can quickly settle in the trap thus enhancing treatment effectiveness.
- ✓ As far as possible use the natural topography to reduce excavation or embankments.
- ✓ Ensure easy access for removal of sediments and nutrients that can be returned to the land.

Best Practice Construction Guidance for a Sediment Trap Bund

- ✓ Install overflow pipes to control maximum water level.
- ✓ Infield operations should only be undertaken during dry weather.
- ✓ Strip the topsoil and stockpile it nearby for use later; the stockpile of topsoil should be located so that the topsoil is not washed into the new sediment trap bund during the construction works.
- ✓ Excavate and form the sediment trap bund base and side slopes as required.
- ✓ Install pipes where required.
- ✓ Spread the stripped topsoil over the bund as required. The placement must be done when the topsoil is dry to avoid compaction.
- ✓ Where there are steep slopes you can construct sediment trap bunds in series linking them by pipes or a cut away in the bank between each basin.
- ✓ To further stabilise the embankment, you can sow an appropriate low amenity, low maintenance grass seed mixture that can withstand sediment loading over the topsoil. Sow at 25 g/m^2 (grams per square metre).
- ✓ Perimeter livestock fencing (if required) should be erected.

Best Practice Maintenance for a Sediment Trap Bund

- ✓ Outlet pipes should be checked for blockages, vegetation build-up and debris (at least twice per year and following heavy rainfall) and cleared as necessary.
- ✓ Accumulated sediment to be periodically reclaimed as required. The sediment should be left to dry out and returned to land.
- ✓ Perimeter stock fencing should be checked for integrity / holes and repaired as required.

If Rural SUDS are not maintained in accordance with the above basic guidelines, they will no longer treat runoff and may release their pollutants to the watercourse they are protecting.

PART 7 – SPECIFICATION SHEET SEDIMENT TRAP BUND

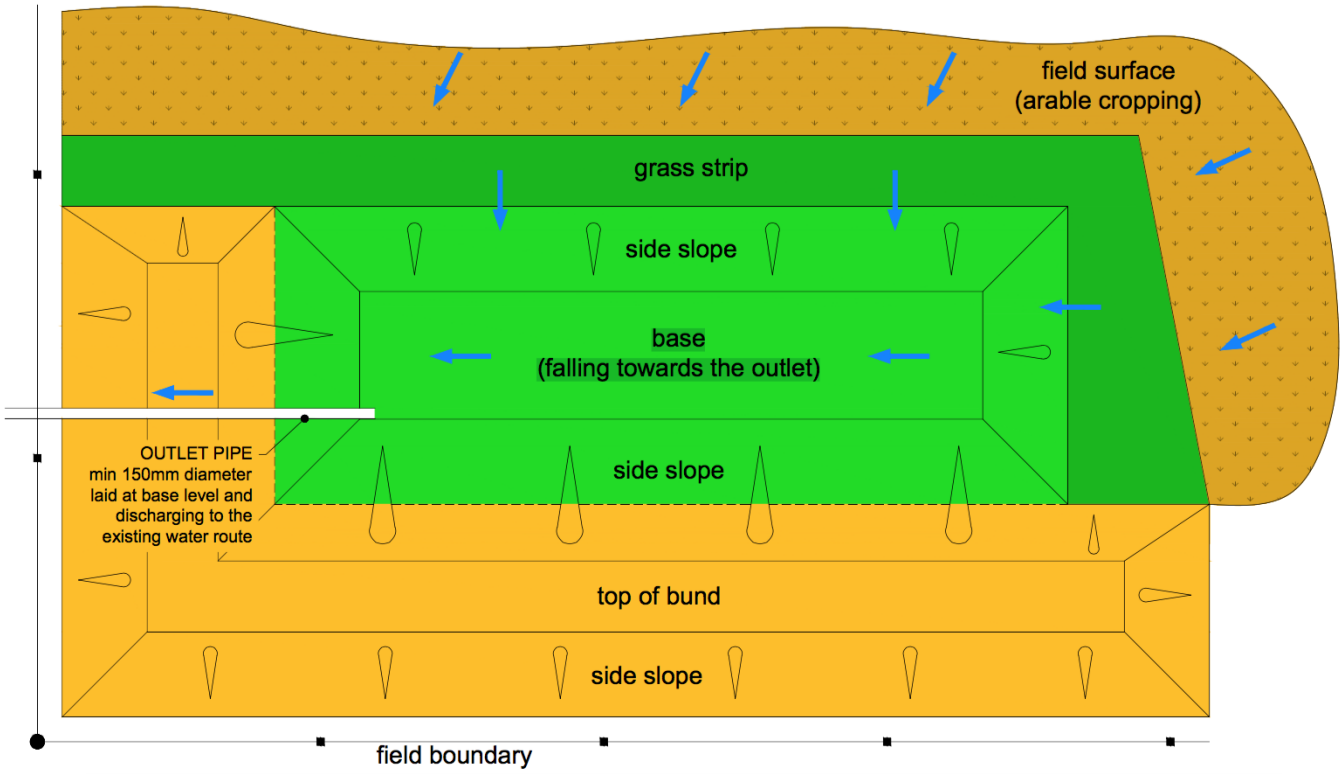
Recommended Specifications and Example Drawings for a Sediment Trap Bund

