Grass Linings

DRAINAGE CONTROL TECHNIQUE

Low Gradient	✓	Velocity Control		Short Term	
Steep Gradient	[1]	Channel Lining	✓	Medium-Long Term	✓
Outlet Control		Soil Treatment		Permanent	✓

[1] May be used on short, steep slopes (i.e. batter chutes) if the water depth is shallow and the maximum allowable flow velocity is not exceeded.

Symbol 

Photo 1 – Grass-lined flow diversion channel

Photo 2 – Grass-lined flow diversion bank

Key Principles

1. The principal hydraulic design parameter either the allowable flow velocity or allowable shear stress.
2. The key operational issue is the control of surface flow (with respect to location and velocity), including preventing the diversion of water flow along the up-slope edge of the turf.

Design information

Minimum longitudinal grade of 0.2% or 1 in 500.

Typical Manning's (n) roughness values for grass 50–150mm blade length are presented in Table 1. It should be noted that significant variations could occur in the channel roughness depending on the type, health and density of grass.

Maximum allowable flow velocities are presented in Table 2 for various soil types, channel gradients and percentage grass cover.

Recommended maximum channel bank slopes of 3:1(H:V) for non-mowable banks, and 4:1(H:V) for mowable banks. Channel bank slopes of 6:1(H:V) or flatter are recommended adjacent to roadways for reasons of safety.

In circumstances where concentrated flows are likely to occur immediately after establishment of the drain, then the general design option are:

- specify an appropriate *Erosion Control Mat* with grass seeding;
- install velocity control *Check Dams* to limit flow velocities to those acceptable for the unprotected soil;
- specify turf (sod) anchored with wooden pegs;
- specify pre-grown reinforced grass (*Turf Reinforcement Mats, TRMs*).

Table 1 – Manning's roughness for grassed channels (50–150mm blade length) [1]

Hydraulic radius (m)	Channel slope (%)					
	0.1	**0.2**	**0.5**	**1.0**	**2.0**	**5.0**
0.1	—	—	—	0.105	0.081	0.046
0.2	—	0.091	0.068	0.057	0.043	0.030
0.3	0.078	0.064	0.053	0.043	0.031	0.030
0.4	0.063	0.054	0.044	0.033	0.030	0.030
0.5	0.056	0.050	0.038	0.030	0.030	0.030
0.6	0.051	0.047	0.034	0.030	0.030	0.030
0.8	0.047	0.044	0.030	0.030	0.030	0.030
1.0	0.044	0.044	0.030	0.030	0.030	0.030
>1.2	0.030	0.030	0.030	0.030	0.030	0.030

[1] Values are presented to three significant figures for convenience, but this should not imply the values are accurate to three significant figures. A Manning's roughness of 0.03 is adopted for hydraulic radius greater than 1.2 metres in accordance with recommendations of original research, however this may not always be appropriate.

Table 2 – Maximum allowable velocities for bare earth and grassed channels [1]

Channel gradient (%)	Percentage of stable vegetal cover			
	0	**50**	**70**	**100**
Erosion resistant soils:				
1	0.7	1.6	2.1	2.8
2	0.6	1.4	1.8	2.5
3	0.5	1.3	1.7	2.4
4		1.3	1.6	2.3
5		1.2	1.6	2.2
6			1.5	2.1
8			1.5	2.0
10			1.4	1.9
15			1.3	1.8
20			1.3	1.7
Easily eroded soils:				
1	0.5	1.2	1.5	2.1
2	0.5	1.1	1.4	1.9
3	0.4	1.0	1.3	1.8
4		1.0	1.2	1.7
5		0.9	1.2	1.6
6			1.1	1.6
8			1.1	1.5
10			1.1	1.5
15			1.0	1.4
20			0.9	1.3

[1] Adapted from Natural Resources & Mines (2004)

Photo 3 – Example of up-slope edge of turf that can redirect water flow

Photo 4 – Undesirable rilling along edge of turf caused by lateral inflows

Photo 5 – Lateral turf strips can reduce the risk of flow diversion along up-slope edge of turf

