Filter Tube Dams

SEDIMENT CONTROL TECHNIQUE

Type 1 System		Sheet Flow		Sandy Soils	✓
Type 2 System	[1]	Concentrated Flow	✓	Clayey Soils	[2]
Type 3 System	[1]	Supplementary Trap		Dispersive Soils	

[1] Classification depends on the flow rate able to pass through the filtration system (i.e. filter tubes).

[2] Filter tubes provide limited capture of clay-sized particles, but typically provide a better capture rate than most traditional Type 3 systems.

Symbol

Photo 1 – Filter tube dam

Photo 2 – Filter tube incorporated into a flow diversion bank

Key Principles

1. Most filtration systems have only a limited ability to capture and retain clay-sized particles; therefore, operators should not expect a significant change in the colour or clarity of water passing through the filter tubes.
2. Critical design parameters are the 'filtration' capacity of the filter tubes (governed by the pore size and mass per unit area), and the allowable flow rate through the filtration system.
3. The allowable flow rate through the filtration system is governed by the maximum allowable hydraulic head, the allowable flow rate per filter tube, and the number of parallel filter tubes.
4. Critical operational issues include:
   - the prevention of blockage of the filter tubes by bulk coarse sediment—achieved by either raising the inlet to the filter tubes and/or placing the filter tube dam down-slope of a coarse (Type 3) sediment trap; and
   - controlling sediment 'crusting' that can form on the surface of the filter tubes reducing their discharge—usually achieved by regularly brushing the surface of the filter tubes with a stiff-bristled broom.
5. Gravity-induced 'sedimentation' can be improved by raising the invert of the filter tubes above ground level (minimum 300mm is ideal), however, this is not always practical.
6. Filter tubes can be incorporated into a number of traditional Type 2 sediment traps such as *Modular Sediment Traps, Rock Filter Dams* and *Sediment Weirs*.

Design Information

Recommended sediment trapping classification is presented in Table 1.

Table 1 – Recommended sediment trapping classification

Sediment control classification [1]	Requirements
Type 2	• Minimum filter fabric specifications: pore size EOS less than 160microns, O_{95} less than 90microns; minimum mass of 300gsm (minimum 'bidim' A44 or equivalent). • Specified design flow rate able to pass through the combined filter system (based on 50% blockage) without flow bypassing. • Minimum surface area of upstream settling pond during design flow of $80m^2/(m^3/s)$.
Type 3	• Any 2 of the above requirements satisfied.

[1] Discussion of the sediment control classification system is provided in a separate fact sheet.

One or more parallel filter tubes may need to be used depending on the required total flow rate.

The design flow rates for filter tubes can vary significantly depending on the length of the tubes and type of geotextile used in its manufacture. Product specific pressure–discharge or head–discharge relationships should be obtained from the relevant manufacturer or distributor.

Photo 3 – Note filter tube inlet is raised above ground level to encourage ponding

Photo 4 – Example of plywood used to form a sealed dam

Filter tube dams are most commonly used when it is not practical to direct sediment-laden water to a *Sediment Basin*, and some degree of control is required of medium to fine sediments.

Wherever practical, the dams should discharge onto a substantial grassed filter bed (*Buffer Zone*) to assist in the capture of fine sediment particles.

Photo 5 – Filter tube outlet structure within a confined channel

Photo 6 – Filter tube dam located at the base of a rock-lined chute

If the manufacturer's head–discharge relationship is not available, then an approximate relationship can be estimated from the specified permittivity of the geotextile. The following guidelines can be used to 'estimate' a head–discharge relationship.