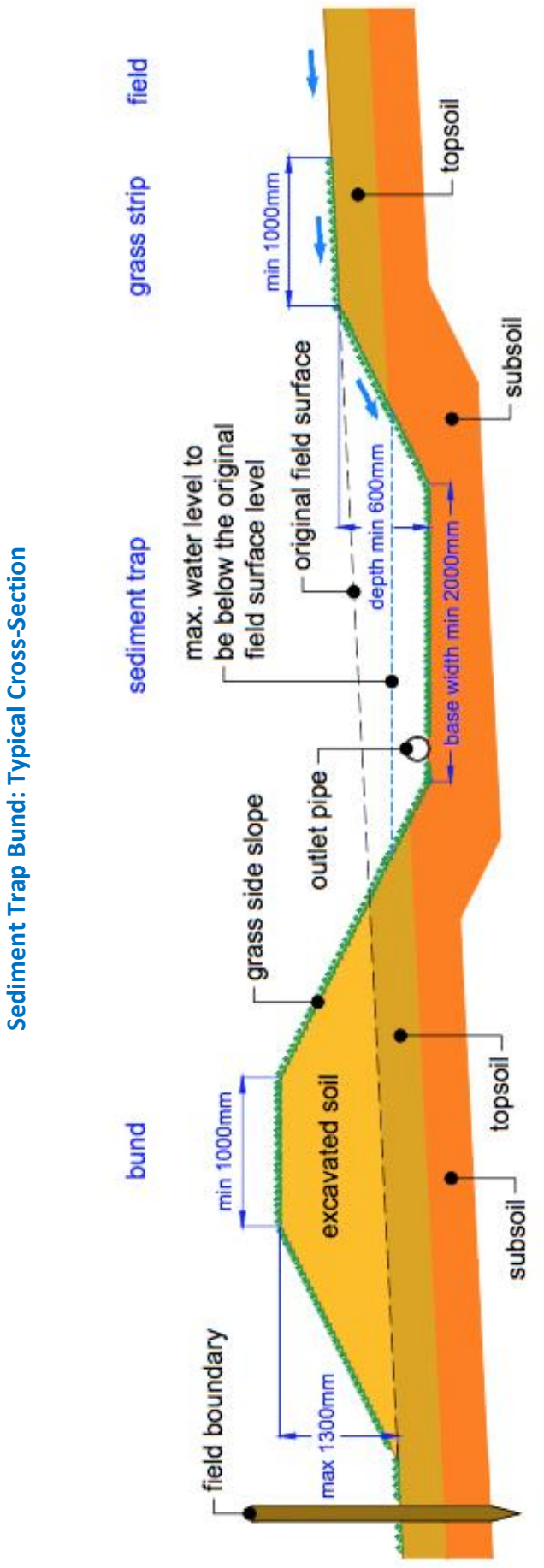
The table below provides recommended minimum and maximum dimensions for a sediment trap bund. The range of dimensions will help you choose the most suitable sediment trap bund for your field. The table should be read in conjunction with the example drawings that show the general layout of a sediment trap bund and how it should be constructed. The actual dimensions of a sediment trap bund will depend on its location, the natural fall of the ground, and the volume of runoff to be attenuated and treated based on field size.

