1.6.4 Turfing

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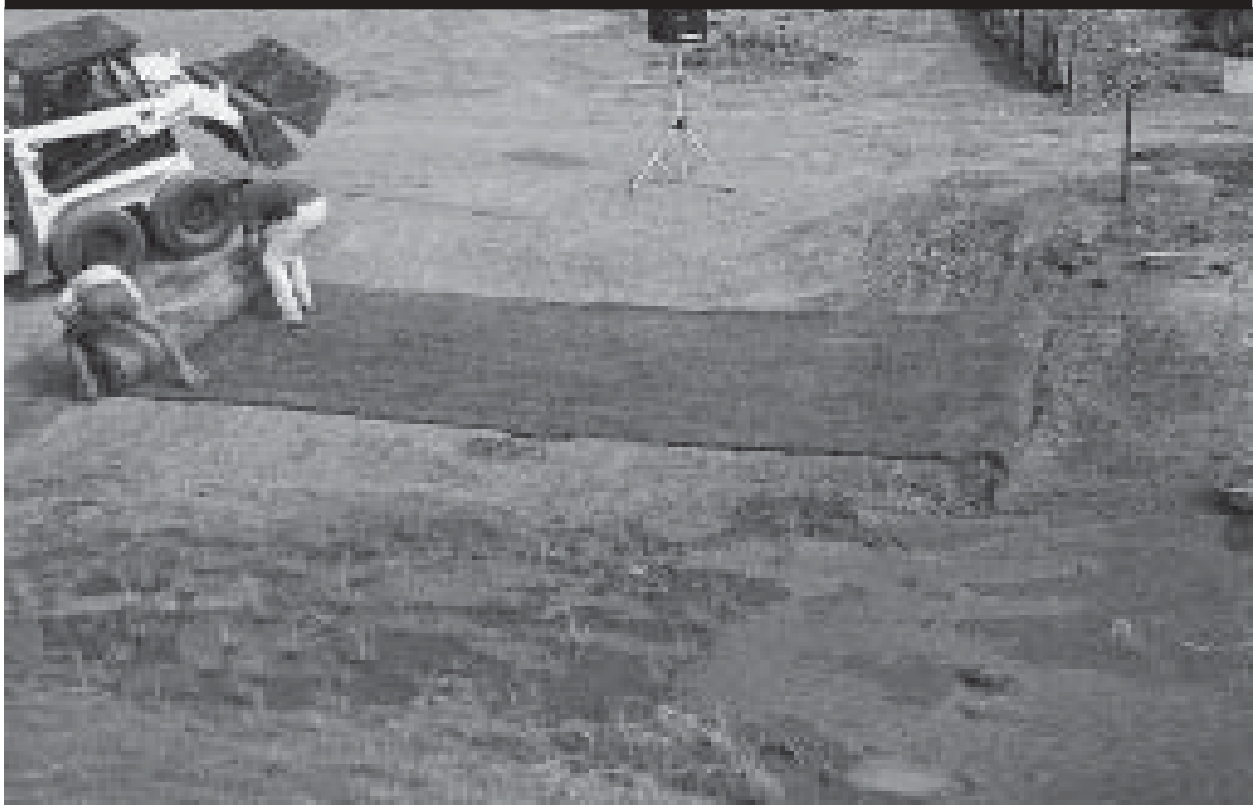


Plate 1.6.4 Turfing

Definition

The establishment and permanent stabilisation of disturbed areas by laying a continuous cover of grass turf.

Purpose

To provide immediate vegetative cover to stabilise soil on disturbed areas such as. For example:

- Critical erosion prone areas on the site.
- Critical areas on the site that cannot be stabilised by conventional sowing methods.
- Runoff Diversion Channels and other areas of concentrated flow where velocities will not exceed the specifications for a grass lining.

Application

Turfing is the preferred method for disturbed areas that must be immediately stabilised. It is particularly useful for:

- Watercourses and channels carrying intermittent flow.
- Areas around drop inlets.
- Residential or commercial lawns to allow prompt use and for aesthetic reasons.
- Steep areas.

Design

While there are no specific design criteria for Turfing, Turf reinforced with geosynthetic matting should be considered for areas of high erosion potential; for example, steep slopes or concentrated overland flow paths.

Construction Specifications

Site Preparation

Before Turfing, properly prepare the site in order to ensure the successful establishment of vegetation. This includes applying fertiliser as in Table 1.6 of these Guidelines, uniformly grading the area, clearing all debris, removing stones and clods and scarifying hard packed surfaces.

Turf Installation

During periods of high temperatures, lightly irrigate soil immediately before laying turf.

Lay the first row of turf in a straight line with subsequent rows placed parallel to and tightly wedged against each other. Stagger lateral joints in a brick-like pattern. Do not stretch or overlap turf and make sure all joints are butted tight in order to prevent voids, which can cause drying of the grass roots.

