Coarse Sediment Traps

SEDIMENT CONTROL TECHNIQUE

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

[1] Though primarily a Type 3 sediment trap, the concept can be incorporated into Type 2 systems.

[2] These sediment traps provide only limited capture potential of fine sediments such as silt and clay-sized particles.

Symbol

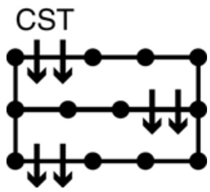

Photo 1 – Coarse sediment trap located at end of drainage swale

Photo 2 – Coarse sediment trap located at a stormwater outlet

Key Principles

1. The key design parameter is usually the surface area of the largest settling chamber, however, in most cases it is a case of simply making the best use of the available land area.
2. The sediment trapping ability of this technique is not necessarily different from a standard sediment fence installed along the contour.
3. In general, these are not very effective sediment traps. The need for such a sediment trap is likely to indicate that less than satisfactory erosion and sediment controls exist on the site.

Design Information

Hydraulic capacity is governed by the weir flow rate of the incorporated spill-through weirs, and the allowable through-flow velocity.

A minimum of 2 settling chambers is recommended; however, the design should attempt to make best use of the available land space to optimise sediment capture.

Ideally, the width of a spill-through weir should not exceed 25% of the chamber length.

Ideally, the length of an individual settling chamber should not be less than 4 times its width.

Ideally, the largest chamber should have a surface area per unit discharge of at least $7 m^2/m^3/s$.

If located downstream of a high velocity pipe outlet, the trap should ideally be located at least 8 pipe diameters downstream of the outlet.

Design procedure:

Step 1 Determine the design flow rate, Q (m^3/s).

Step 2 Select a first trial of the spill-through weir width (W) and maximum hydraulic head (H) from Table 1 based on the design flow rate.

Step 3 Determine the minimum recommended length of each settling chamber; $L_{min} = 4*W$.

Step 4 If the critical sediment size is known, then determine the allowable through-flow velocity (V) from Table 2. Otherwise, select an allowable velocity of 0.3m/s.

Step 5 Given the allowable through-flow velocity, determine the minimum settling chamber width from Tables 3 to 5, as appropriate for the nominated velocity.

Step 6 Check that the chamber width does not exceed 25% of the chamber length (L).

Step 7 Check that the surface area of the 'largest' settling chamber (A_s) divided by the design flow rate (Q) is not less than the ideal surface area per unit discharge presented in Table 2. Note; this objective may not always be achievable.

Step 8 Design the final outlet structure based on the required treatment standard. Figures 4 to 7 provide typical examples.

(a) Weir flow equation for a rectangular spill-through weir:

Rectangular weir: $$Q = 1.7\,W\,H^{3/2} \qquad \text{(Eqn 1)}$$

where: Q = Design flow rate (usually 0.5 times the 1 in 1 year ARI peak discharge) [m^3/s]
W = Weir width [m]
H = Hydraulic head = height of upstream water level above weir crest [m]

Table 1 – Flow rates passing over a spill-through weir (m^3/s)

Hydraulic head, H (m)	Spill-through weir width, W (m)									
	0.3	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
0.10	0.016	0.027	0.054	0.081	0.108	0.134	0.161	0.188	0.215	0.242
0.15	0.030	0.049	0.099	0.148	0.198	0.247	0.296	0.346	0.395	0.444
0.20	0.046	0.076	0.152	0.228	0.304	0.380	0.456	0.532	0.608	0.684
0.25	0.064	0.106	0.213	0.319	0.425	0.531	0.638	0.744	0.850	0.956
0.30	0.084	0.140	0.279	0.419	0.559	0.698	0.838	0.978	1.12	1.26
0.35	0.106	0.176	0.352	0.528	0.704	0.880	1.06	1.23	1.41	1.58
0.40	0.129	0.215	0.430	0.645	0.860	1.08	1.29	1.51	1.72	1.94

(b) Maximum allowable through-flow velocity:

Table 2 provides the ideal pond surface area per unit discharge, and allowable through velocity.

