Stilling Ponds

DE-WATERING SEDIMENT CONTROL TECHNIQUE

Low Flow Rates	[1]	Low Filtration	✓	Sandy Soils	✓
Medium Flow Rates		Medium Filtration	✓	Clayey Soils	✓
High Flow Rates		High Filtration	[2]	Polluted Soils	[3]

[1] These systems operate on a batch flow process based on treatment volume rather than flow rate.

[2] Treatment standard depends on duration of settlement and possible use of coagulants.

[3] Can be used to capture pollution spills on a construction site.

Symbol

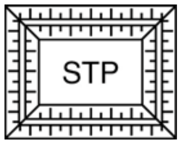

Photo 1 – Stilling pond

Key Principles

1. The key design parameters are the settlement time and the application of chemical coagulants to achieve effective and rapid settlement.
2. The mechanics and performance of this technique are similar to that of a standard ‘wet’ sediment basin.
3. Unlike a *Settling Pond* the sediment trapping efficiency of a stilling pond is **not** dependent on flow entry conditions or the length-width ratio of the pond.

Design Information

Hydraulic capacity of the stilling pond is governed by:

- the volume of the pond; and
- the total batch time including filling, settlement and decanting.

Stilling ponds are designed following procedures similar to those adopted for ‘wet’ (Type F/D) *Sediment Basins*; however, the treatment volume is not based on a particular storm event.

Where necessary, baffled inflow conditions may be required to minimise the re-suspension of settled sediment, thus reducing the total batch time (refer to *Settling Ponds* fact sheet).

Minimum desirable depth of settling pond is 0.3m.

Recommended minimum sediment storage volume is 10% of pond volume. The maximum allowable depth of settled sediment (prior to clean-out) depends on the decent system. It is critical that settled sediment is not drawn into the outlet pipe during de-watering of the pond. Typically this requires a minimum clear water depth of 0.2m.

Table 1 – Theoretical particle settling velocity (m/hr)

Design standard	Critical sediment size (mm)	Theoretical particle settling velocity (m/hr) [1]		
		10° C [2]	15° C [2]	20° C [2]
Type 3 sediment trap	0.50	600	688	782
	0.20	96	110	125
	0.15	54	62	70
Type 2 sediment trap	0.10	24	28	31
	0.05	6.0	6.9	7.8
Type 1 sediment trap	0.04	3.8	4.4	5.0
	0.03	2.2	2.5	2.8
	0.02	0.96	1.10	1.25

[1] Actual settling velocity can be significantly slower due to wind and residual inflow turbulence.

[2] Temperature of water within the settling pond.

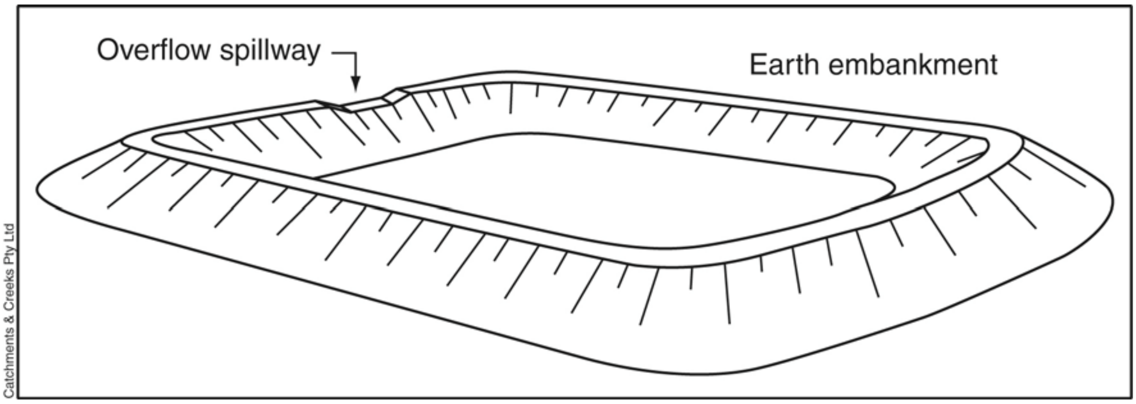

Figure 1 – Stilling pond with overflow spillway

Recommended maximum bank slopes for formed embankments are provided in Table 2.

Table 2 – Recommended maximum bank gradients

Site conditions	Gradient (H:V)
Internal banks for unfenced ponds within public-accessible urban areas	5:1
Internal banks for fenced ponds and ponds located within rural areas	2:1
External banks greater than 1m high	2:1
External banks not greater than 1m high	1.5:1

(a) Decant system:

The decant system may consist of a pump or manually controlled siphon.

When de-watering the pond it is extremely important for the process not to resuspend previously settled sediment. Thus, intake pipes must be housed in an appropriate flow control chamber to prevent settled sediment being removed from the pond. Intake pipes must **not** be allowed to rest on the bottom of the pond, or in any other location that will allow the entrainment of settled sediment.

An appropriate housing chamber for an inflow pipe can be formed from a section of PVC drainage pipe, sealed at one end, and perforated along its length with inflow holes.

As an alternative, the inflow pipe may be suspended from a floating raft that is designed to prevent the intake pipe from resting too close to the settled sediment. The intake pipe is normally placed inside a horizontal perforated PVC pipe attached to the underside of a floating raft. Perforations in the PVC pipe would only exist along the top of the pipe, thus minimising the risk of settled sediment being entrained into the outlet.