Description of Feature	Minimum		Maximum	
	(millimetres)	(feet)	(millimetres)	(feet)
Grass strip width *	1,000	3	The wider the better	
Base Width	2,000	6½	---	
Base Length	6,000	20	Width to Length ratio to be 1:3	
Base Fall	Slight fall towards the outlet pipe			
Depth of trap	600	2	1,500	5
Side Slopes	1 in 2		1 in 4	

* **Note**: Grass strips are essential to reduce turbulence in the runoff and allow initial trapping of coarse sediments.

Sediment Trap Bund: Typical Plan





Sediment Trap Bund: Typical Cross-Section

PART 8 – MAXIMISING THE BENEFITS OF RURAL SuDS

Rural SuDS can be designed to provide a range of benefits in addition to reducing diffuse pollution - from reducing flood risk to increasing wildlife habitat. By considering these benefits at the design stage you can maximise the benefits that can be gained with little additional effort or cost.

Flood control Rural SuDS are increasingly being used as natural flood management (NFM) measures to help control flooding in rural communities. Rural SuDS slow flows during large rainfall events. This helps manage rainfall surges in burns and rivers. While the Rural SuDS featured in this guidance are designed for treating storm water, they will inherently provide some flood storage. The potential for slowing flows to local watercourses should be considered at the design stage. Excellent examples where Rural SuDS are helping to deal with rural flooding can be found throughout the UK. The Tweed Forum is a group of stakeholders (land managers, Scottish Government, Universities, NFU and others) who are restoring natural habitats to help alleviate flooding issues in Eddleston and Peebles. *The Eddleston Project* aims to slow flows by creating large woody in-channel barriers and 'leaky' ponds. They store and hold back water during large rainfall events. In Belford, Northumbria, the construction of 'runoff attenuation features' (RAFs) have delivered low cost options for flood management to help with flooding in the small town. RAFs are Rural SuDS that reduce downstream flooding by slowing and storing floodwater both in watercourses and on surrounding farmland. The RAFs have been shown to reduce flooding by 15-30%, at a cost that is typically 10% of traditional flood schemes. A *RAF handbook* is available to learn more about these measures.

Habitat provision Rural SuDS can provide fantastic habitats for a range of wildlife. There is great opportunity to design your Rural SuDS to not only treat runoff, but attract wildlife and increase connectivity with local habitats. Wet Rural SuDS are particularly attractive to mammals, amphibians, fish, birds and invertebrates. Wherever possible, you should design your Rural SuDS to maximise biodiversity benefits. This in turn can provide additional benefits such as increase pollinator populations that help sustain arable crops, to improving general aesthetics and wildlife. **Rural SuDS will also help you achieve GAEC (Good Agricultural and Environmental Condition).**

Image © Alison Duffy

Climate change Runoff volumes could increase with climate change. Rural SuDS, particularly those that are wet, thus mimicking natural wetlands, can play an important role in regulating greenhouse gases and adaptation to climate change. Wet Rural SuDS, such as a wetland or the wet swale shown here, absorb and store carbon through photosynthesis and can help to maintain soil formation and fertility by capturing valuable nutrients that can be reclaimed and reused around the farm.

Image © WWT

PART 9 – OTHER MANAGEMENT OPTIONS

This guidance document provides information for Rural SuDS that are currently funded under Agri-Environment Climate Scheme (AECS). There are other sustainable management measures that can be used to mitigate diffuse pollution from steading and field runoff. This section provides an overview of these measures including supporting information for further reading.

- ✓ **Best Management Practices:** Examples of good in-field practice include managing tramline and farm track runoff, implementing buffer zones such as vegetated buffer strips or woodland, planning fertiliser application, ensuring the correct standoff distance (from watercourses, wells, springs) for fertiliser application, managing soil structure and compaction, planning suitable crops appropriate to the location, and catch and cover crops to reduce bare soil exposure. Examples of steading good practice focus predominantly on *good housekeeping* and planning, for example keeping yard areas clean and tidy, storing chemicals in bunded areas to contain spills, ensuring high risk activities are carried out correctly. Further information: *SEARS Reducing the Risk of Water Pollution. Diffuse Pollution Regulations: GBR 18, Farming & Water Scotland Diffuse Pollution – Reducing the Risk, Rural Sustainable Drainage Systems (Rural SuDS)*
- ✓ **Sediment fences:** these are short term measures that can be moved according to crop rotation. They are typically used on moderate slopes for high risk crops where there is flow containing high sediment content, for example potatoes. Sediment fences are constructed along the lateral slope of fields and comprise of a narrow weave geotextile mounted on wooden posts, with the geotextile anchored (buried) beneath the soil surface. The fence intercepts field runoff, trapping soil and allowing water to percolate through the geotextile. Sediment fences are an effective short term measure to reduce soils loss however their effectiveness relies upon regular maintenance to remove deposits.