(a) Filter tubes placed on relatively level ground (as per Figures 1 to 5)

- Allowable flow rate is the lesser of:
  - (i) the assessed flow rate based on the effective hydraulic head (see below);
  - (ii) the hydraulic capacity of the filter tube's inlet (usually governed by orifice or weir flow relationships as appropriate for the site conditions—refer to (b) below).
- Assume full sediment blockage of the underlying surface area of the filter tube; thus include only the top surface area of the filter tube.
- Assume 10 to 50% blockage of the upper surface area of the bag (depending on intended duration of use and frequency of maintenance).
- When determining the hydraulic head (ΔH), assume zero flow occurs at a water depth of 50mm; therefore, the available hydraulic head is equal to the upstream water level (relative to the under-surface of the filter tubes) minus 50mm.

$$Q = B.F. \times \Delta H \times A \times \psi \qquad \text{(Eqn 1)}$$

where:

- Q = Total flow rate through the filter tube [m^3/s]
- B.F. = Blockage factor, assume 0.9 to 0.5 depending on expected usage
- ΔH = Hydraulic head loss through the filter tube [m]
- A = Upper surface area of the filter tube [m^2]
- ψ = Permittivity of the geotextile (AS 3706-9) [s^{-1}]

Warning: *It is noted that significant errors can result from the above equation, especially if applied to 'woven' fabrics, thus preference must always be given to head–discharge relationships determined from prototype testing, rather than estimations based on standard permittivity testing of the fabric. Note; standard permittivity testing is based on flow rates achieved at a hydraulic head of 100mm.*

(b) Filter tubes placed down significant slopes (say, >5%)

In situations where the filter tube lies down a slope such that the bulk of the filter tube is well below the inlet of the filter tube, the maximum flow rate will usually be governed by the hydraulic capacity of the filter tube's inlet. The hydraulic capacity of the filter tube's inlet is usually governed by orifice or weir flow relationships as appropriate for the site conditions.

The hydraulic capacity of a filter tube's inlet consisting of a solid PVC pipe collar is presented in Table 2. It is noted that the hydraulic head is relative to the invert of the pipe collar.

Table 2 – Hydraulic capacity (L/s) of a 150, 200, 300 & 375mm diameter pipe inlet [1]

Pipe dia 'D'	Upstream water level 'H' (m) relative to the invert of the pipe inlet												
	0.20	**0.25**	**0.30**	**0.35**	**0.40**	**0.45**	**0.50**	**0.55**	**0.60**	**0.70**	**0.80**	**0.90**	**1.0**
150mm	15	19	22	25	27	29	30	31	31	30	28	23	16
200mm	23	29	35	41	45	50	54	57	59	63	64	63	60
300mm	36	49	62	74	85	96	106	115	123	138	150	160	170
375mm	43	63	82	100	118	134	150	166	180	207	230	250	270

[1] Tabulated flow rates are based on 'inlet control conditions', which assume atmospheric pressure within the solid discharge pipe immediately downstream of the inlet.

(c) Incorporation of filter tubes into various structures

Filter tubes cannot be incorporated into highly pervious barriers such as a *Sediment Fence*, thus care must be taken to ensure the formation of a near-impervious barrier that will promote the maximum quantity of flow through the filter tubes.

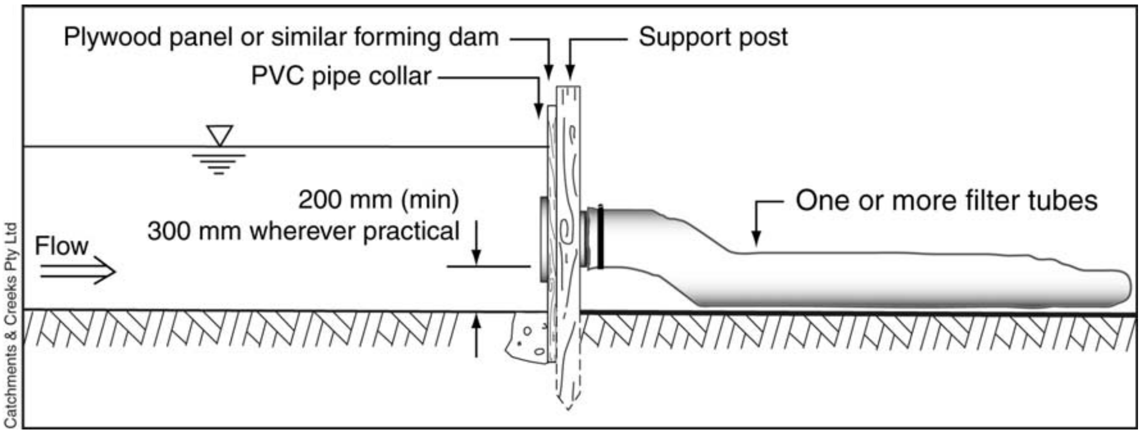

Figure 1 – Typical arrangement of a filter tube dam

Filter tubes are most successfully incorporated into *Flow Diversion Banks* (Figure 2) as a low-flow, sediment-control outlet system. Earth embankments should have a minimum height of 500mm, with 200mm clearance over the pipe obvert, and maximum 2:1(H:V) side slopes.

