

SOURCE / SITE CONTROL

SWALES



Example of a Swale

PRIMARY CONSIDERATIONS	
Construction Cost	MEDIUM
Maintenance Requirements	MEDIUM
Land Take	LOW

BENEFITS	
<input checked="" type="checkbox"/> Water Quality Control	YES
<input checked="" type="checkbox"/> Water Quantity Control	YES
<input checked="" type="checkbox"/> Amenity Value	NO
<input checked="" type="checkbox"/> Habitat Creation Value	YES
<input checked="" type="checkbox"/> Biological Treatment	NO

DESCRIPTION

Swales are channels lined with grass, which are used to convey run-off to infiltration and in the process trap pollutants and reduce run-off velocity. Pollutant removal is achieved by the filtering channel vegetation, sub-soil matrix, and/or infiltration into the underlying soils. Swales are particularly suitable for controlling run-off from small residential developments, parking areas and roads.

DESIGN

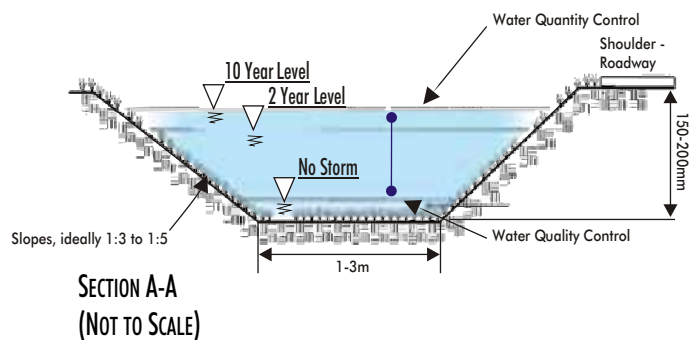
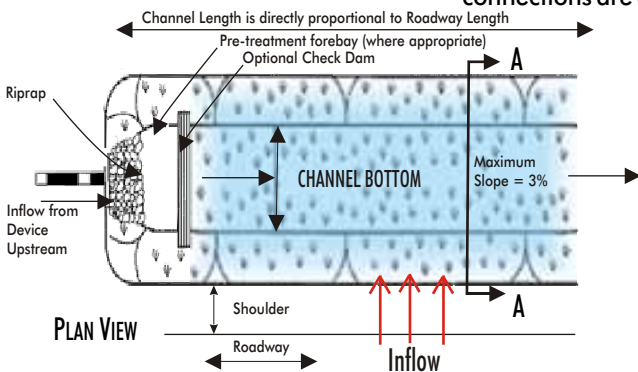
- ◆ Trapezoidal or parabolic cross section with relatively flat side slopes (less than 3:1) to maximise contact with the vegetation thus enhance treatment.
- ◆ Position along the side of the impervious area that they drain to facilitate sheet flow.
- ◆ Kerb cuts or a low earth weir may be required at the edge of the swale to admit flow.
- ◆ Point inflows should be minimised to prevent erosion.
- ◆ Outflow can be :

- ◆ The use is constrained to where saturation of the soil is unlikely.
- ◆ The width of the base should not exceed 3m to prevent the formation of small channels or gullies.
- ◆ Slopes should be 1-3%, if longitudinal slope > 4%, incorporate check-dams to reduce effective slope, run-off velocities and consequent potential for erosion.
- ◆ Accuracy of grading is essential, as departure from design slopes will reduce effectiveness of treatment (Minnesota Urban Small Sites BMP Manual).
- ◆ The swale should be wider than deep, minimising any safety risks.
- ◆ The depth of flow should not exceed 0.1m.
- ◆ Flow Velocity should be less than 0.3m/s (CIRIA, 2000).
- ◆ Design to empty within 24 hours of a storm.
- ◆ Install an underdrain, typically a gravel layer encasing a longitudinal perforated pipe, beneath the soil layer to assist infiltration (filter drains) in most cases.
- ◆ Construct the base at least 1.5m above the maximum groundwater level and only where the groundwater classification allows.
- ◆ Hydraulic Design should avoid flooding for 1:30 year storm. For 100 year events property flooding should not take place and overland flows should not pass from the site and cause flooding to other areas.