Image © Andy Vinten

Filter fence. Note upslope spurs at plot edges to constrain lateral movement of sediment

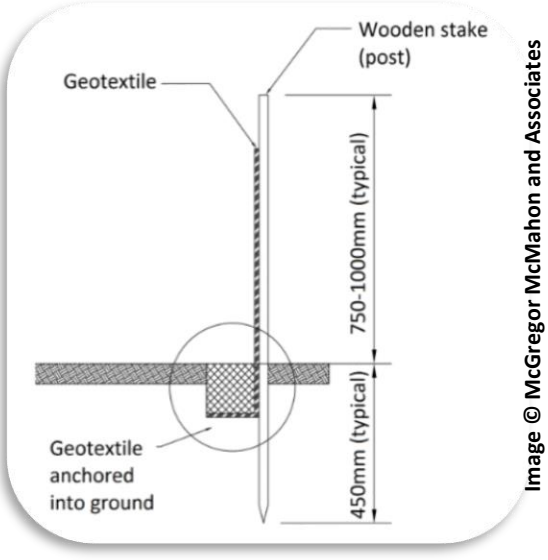


Image © McGregor McMahon and Associates

Typical detail of sediment fence. Note the circle indicates anchoring of the geotextile

PART 9 – OTHER MANAGEMENT OPTIONS

- **Modification of existing field ditches:** these are on-line or offline measures (i.e. within or joining a ditch) to provide treatment and storage of runoff. Where the ditch system affects a natural watercourse then approval is required under The Water Environment (Controlled Activities) (Scotland) Regulations from your local SEPA office. On-line (in-ditch) wetlands can be created by widening the existing ditch and varying the depth of the ditch base. This creates habitats for different marginal and aquatic plant species. This option is most suitable where ditch slopes have shallow gradients, however check-dams can be used to manage steeper sites and offer the advantage of promoting settling of sediment in pockets along the ditch length. Off-line wetlands can be created where there is suitable available land. This option allows high watercourse flows to be diverted (using baffles or check-dams) to the off-line wetland. This provides greater attenuation volume and is suitable in areas where flooding is an issue. Further information: *Natural Flood Management Handbook, WWT Constructed Farm Wetlands Guide*, *Rural Sustainable Drainage Systems (RSuDS)* and *RAF (Runoff Attenuation Features) handbook.*

- **Buffer Strips:** Buffer strips are now common practice. They are excellent barriers between farming activities and a watercourse for trapping large soil particles and pollutants in runoff. However, they do not slow down runoff sufficiently to trap finer soil particles and dissolved nutrients. They are designed so that runoff passes as sheet flow across the surface, slowing flow and encouraging settlement of solids. They provide pre-treatment (removal of course solids) upstream of Rural SuDS. Further information: *Rural Sustainable Drainage Systems (RSuDS)*.

Image © Alison Duffy

- **Infiltration systems:** these may be used where conditions are suitable (e.g. high infiltration capacity of soil) and risk to groundwater has been assessed and where runoff has low pollution risk (e.g. roof water) or has undergone prior treatment (in e.g. a sediment trap bund).

- **Downpipe diversion:** where appropriate it may be possible to disconnect building downpipes, re-directing flow across vegetated areas rather than discharge directly into the watercourse or farm drainage system.

- **Rain water harvesting (RWH):** capturing, storing and re-using roof water from farm buildings. RWH techniques can range from simple water butts for downpipes to complex systems to re-use water within buildings and farm operations. Further information: *Environment Agency Rainwater Harvesting an On-Farm Guide*.

- **Green roofs:** intercept rainfall at source and temporarily store rainwater, with some water lost by plant uptake and evaporation, and discharges from the roof at a controlled rate. Green roofs are particularly suited to flat roofed buildings. There are different types of green roofs and planting however extensive green roofs (roofs with dense low height, low maintenance plants such as *sedum*) are particularly suitable for farm buildings. Further information: *CIRIA C644 Building Greener, Rural Sustainable Drainage Systems (Rural SuDS)*, *CIRIA C753 The SUDS Manual.*

PART 10 – CASE STUDIES

FIELD SEDIMENT TRAP BUND IN FIFE (1)

The problem

Loch Leven is a site of high nature conservation, a designated Site of Special Scientific Interest, (SSSI), a Special Protection Area (SPA), a Ramsar site (wetland of international importance) and a National Nature Reserve (NNR). Loch Leven is in a phosphate sensitive zone. Agriculture is a significant source of diffuse pollution. Intensive arable farming, erosion and steep fields cause phosphate losses during periods of high rainfall.