On sloping areas or channels where erosion may be a problem, lay turf downslope with the ends of the turf material overlapped such that the upslope turf overlaps the downslope turf by at least 100 mm. It may be necessary to secure the turf with pegs or staples. Ensure the turf at the top of the slope is appropriately trenched in to prevent runoff moving underneath it.

As Turfing is completed in one area, roll or tamp the entire area to ensure solid contact of the grass roots with the soil surface. After rolling, immediately water the Turf until the underside of the new turf and soil surface below the turf are thoroughly wet.

Maintenance

- Water daily during the first week of laying unless there is adequate rainfall.
- Do not mow the area until the turf is firmly rooted.
- Apply fertiliser regularly as in Table 1.6 of these Guidelines for ongoing successful establishment.

1.7 Geosynthetic Erosion Control Systems (GECS) GS

Definition

The artificial protection of channels and erodible slopes utilising artificial erosion control material such as geosynthetic matting, geotextiles or erosion matting.

Purpose

To immediately reduce the erosion potential of disturbed areas and/or to reduce or eliminate erosion on critical sites during the period necessary to establish protective vegetation. Some forms of artificial protection may also help to establish protective vegetation.

Application

- On short steep slopes.
- On areas that have highly erodible soils.
- In situations where tensile and shear strength characteristics of conventional mulches limit their effectiveness in high runoff velocities.
- In channels (both perennial and ephemeral) where the design flow produces tractive shear forces greater than in-situ soil can withstand.
- In areas where there is not enough room to install adequate sediment controls.
- In critical erosion-prone areas such as sediment retention pond outlet and inlet points.
- In areas that may be slow to establish an adequate permanent vegetative cover.
- In areas where the downstream environment is of high value and rapid stabilisation is needed.

Design

There are two categories of GECS; temporary degradable and permanent non-degradable.

Temporary Degradable GECS

These are used to prevent loss of seedbed and to promote vegetation establishment where vegetation alone will be sufficient for site protection once established. Common temporary GECS are erosion control blankets, open weave meshes/matting and organic erosion control netting (fibre mats factory-bonded to synthetic netting).

Permanent Non-Degradable GECS

These are used to extend the erosion control limits of vegetation, soil, rock or other materials. Common permanent GECS are three-dimensional erosion control and revegetation mats, geocellular confinement systems, reno mattresses and gabions.

The selection of an appropriate GECS is a complex balancing of the relative importance of the following requirements.

- *Endurance*: durability, degree of resistance to deformation over time and ultraviolet radiation and to chemicals (natural or as pollutants).
- *Physical*: thickness, weight, specific gravity and degree of light penetration. Generally a thicker heavier material will provide better protection.
- *Hydraulic*: ability of the system to resist tractive shear strength and protect against channel erosion, erosion of underlying soils or slope erosion from rainfall impact.
- *Mechanical*: deformation and strength behaviour. Tensile strength and elongation, stiffness (how well it will conform to the subgrade) and how well it will resist tractive shear forces.

When a geotextile is to be used for temporary channel or spillway protection, consider combining a high strength, low permeability cloth over a soft pliable needle punch cloth pinned to ensure the cloth is in contact with the entire soil surface. Trench and pin all flow entry points such that the upslope geotextile edge overlaps the downslope geotextile mat. Toe in the upslope end of the downslope mat.

In high risk areas such as spillways and diversions, pin geotextiles down on a 0.5 o grid or in accordance with the manufacturers' specifications, whichever provides the greatest number of contact points.

There is a large number of products available for all situations and depending on the degree of protection needed, a product or combination of products will be available to suit the situation. It is vital that the product utilised is designed for the intended use and installed

and maintained according to its specifications. Decision analysis techniques ranking the various GECS available should be used based on the following categories.

- Sediment yield (generally ranked highest)
- Stability under flow
- Vegetation enhancement
- Durability
- Cost

When installing GECS within a channel, it is important that the design velocity of the product is considered and again that the product chosen is appropriate for the use.

Many products provide for the combination of a revegetation technique and an artificial erosion control measure. Again, design specifications need to be closely followed in all cases.

Maintenance

Inspect after every rainfall and undertake any maintenance immediately.

