Chutes Part 2: Synthetic linings

DRAINAGE CONTROL TECHNIQUE

Low Gradient		Velocity Control		Short Term	✓
Steep Gradient	✓	Channel Lining		Medium-Long Term	✓
Outlet Control	[1]	Soil Treatment		Permanent	[2]

[1] Chutes can act as stable outlet structures for *Catch Drains* and *Flow Diversion Banks*.

[2] The design of permanent chutes may require consideration of issues not discussed here.

Symbol → CH →

Photo 9 – Temporary chute lined with filter cloth

Photo 10 – Permanent concrete-lined batter chute

Key Principles

1. The critical design components of a chute are the flow entry into the chute, the maximum allowable flow velocity down the face of the chute, and the dissipation of energy at the base of the chute.
2. The critical operational issues are ensuring unrestricted flow entry into the chute, ensuring flow does not undermine or spill out of the chute, and ensuring soil erosion is controlled at the base of the chute.
3. Most chutes fail as a result of water failing to enter the chutes properly. It is critical to control potential leaks and flow bypassing, especially at the chute entrance.

Design Information

The material contained within this fact sheet has been supplied for use by persons experienced in hydraulic design.

The following information must be read in association with the general information presented in *Part 1 – General information*.

Part 2 of this fact sheet addresses design issues for chutes lined with materials such as:

- non-woven filter cloth (commonly used for short-term batter chutes);
- woven fabrics, which can include *Erosion Control Mats* and *Sediment Fence* fabric;
- rolled plastic sheeting;
- corrugated sheet iron;
- concrete.

The design procedure outlined within this fact sheet has been developed to provide a simplified approach suitable only for those involved in the regular design of temporary drainage chutes. The procedure is just **one** example of how chutes can be designed.

Tables 8 and 9 provide guidance on the selection of an allowable flow velocity for various categories of temporary erosion control mats. Wherever possible, the allowable velocity and/or allowable shear stress should be obtained from the manufacturer/distributor of the chosen product.

In circumstances where the manufacturer/distributor supplies only the allowable shear stress, then an equivalent allowable flow velocity can be determined from Table 11.

Table 8 – Allowable flow velocity for various erosion control mats

Type	Description	Allowable velocity	Comments
Non-woven fabric	Filter cloth	Typically around 1.0 to 1.5m/s	• Minimum 'bidim' A24 or equivalent. • Assume an allowable velocity of 1.0m/s when placed on medium erodible soils, and 1.5m/s when placed on low erodible soils.
Woven fabric	Blankets reinforced with synthetic mesh	1.6 to 3.6m/s	• Allowable flow velocity depends on soil erodibility and strength of the mat. • Warning: debris and wildlife (e.g. birds and reptiles) can become entangled in the mesh.
Erosion control mesh	Jute mesh sprayed with bitumen	Refer to Table 9	• Typical design life of 1 year. • Allowable flow velocity depends on the soil's erosion resistance.

Table 9 – Allowable flow velocity for temporary channel linings [1]

Anticipated inundation =	Less than 6 hours			Less than 24 hours		
Soil erodibility =	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
Jute or coir mesh sprayed with bitumen, and Coconut/jute fibre mats	2.3	2.0	1.7	1.7	1.5	1.3

Source: Landcom (2004)

Erosion control blanket/mat classification system:

A classification system for erosion control blankets and mats (e.g. Class 1, Type A) is provided in Table 10. In general terms, this classification system is based on the following distinctions.

Class 1 includes those temporary, light-duty Rolled Erosion Control Products (RECPs) that are primarily used in areas of 'sheet' flow, and thus are termed *Erosion Control Blankets*.

Class 2 includes those temporary, heavy-duty Rolled Erosion Control Products (RECPs) that are primarily used in areas of medium shear stress such as drainage channels. These products are termed *Blankets or Mats* depending on their use.

Class 3 comprises permanent, heavy-duty Rolled Erosion Control Products (RECPs) that are primarily used in areas of high shear stress such as drainage channels and spillways/chutes.

Class 3 Type B, C and D Turf Reinforcement Mats (TRM) are permanent, 100% synthetic, open-weaved mats that shall be continuously bonded at the filament intersections.

Table 10 presents the flow stability properties of erosion control blankets and mats in terms of permissible shear stress measured in units of Pascals (Pa). Permissible shear stress is considered a more reliable measure of blanket's resistance to damage by water flow and is the measure typically used within Europe and USA; however, allowable flow velocity is more commonly used within Australia.

