Vegetated swales and drains

This fact sheet is one of a series which provides advice to extension officers and land owners on the use of vegetated swales and drains to improve farm run-off water quality, specific to coastal agriculture in the wet/dry tropics region between central and Far North Queensland.

Vegetated swales and drains

Vegetated swales and drains are shallow, open, vegetated channels primarily designed for conveying water in a longitudinal manner through a drainage pathway. They can also be designed to manage water quality by reducing flow velocities (speeds) compared to bare soil, piped or concreted conveyance systems.

They can remove coarse and medium sized sediments and are commonly combined with buffer strips, sediment basins and constructed wetlands to provide further treatment.

The main difference between swales and drains is how they hold water. Swales are located in areas which can fully drain and are therefore typically dry. Swales can also be headlands or access tracks that are not used regularly for farm traffic. Drains are located on flat or backwatered locations which results in them holding water. Swales ideally have a trapezoidal cross-section with a flat base, while drains have a shallow 'v'-shaped configuration (Figure 1).

Swales and drains should be designed to convey the required run-off volume effectively, and be well vegetated to allow for seasonal slashing. Ideally they will be located on slopes with 1-4% grade.

Treatment processes

The interaction between water flow and vegetation within these systems facilitates settlement and retention of pollutants. Vegetation type/height will influence the treatment performance.

- **Swales/drains with low vegetation** (such as mown grass) can achieve moderate sediment deposition rates provided flows are well distributed across the full width and length of the swale and the longitudinal grade of the swale is kept low enough to maintain slower flow conditions (less than 4%).
- **Swales/drains with taller/reed type vegetation** can offer improved sediment retention by slowing flows more and providing enhanced sedimentation for deeper flows. However, densely vegetated swales have higher hydraulic roughness and therefore require a larger area to convey flows compared to grass swales.

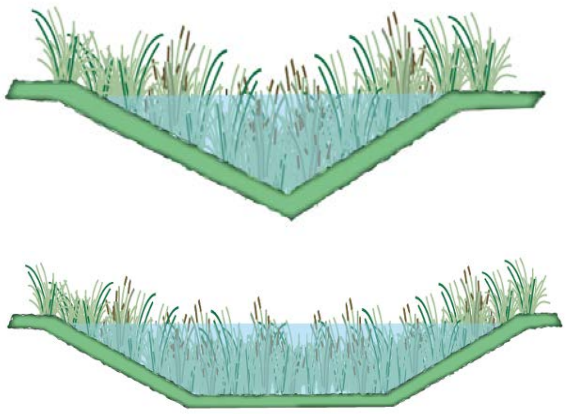
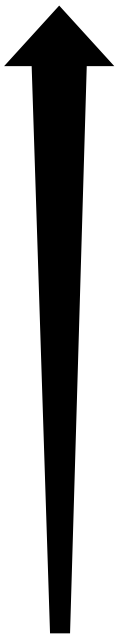


Figure 1 – Vegetated drain (top) and vegetated swale (bottom) cross sections.

Table 1 – Summary of vegetated swale and drain treatment processes

Pollutant Size / Type	Treatment Performance	Description of Vegetated Swales and Drains Treatment Process
Coarse to medium sized pollutants (e.g. sediments)		Vegetation facilitates enhanced sedimentation of particles, particularly coarse to medium sediments, through filtration and deposition.
Fine particulates (e.g. fine sediments and particulate nutrients)		Vegetation may also trap some fine particles which may retain or adsorb pollutants.
Dissolved pollutants (e.g. nutrients, chemicals and pesticides)		There may be some direct uptake of nutrients by vegetation. Regular wetting and drying in swales and drains will enhance the decomposition of organic matter and decreases the availability of phosphorus trapped in the sediments.

Use of vegetated swales and drains on farms to manage run-off

Vegetated swales and drains can be used as part of an overall farm drainage strategy to improve run-off water quality provided best practice farm management practices are implemented and a number of key design considerations are addressed. Planning treatment elements should also consider their position in the catchment and whether the location is suitable.

Sizing

Typically, swales and drains are applicable for smaller scale contributing catchments up to 2 hectares provided the pollutant load is not excessive. For an area of this size the vegetated swales and drains should be able to convey and treat frequent storm flows effectively. The width and length required to treat flows from catchment areas larger than this can be problematic (especially for flat bottom swales).