Table 2 – Recommended allowable through-flow velocity (m/s)

Design standard	Critical sediment size (mm)	Surface area of settling pond per unit discharge ($m^2/m^3/s$) [1]			Allowable through-velocity (m/s)
		10° C	**15° C**	**20° C**	
Type 3 sediment trap	0.50	7.2	6.3	5.5	0.3
	0.20	45	40	35	0.3
	0.15	80	70	62	0.3
Type 2 [2] sediment trap	0.10	180	160	140	0.2
	0.05	720	630	550	0.2

[1] A 20% increase in the theoretical surface area has been included to account for inflow turbulence.

[2] Aboveground traps formed from sediment fence fabric cannot operate as Type 2 sediment traps.

(c) Minimum width of settling chambers:

Tables 3 to 5 provide the minimum required width of individual settling chambers based on a maximum through-flow velocity (from Table 2) of 0.1, 0.2 and 0.3m/s, and a spill-through weir crest set 300mm above ground level.

Table 3 – Minimum width of individual settling chambers (m) for a through-flow velocity, V = 0.1m/s

Hydraulic head, H (m)	Spill-through weir width, W (m)									
	0.3	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
0.10	0.4	0.7	1.3	2.0	2.7	3.4	4.0	4.7	5.4	6.0
0.15	0.7	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9
0.20	0.9	1.5	3.0	4.6	6.1	7.6	9.1	11	12	14
0.25	1.2	1.9	3.9	5.8	7.7	9.7	12	14	15	17
0.30	1.4	2.3	4.7	7.0	9.3	12	14	16	19	21
0.35	1.6	2.7	5.4	8.1	11	14	16	19	22	24
0.40	1.8	3.1	6.1	9.2	12	15	18	22	25	28

Table 4 – Minimum width of individual settling chambers (m) for a through-flow velocity, V = 0.2m/s (minimum width limited to 0.3m)

Hydraulic head, H (m)	Spill-through weir width, W (m)									
	0.3	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
0.10	0.3	0.4	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0
0.15	0.3	0.6	1.1	1.6	2.2	2.7	3.3	3.8	4.4	4.9
0.20	0.5	0.8	1.5	2.3	3.0	3.8	4.6	5.3	6.1	6.8
0.25	0.6	1.0	1.9	2.9	3.9	4.8	5.8	6.8	7.7	8.7
0.30	0.7	1.2	2.3	3.5	4.7	5.8	7.0	8.1	9.3	11
0.35	0.8	1.4	2.7	4.1	5.4	6.8	8.1	9.5	11	12
0.40	0.9	1.5	3.1	4.6	6.1	7.7	9.2	11	13	14

Table 5 – Minimum width of individual settling chambers (m) for a through-flow velocity, V = 0.3m/s (minimum width limited to 0.3m)

Hydraulic head, H (m)	Spill-through weir width, W (m)									
	0.3	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
0.10	0.3	0.3	0.5	0.7	0.9	1.1	1.3	1.6	1.8	2.0
0.15	0.3	0.4	0.7	1.1	1.5	1.8	2.2	2.6	2.9	3.3
0.20	0.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.1	4.6
0.25	0.4	0.7	1.3	1.9	2.6	3.2	3.9	4.5	5.2	5.8
0.30	0.5	0.8	1.6	2.3	3.1	3.9	4.7	5.4	6.2	7.0
0.35	0.6	0.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1
0.40	0.6	1.0	2.0	3.1	4.1	5.1	6.1	7.2	8.2	9.2

Coarse sediment traps can be used as an elaborate outlet structure for a sediment fence as shown in Figure 1.