Table 11 defines the relationship between allowable shear stress (Pa) and allowable flow velocity (m/s) for various values of hydraulic radius (R) and assumed Manning's n roughness presented within the table. The table is therefore appropriate for non-vegetated, three-dimensional turf reinforcement mat (TRM) such as Class 3, Types B, C and D mats.

Table 10 – Classification of erosion control mats

Class	1						2			3			
Type	**A**	**B**	**C**	**AU**	**BU**	**CU**	**A**	**B**	**C**	**A**	**B**	**C**	**D**
Permissible shear stress (Pa)	N/A	50	70	N/A	50	70	N/A	95	95	95	95	170	240

[1] For more information on this classification system, refer to the fact sheet on *Erosion Control Mats*.

Table 11 – Equivalent allowable flow velocity (m/s) for a given permissible shear stress (Pa) for non-vegetated turf reinforcement mats

Assumed Manning's roughness	Hydraulic radius (m)	Permissible shear stress (Pa)						
		50	**70**	**95**	**100**	**150**	**170**	**240**
0.06	**0.05**	0.65	0.72	0.79	0.85	0.91	0.97	1.02
0.04	**0.10**	1.09	1.22	1.33	1.44	1.54	1.63	1.72
0.036	**0.15**	1.29	1.45	1.58	1.71	1.83	1.94	2.05
0.033	**0.20**	1.48	1.66	1.81	1.96	2.09	2.22	2.34
0.031	**0.25**	1.64	1.83	2.00	2.16	2.31	2.45	2.59
0.029	**0.30**	1.80	2.02	2.21	2.38	2.55	2.70	2.85
0.026	**0.40**	2.11	2.36	2.58	2.79	2.98	3.16	3.33
0.023	**0.50**	2.47	2.77	3.03	3.27	3.50	3.71	3.91
0.02	**1.0**	3.19	3.57	3.91	4.23	4.52	4.79	5.05
0.02	**1.5**	3.42	3.82	4.19	4.52	4.83	5.13	5.40
0.02	**2.0**	3.59	4.01	4.39	4.74	5.07	5.38	5.67
0.02	**2.5**	3.72	4.16	4.56	4.92	5.26	5.58	5.88
0.02	**3.0**	3.84	4.29	4.70	5.07	5.43	5.75	6.07

Table 12 provides approximate Manning's roughness values for various materials.

Table 12 – Manning's roughness for various channel linings [1]

Material	Flow depth less than 150mm	Flow depth of 150 to 600mm	Flow depth greater than 600mm
Plastic sheeting [1]		0.013	
Concrete [1]	0.015	0.013	0.013
Asphalt [1]	0.018	0.016	0.016
Filter cloth on smooth earth	0.018	0.016	0.013
Filter cloth on rough earth	0.028	0.022	0.019
Jute mesh [1]	0.028	0.022	0.019
Wood excelsior blanket [1]	0.066	0.035	0.028
TRM – unvegetated [1]	0.036	0.026	0.020

[1] Sourced from Fifield (2001) *"Designing for Effective Sediment and Erosion Control on Construction Sites"*

Hydraulic design of synthetic-lined chutes:

Step 1 Determine the design discharge (Q) for the chute.

Step 2 Choose the preferred lining material for the chute.

Step 3 Determine the slope (S) of the chute from the site geometry. The chute should be straight, with no bends or curves, from the crest to the base of the chute.

Step 4 Determine the allowable flow velocity (V_{allow}) for the chosen lining material. The allowable flow velocities for various materials are presented in Tables 8 and 9, or Table 11 if the mat Class and/or allowable shear stress (Table 10) is known.

Step 5 Nominate the chute profile: e.g. rectangular, trapezoidal or parabolic.

Parabolic profiles are typically only used for minor, temporary drainage chutes lined with fabric.

Step 6 Determine the maximum allowable approach flow depth, 'H' (relative to the inlet crest) upstream of the chute's inlet for the nominated design discharge.

Where necessary, design and specify appropriate *Flow Diversion Banks* or the like to appropriately control the approach flow and prevent any water bypassing the chute.

Step 7 Determine the required inlet geometry of the chute using an appropriate weir equation.