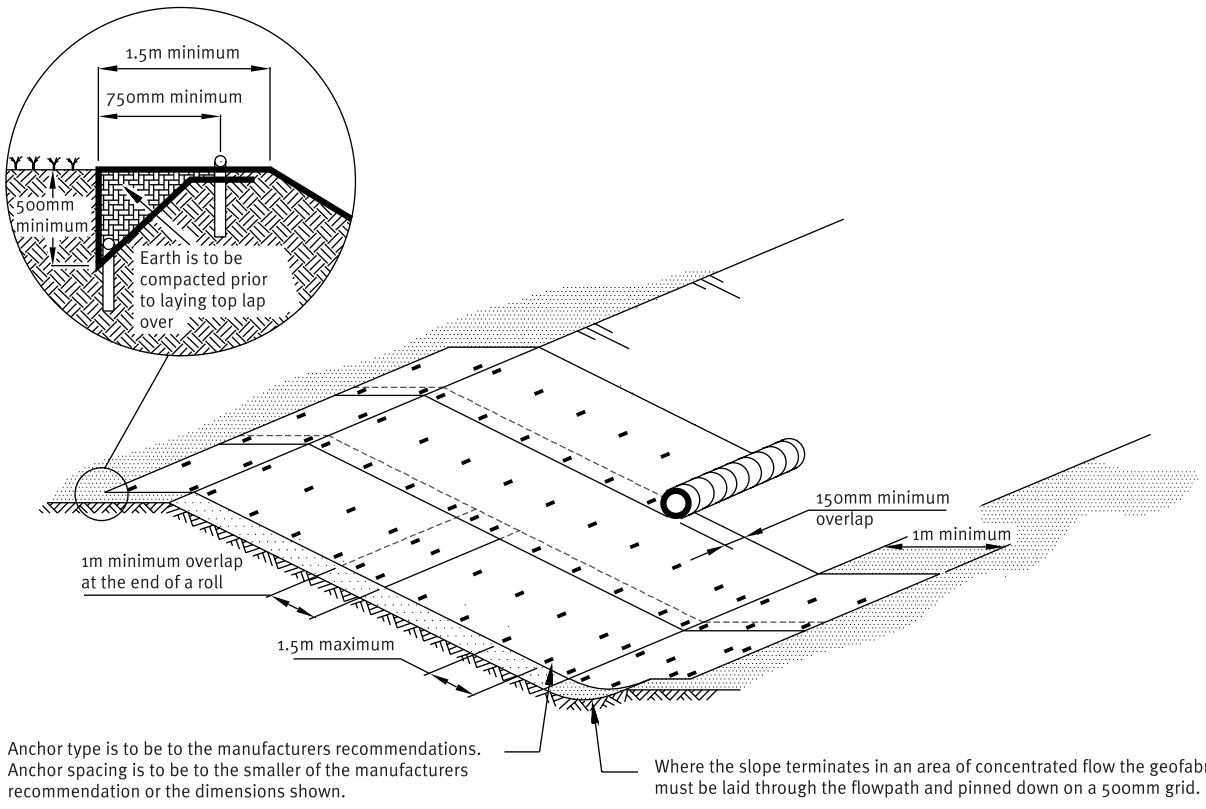


Figure 1.7.1 Geotextile Laid on Slope

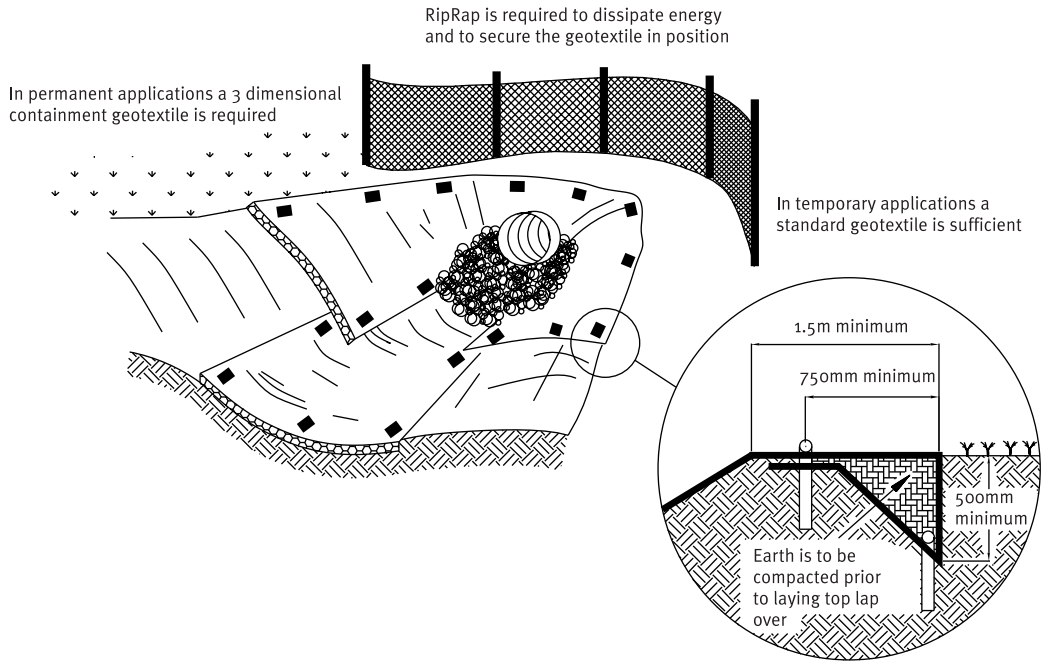


Figure 1.7.2 Geotextile at Culvert Outlet

1.8 Stabilised Construction Entrance

Plate 1.8 Stabilised Construction Entrance

Definition

A stabilised pad of aggregate on a filter cloth base located at any point where traffic will be entering or leaving a construction site.