A field 'pinch point' existed in a gateway to an access track that is drained by a ditch that flows into the loch. Compaction and wheel ruts further exacerbated the sediment laden pathway with large volumes of soil entering the ditch and delivering large quantities of fine, nutrient rich sediments to the loch.

The Rural SuDS Solution

Identifying and tackling hot spots is a simple and effective way of achieving significant reductions in the mobilisation of pollutants from farmland. A treatment train approach was taken whereby the gateway and track at the bottom of the field were realigned. A ***sediment Trap Bund*** with a surface area of 50m^2 and depth of 1.5m was installed. A 20m wide ***buffer strip*** was sown above the trap to slow runoff flow and capture coarse sediments before reaching the Sediment Trap Bund During very high rainfall, the Sediment Trap Bund fills to capacity and overflows into the ditch.

A further treatment phase is provided by directing ditch flows through a 100 m long, 3 m wide reed bed. This slows the ditch flow allowing any remaining fine nutrient rich sediment to be intercepted before entering the loch.

More information and acknowledgements

Richard Lockett – Lockett Agri-Environmental
locket@agri-environmental.co.uk

See Winter 2014 article in Conservation **land** Management - '***Tackling agricultural diffuse pollution 'hotspots' in the Loch Leven catchment***'.

Farmer Robin Niven
Brian D'Arcy (Abertay University and CDM, land management consultancy).

Image © Brian D'Arcy

Loch Leven in background showing runoff pinch point and sediment transfer route from field to ditch

Image © Richard Lockett

Sediment Trap Bund following heavy rainfall (buffer strip in background)

Image © Neil Berwick

Sediment Trap Bund summer 2015

Image © Michael McDaid

Reed Bed intercepts any remaining nutrients

PART 10 – CASE STUDIES

FIELD SEDIMENT TRAP BUND IN FIFE (2)

The problem

For the background to the problem in the Loch Leven catchment see Case Study 1. This farm is located in the upper catchment that consists of steep grass and heather hill slopes. During high winter rainfall events, runoff is channelled through hot spots - wide gullies in the arable fields carrying large volumes of topsoil into downstream watercourses. Although a 20m buffer strip was installed at this location, heavily silt laden flow from one arable field was still making its way through the buffer strip to the local Burn during high rainfall events.

Image © Andy Vinten

Runoff pathway in the field

The Rural SuDS Solution

The chosen solution was to install a ***Sediment Trap Bund*** at an erosion 'pinch point' in the corner of an arable field with an additional ***buffer strip*** above the bund to help manage flows and remove coarse sediments. Key considerations during the design phase were field size and slope, rainfall and sandy soils allowing infiltration. Total field area is ~ 140,000 m^2 (14 ha) with sediment trap bund area ~ 0.26% of field area.

Image © Andy Vinten

Excavation of the sediment trap bund 2004

Crop rotation means that the bund is de-sedimented every three years – following root crops (potatoes / swedes). Sediment is removed using a local contractor and digger and left to dry out for a few weeks. The reclaimed dry sediment is then distributed further up the field. Approximately 800 tonnes of topsoil has been recovered in seven years – 200 tonnes from one potato crop.

Image © Alison Duffy

Sediment Trap Bund after heavy rainfall

The farmer said that 'The sediment trap bund could have been larger and although this would have meant less time between de-sedimentation the task would have been more onerous – it is easier and cheaper to do a little more often'.

Image © Alison Duffy

Sediment Trap Bund, summer 2015

More information and acknowledgements

Dr Andy Vinten, James Hutton Institute
andy.vinten@hutton.ac.uk

Farmer Angus Bayne, Wester Gospetry Farm
Brian D'Arcy (Abertay University and CDM, land management consultancy).