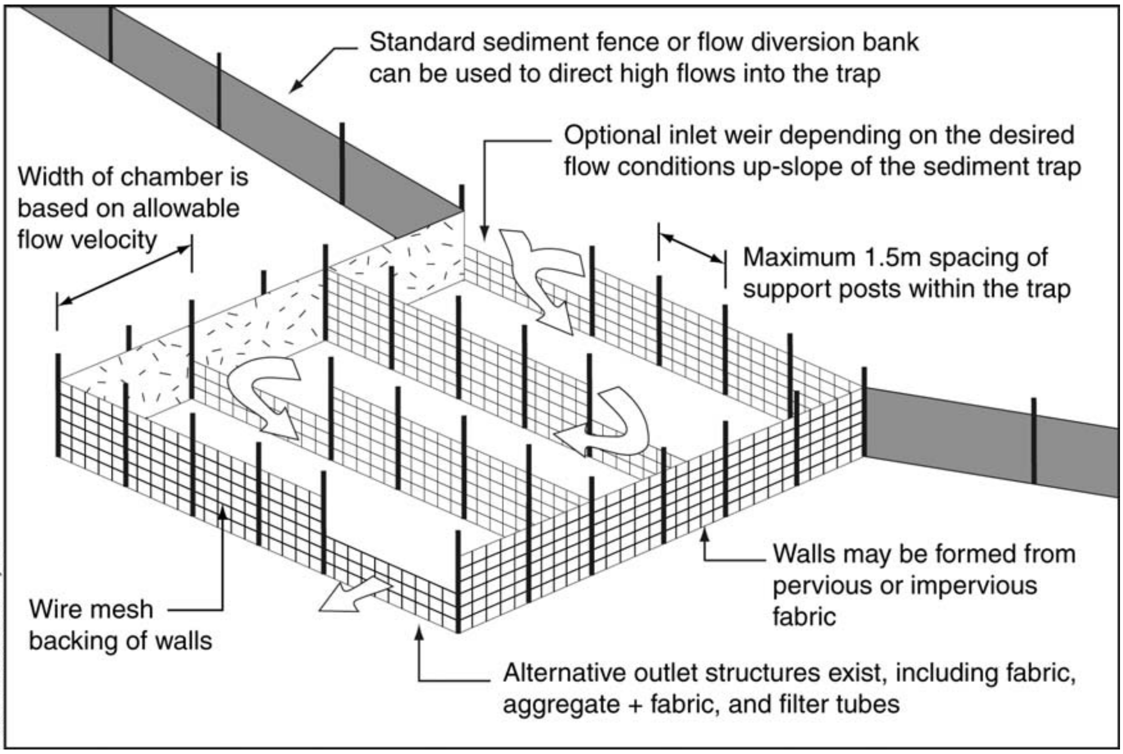

Figure 1 – Coarse sediment trap acting as a sediment fence outlet structure

In circumstances where a stormwater pipe discharges at least 300mm above the receiving discharge channel, a coarse sediment trap can be installed within the discharge channel as shown in Figure 2. If the chamber is partially confined by earth banks (as in Figure 2), then the final sediment fence can be replaced with a more elaborate filtration system as discussed in Sections (e) and (f) below. Examples of these alternative outlet structures are provided in Figures 5 to 7.