Purpose

To prevent site access points from becoming sediment sources and to help minimise dust generation and disturbance of areas adjacent to the road frontage by giving a defined entry/exit point.

Application

Use a Stabilised Construction Entrance at all points of construction site ingress and egress with a construction plan limiting traffic to these entrances only. They are particularly useful on small construction sites but can be utilised for all projects.

Design

- Clear the entrance and exit area of all vegetation, roots and other unsuitable material and properly grade it.
- Provide drainage to carry runoff from the Stabilised Construction Entrance to a sediment control measure.
- Place aggregate to the specifications below and smooth it.

Table 1.8 Stabilised Construction Entrance Aggregate Specifications

Aggregate Size	50 – 75 mm washed aggregate
Thickness	150 mm minimum
Length	10 minimum
Width	4 o minimum

Maintenance

Maintain the Stabilised Construction Entrance in a condition to prevent sediment from leaving the construction site. After each rainfall inspect any structure used to trap sediment from the Stabilised Construction Entrance and clean out as necessary.

When wheel washing is also required, ensure this is done on an area stabilised with aggregate which drains to an approved sediment retention facility.

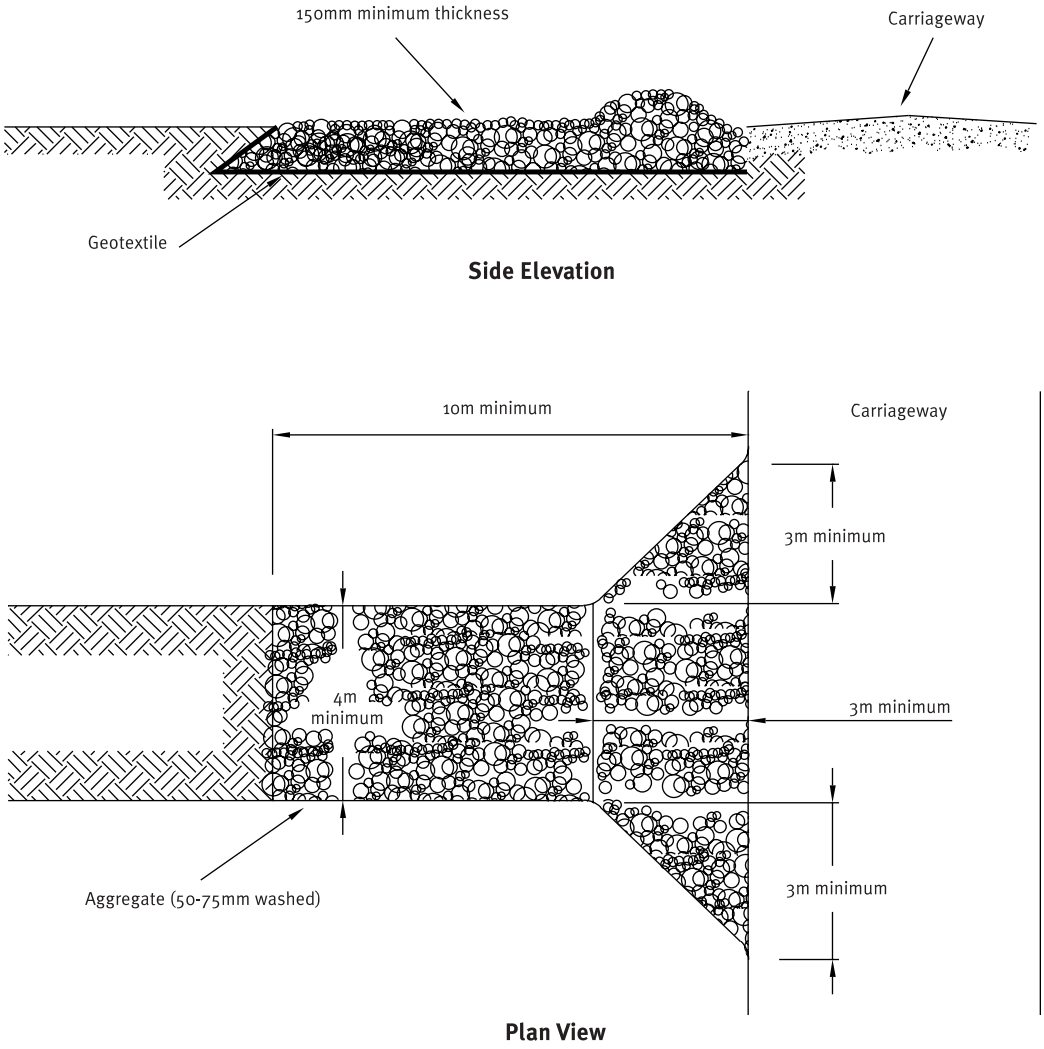


Figure 1.8 Stabilised Construction Entrance

1.9 Pipe Drop Structure/Flume

Plate 1.9 Pipe Drop Structure

Definition

A temporary pipe structure or constructed flume placed from the top of a slope to the bottom.