Site constraints

Vegetated swales and drains are not ideally suited to sites with:

- Steep topography (>4%) - check dams may be required for these slopes to protect scour.
- Flat topography (<1%) – swales can become waterlogged or boggy if they are unable to drain effectively, which can be difficult to maintain and can be problematic for vehicle movement and result in problems with mosquitoes. Drains are more suited to these conditions.
- Large catchment (>2ha) - swales and drains would need to be large and specifically designed to reduce risk of failure due to large flow depths and velocities generated from larger catchment.
- Acid sulphate soils (follow best practice guidelines).

These site characteristics don't preclude the use of swales or drains, but it may require additional design considerations and have cost implications.

Vegetated Swale
Photo: QDAFF

Drain
Photo: QDAFF

Position and role in a run-off treatment train

The adoption of in-paddock best management practices and appropriate location within the farm are critical to reduce the loads entering the swales and drains.

Once these preventative methods have been employed, swales and drains can be used. They alone cannot provide sufficient treatment to significantly reduce pollutant loads in farm run-off, but can provide an important pre-treatment function for other elements in a treatment train.

Swales and drains are ideally located as one of the first elements in a treatment train, removing coarse sediments from farm run-off before it enters tertiary treatment systems such as sediment basins or constructed wetlands (Figure 2).

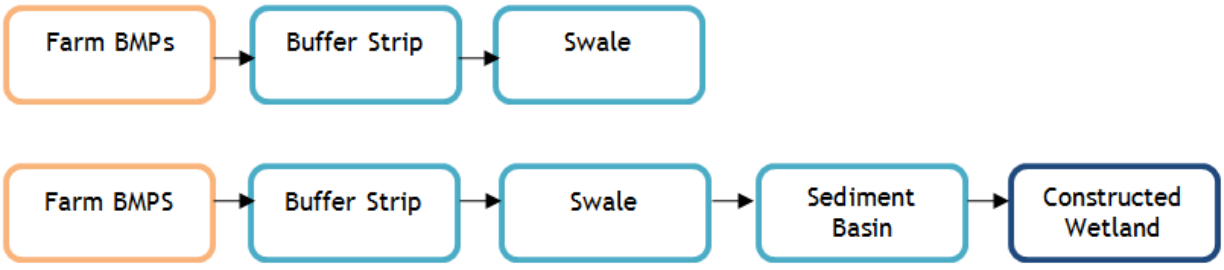


Figure 2 – Possible locations of vegetated swales and drains in farm run-off treatment trains.

Design, construction and maintenance

Design requirements

For water quality improvement functions, swales and drains should focus on ensuring frequent storm flows (typically up to the 3 month Average Recurrence Interval flow (ARI)) are conveyed within the swale or drain profile. Flows above these levels should exit the farm via breakout and overflow channels as these high flows can damage the swales and drains. In most cases, a swale or drain will also be required to provide a flow conveyance function as part of a larger drainage system.

The design of vegetated swales and drains should consider the following design features:

Batter slope and depth

Depth and batter slope will influence the conveyance capacity and overall footprint (top width) of the swale or drain and should be designed with consideration of maintenance (mown/slashed edges shouldn't be steeper than 1 in 4) and vehicle crossings (at grade crossings shouldn't be steeper than 1 in 9). For vegetated swales the floor of the drainage path should be configured to have a flat cross section.

Width

Width will be driven largely by the available space, but the greater the width, the greater the conveyance and treatment capacity for a shallow swale or drain.

Length

Length will be driven by the available space but the greater the length the greater the area for treatment.

Soils

Soils need to be appropriate to support construction of swales and drains and not be erosive.

Longitudinal slope

The longitudinal slope of the drainage path should be between 0.5% and 5%. A steeper longitudinal slope will still provide an effective drain, but can increase erosion risk and diminish treatment effectiveness.

Additional design considerations:

Weed management

Densely vegetated emergent macrophytes (reeds and sedges) within the swale or drain can make it difficult for weeds to establish by occupying the habitat.

Flow velocities

Velocities within swales and drains should be kept low, preferably less than 0.1m/s for frequent flows and less than 2 m/sec in major storm events to prevent damaging the vegetation.

Check dams

If check dams are required to manage flow velocities (e.g. on steep sites), these can be small e.g. 100mm rock weirs or equivalent, placed along the base of the swale to slow flows and protect it from scour. A rule of thumb for locating check dams is for the crest of a downstream check dam to be at 4% grade from 100mm below the toe of an upstream check dam (Figure 3).