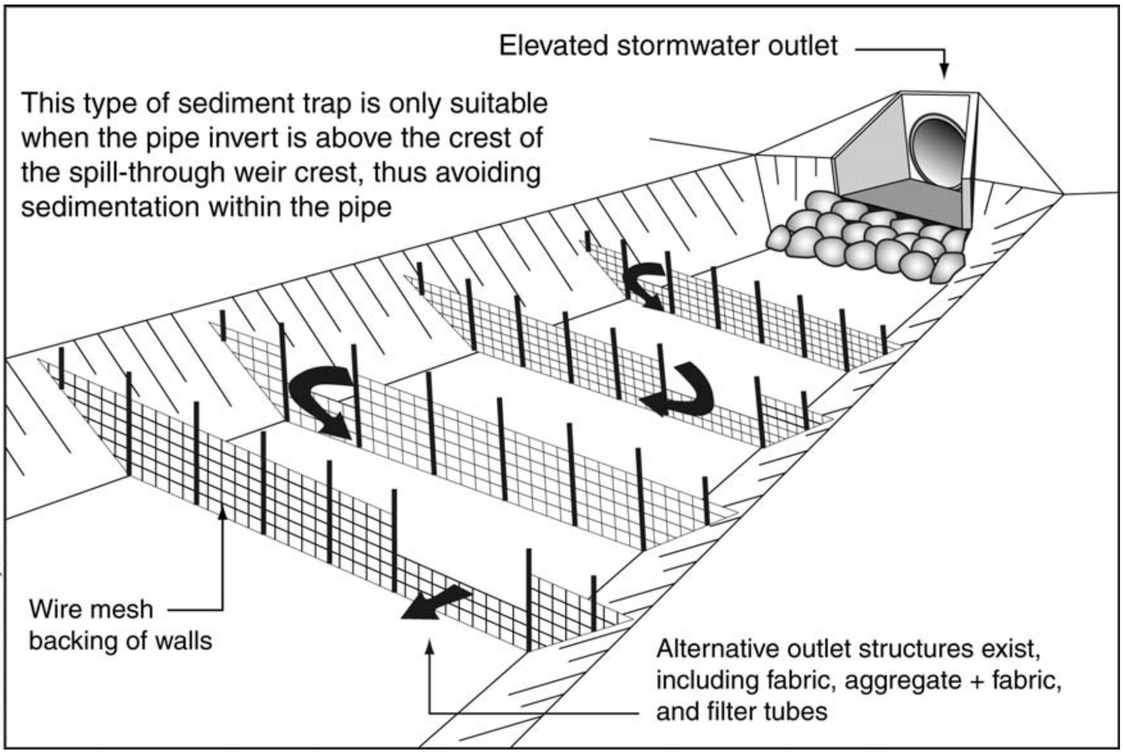

Figure 2 – Partially confined coarse sediment trap located at a stormwater outlet

(d) Fabric-based spill-through weirs:

Fabric spill-through weirs are most commonly formed from woven sediment fence fabric; however, these outlet structures can also be formed from non-woven fabrics reinforced with a wire mesh backing.

A fabric-based spill-through weir is used in the construction of Type 3 sediment traps that are designed for a critical sediment size of 0.5mm or greater.