Purpose

A Pipe Drop Structure or a Flume is installed to convey surface runoff down the face of unstabilised slopes in order to minimise erosion on the slope face.

Application

Pipe Drop Structures or Flumes are used in conjunction with Runoff Diversion Channels. The Runoff Diversion Channels direct surface runoff to the Pipe Drop Structure or Flume which conveys concentrated flow down the face of a slope. Limit the catchment area of each Pipe Drop Structure or Flume to 1.0 ha. If other forms of Pipe Drop Structures or Flumes are being considered, Auckland Regional Council approval of those structures will be necessary on a case by case basis.

Design

- Construct all Pipe Drop Structures or Flumes of watertight materials.
- Extend the Pipe Drop Structure or Flume beyond the toe of the slope and adequately protect the outlet from erosion using riprap over a geotextile apron.
- Use of the following Design Criteria for Pipe Drop Structure, is shown in Figure 1.9.

Table 1.9 Design Criteria for Pipe Drop Structure

Pipe Diameter (mm)	Maximum Catchment Area (ha)
150	0.05
300	0.2
450	0.6
500	1.0
600	1.0

- Ensure that at the Pipe Drop Structure or Flume inlet, the height of the Runoff Diversion Channel is at least twice the pipe diameter or height of Flume as measured from the invert.
- Install a flared entrance section of compacted earth. To prevent erosion, place impermeable geotextile fabric into the inlet extended a minimum of 1.0 o in front of and to the side of the inlet and up the sides of the flared entrance. Ensure this geotextile is keyed 150 mm into the ground along all edges.
- When the catchment area is disturbed, ensure the Pipe Drop Structure or Flume discharges into a Sediment Retention Pond or a stable conveyance system that leads to a pond. When the catchment area is stabilised, ensure the Pipe Drop Structure or Flume outlets onto a stabilised area at a non-erosive velocity. The point of discharge may be protected by rock rip rap.
- Ensure the Pipe Drop Structure or Flume has a minimum slope of 3%.

Construction Specifications for Pipe Drop Structures

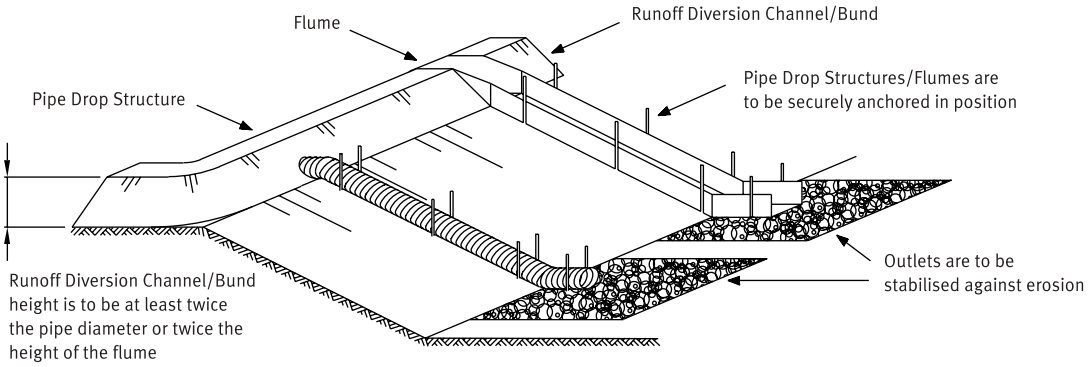
- A common cause of failure of Pipe Drop Structures is water saturating the soil and seeping along the pipe where it connects to the Runoff Diversion Channel. Backfill properly around and under the pipe with stable material in order to achieve firm contact between the pipe and the soil at all points to eliminate this type of failure. Pipe material used for the Pipe Drop Structure can consist of rigid pipe material or flexible pipe as required. If flexible pipe material is utilised, it is vital that the material be pinned to the slope in the required position.
- Place Pipe Drop Structures on undisturbed soil or well-compacted fill at locations as detailed within the Erosion and Sediment Control Plan for the site.
- Immediately stabilise all disturbed areas following construction.
- Secure the Pipe Drop Structure to the slope at least every 4 0. Use no less than two anchors equally spaced along the length of the pipe.
- Ensure all pipe connections are watertight.

