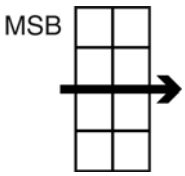
Modular Sediment Barriers (Instream)

INSTREAM PRACTICES

Flow Control		No Channel Flow	✓	Dry Channels	✓
Erosion Control		Low Channel Flows	✓	Shallow Water	✓
Sediment Control	✓	High Channel Flows		Deep Water	



Symbol

Photo 1 – Modular sediment barrier

Photo 2 – Modular unit

Modular sediment barriers as discussed within this fact sheet are a modification of the 'Sediment Weir' technique presented within a separate fact sheet. It should be noted that a patented design exists ('WaterClean FilterBale' by Star Water Solutions) for individual modular units containing replaceable filter cartridges and wrapped in filter cloth.

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 structure, especially when working in clayey soils.
2. Sediment trapping is primarily achieved by the filtration of minor flows passing through the structure, however, sedimentation may also occur within the settling pond formed by the modular weir during high flows.
3. The critical design parameter for optimising particle settlement is the 'surface area' of the settling pond. The hydraulic properties of the modular barrier are critical in achieving the desired stage-discharge relationship to achieve optimum settling pond conditions.
4. The allowable flow rate through the modular barrier is governed by the maximum allowable hydraulic head, the allowable flow rate per module, and the number of modules.
5. Sediment 'filtration' and gravity-induced 'sedimentation' can be improved by filling the modular units with compost or special pollutant-adsorbing filter bags (e.g. *'WaterClean FilterBale'*), or attach one or more filter tubes to the weir (Figure 4).

Design Information

The following design procedure may not always be applicable due to the absence of product-specific head vs discharge relationships.

Wherever possible, product-specific head vs discharge relationships should be obtained from the manufacturer or distributor. Preference must always be given to head–discharge relationships determined from prototype testing rather than estimations based on standard permittivity testing typically based on a hydraulic head of 100mm.

Design Procedure

1. Determine the primary design discharge (Q) for water passing through the modular barrier just prior to flows overtopping the units (Figure 1). This is normally set equal to the expected dry weather flow rate of the stream.
2. Determine the weir design discharge (Q_{WEIR}) for overtopping flows (Figure 2). The appropriate design event may be set by the licence conditions (set by State or local authority), otherwise choose a stream flood frequency of at least 10 times the expected operational life of the structure, but at least a 1 in 1 year channel flow.
3. Determine the desirable settling pond surface area (A_s) from Table 1 based on the design discharge (Q). Where practical, a critical particle size of 0.05mm should be chosen.
4. Determine the maximum allowable water level within the settling pond. This may be based on-site constraints, or related to flooding and/or public safety issues.
5. Determine the required width of the modular barrier (W). The width (perpendicular to the direction of flow) may be limited by site constraints, or controlled by the hydraulic management of overtopping flows. The hydraulic analysis of overtopping flows is normally based on weir equations—refer to the separate fact sheet *'Chutes Part 1: General Information'*.
6. Select the required crest elevation of the modular barrier to achieve the desired settling pond surface area. Ensure the weir crest is sufficiently below the maximum allowable water elevation to allow for expected overtopping flows (possibly an iterative design step).

   Operators should **avoid** circumstances where the instream settling pond needs to be excavated (expanded) to achieve the required surface area as this can cause undesirable channel damage.
7. Determine the maximum allowable head loss (ΔH) through the modular barrier. If flow conditions downstream of the barrier are such that there is little or no backwater effects during the design discharge (Q), then assume ΔH is equal to the height of the barrier (H).

   If flow depths downstream of the modular barrier are expected to be significant, then the maximum allowable head loss (ΔH) should be taken as the expected variation in water level across the barrier during the design discharge.
8. Select an appropriate 'design' blockage factor (B.F.).
9. If the available pond surface area is insufficient to settle the required particle size, then the efficiency of the sediment trap may be improved by incorporating additional filtration system into the modular units or incorporating *Filter Tubes* (refer to *Filter Tube Barriers*) into the structure. Note the filter tube intake pipes need to be set at an elevation above the expected settled sediment depth.
10. Determine the rock size required for the splash pad downstream of the modular barrier.