Photo 3 – Upstream face of a fabric spill-through weir with aggregate splash pad

Photo 4 – Downstream face of fabric spill-through weir with aggregate splash pad

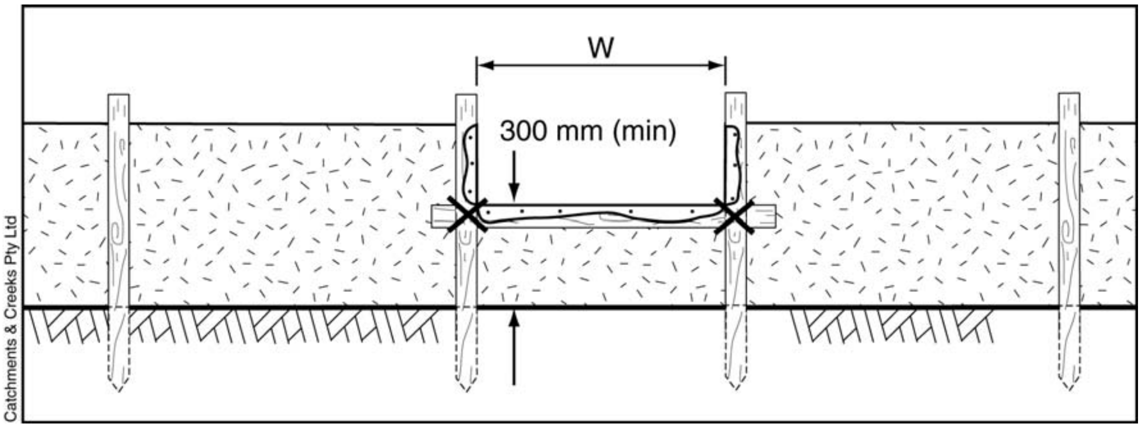

Figure 3 – Typical profile of a spill-through weir

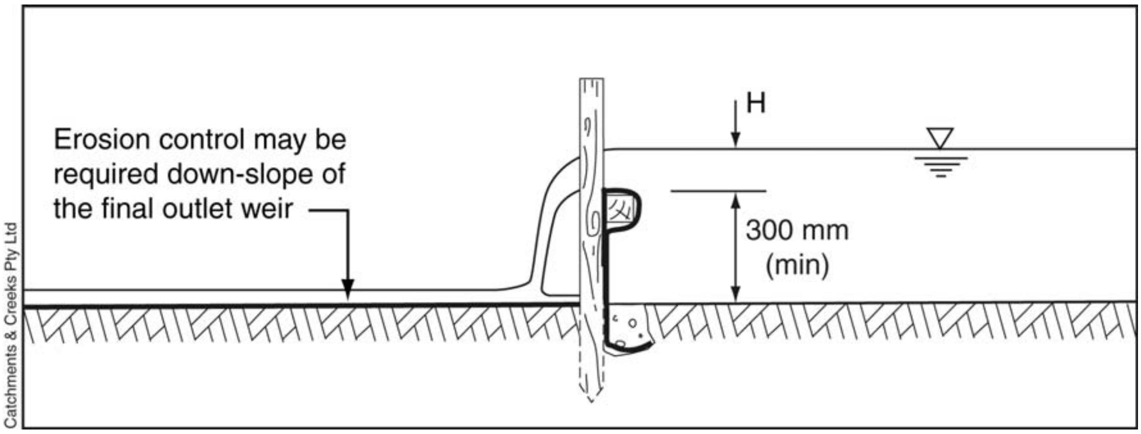

Figure 4 – Example of a final outlet chamber wall consisting of a spill-through weir formed from sediment fence fabric

Alternatively, the internal barriers may be formed from shade cloth (instead of woven fabric) to allow flow to pass both over the spill-through weirs and through the fabric. Such designs allow better flow movement from cell to cell, and reduced sediment re-suspension.

(e) Fabric and aggregate spill-through weirs:

Little benefit is gained from the use of a fabric and aggregate spill-through weir if the sidewalls of the sediment trap are formed from woven sediment fence fabric. This type of final outlet structure is normally used on coarse sediment traps partially confined within earth banks where the outlet structure forms the only discharge point.

Fabric and aggregate spill-through weirs are most commonly formed from a woven sediment fence fabric overlayed with heavy-grade, non-woven filter cloth (minimum 'bidim' A34 or equivalent), with an upstream 15–25mm aggregate filter (Photo 6).

It is noted that little can be gained through the use of an aggregate filter unless a non-woven fabric is appropriately integrated behind (i.e. downstream) the aggregate.

Placing filter cloth on the leading face of the aggregate filter (i.e. upstream) can result in rapid blockage of the filter cloth, and failure of the aggregate filter to achieve the required degree of partial sediment blockage that is essential in the long-term operation of an aggregate filter.

A fabric and aggregate spill-through weir is most commonly used in the construction of a partially enclosed coarse sediment trap when the nominated critical sediment size is less than 0.5mm.