If the approach channel (the channel immediately upstream of the chute's crest) is short, then the relationship between the upstream water level (H) and discharge (Q) can be determined from one of the weir equations presented in Table 1 (*Part 1 – General information*). Table 2 (Part 1) provides specific H–Q information for parabolic chutes ($T = 3.3(Y)^{0.5}$), and trapezoidal chutes with 2:1 (H:V) side slopes.

If the approach channel is long, and friction loss within this channel is likely to be significant, then an appropriate backwater analysis may be required.

Step 8 Where necessary, detail appropriate measures to control scour at the entrance to the chute (see Part 1 of this fact sheet, including Figure 3).

Step 9 Determine the Manning's (n) roughness for the material either from Table 12, or product documentation.

Step 10 Using Manning's equation, or Tables 13 to 18 (if appropriate), determine the uniform flow depth (y) and maximum flow velocity (V) down the chute.

Manning's equation: $Q = A.V = (1/n)\ A\ .\ R^{2/3}.\ S^{1/2}$

Check that the maximum flow velocity (V) does not exceed the allowable flow velocity of the nominated chute lining (determined in Step 3). If the flow velocity exceeds the allowable velocity, then redesign the chute (e.g. increase the bed width, or choose an alternative chute lining).

Step 11 Specify the required depth of the chute, being the greater of:

(i) 300mm (unless a lower depth is supported by expected flow conditions);

(ii) 0.67(H) plus minimum freeboard of 150mm; ('H' determined from Step 6)

(iii) the uniform flow depth (y) plus a minimum freeboard of 150mm, or the equivalent of the flow depth, whichever is smaller.

Step 12 Design the required outlet energy dissipation structure at the base of the chute.

Refer to Part 1 of this fact sheet or the fact sheet on *Outlet Structures*.

Design example 1: Temporary chute lined with filter cloth

Design a temporary batter chute lined with filter cloth and cut into a non-dispersive soil. The design discharge is 5L/s, the batter slope is 3:1, and the maximum allowable water level upstream of the inlet (H) is 100mm during the design discharge.

Step 1 Design discharge given as 5L/s or 0.005m^3/s.

Step 2 Lining material given as filter cloth.

Step 3 The chute slope is given as, S = 33.3% (3:1).

Step 4 Given the stable soil, choose an allowable flow velocity for the filter cloth of 1.5m/s from Table 8.

Step 5 Trial both a parabolic and trapezoidal profile for the chute.

Step 6 The maximum allowable approach flow depth given as, H = 0.1m

Step 7 Table 2 (Part 1) indicates that for a parabolic chute with side slopes of 2:1 and an approach flow depth of 0.1m, the maximum discharge is 65L/s, which exceeds the design discharge of 5L/s, OK.

For a trapezoidal chute with bed width, b = 0.3m, Table 2 indicates a maximum discharge of 24L/s, which also exceeds the design discharge of 250L/s, OK.

Both options are suitable, so try a parabolic chute.

Step 8 Due to the low flow rate, inlet scour control measures are unlikely to be necessary.

Step 9 From Table 12 choose a design Manning's roughness of 0.02 (a best guess of the expected chute conditions).

Step 10 From Table 13 is can be seen that for a Manning's roughness n = 0.02, a slope of 3:1, and with an allowable flow velocity of 1.5m/s, the maximum allowable discharge down a parabolic chute is 7.8L/s, which exceed our design discharge of 5L/s, OK.

Step 11 From Table 13 the uniform flow depth is expected to be less than 0.018m, however splash and turbulence is likely to result in a significant variation in this flow depth.

Given the shallow flow depth, choose a total chute depth, Y = 200mm. Thus the top width, $T = 3.3(0.2)^{0.5} = 1.48$m

Step 12 Design of outlet structure as per *Part 1 – General information*:

Given that the flow approaching the outlet structure is less than 50mm in depth, and the velocity is less than 2m/s, Table 5 (Part 1) indicates a required rock size, d_{50} = 100mm.

Table 6 (Part 1) indicates a length of rock protection, L = 1.0m.

From Figure 6 (Part 1), W_1 = 1.47 + 0.6 = 2.07m, and W_2 = 1.47 + 0.4(1.0) = 1.87m

Let $W_1 = W_2$ = 2m

However, given the very low flow depth and low flow velocity, it is likely that simply extending the filter cloth a length of 1.5m and width of 2m, would be sufficient to control scour at the base of the chute.

Design example 2: Temporary, concrete-lined chute

Design a temporary, concrete-lined batter chute with a design discharge of 0.25m^3/s on a batter slope of 3:1, and the maximum allowable water level upstream of the inlet (H) of 200mm.