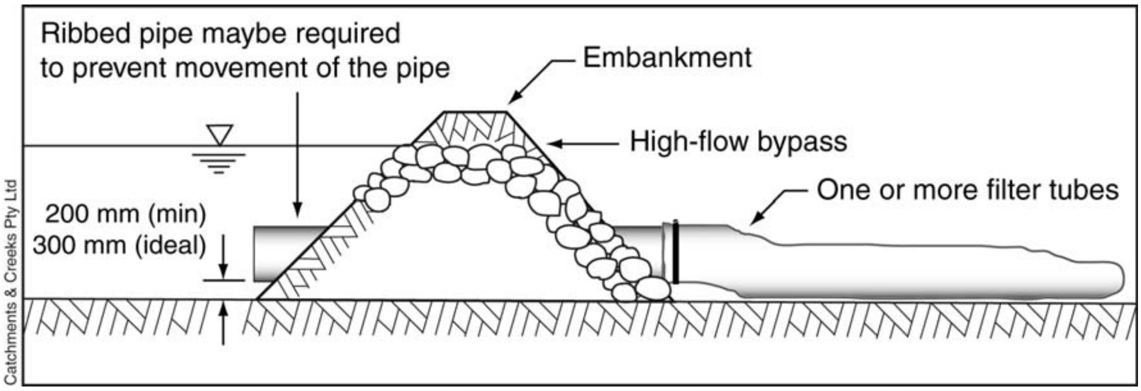

Figure 2 – Filter tube dam incorporated into a flow diversion bank

Incorporating filter tubes into *Modular Sediment Traps* (Figure 3) requires the modification of some of the modular units to house the connection pipes; however, once modified, these units can be reused on similar installations.

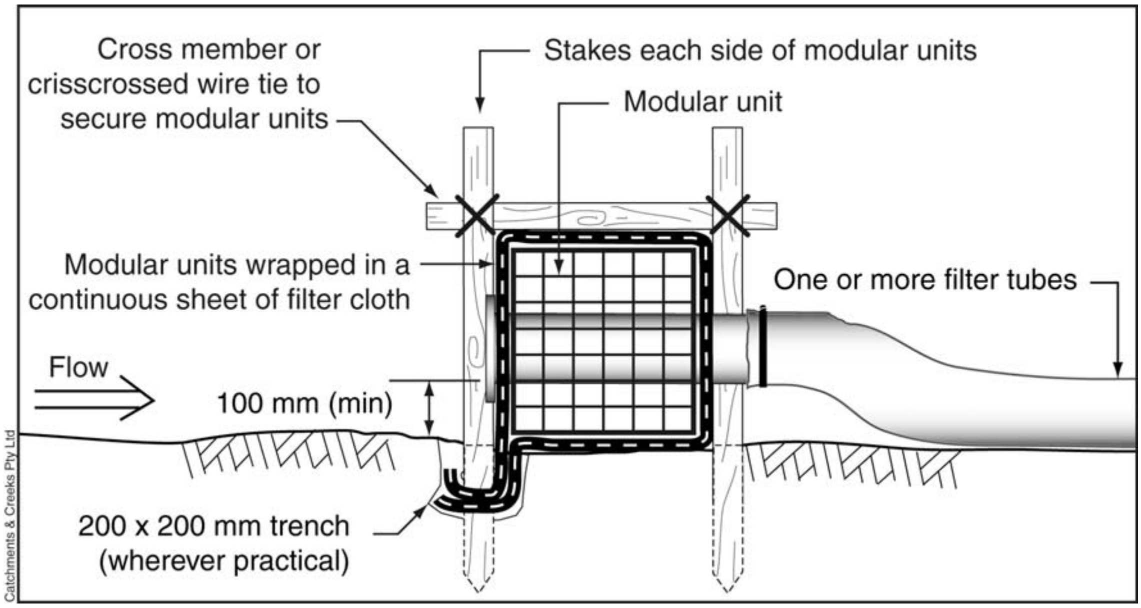

Figure 3 – Typical arrangement of filter tubes incorporated into a modular sediment trap