Photo 5 – Fabric spill-through weir with aggregate filter

Photo 6 – Fabric spill-through weir with aggregate filter and a non-woven fabric (filter cloth) backing

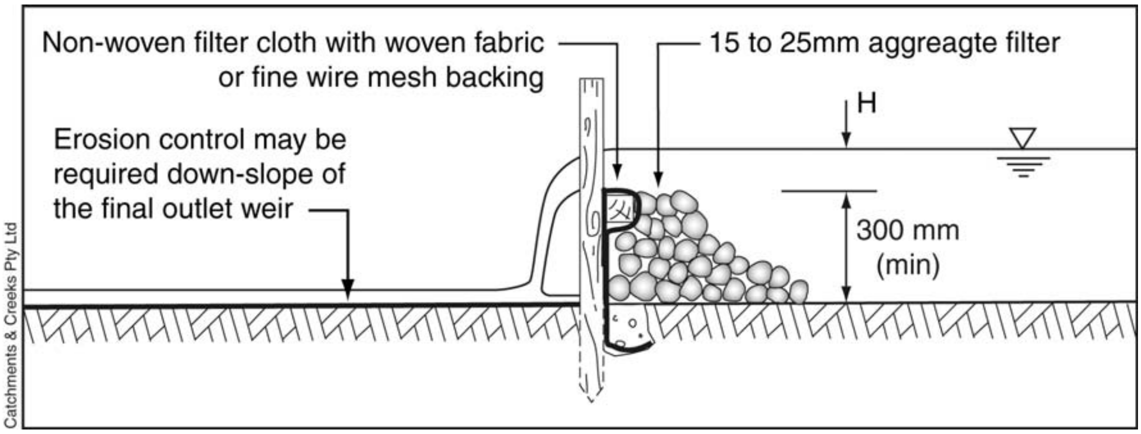

Figure 5 – Final outlet chamber wall (outlet structure) consisting of a spill-through weir formed from non-woven fabric and upstream aggregate filter

(f) Filter tube dam outlet structures:

Filter tube dam outlet structures are most commonly used on fully recessed and partially enclosed coarse sediment traps when the nominated critical sediment size is less than 0.5mm.

Technically, it would be feasible to achieve a Type 2 treatment standard if the surface area of at least one settling chamber satisfies the requirements presented in Table 2, and the outlet discharges onto a substantial grassed filter bed (buffer zone).

Photo 7 – Filter tube outlet structure on a U-shaped sediment trap

Photo 8 – Filter tube outlet structure on a coarse sediment trap

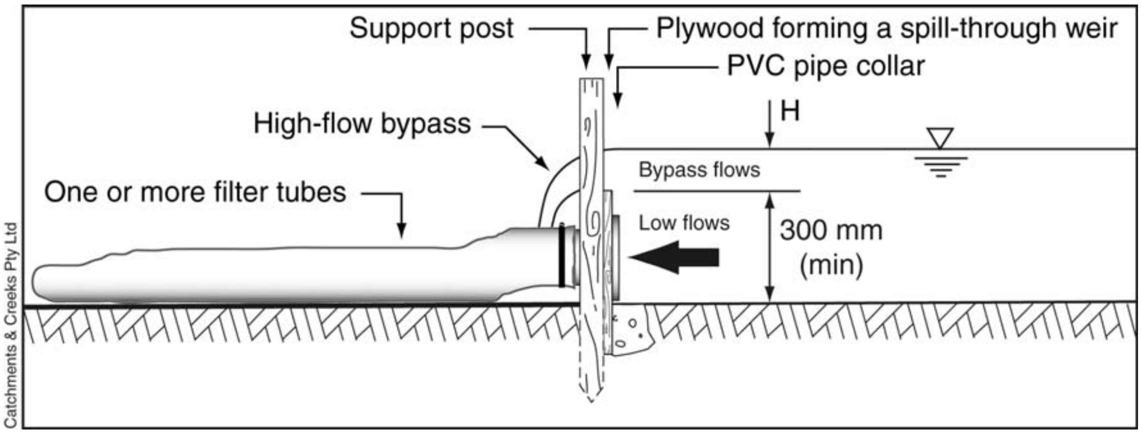

Figure 6 – Final outlet chamber wall consisting of a spill-through weir incorporating one or more filter tubes