Step 1 Design discharge given as 0.25m^3/s.

Step 2 Lining material given as concrete.

Step 3 The chute slope is given as, S = 33.3% (3:1).

Step 4 Assume an allowable flow velocity of 5m/s for the concrete. Flow velocity is unlikely to be a limiting factor in the design.

Step 5 Assume a Manning's roughness of 0.015 for rough concrete.

Step 6 Adopt a trapezoidal profile with 2:1 side slopes for the chute.

Step 7 Maximum allowable approach flow depth given as, H = 0.2m

Step 8 Table 2 (Part 1) indicates that for a trapezoidal chute with bed width, b = 1.5m, Table 2 indicates a maximum discharge of 0.273m^3/s, which just exceeds the design discharge of 0.25m^3/s, OK.

Step 9 As discussed in Part 1 of this fact sheet, to control inlet scour, it will be necessary to extend the concrete lip at least 5(H) or 1.0m upstream of the inlet crest.

Step 10 Using Manning's equation, uniform flow conditions can be determined down the chute as:

Flow depth, y = 0.04m

Velocity, V = 4.18m/s

Top width of flow, T = 1.65m

Step 11 Chute depth should be the greater of:

(i) 0.3m

(ii) 0.67(H) + 0.15m = 0.67(0.2) + 0.15 = 0.284m

(iii) y + 0.15m = 0.04 + 0.15 = 0.19m

Thus, choose a chute depth of 0.3m down the face of the slope.

Step 12 Design of outlet structure as per Part 1 – 'General Information':

Given that the flow approaching the outlet structure is less than 50mm in depth, and the velocity of 4.18m/s, Table 5 (Part 1) indicates a required rock size, d_{50} = 200mm (note; the rock size specified for a velocity of 5m/s has been chosen).

Because the outlet structure is located downstream of a smooth, concrete-lined chute, then (in accordance with the recommendations presented in Part 1) the rocks should be grouted in place to avoid displacement.

Table 6 (Part 1) indicates a minimum length of rock protection, L = 2.2m (a value interpolated between the values presented for V = 4m/s and V = 5m/s).

Table 7 (Part 1) indicates a recess depth, Z = 0.5m

From Figure 6 (Part 1), W_1 = 1.65 + 0.6 = 2.25m, and W_2 = 1.65 + 0.4(2.2) = 2.53m

Let W_1 = 2.25m and W_2 = 2.5m

Table 13 – Maximum allowable discharge and corresponding uniform flow depth

Parabolic Chute – lined with filter cloth										
Manning's n = 0.02				Top width, $T = 3.286(Y)^{0.5}$				Freeboard of 150mm (max.)		
Chute slope (H:1)	Allowable flow velocity down Chute [1]									
	0.6 m/s		0.8 m/s		1.0 m/s		1.5 m/s		2.0 m/s	
	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)
20:1	3.3	0.019	8.7	0.029	18	0.041	68	0.075	175	0.117
10:1	1.5	0.011	3.9	0.017	8.1	0.024	31	0.044	79	0.069
6:1	0.9	0.008	2.2	0.012	4.6	0.016	17	0.030	44	0.047
5:1	0.7	0.007	1.8	0.010	3.7	0.014	14	0.026	36	0.041
4:1	0.6	0.006	1.4	0.009	2.9	0.012	11	0.022	28	0.034
3:1	0.4	0.005	1.0	0.007	2.1	0.010	7.8	0.018	20	0.028
2.5:1	0.3	0.004	0.8	0.006	1.7	0.009	6.3	0.016	16	0.024
2:1	0.2	0.003	0.6	0.005	1.3	0.007	4.9	0.013	13	0.020
1.75:1	0.2	0.003	0.5	0.005	1.1	0.007	4.3	0.012	11	0.018
1.67:1	0.2	0.003	0.5	0.005	1.1	0.006	4.1	0.012	10	0.018
1.5:1	0.2	0.003	0.5	0.004	1.0	0.006	3.6	0.011	9.1	0.016
1.25:1	0.2	0.002	0.4	0.004	0.8	0.005	2.9	0.009	7.4	0.014
1:1	0.1	0.002	0.3	0.003	0.6	0.004	2.3	0.008	5.8	0.012

Note: [1] An appropriate allowable flow velocity must be selected based on site conditions.