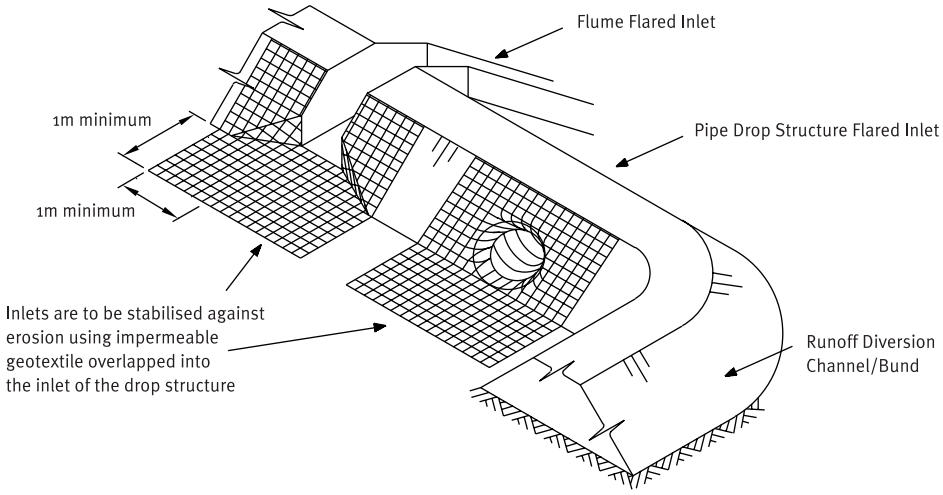
Construction Specifications for Flumes

- A common failure of Flumes is outflanking of the Flume entrance or scouring of the invert to the Flume. This can be prevented by waterproofing the entrance to the Flume by trenching in an appropriate impervious geotextile or plastic liner so that all flows are channelled directly into the flume. Alternatively a piped entrance can be installed.
- Flumes can be constructed from materials such as corrugated steel, construction ply, sawn timber or halved plastic piping.
- Construct the Flume to ensure there are no leaks. For wooden or plywood Flumes or Flumes where leakage is likely, extend an impervious liner down the full length of the Flume structure.
- For slopes greater than 30%, a Flume can be constructed from a standard 1.2 0 x 2.4 0 x 22mm plywood sheet. This will be adequate for a catchment of up to one ha. Specific design is required for larger catchments.
- Fasten the Flume to the slope using waratahs or wooden stakes placed in pairs down the slope at 1 to 4 0 spacings, depending on the Flume material used. Fasten the Flume to the waratahs or stakes using wire or steel strapping.
- Place Flumes on undisturbed soil or well compacted fill at locations as detailed in the site's Erosion and Sediment Control Plan.

Maintenance

- Inspect the Pipe Drop Structure/Flume periodically and after each rain event. Immediately carry out any maintenance required.
- Keep the inlet open at all times.





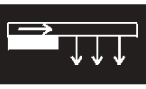
Design Criteria for Pipe Drop Structure

Pipe Diameter (mm)	Maximum Catchment Area (ha)
150	0.05
300	0.20
450	0.60
500	1.00
600	1.00

Specific designs are required for flume sizing

Figure 1.9 Pipe Drop Structure

1.10 Level Spreader



Definition

A non-erosive outlet for concentrated runoff constructed todisperse flows uniformly across a slope.

Purpose

To convert concentrated flow to sheet flow and release it uniformly over a stabilised area to prevent erosion.

The Level Spreader provides a relatively low cost option which can release concentrated flow where site conditions are suitable. Particular care is needed to ensure the Level Spreader outlet lip is completely level and is in stable, undisturbed soil or is well armoured. Any depressions in the Level Spreader lip will reconcentrate flows, resulting in further erosion.

Application

- Where sediment-free storm runoff can be released in a sheet flow over a stabilised slope without causing erosion.
- Where sediment-laden overland flow can be released in sheet flow across the inlet to a Sediment Retention Pond.
- Where the area below the Level Spreader lip is uniform with the slope of 10% or less and/or is stable for the anticipated flow conditions.
- Where the runoff water will not re-concentrate after release.
- Where there will be no traffic over the Level Spreader.

Design

- Determine the capacity of the Level Spreader by estimating peak flow from the 20 year storm.
- Where possible, choose a site for the Level Spreader that has a natural contour that will allow for the rapid spreading of flows, for example, at the end of a knoll or ridge.
- Select the appropriate length, width and depth of the spreader from Table 1.10 below.