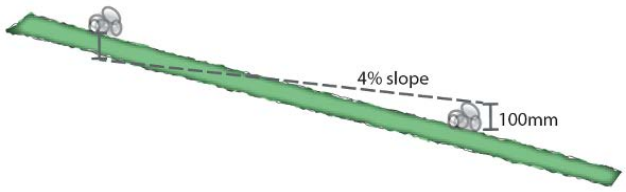


Figure 3 – Rock check dams on base of steep swales/drains

Design checklist:

Vegetated drain:

- Upstream catchment <2ha
- 1 in 4 batters
- Longitudinal slope less than 5%

Vegetated swale:

- Upstream catchment <2ha
- Batters between 1 in 4 and 1 in 9 (for vehicle access)
- Longitudinal slope between 0.5% and 5%
- Floor of swale has a flat cross section
- Swale is able to drain completely

Typical construction issues

Existing vegetation and approvals

Swales and drains should be established to minimise impacts on existing wetlands/waterways and native vegetation. Typically, swales and drains would be located within the production area. The likelihood of requiring a clearance approval would be low.

Earthworks

Swales and drains will require some earthworks to create the conveyance/treatment channel. The amount of earthworks should be minimal to avoid disturbing acid sulfate soils and shallow bedrock. Exposing bare soils should be minimised during construction to reduce the risk of sediment moving off site of earthworks approvals.

Any potential changes in hydrology resulting from flows being directed into or away from existing wetlands or waterways needs to be carefully managed to avoid creek bank erosion. Also, earthworks and any changes to hydrology within the vicinity of an area mapped as a wetland protection area may require an approval.

Planting and establishment

Swales and drains need to be well vegetated with grasses, sedges and rushes. The most cost effective approach is to seed the system with a mix of native species or if suitable vegetation exists nearby on farm, allow the vegetation to recruit or colonise naturally. Natural recruitment however increases the risk of erosion, weeds and increased maintenance.

Use local guidelines if they are available to assist with plant selection or contact your local Landcare or NRM group. Natural wetlands and riparian zones are a good reference from which to create a species template.

The dry season is the best time to establish vegetation in the swales and drains to reduce the risk of erosion. This allows for adequate establishment/root growth before the heavy summer rainfall period. Establishing it early in the dry season allows for growth of the root system while the ground is still moist. Some watering may still be required during the dry season.

Cost implications/risk

The risk of not achieving the desired design planting densities is poor treatment performance and the colonisation of weeds. Therefore it is important that the vegetation in the swales and drains is established successfully.

Swale being established in new block
Photo: QDAFF

Maintenance

Swales and drains rely on good vegetation for optimal treatment, therefore ensuring adequate vegetation growth is the key maintenance objective for these systems. Plant cover should be at least 80% with plants not slashed lower than 300mm.

Typical maintenance of swales and drains can be done with slashers or by hand and will involve:

- Removing weeds and pest habitat (slashing, not spraying).
- Reseeding of to achieve design densities.
- Irrigating vegetation, if required. This could be necessary if headlands and tracks are the swales and are damaged by machinery during harvest. Irrigation may be needed to re-establish cover before the onset of the wet season.
- Removing sediment where it is building up and impeding flows. This should be done during the dry season and removed sediment should be disposed of in the farm blocks, away from drainage lines.
- Filling in any areas impacted by erosion especially if it is creating isolated pools.
- Protecting boggy, wet swales from traffic. As part of farm BMP wet season routes need to be identified.

Swales and drains should be inspected every six months and before the wet season to ensure they are ready to receive run-off.

Further information

This fact sheet is part of a series on run-off treatment systems, as listed below. The Wetland Management Handbook provides more detail on treatment structures and general farm management to improve water quality leaving farms.

These resources and other wetland management tools and guides are available at http://wetlandinfo.ehp.qld.gov.au/wetlands/management/wetland-management/

Number	Publication Title
Fact sheet 1	Farm runoff treatment systems—toolkit
Fact sheet 2	Buffer strips
Fact sheet 3	Vegetated swales and drains
Fact sheet 4	Sediment basins
Fact sheet 5	Constructed (treatment) wetlands

These factsheets were developed by the Queensland Department of Agriculture, Fisheries and Forestry (QDAFF), Healthy Waterways and E2DesignLab with funding from the Queensland Wetlands Program.

The Queensland Wetlands Program supports projects and activities that result in long-term benefits to the sustainable management, wise use and protection of wetlands in Queensland. The tools developed by the Program help wetlands landholders, managers and decision makers in government and industry. The Program is a joint initiative of the Australian and Queensland governments.

Contact wetlands@ehp.qld.gov.au
or visit www.wetlandinfo.ehp.qld.gov.au

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