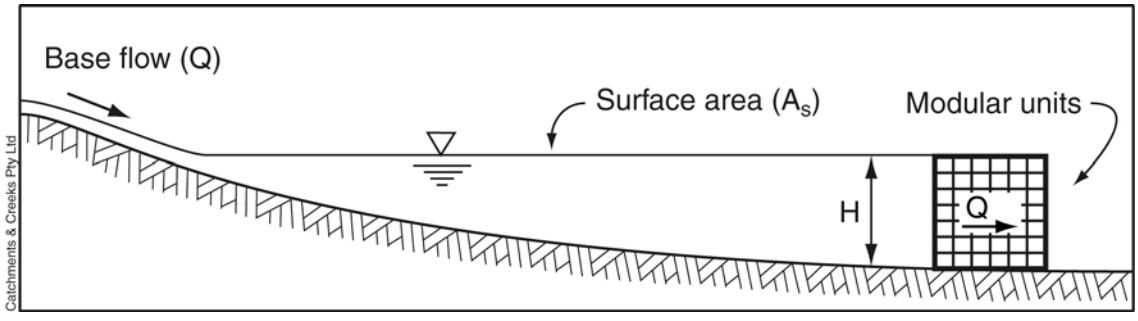


Figure 1 – Minimum design flow condition

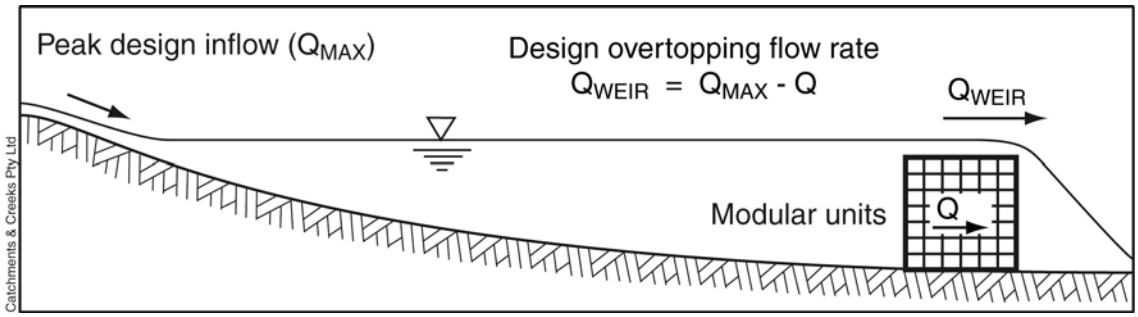


Figure 2 – Maximum design flow condition

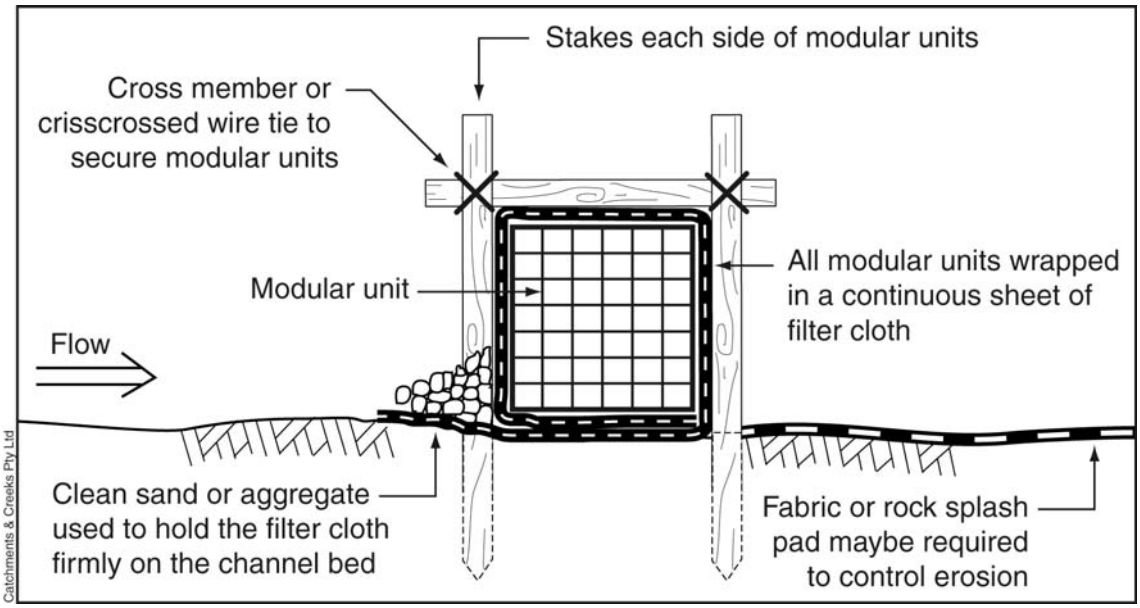


Figure 3 – Typical installation of modular units on channel bed

Incorporating filter tubes into a modular sediment barrier (Figure 4) 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.

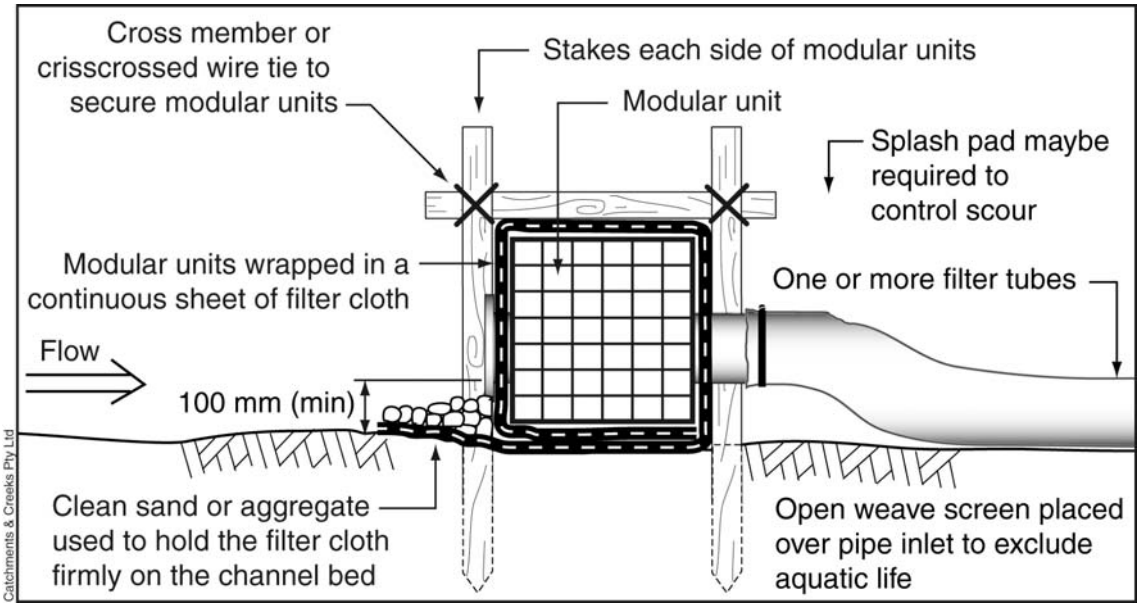


Figure 4 – Typical arrangement of filter tubes incorporated into a modular sediment trap

It is important to ensure a good contact is achieved between the modular units and the ground surface to prevent leakage. When installing a modular sediment barrier into a concrete-lined drain, benefit may be obtained from using 50mm soft foam as a water seal between the units and the concrete surface (Figure 5).