Table 1.10 Level Spreader Design Criteria

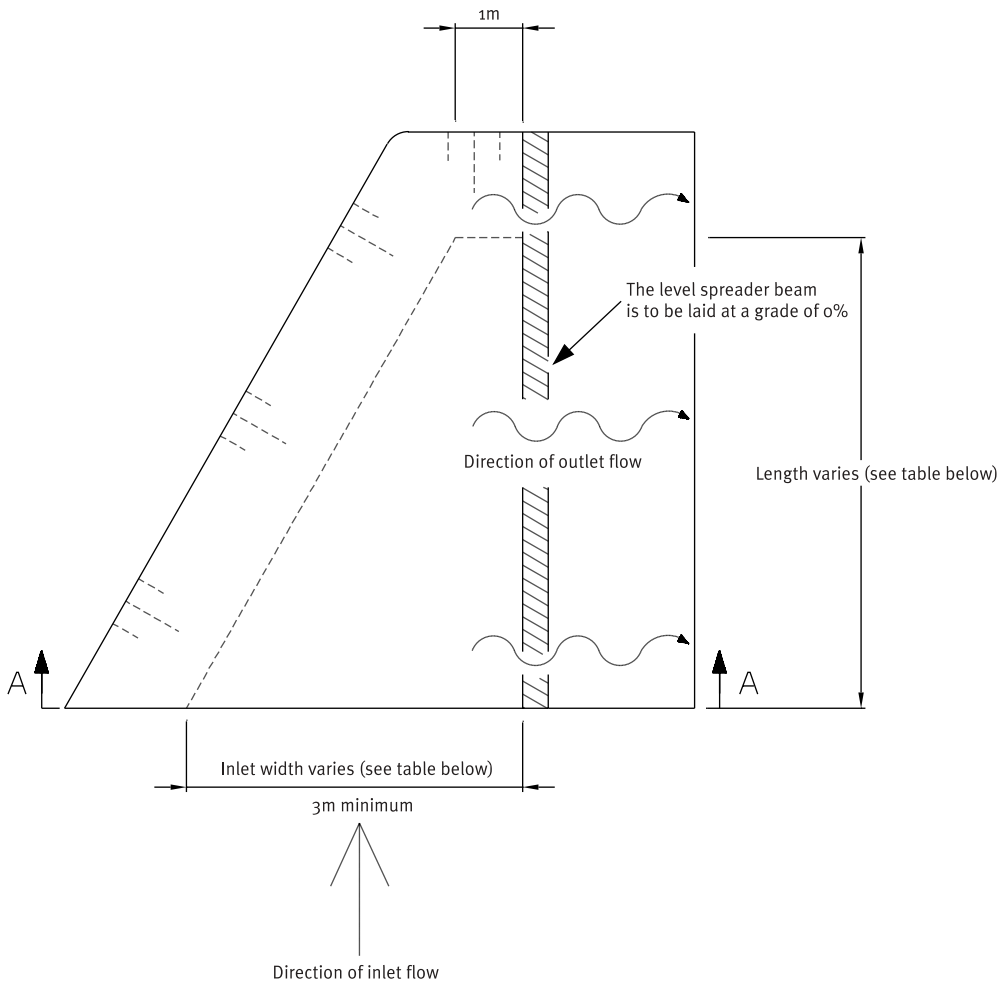
Design Flow (m^3/sec)	Inlet Width (o)	Depth (mm)	End Width (o)	Length (o)
0 – 0.3	3	150	1	3
0.3 – 0.6	5	180	1	7
0.6 – 0.9	7	220	1	10

- Construct a 6 o long transition section in the Runoff Diversion Channel leading up to the Level Spreader so the width of the Runoff Diversion Channel will smoothly meet the width of the Level Spreader to ensure uniform outflow. The Level Spreader trench tapers down to 1 o at the end of the Level Spreader.
- Maintain a minimum inlet width of 3 o.
- Ensure that the grade of the Level Spreader is 0%.
- Construct the Level Spreader lip on undisturbed soil, incorporating a 50 x 150 mm board (Spreader Beam) levelled and positioned edge on as shown below. An alternative is to armour the Level Spreader to a uniform height and zero grade over the length of the Level Spreader. Use geotextile and ensure the disturbed area is seeded and fertilised for vegetation establishment.

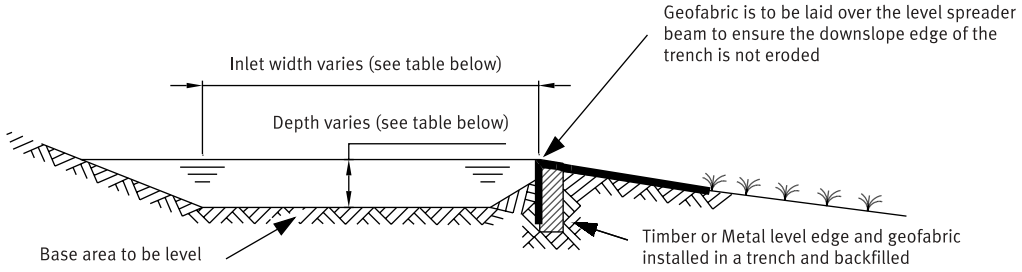
Maintenance

Inspect Level Spreaders after every rainfall until vegetation is established and promptly undertake any necessary repairs. Ensure vegetation is kept in a healthy and vigorous condition.