Photo 6 – Turf should be anchored with wooden pegs, not metal staples

Photo 7 – Placement of turf in a "stretcher bond" form to reduce the risk of rill erosion occurring between individual strips of turf (flow is from top to bottom of photo)

Photo 8 – Check dams and sediment traps placed on turfed drains can cause flow bypassing and erosion (rilling) along the edge of the turf

Manning's roughness for grass:

In addition to Table 1, the following equations exist for 50-150mm grass:

Findlay & Ellul (1976) $$n = 0.027 + \frac{0.00534}{(V.R)^{0.75}}$$ (units: V [m/s], R [m])

Witheridge (2007) $$n = \frac{R^{0.167}}{5124 + 20.77 \log(R^{1.4}.S^{0.4})}$$ (units: R [m], S [m/m])

Lateral strips of turf (Figures 1 & 2 and Photo 7) can be incorporated into *Grass Filter Strips* to reduce the risk of erosion along the up-slope edge of the turf. These lateral turf strips are only required if the *Grass Filter Strips* are **not** placed along the contour.

Such flow control techniques can also be utilised when turf is used a surface lining in drainage channels and chutes to reduce the risk of the types of erosion observed in Photo 4.

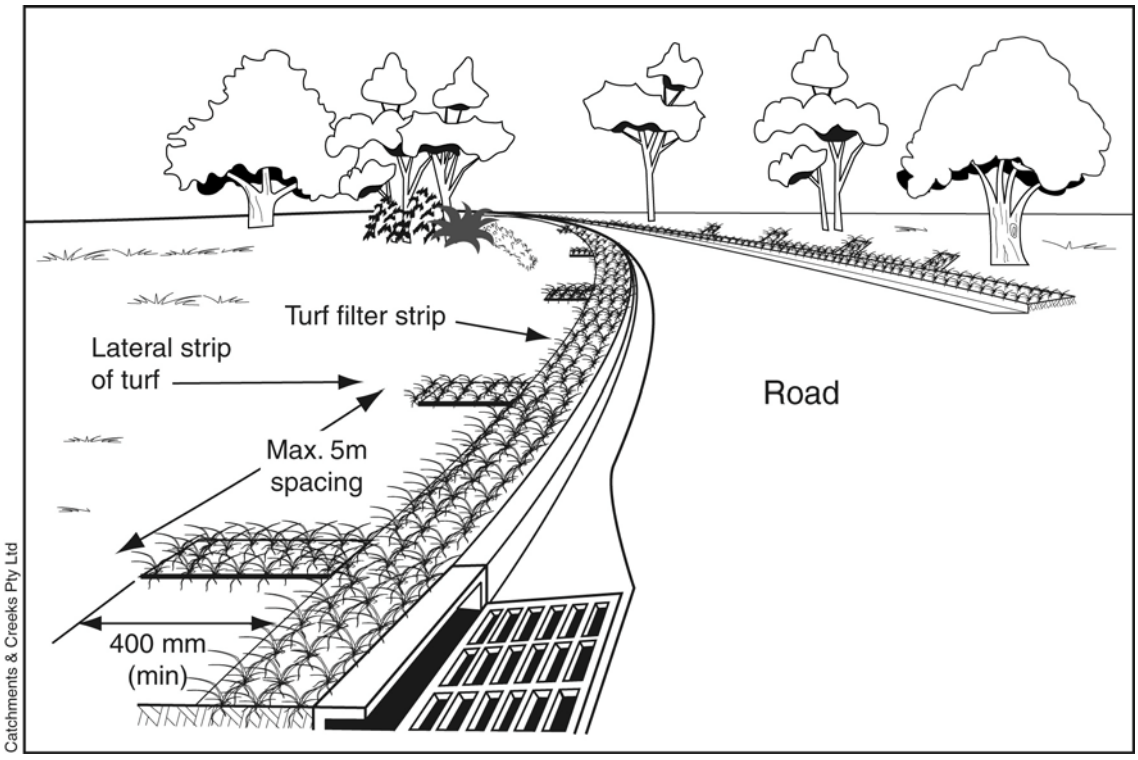

Figure 1 – Use of lateral strips of turf to control rilling along the up-slope edge of a roadside grass filter strip