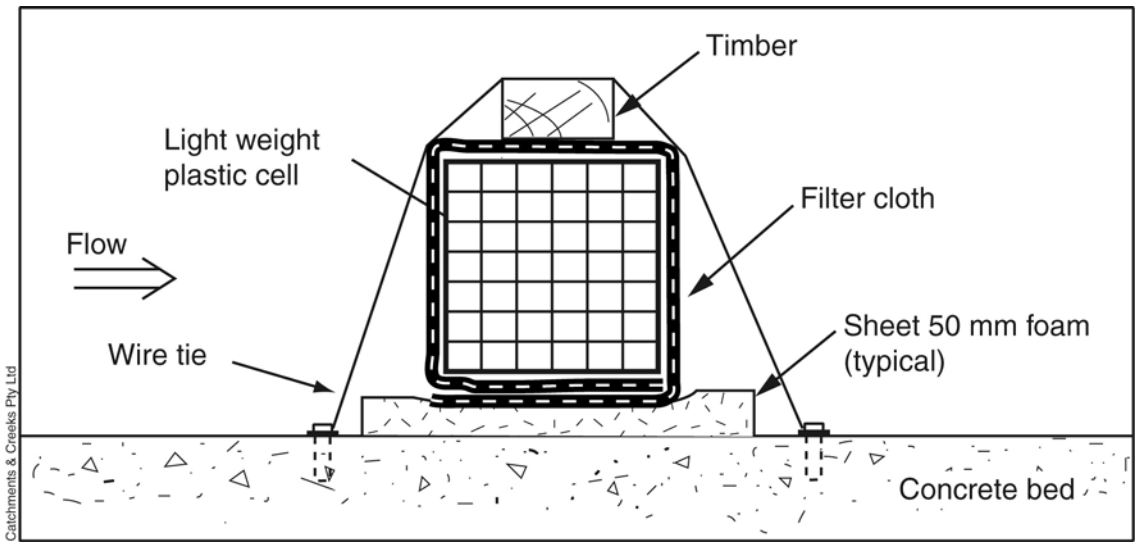


Figure 5 – Typical installation of modular sediment barrier within a concrete drain

Settling pond:

Table 1 provides the required pond surface area per unit flow rate for various nominated 'critical' sediment particle sizes. The critical sediment particle size for a modular barrier may be assumed to be 0.05mm unless otherwise directed. The chosen critical sediment size should reflect the environmental values of the receiving water body and the expected weather conditions.

Ideally, the settling pond should have a length (in the main direction of flow) at least three times its average width. If the pond length is less than three times its average width, then the pond area should be increase by 20% from the values presented in Table 1.

It is noted that achieving the minimum pond surface area may not be practical in all circumstances, in which case a greater focus should be placed on the design of additional filter medium and/or the incorporation of filter tubes (Figure 4).

Table 1 – Minimum settling pond surface area per unit inflow rate

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 [2]	15° C [2]	20° C [2]	
Type 3 sediment trap	0.50	6	5.2	4.6	0.3
	0.20	38	33	29	0.3
	0.15	67	60	52	0.3
Type 2 sediment trap	0.10	150	130	115	0.2
	0.05	600	525	460	0.2
Type 1 sediment trap	0.04	940	820	720	0.2
	0.02	3700	3230	2860	0.2

[1] Pond area is based on a rectangular pond operating with uniform inflow conditions across its width.

[2] Assume a pond temperature the same as the typical rainwater temperature during the time of year when the pond is likely to be operating at capacity.

Description

A sediment filtration barrier formed from modular units wrapped in filter cloth.

Purpose

Modular sediment barriers are a specialist sediment control system developed for specialist installation purposes.

Originally developed to allow the formation of a 'Sediment Weir' type structure within concrete lined drainage channels during construction and maintenance activities.

Used as an alternative to a straw bale barrier.

Limitations

In the absence of an appropriate internal filter media, the filter cloth provides limited capture of clay-sized particles.

Advantages

Light, reusable and durable.

Disadvantages

Can be difficult and time consuming to install.

Special Requirements

It is important to ensure a good contact is achieved between the modular units and the ground surface to prevent leakage.

Various anchoring systems can be employed (including the use of timber stakes) so long as the system is able to suitable restrain the units from movement.

Site Inspection

Check for leakage under or around the sediment trap.

Check for excessive sedimentation around the entrance to the filter tubes (if used).

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

Materials

- Modular units: open mesh stackable cells (e.g. *Atlantis* Matrix Tank Modules or milk crates).
- Filter Fabric: heavy-duty, needle-punched, non-woven filter cloth minimum 'bidim' A44 or equivalent.
- Aggregate: 15 to 25mm clean gravel or aggregate.
- Foam: minimum 50mm thick, soft foam.