Table 14 – Maximum allowable discharge and corresponding uniform flow depth

Parabolic Chute – lined with filter cloth										
Manning's n = 0.03				Top width, $T = 3.286(Y)^{0.5}$				Freeboard of 150mm (max.)		
Chute slope (H:1)	Allowable flow velocity down Chute [1]									
	0.6 m/s		0.8 m/s		1.0 m/s		1.5 m/s		2.0 m/s	
	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)
20:1	8.6	0.035	21	0.053	45	0.075	172	0.140	255	0.150
10:1	3.9	0.021	9.8	0.032	20	0.044	77	0.082	201	0.128
6:1	2.2	0.014	5.5	0.022	11	0.030	43	0.056	112	0.087
5:1	1.7	0.012	4.5	0.019	9.3	0.026	35	0.049	90	0.075
4:1	1.4	0.010	3.5	0.016	7.1	0.022	27	0.041	70	0.064
3:1	1.0	0.008	2.5	0.013	5.2	0.018	20	0.033	51	0.051
2.5:1	0.8	0.007	2.0	0.011	4.2	0.016	16	0.029	41	0.044
2:1	0.6	0.006	1.6	0.009	3.3	0.013	12	0.024	32	0.038
1.75:1	0.5	0.006	1.4	0.009	2.8	0.012	11	0.022	27	0.034
1.67:1	0.5	0.005	1.3	0.008	2.7	0.012	10	0.021	26	0.033
1.5:1	0.5	0.005	1.1	0.008	2.4	0.011	8.9	0.020	23	0.030
1.25:1	0.4	0.004	0.9	0.007	1.9	0.009	7.3	0.017	19	0.026
1:1	0.3	0.004	0.7	0.006	1.5	0.008	5.6	0.014	15	0.022

Note: [1] An appropriate allowable flow velocity must be selected based on site conditions.

Table 15 – Maximum allowable discharge and corresponding uniform flow depth

Trapezoidal Chute – lined with filter cloth

Manning's n = 0.02	Bed width = 0.5 metres	Side slopes 2:1 (H:V)

Chute slope (H:1)	Allowable flow velocity down Chute [1]									
	0.6 m/s		0.8 m/s		1.0 m/s		1.5 m/s		2.0 m/s	
	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)
20:1	4.2	0.013	9.1	0.021	17	0.031	57	0.061	145	0.103
10:1	2.4	0.008	5.0	0.012	9	0.017	28	0.034	67	0.055
6:1	1.6	0.005	3.3	0.008	6	0.012	18	0.022	41	0.036
5:1	1.4	0.005	2.9	0.007	5	0.010	15	0.019	34	0.030
4:1	1.2	0.004	2.4	0.006	4.3	0.008	13	0.016	28	0.025
3:1	0.9	0.003	1.9	0.005	3.4	0.007	10	0.013	22	0.020
2.5:1	0.8	0.003	1.7	0.004	3.0	0.006	8.5	0.011	18	0.017
2:1	0.7	0.002	1.4	0.004	2.5	0.005	7.1	0.009	15	0.015
1.75:1	0.6	0.002	1.3	0.003	2.2	0.004	6.4	0.008	13	0.013
1.67:1	0.6	0.002	1.2	0.003	2.2	0.004	6.1	0.008	13	0.013
1.5:1	0.5	0.002	1.1	0.003	2.0	0.004	5.6	0.007	12	0.012
1.25:1	0.5	0.002	1.0	0.002	1.7	0.003	4.8	0.006	10	0.010
1:1	0.4	0.001	0.8	0.002	1.5	0.003	4.1	0.005	8.6	0.008

Note: [1] An appropriate allowable flow velocity must be selected based on site conditions.

Table 16 – Maximum allowable discharge and corresponding uniform flow depth

Trapezoidal Chute – lined with filter cloth

Manning's n = 0.02	Bed width = 1.0 metres	Side slopes 2:1 (H:V)

Chute slope (H:1)	Allowable flow velocity down Chute [1]									
	0.6 m/s		0.8 m/s		1.0 m/s		1.5 m/s		2.0 m/s	
	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)
20:1	7.9	0.013	17	0.020	30	0.029	92	0.055	212	0.090
10:1	4.6	0.008	10	0.012	17	0.017	50	0.032	110	0.050
6:1	3.1	0.005	6.4	0.008	11	0.011	33	0.021	70	0.033
5:1			5.6	0.007	10	0.010	28	0.018	60	0.029
4:1			4.7	0.006	8.2	0.008	23	0.015	50	0.024
3:1			3.8	0.005	6.7	0.007	19	0.012	40	0.019
2.5:1					5.8	0.006	16	0.011	34	0.017
2:1					4.8	0.005	14	0.009	28	0.014
1.75:1							12	0.008	26	0.013
1.67:1							12	0.008	25	0.012
1.5:1							11	0.007	23	0.011
1.25:1							9.4	0.006	20	0.010
1:1							7.9	0.005	16	0.008

Note: [1] An appropriate allowable flow velocity must be selected based on site conditions.