Incorporating filter tubes into a *Sediment Weir* (Figure 4) can increase the working life of the sediment weir, allowing the sediment trap to continue to function successfully even if the sediment weir and/or the filter cloth incorporated into the weir becomes blocked with sediment.

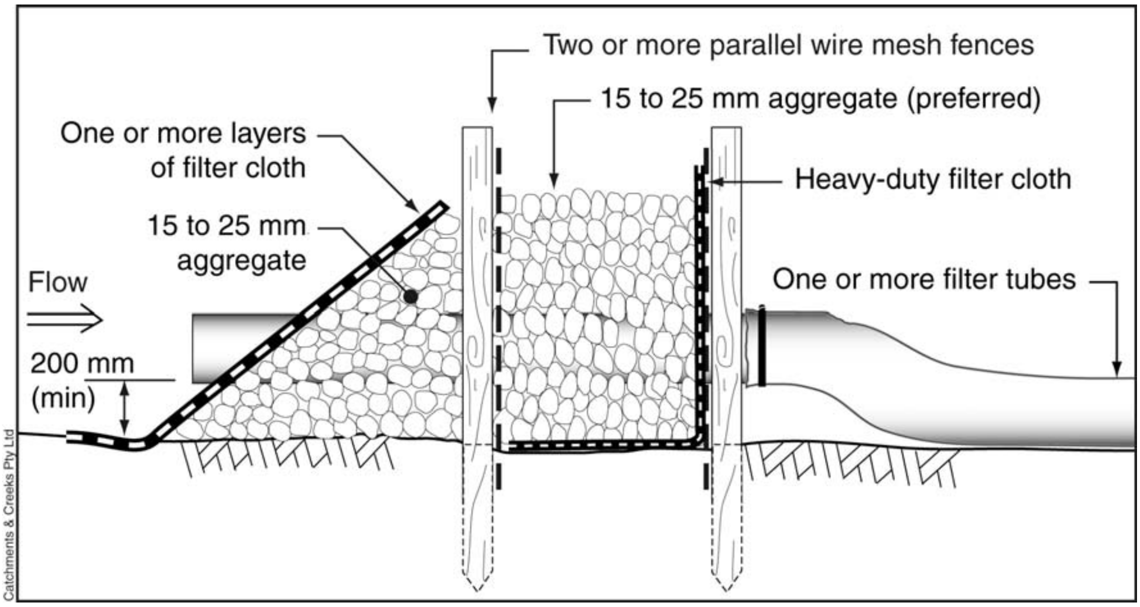

Figure 4 – Typical arrangement of filter tubes incorporated into a sediment weir

Similar to the above discussion, filter tubes can also be successfully incorporated into *Rock Filter Dams* (Figure 5) to extend their can working life.

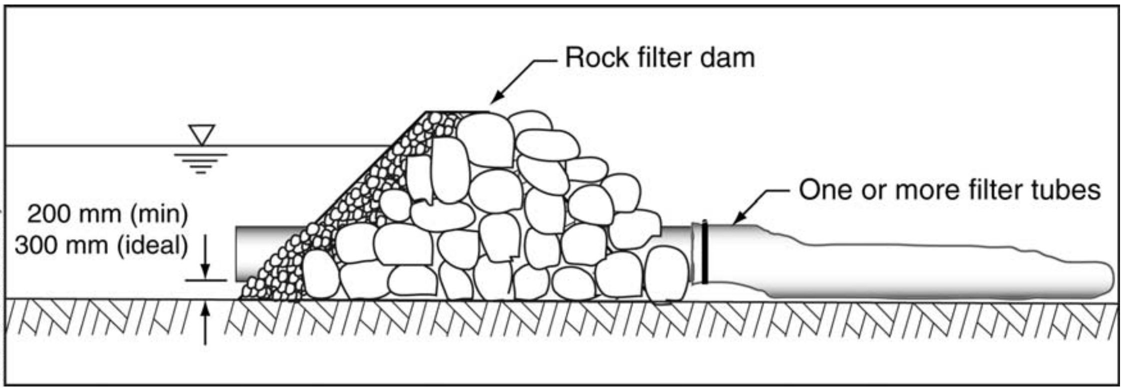

Figure 5 – Typical arrangement of filter tubes incorporated into a rock filter dam