Installation

1. Prior to commencing any works, obtain all necessary approvals and permits required to conduct the necessary works including permits for the disturbance of riparian and aquatic vegetation, and the construction of all permanent or temporary instream barriers and instream sediment control measures.
2. Refer to approved plans for location and installation details. If there are questions or problems with the location or method of installation contact the engineer or responsible on-site officer for assistance.
3. If there is flow within the watercourse or drainage channel at the time of construction of the modular barrier, then install appropriate downstream sediment control devices and/or flow diversion systems prior to construction of the barrier. Such measures should only be installed if considered appropriate for the local conditions, and only if their installation is judged to provide a net overall environmental benefit.
4. To the maximum degree practical, construction activities and equipment must not operate within open flowing waters.
5. Where practicable, divert all surface water runoff from the adjacent construction site into stable, undisturbed, vegetated areas adjoining the watercourse so as to minimise the direct discharge of sediment-laden water into flowing channel waters.
6. Ensure clearing and excavation of access paths and the banks and bed of the watercourse are limited to the minimum practicable.
7. If flow diversion systems cannot be installed, then conduct bank excavations by pulling the soil away from the channel.
8. If dispersive, highly unstable, or highly erosive soils are exposed, then priority must be given to the prompt stabilisation of all such areas.
9. Clear the foundation area of the modular barrier of woody vegetation and organic matter. Delay any channel disturbances up-slope of the barrier until the barrier is able to act as a suitable sediment trap.

10. Using minimum 2.4m wide fabric, lay the fabric on the ground with at least 200mm of the fabric placed upstream of the barrier.
11. If more than one sheet of fabric is used, then overlap the filter fabric a minimum of 600mm at all joints.
12. Place the modules end to end of the fabric with the upstream edge aligned with the down-slope edge of the trench.
13. Fold the remainder of the filter cloth over the modular units such that the end of the fabric extends at least 200mm upstream of the barrier.
14. Secure stakes immediately up-slope and downstream of each modular unit. The upstream stake should be used to both secure the modular units and anchor the fabric.
15. Using either a timber cross member or crisscrossed wire, secure the modular units to the stakes such that vertical movement is prevented.
16. Use a continuous layer of sand or aggregate to hold the fabric firmly on the channel bed.
17. Use geotextile fabric and/or minimum 200mm diameter rock to form a splash pad that extends downstream from the barrier a distance at least twice the height of the barrier.

Alternative requirements for placement within a concrete channel:

1. Place a continuous layer of minimum 50mm soft foam across the channel at the proposed location of the sediment barrier.
2. Cover the foam with filter fabric before placing the central core of tightly packed modules. Sufficient length of fabric should exist upstream of the barrier to allow the fabric to eventually be placed over the modules to form a continuous sediment barrier. Overlap the filter fabric a minimum of 600mm at all joints, with the upstream strip laid over the downstream strip.
3. Place the modules end to end across the channel, then fold the filter cloth over the modules.
4. Place a solid timber beam on top of the sediment barrier and anchor the beam to the channel bed using rock bolts and heavy-duty wire ties.

Maintenance

1. Inspect the modular barrier daily and after any changes in stream flow. Make repairs as needed.
2. Inspect the barrier for undercutting or undesirable seepage flows.
3. If flow through the structure is reduced to an unacceptable level, the filter medium should be removed and replaced.
4. If a greater degree of water treatment (filtration) is required, extra geotextile filter fabric should be placed over the upstream face of the structure.
5. Check the structure and surrounding channel banks for damage from overtopping flows and make repairs as necessary.
6. Immediately replace any rock displaced from the downstream splash pad.
7. Remove sediment and restore original sediment storage volume when collected sediment exceeds 10% of the specified storage volume.
8. Dispose of sediment and debris in a manner that will not create an erosion or pollution hazard.

Removal

1. The modular barrier should be removed as soon as possible after they are no longer needed.
2. If there is flow within the watercourse or drainage channel at the time of removal of the modular barrier, then install appropriate instream sediment control devices and/or flow diversion systems prior to its removal.
3. All settled sediment upstream should be removed prior to removal of the modular barrier. Dispose of the sediment in a manner that will not create an erosion or pollution hazard.
4. Remove all materials used to form the modular barrier including the geotextile filter cloth and recycle or dispose of in a manner that will not create an erosion or pollution hazard.
5. Restore the watercourse channel to its original cross-section, and smooth and appropriately stabilise and/or re-vegetate all disturbed areas.