Table 17 – Maximum allowable discharge and corresponding uniform flow depth

Trapezoidal Chute – lined with filter cloth

Manning's n = 0.02 | Bed width = 1.5 metres | Side slopes 2:1 (H:V)

Chute slope (H:1)	Allowable flow velocity down Chute [1]									
	0.6 m/s		0.8 m/s		1.0 m/s		1.5 m/s		2.0 m/s	
	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)
20:1	12	0.013	24	0.020	44	0.028	128	0.053	284	0.085
10:1	6.8	0.008	14	0.012	25	0.016	71	0.031	155	0.049
6:1	4.6	0.005	9.5	0.008	17	0.011	47	0.021	101	0.032
5:1			8.2	0.007	15	0.010	41	0.018	87	0.028
4:1			7.0	0.006	12	0.008	34	0.015	73	0.024
3:1			5.7	0.005	10	0.007	28	0.012	58	0.019
2.5:1					8.6	0.006	24	0.011	50	0.016
2:1					7.2	0.005	20	0.009	42	0.014
1.75:1							18	0.008	38	0.012
1.67:1							18	0.008	37	0.012
1.5:1							16	0.007	33	0.011
1.25:1							14	0.006	29	0.010
1:1							12	0.005	25	0.008

Note: [1] An appropriate allowable flow velocity must be selected based on site conditions.

Table 18 – Maximum allowable discharge and corresponding uniform flow depth

Trapezoidal Chute – lined with filter cloth

Manning's n = 0.02 | Bed width = 2.0 metres | Side slopes 2:1 (H:V)

Chute slope (H:1)	Allowable flow velocity down Chute [1]									
	0.6 m/s		0.8 m/s		1.0 m/s		1.5 m/s		2.0 m/s	
	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)	Flow (L/s)	Depth (m)
20:1	15	0.013	32	0.020	57	0.028	164	0.052	360	0.083
10:1	9.1	0.008	19	0.012	33	0.016	94	0.030	199	0.048
6:1	6.2	0.005	13	0.008	22	0.011	63	0.021	131	0.032
5:1			11	0.007	19	0.010	54	0.018	113	0.028
4:1			9.3	0.006	16	0.008	45	0.015	95	0.023
3:1			7.4	0.005	13	0.007	36	0.012	76	0.019
2.5:1					11	0.006	32	0.011	66	0.016
2:1					10	0.005	27	0.009	56	0.014
1.75:1							24	0.008	50	0.012
1.67:1							23	0.008	48	0.012
1.5:1							21	0.007	44	0.011
1.25:1							19	0.006	39	0.010
1:1							16	0.005	33	0.008

Note: [1] An appropriate allowable flow velocity must be selected based on site conditions.

Common Problems

Most temporary chute linings have a short service life. Problems can occur if the service life of the chute extends beyond that of the materials used to construct the chute.

Inappropriate inlet geometry or sealing can cause inflow to bypass the chute resulting in erosion.

Water can pass between fabric linings and underlying soil.

Erosion and/or natural settlement along the sides of long-term, hard surface linings such as concrete, can result in inflows being deflected by the now-elevated edge of the lining.

Severe rilling along the sides of the chute can be caused by splash or lateral inflows being deflected by the edge of the chute.

Erosion at the base of the chute caused by inadequate energy dissipation.

Special Requirements

Upper edge of flexible linings, such as filter cloth, must be well secured (i.e. pinned and buried) in an anchor trench.

Porous fabrics, such as filter cloth, must only be used on non-dispersive soil.

Good subsoil drainage and foundations are required to stabilise impervious linings.

Site Inspection

Check flow entry conditions to ensure no bypassing, undermining, sedimentation or erosion.

Ensure the chute is straight.

Check for erosion around the edges of the chute (top and sides).

Ensure the outlet is appropriately stabilised.