If filter tubes are incorporated into Type 2 sediment traps, then the operation of the filter tubes should not be allowed to prevent the formation of the required settling pond surface area upstream of the structure (refer to the design guidelines for *Rock Filter Dams* and *Sediment Weirs*). Where necessary, the flow rate entering the filter tubes can be regulated by attaching an orifice plate to the entrance of each filter tube (Figure 6).

(d) Hydraulic analysis of orifice flow

Flow rate through a filter tube can be regulated by appropriately sizing the orifice plate attached to the inlet of the filter tube. Table 3 provides typical stage–discharge relationships for various circular orifice plates.

Equation 2 provides the flow characteristics for a circular orifice plate discharging into a chamber (or discharge pipe) containing atmospheric pressure (i.e. partial full flow conditions).

Rectangular weir: $Q = C_d A_o \sqrt{(2 g H)}$ (Eqn 2)

where: Q = Design flow rate [m^3/s]
A_o = Open flow area of orifice plate = ($0.25 \pi d^2$) [m^2]
d = diameter of the orifice [m]
π = pi = 3.142
g = acceleration due to gravity = 9.8 [m/s^2]
H = Hydraulic head = depth of water above centre of the orifice [m]

Table 3 – Hydraulic capacity (L/s) for an orifice plate attached to a partial full (atmospheric) discharge pipe [1]

Water depth H (m)	Orifice diameter 'd' (mm)										
	20	**25**	**30**	**40**	**50**	**60**	**80**	**100**	**150**	**200**	**250**
0.1	0.27	0.43	0.61	1.09	1.70	2.45	4.36	6.82	15	27	43
0.2	0.39	0.60	0.87	1.54	2.41	3.47	6.17	9.64	22	39	60
0.3	0.47	0.74	1.06	1.89	2.95	4.25	7.56	11.8	27	47	74
0.4	0.55	0.85	1.23	2.18	3.41	4.91	8.73	13.6	31	55	85
0.5	0.61	0.95	1.37	2.44	3.81	5.49	9.76	15.2	34	61	95
0.6	0.67	1.04	1.50	2.67	4.17	6.01	10.7	16.7	38	67	104
0.8	0.77	1.21	1.74	3.09	4.82	6.94	12.3	19.3	43	77	121
1.0	0.86	1.35	1.94	3.45	5.39	7.76	13.8	21.6	49	86	135
1.2	0.94	1.48	2.13	3.78	5.90	8.50	15.1	23.6	53	94	148

[1] Tabulated flow rates are based on orifice flow equation (C_d = 0.62) assuming atmospheric pressure within the outlet pipe immediately downstream of the orifice.