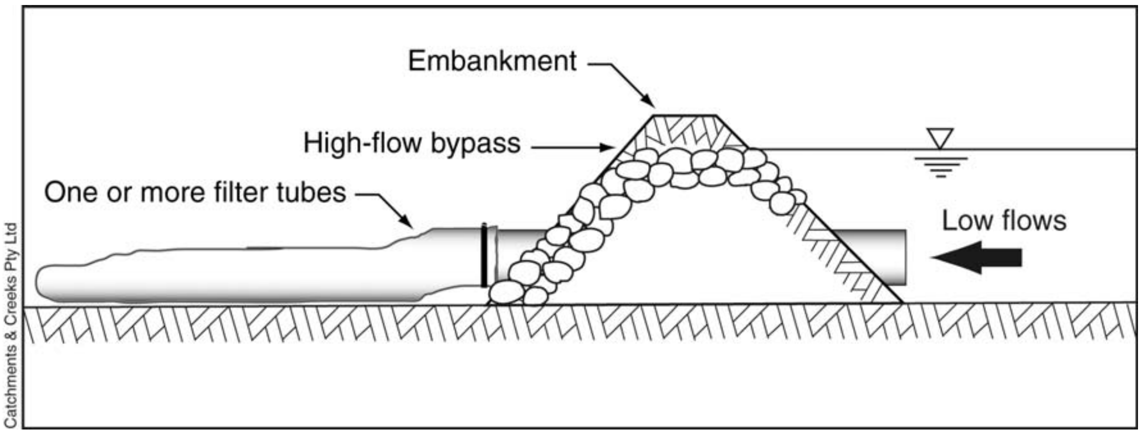

Figure 7 – Alternative filter tube outlet system suitable for a partially enclosed coarse sediment trap

Description

A coarse sediment trap typically consists of two or more aboveground, settling chambers formed from a grid of sediment fence fabric. Flow through the structure is controlled by the use of spill-through weirs.

In the typical aboveground arrangement, flow is also allowed to filter through the walls of the settling chamber.

In some regions these systems are referred to as ‘Type A’ sediment traps.

Purpose

The main purpose for using such a sediment trap is to improve the sediment trapping ability of a sediment fence that cannot be installed along the contour, and where such a sediment fence is likely to experience high flows.

Also used as a temporary sediment trap at the end of stormwater pipes.

Generally suited to the trapping of coarse sediments resulting from the disturbance of sandy soils.

Though primarily a Type 3 sediment trap, the concept can be incorporated into a Type 2 sediment trap with a *Filter Tube Dam, Rock Filter Dam* or *Sediment Weir* outlet structure.

Limitations

Most commonly a Type-3 sediment trap with medium trapping efficiency for coarse sediment.

Typically limited to sandy soil disturbances with a maximum catchment area of around 0.25ha.

Advantages

The standard layout does not require excavation.

A free draining sediment trap.

Significantly more sediment storage volume compared to a standard sediment fence.

The baffled chambers can reduce the effects of inflow jetting when used as a sediment trap at stormwater outlets, thus reducing the risk of sediment re-suspension.

Disadvantages

Can be difficult to de-silt without causing disturbance to the individual settling chambers.

Special Requirements

May require scour control measures to avoid erosion at the outlet.

Location

Located at a low point in a long sediment fence that is likely to experience high flows.

Located at elevated stormwater outlets where the pipe invert is at least 300mm above the outlet channel.

Site Inspection

Check for adequate flow controls up-slope of the sediment trap.

Check for adequate scour control at the outlet.