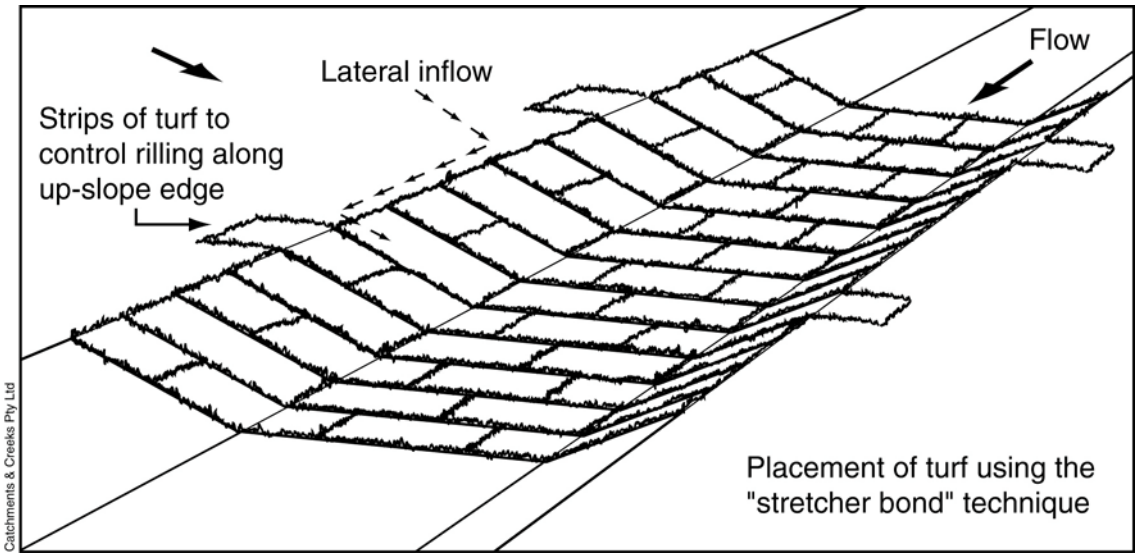

Figure 2 – Placement of turf in high-velocity drainage channels and chutes

Permanent grass-lined drains must be formed in a manner and profile that allows all necessary ongoing maintenance, including if necessary, mowing.

If the drain is going to be used as a **permanent stormwater treatment swale**, then the channel should have a flat base with a bed width of 0.6 to 2.5 metres. Maximum desirable flow velocity of 0.5m/s during the nominated design (treatment) storm. Always seek specific design information from the relevant regulating authority.

Description

Channels and chutes lined with grass either developed from seed, or the placement of turf.

Purpose

Used as a channel liner in temporary and permanent channels and short, low-velocity chutes.

Limitations

Non-reinforced grass channels are limited to a design velocity of around 1.5 to 2m/s with a minimum slope of 0.2%.

Advantages

The grass can remove sediment and nutrients during periods of low flow, thus improving the site's overall discharge water quality.

Disadvantages

Minor erosion and soil saturation problems can occur if subjected to a constant trickle flow.

In permanent drainage channels, a concrete invert or underground low-flow pipe may be required to alleviate mosquito and soil saturation problems.

Common Problems

Rill erosion can occur along the upper edge of the turf if it is not properly laid.

Early failure of a channel can result if the grass or turf is established directly on a dispersive soil.

Invert erosion can be result from high velocity flows occurring during the grass establishment period (grass seeding).

Turf strips can be displacement by high velocity flows if such flows occur within the first few weeks after placement.

Special Requirements

A uniform and complete grass cover is usually required to control soil erosion.

May require diversion of flows while grass is being established (grass seeding).

Requires placement of a suitable topsoil layer prior to seeding or laying turf.

Turf is normally placed transversely on ripped subsoils that have been covered with a 75mm layer of topsoil.

Turf usually cannot be placed directly over a dispersive soil. A minimum 75mm layer of non-dispersible topsoil should placed over the dispersive soil prior to placement of the turf.