Installation (chute formation)

1. Refer to approved plans for location and construction details. If there are questions or problems with the location or method of installation, contact the engineer or responsible on-site officer for assistance.
2. Clear the location for the chute clearing only what is needed to provide access for personnel and equipment for installation.
3. Remove roots, stumps, and other debris and dispose of them properly.
4. Construct the subgrade to the elevations shown on the plans. Remove all unsuitable material and replace with stable material to achieve the desired foundations.
5. If the chute is temporary, then compact the subgrade to a firm consistency. If the chute is intended to be permanent, then compact and finish the subgrade as specified within the design plans.
6. Ensure the subgrade is firm enough to minimise water seepage.
7. Ensure the sides of the chute are no steeper than a 1.5:1 (H:V) slope.
8. Ensure the completed chute has sufficient deep along its full length.
9. Ensure the chute is straight from its crest to the toe of the chute.
10. On fill slopes, ensure that the soil is adequately compacted for a width of at least one metre each side of the chute to minimise the risk of soil erosion, otherwise protect the soil with suitable scour protection measures such as turf or erosion control mats.
11. Place and secure the chute lining (refer to separate specifications).
12. If concrete is used as a lining, then keep the subgrade moist at the time concrete is placed. Form, cut-off walls and anchor blocks as directed in the approved plans.
13. Install an appropriate outlet structure (energy dissipater) at the base of the chute (refer to separate specifications).
14. Ensure water leaving the chute and the outlet structure will flow freely without causing undesirable ponding or scour.
15. Appropriately stabilise all disturbed areas immediately after construction.

Installation (fabric placement)

The method of fabric installation varies with the type of fabric. Installation procedures should be provided by the product manufacturer or distributor. A typical installation procedure is described below, but should be confirmed with the product manufacturer or distributor.

1. Geosynthetic fabrics must be stored away from direct sunlight or covered with ultraviolet light protective sheeting until the site is ready for their installation.
2. Excavate a 300mm deep by 150mm wide anchor trench along the full width of the upstream end of the area to be treated.
3. At least 300mm of the fabric must be anchored into the trench with the roll of matting resting on the ground up-slope of the trench.
4. Staple the fabric within the trench at 200 to 250mm spacing using 100mm wide by 150mm penetration length U-shaped, 8 to 11 gauge wire staples. Narrower U-sections may easily tear the matting when placed under stress.
5. When fabric has been anchored within the trench, then backfilled the trench and compact.
6. When spreading the fabric, avoid stretching the material.
7. Ensure the fabric remains in good contact with the soil.
8. If the inflow channel curves (upstream of the crest), then suitably fold (in a downstream direction) and staple the fabric to maintain the fabric parallel to the direction of channel flow.
9. Staple the surface of the fabric at 1m centres. On irregular ground, additional staples will be required wherever the fabric does not initially contact the ground surface.
10. Install intermediate anchor trenches at 3m (max) intervals down the chute.
11. If the chute extends beyond the length of the fabric, then form a new trench is formed at least 300mm up-slope of the end of the fabric such that the end of the fabric will be able to fully cover the trench. A new roll of fabric is then anchored within this trench as per the first. The process is continued down the slope until the desired area is fully covered.
12. If chute is subject to lateral inflows, ten anchor the outer most sides of the fabric in a 300mm deep trench and staple at 200 to 250mm centres.
13. The installation procedure must ensure that the fabric achieves and retains good contact with the soil.
14. Damaged fabric must be repaired or replaced.

Maintenance

1. During the construction period, inspect all chutes prior to forecast rainfall, daily during extended periods of rainfall, after significant runoff producing storm events, or otherwise on a weekly basis. Make repairs as necessary.
2. Check for movement of, or damage to, the chute lining, including surface cracking.
3. Check for soil scour adjacent the chute. Investigate the cause of any scour, and repair as necessary.
4. Ensure sediment is not partially blocking flow entry into the chute. Where necessary, remove any deposited material to allow free drainage.
5. Dispose of any sediment in a manner that will not create an erosion or pollution hazard.
6. When making repairs, always restore the chute to its original configuration unless an amended layout is required.

Removal

1. When the soil disturbance above the chute is finished and the area is stabilised, the chute and any associated flow diversion banks should be removed, unless it is to remain as a permanent drainage feature.
2. Dispose of any materials, sediment or earth in a manner that will not create an erosion or pollution hazard.
3. Grade the area in preparation for stabilisation, then stabilise the area as specified in the approved plan.