Materials

- Sediment fence fabric: polypropylene, polyamide, nylon, polyester, or polyethylene woven or non-woven fabric, at least 700mm in width and a minimum unit weight of 140gsm. The fabrics should contain ultraviolet inhibitors and stabilisers to provide a minimum of 6 months of useable construction life (ultraviolet stability exceeding 70%).
- Wall reinforcement: wire or steel mesh minimum 14-gauge with a maximum mesh spacing of 200mm.
- Support posts/stakes: 1500mm^2 (min) hardwood, 2500mm^2 (min) softwood, or 1.5kg/m (min) steel star pickets suitable for attaching fabric.
- Aggregate: 15 to 25mm clean gravel or aggregate.
- Filter tube: manufactured from a non-woven geotextile with or without UV-stabilised reinforcement. Wide strip tensile strength (AS3706.2) minimum 20kN/m in both directions. Pore size (EOS, O_{95}, AS 3706.7) less than 90µm. Mass per unit area (AS3706.1) minimum 300gsm.

Installation (using sediment fence fabric)

1. Refer to approved plans for location, extent, and required type of fabric (if specified). If there are questions or problems with the location, extent, fabric type, or method of installation, contact the engineer or responsible on-site officer for assistance.
2. Clear the location of the sediment trap. Remove trees, stumps, roots and other surface and sub-surface matter that would interfere with installing and maintaining the trap.
3. Take necessary steps to ensure inflow correctly enters the sediment trap and does not bypass the trap.
4. Excavate a 200mm wide by 200mm deep trench along the outline of the settling chambers.
5. Secure the support posts into the ground spaced no greater than 1.5m.
6. If specified, securely attach the support wire or mesh to the inside face of the support posts with the mesh extending at least 200mm into the excavated trench.
7. Ensure the mesh and fabric are attached to the inside face of the support posts even when directing the fabric around a corner.
8. Wherever possible, construct the settling chamber walls from a continuous roll of fabric. Where necessary, join the fabric either by:
   (i) attaching each end to two overlapping posts/stakes with the fabric folding around the associated stake one turn, and with the two stakes tied together with wire; or
   (ii) overlapping the fabric to the next adjacent support post/stake.
9. Securely attach the fabric to the support posts/stakes using 25mm staples or tie wire at maximum 150mm spacing with the fabric extended at least 200mm into the trench.
10. Securely attach the fabric to the support wire/mesh, if any, along the full length of the fabric at a maximum spacing not exceeding 0.5m.
11. Ensure the chamber walls are at least 450mm high, but not more than 700mm high.
12. Backfill the trench and tamp the fill to firmly anchor the bottom of the fabric and mesh to prevent water from flowing under the chamber walls.

Installation of spill-through weirs

1. Locate the spill-through weirs at alternate ends of the settling chambers.
2. Ensure the spill-through weir crest is at least 300mm above the ground.
3. Securely tie a horizontal cross member (weir) to the support posts/stakes each side of the weir. Cut the fabric down the side of each post and fold the fabric over the cross member in the direction of overflow. Securely tie the fabric to the support posts and cross member.
4. Install a suitable splash pad or other erosion control measures at the outlet of the final spill-through weir to control soil erosion.

Maintenance

1. Inspect the sediment trap at least weekly and after any significant rain. Make necessary repairs immediately.
2. Repair any torn sections with a continuous piece of fabric.
3. When making repairs, always restore the system to its original configuration unless an amended layout is required or specified.
4. If the fabric is sagging at any point, then install additional support posts/stakes.
5. Remove accumulated sediment if the sediment deposit exceeds a depth of 200mm.
6. Dispose of sediment in a suitable manner that will not cause an erosion or pollution hazard.

Removal

1. When disturbed areas up-slope of the sediment trap are sufficiently stabilised to restrain erosion, the sediment trap must be removed and the area rehabilitated.
2. Remove all materials and collected sediment and dispose of in a suitable manner that will not cause an erosion or pollution hazard.
3. Rehabilitate/revegetate the disturbed ground as necessary to minimise the erosion hazard.