PART 10 – CASE STUDIES

STEADING SWALE AND CONSTRUCTED FARM WETLAND NEAR DUMFRIES

The problem

Caerlaverock is a national nature reserve (NNR), a Ramsar site and a Special Protection Area (SPA) for birdlife. It is managed by Scottish Natural Heritage (SNH) and covers part of the Solway Firth and the land south of Dumfries. The NNR has saltmarsh, mudflats and grazing land. It is an internationally important wintering site for waterfowl and wading birds. It also used by the nationally rare Natterjack Toad and Tadpole Shrimp, both species susceptible to water quality issues. The conservation charity Wildfowl & Wetlands Trust (WWT) runs a centre called WWT Caerlaverock next to the NNR.

Image © WWT

Powhillon Farm illustrating location of the CFW

The Rural SuDS Solution

Powhillon ***Constructed Farm Wetland (CFW)*** on the Caerlaverock reserve treats farmyard run-off preventing nutrients, particularly high levels of phosphorous reaching sensitive wetland habitats and the nearby watercourse. A feasibility study determined soil types/ topography and discussions with SEPA ensured agreement with the proposal. Previous to construction, clean and dirty water were separated. Construction work was carried out by the farmer over two and a half days.

Image © WWT

Construction of Pond 1 in 2012 showing berm. Swale in background to the right of the digger

A ***Swale*** directs runoff from the yard into the CFW that consists of two ponds (5x4 m each, maximum depth 1.1 m). Runoff is aided by a concrete bund that prevents yard runoff flowing into a ditch that flows into the reserve. Swale vegetation slows runoff before it reaches the CFW and increase infiltration into the ground. Treated water from the CFW then flows into a bunded wet woodland.

Image © WWT

Concrete bund directs runoff away from a ditch to the left and into the newly constructed (unplanted) swale that transfers runoff from the yard

The swale should be scraped on a regular basis to remain functional. Sediment should be removed from the ponds every three to five years. Water quality is analysed to assess efficiency. To date the CFW works very well as a zero discharge system as remaining effluent is reduced through evaporation and uptake by trees in the wet woodland.

Image © WWT

CFW Pond 2 summer 2013

More information and acknowledgements

Joe Bilous / Anne Harrison, Wildfowl & Wetlands Trust.

More information on the case study can be found in the *WWT Constructed Farm Wetlands Guide*

A video featuring construction of the CFW can be accessed at: www.wwt.org.uk/farmwetlands

PART 10 – CASE STUDIES

FIELD SEDIMENT TRAP BUND AND POND IN ANGUS

The problem

The Lunan Catchment includes two designated Sites of Special Scientific Interest (SSSI) lochs that are classed as poor / moderate ecological and chemical status. With the maximum elevation in the catchment being 250 m, significant field slopes mean there are considerable volumes of soil eroded annually resulting in severe diffuse pollution impacts to the lochs. Groundwater and the main Burn, the Lunan Water, have high nitrate concentration with poor salmon and sea trout numbers. The lochs also suffer from over-enrichment with phosphorous from farming (mainly potatoes and other root crops) and septic tanks, leading to serious eutrophication in the summer months.

Image © Google Earth

Location showing arable field, buffer strip, Sediment Trap Bund and Pond and the exceedance (extreme rainfall event) overland flow route to watercourse

The Rural SuDS Solution

A large ***Sediment Trap Bund*** connecting to a small field ***Pond*** were installed on a slope just below an erosion risk area in an arable field, potatoes being a main crop. Total area of the field is 100,152 m^2 (~ 10 ha). The Sediment Trap Bund dimensions are 15x15 m and the Pond dimensions are 10x15 m providing 0.23% and an additional 0.15% of field area. (This system was constructed before development of current guidelines - the recommended pond size is now 0.25% of field area). The outflow is piped approximately 56 m underground to a small watercourse that joins the Lunan Water. A slotted, twin walled pipe sits vertically at the bottom of the pond for high level (exceedance) flows during large rainfall events. These exceedance flows then flow overland downhill towards the watercourse.