Figure 1.10 Level Spreader



Plan View



Section A-A

Design Flow (m^3/sec)	Inlet width (m)	Depth (mm)	End width (m)	Length (m)
0-0.3	3	150	1	3
0.3-0.6	5	180	1	7
0.6-0.9	7	220	1	10

1.11 Surface Roughening

1.11 Surface Roughening

Figure 1.11 Tracking

Definition

Roughening a bare earth surface with horizontal grooves running across the slope, or tracking with construction equipment.

Purpose

To aid in the establishment of vegetative cover from seed, to reduce runoff velocity, to increase infiltration, to reduce erosion and assist in sediment trapping.

Application

Apply Surface Roughening on all construction sites requiring slope stabilisation with vegetation, particularly on slopes steeper than 25%.

Design

Not Applicable.

Construction Specifications

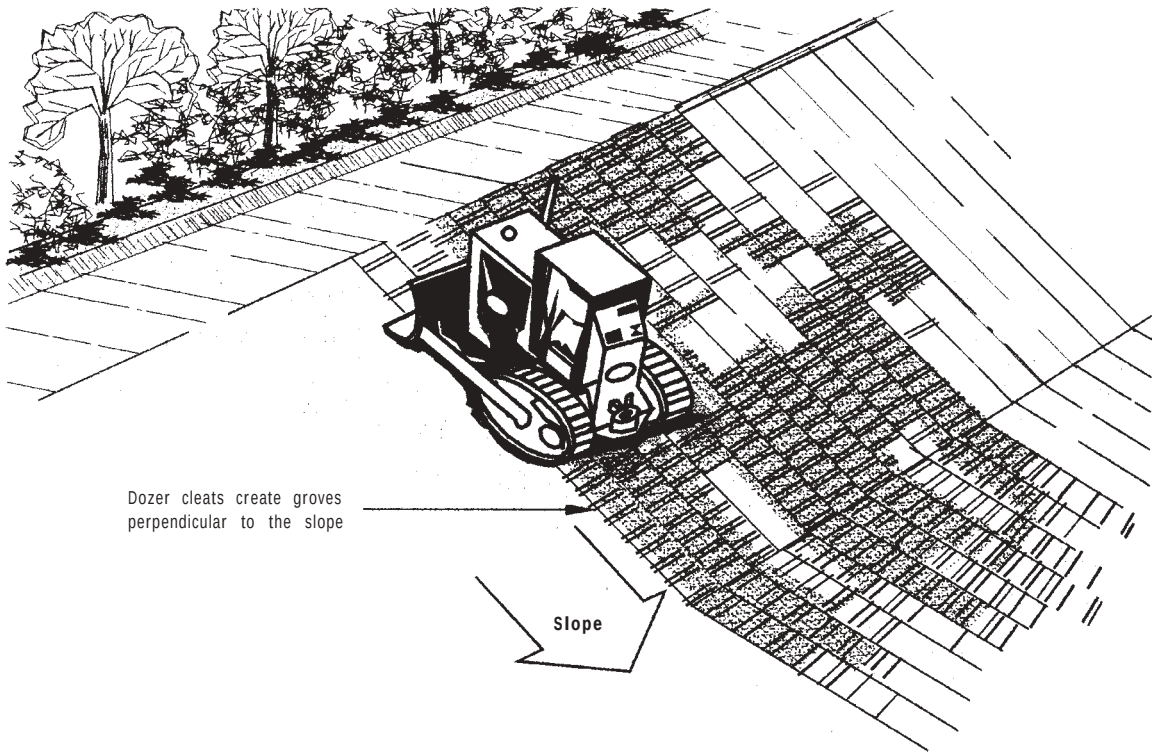
Surface Roughening is promoted by the Auckland Regional Council because it aids the establishment of vegetation, improves infiltration and decreases runoff velocity. Graded areas with smooth, hard surfaces may be initially attractive but such surfaces increase the potential for erosion. A rough, loose soil surface gives a mulching effect that protects fertiliser and seed.

Various methods are available for Surface Roughening such as stair step grading, discing and forming grooves by machinery tracking. Factors to be taken into account when choosing a method are slope steepness, mowing/maintenance requirements and whether the slope is formed by cutting or filling.

Machinery tracking up and down the slope is the recommended method, with the cleats of the machine tracks providing a series of mini contour drains, slowing overland flow down the slope and helping to keep the grass seed on the slope.

Maintenance

Periodically check the slopes for rills and washes. Reseed and/or rework the area as necessary.


Dozer cleats create groves perpendicular to the slope
Slope