Swale Drain in Residential Area, Scotland

- A) Invert Level: (Rough channel); Water level is a function of normal depth or of the throttle and in-flow rate. Not advisable to meet either volume reduction or attenuation targets for design events.
- B) High Level: (Mini-retention basin combined with a conveyance channel); "Deep" water allows low values of conveyance velocity to be determined, which will reduce scour. Appropriate where soil conditions are relatively permeable or under drainage is provided.
- C) Infiltration: (Not a conveyance channel); All in-flows infiltrated naturally or a land drainage pipe is used below the swale to ensure winter saturated conditions do not prevent infiltration taking place. Considerably less risk of erosion problems. Pipe connections are avoided.



MORE OVERLEAF - 1 of 2

SWALES

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DESIGN

- ◆ Size pipes, as large as possible, connecting swales under driveways and roads to provide clogging.
- ◆ In areas where infiltration is not possible under-drains can be incorporated into the design (filter drain design) and the filtered run-off can be returned to the sewer network or outfall to watercourses.
- ◆ Swales should treat areas of 5 hectares or less.
- ◆ A thick vegetation cover is needed for proper function.
- ◆ Grass species should be selected taking into account their vigorousness, the soil type, their ability to tolerate silt and the available light. Should also be tolerant to periodic inundation and exposure to flow velocities.
- ◆ Native grasses are best for enhancing bio-diversity and wildlife.
- ◆ During construction, it is important to stabilise the channel before the turf has been established, either with a temporary grass cover or with the use of natural or synthetic erosion control products.
- ◆ Protect from construction run-off.
- ◆ No flow should be routed through the swale, until the vegetation becomes established.
- ◆ Avoid end of pipe swales, as they are susceptible to erosion.

POLLUTANT REMOVAL

A study by the Centre for Watershed Protection Monitoring suggest relatively high removal rates for some pollutants (TSS) but addition of bacteria and fair performance for phosphorus. A suggested source for the bacteria is dog faeces.

The Centre for Watershed Protection Monitoring studies carried out in Scotland (Macdonald 2002) have shown an overall improvement in the quality of run-off from swales. The results also suggested that a gravel layer below the soil, a shallow slope and a raised outlet enhances performance. Details of other studies are available from the (US) National Stormwater Best Management Practices Database. (www.bmpdatabase.org)

MAINTENANCE CONSIDERATIONS

Mowing in the first year is critical in order to eliminate competition from weeds. Lawn-mowing to an ideal height of 100mm should be maintained (CIRIA, 2000), as grasses tend to flatten down when water is flowing over them, reducing sedimentation.

Maintenance includes:

- ⋮ Periodic litter removal.
- ⋮ Occasional stabilisation of eroded side slopes and base.
- ⋮ Sediment clean-up may be needed on good occasion.
- ⋮ Check regularly for formation of any rills, channels or gullies.

The preservation of swales for the express purpose of serving roads will require these verges to be retained by the local authority and not located within private land.

INTERNATIONAL EXPERIENCE



Scotland

In Scotland, many swales have been located in inappropriate places and so-called end of pipe 'swales' have been fitted in to the available space on the periphery of the site. This has led to erosion problems in many of the systems. Another problem has been careless attention to detail, e.g.; the base of a swale slightly higher than the road, it was supposed to drain.

Pollutant	Removal (%)
TSS	81
TP	29
Nitrate	38
Metals	14-55
Bacteria	-50

ADVANTAGES

- ☑ Provides pollutant removal.
- ☑ Controls peak discharges by reducing run-off velocity.
- ☑ Linear nature makes them work well for treating highway and residential road run-off.
- ☑ Little water ponding on surface except during large storms.
- ☑ Shallow side slopes make them easy to mow.
- ☑ Operational problems or failures are easily detected on the surface.
- ☑ Can be used to link up other types of SUDS creating green wildlife corridors which can also provide aesthetic value.
- ☑ Can be used on most soils.
- ☑ Minimum safety concerns.
- ☑ Relatively inexpensive, simple to build and maintain.
- ☑ Maintenance not technically complicated; mainly involves lawn-mowing.

LIMITATIONS

- ☒ Individual swales can only treat a small area.
- ☒ Roadside swales may be subject to damage from off street parking (although bollards can be used to prevent this).
- ☒ Do not appear effective in reducing levels of bacteria in run-off.
- ☒ Limits the location of trees on roadside verges.
- ☒ Depth requires careful design for the accommodation of services.



FROM PREVIOUS - 2 of 2