Image © Andy Vinten

Excavation of the Pond

Image © Andy Vinten

Pond after January 2016 storms showing high level outlet

More information and acknowledgements

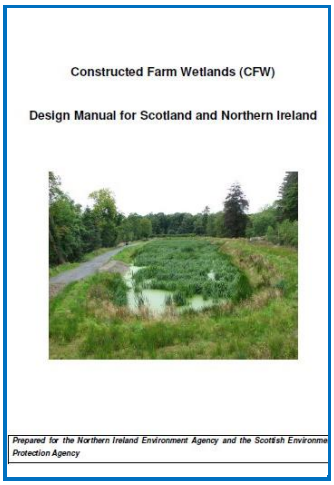
Dr Andy Vinten, James Hutton Institute
andy.vinten@hutton.ac.uk

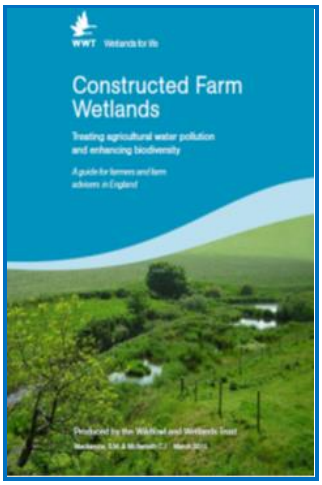
Image © Alison Duffy

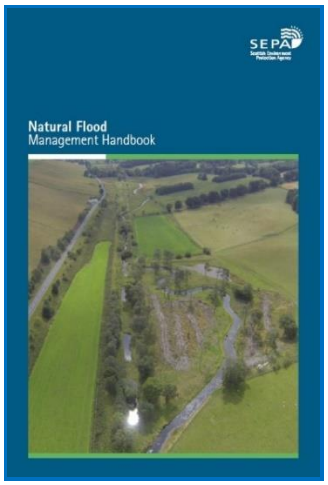
April 2016

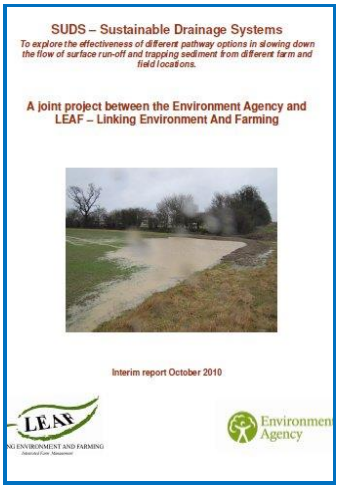
PART 11 – USEFUL INFORMATION

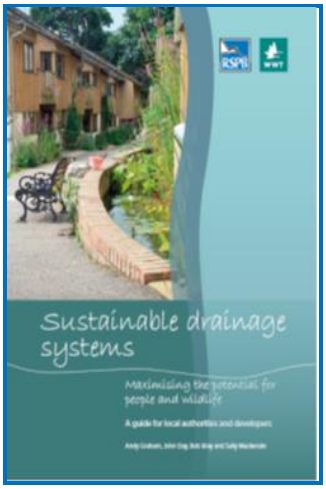
PART 11 - USEFUL INFORMATION

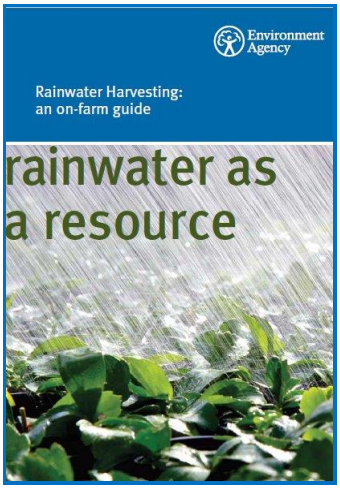












PART 12 – ACKNOWLEDGEMENTS

CREW

Project Managers - Nikki Dodd, Jannette MacDonald, Sue Morrison

Steering Group members

Darrell Crothers – Scottish Environment Protection Agency
Zoe Frogbrook - Scottish Water
Neil Henderson - Scottish Government
Sarah Hutcheon – Scottish Natural Heritage
Ian Speirs - Scottish Government
Jared Stewart - Scottish Water
Dr Mark Wilkinson - James Hutton Institute

ABERTAY UNIVERSITY

Project Manager - Alison Duffy

Project Team

Neil Berwick - Abertay University
Dr Brian D'Arcy - Abertay University / CDM Consulting
Stewart Moir - Abertay University / Moir Environmental
John Shabashow – Abertay University
Vladeta Stojanovic – Abertay University
Dr Rebecca Wade - Abertay University

Advisory Group Members

Anne Harrison - Wildfowl and Wetlands Trust (WWT)
Professor Kate Heal - Edinburgh University
Dr Andy Vinten - James Hutton Institute

IMAGE CREDITS AND AFFILIATIONS