To avoid stormwater runoff flowing down the up-slope edge of turf, lateral strips of turf should butt the upper edge of the turf at maximum 5m intervals.

Location

Grass linings are normally used in low to medium velocity channels when the drain is intended to be a permanent or long-term drainage feature.

Site Inspection

A minimum grass strand length of 50mm should be maintained in areas of medium to high velocity flow.

Check for rill erosion around the up-slope edges of the turf.

Installation

1. Refer to approved plans for location, extent and construction details. If there are questions or problems with the location, extent, or method of installation contact the engineer or responsible on-site officer for assistance.
2. Ensure all necessary soil testing (e.g. soil pH, nutrient levels) and analysis has been completed, and required soil adjustments performed prior to planting.
3. Remove all trees, brush, stumps, and other objectionable material from the channel footprint and dispose of properly.
4. Excavate the channel and shape it to neat lines and dimensions shown on the approved plan. Ensure an adequate allowance in the excavated dimensions, typically 75mm, for the placement topsoil and turfing.
5. Remove and properly dispose of all excess soil so that surface water may enter the channel freely.
6. The procedures used to establish grass within the channel will depend upon the expected weather conditions, the type of grass, and the likely flow conditions within the channel during and immediately after planting. Ensure the adopted planting procedures are consistent with the approved plans or the recommendations of the landscape designers.

Additional requirements when laying turf within a drainage channel:

1. Turf should be used within 12-hours of delivery, otherwise ensure the turf is stored in conditions appropriate for the weather conditions (e.g. a shaded area).
2. Moistening the turf after it is unrolled will help maintain its viability.
3. Turf should be laid on a minimum 75mm bed of adequately fertilised topsoil. Rake the soil surface to break the crust just before laying the turf.
4. During the warmer months, lightly irrigate the soil immediately before laying the turf.
5. Ensure the turf is not laid on gravel, heavily compacted soils, or soils that have been recently treated with herbicides.
6. Lay the first row of turf in a straight line diagonal to the direction of flow. Stagger subsequent rows in a brick-like (stretcher bond) pattern. The turf should not be stretched or overlapped. Use a knife or sharp spade to trim and fit irregularly shaped areas.
7. Ensure the turf extends up the sides of the channel at least 100mm above the elevation of the channel bed, or at least to a sufficient elevation to fully contain the expected channel flow that is considered likely to occur within the first month after placement.
8. On channel gradients of 3:1(H:V) or steeper, or wherever erosion may be a problem, or in situations where high flow velocities (i.e. velocity > 1.5m/s) are likely within the first 2-weeks following placement, secure the individual turf strips with wooden pegs.
9. Ensure that intimate contact is achieved and maintained between the turf and the soil such that seepage flow beneath the turf is avoided.
10. Where practicable, once fixed in place, the turf should be rolled with a roller weighing 60 to 90kg/m width, then watered.
11. After rolling, lightly spread screened topsoil to replace topsoil lost from the turf and to fill any gaps between the rows.
12. Water until the soil is wet 100mm below the turf. Thereafter, watering should be sufficient to maintain and promote healthy growth.

Maintenance

1. During the initial root establishment period, check grassed channels after every rainfall.
2. After grass is established, periodically check the channel including after significant storm events.
3. Check for erosion along the edge of the turfed area. If erosion is occurring, take appropriate measures to avoid further erosion.
4. If damage has occurred, immediately initiate repairs with turf or by seeding as appropriate.
5. Remove excessive sediment deposition or debris from the channel to maintain the channel's required hydraulic capacity.
6. Maintain a healthy and vigorous grass condition whenever and wherever possible, including watering and fertilising as needed.
7. Ensure a minimum grass leaf blade length of 50mm is maintained in areas subject to medium to high flow velocities, and 20 to 50mm in low velocity areas.
8. Mowing should not be attempted until the turf is firmly rooted, usually 2 to 3 weeks after laying.
9. All reasonable measures shall be taken to collect grass clippings immediately after mowing if their removal by subsequent channel flows would contaminate sensitive downstream waterways or otherwise cause undesirable environmental harm.