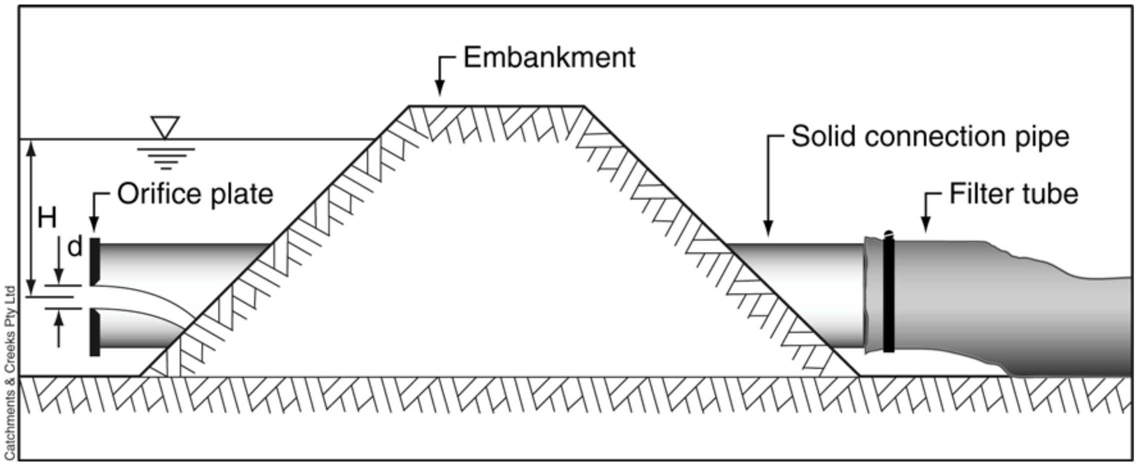

Figure 6 – Discharge control using an orifice plate

Description

One or more parallel long, geotextile tubes incorporated into an impervious or pervious (filter) barrier.

Filter tubes are significantly longer than the more traditional *Filter Socks*.

Purpose

Used to filter medium to fine-grained sediment particulates from minor concentrated flows.

Also used to increase the design flow rate of other sediment traps such as *Rock Filter Dams* and *Sediment Weirs*.

Limitations

Typically low to medium flow rates.

Limited capture of clay-sized particles.

No treatment of dissolved pollutants.

Advantages

Commercially available product.

Filter tubes are light and easy to handle (when empty).

Disadvantages

Filter tubes can be difficult to handle when full of sediment.

Location

Best used down-slope of a Type 3 sediment trap. The Type 3 sediment trap being used to prevent blockage of the entrance of the filter tubes with coarse sediment.

Site inspection

Check for flow bypassing around the filter tubes.

Check for excessive sedimentation around the entrance to the filter tubes.

Check for sediment crusting on the surface of the filter tubes.

Materials

- Filter tube: manufactured from a non-woven geotextile reinforced with a UV-stabilised, woven fabric or poly-propylene mesh. The geotextile fabric should be either polyester or polypropylene. Properties (AS3706) minimum wide strip tensile strength of 20kN/m in both directions; pore size EOS less than 160microns, O_{95} less than 90microns; minimum mass of 300gsm (minimum 'bidim' A44 or equivalent).
- Ribbed pipe (used with earth banks): ribbed, PVC or similar pipe.
- Earth embankment: non-dispersive (Emerson's Aggregate Class 6, 7 or 8) clean earth fill, free of organic debris and with sufficient clay content to prevent the through-flow of water.
- Aggregate: 15 to 25mm crushed rock.

Installation

1. Refer to approved plans for location, extent, and 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. Construct a suitable water-retaining barrier/embankment out of the material specified within the approved plans.
3. While constructing the dam or embankment, install and anchor the specified number of ribbed pipe sections through the dam/embankment.
4. Ensure the inlets to each filter tube are appropriately elevated above the adjacent ground level to minimise the risk of sediment blockage of the pipe entrance.
5. For earth embankment, firmly hand-tamp the earth under and around the ripped pipe/s in lifts not exceeding 100mm. Ensure that all fill material is well-compacted.
6. For earth embankments, ensure that the embankment has minimum dimensions of 500mm height, with 200mm clearance over the pipe obvert, and maximum 2:1(H:V) side slopes.
7. Suitably connect the filter tubes to the downs-slope end of the protruding connector pipes. Ensure all connections are watertight.

Maintenance

1. Inspect the barrier/embankment and filter tubes regularly and at least daily during de-watering operations. Make repairs as needed to the fabric.
2. Inspect the filter tubes for obvious leaks resulting from holes, tears or joint failure in the fabric.
3. Repair or replace any filter tube as necessary to maintain the desired operational performance. In some circumstances flow rate through the filter tubes can be temporarily improved by brushing the bag with a stiff-bristled broom.
4. Replace any filter tube if sediment blockage of the fabric decreases the flow rate to an unacceptable level, or the filter tube contains excessive sediment.

Removal

1. Remove of all materials and dispose of them in a suitable manner that will not cause an ongoing erosion or pollution hazard.