(b) Overflow system:

The overflow spillway may consist of either an overflow pipe (Figure 2), or a rock-lined spillway (Figure 3). The spillway overflow should have a minimum capacity equal to the maximum inflow rate.

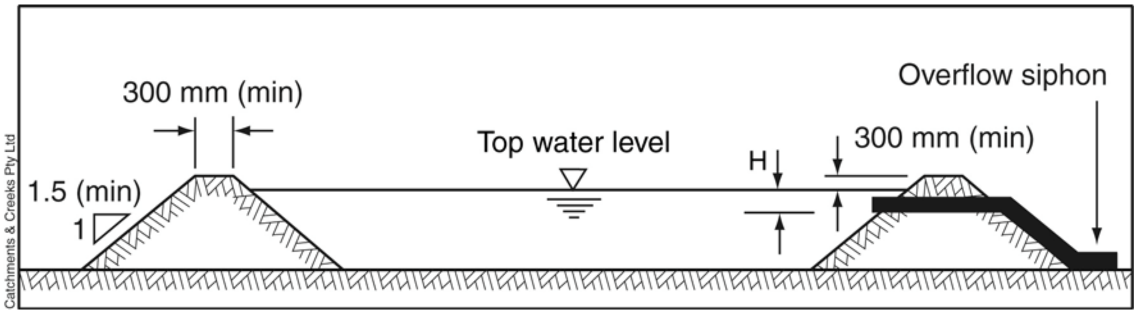

Figure 2 – Siphon overflow system

Siphon outlet pipe can be designed using the design guidelines presented for *Slope Drains*. Table 3 provides inlet flow capacities for pipe diameters of 300 and 375mm.

Table 3 – Hydraulic capacity (L/s) of slope drains with 300 and 375mm diameter pipe [1]

Pipe dia 'D'	Upstream water level 'H' (m) relative to the slope drain invert at its inlet												
	0.20	**0.25**	**0.30**	**0.32**	**0.34**	**0.36**	**0.38**	**0.40**	**0.45**	**0.50**	**0.55**	**0.60**	**0.70**
300mm	36	49	62	67	72	76	81	85	96	106	115	123	138
375mm	43	63	82	89	96	104	11	118	134	150	166	180	207

[1] Tabulated flow rates assume partial full flow conditions exist within the pipe. If the inlet and outlet are drowned, full-pipe siphon flow conditions may commence within the pipe, in which case the flow rate will be governed by the total fall in water level from inlet to outlet.

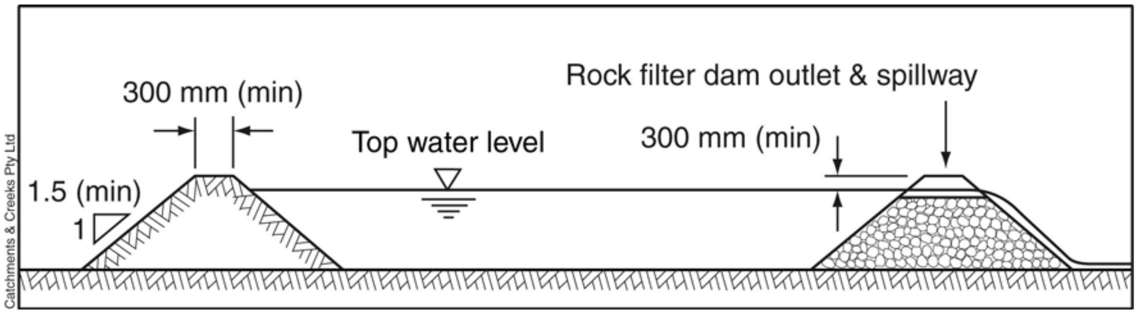

Figure 3 – Rock filter dam low-flow outlet system with overflow spillway

Rectangular or trapezoidal overflow spillways (Figure 4) are designed using an appropriate weir flow equation (Table 4).

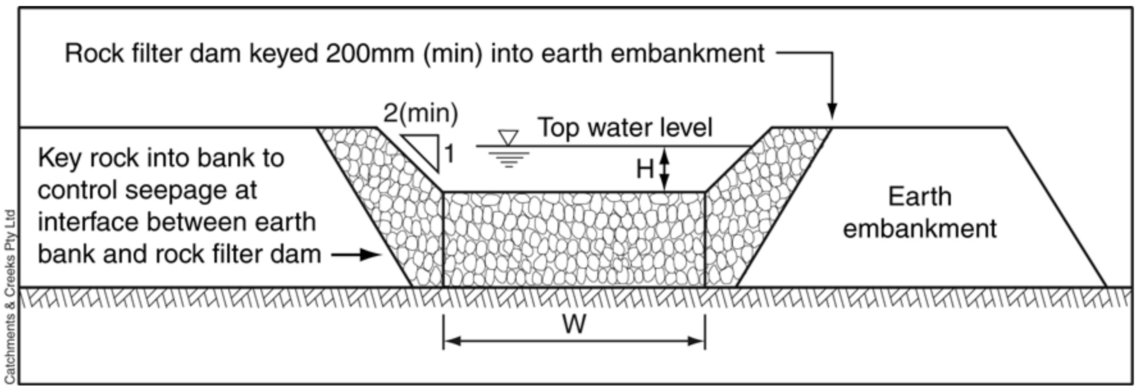

Figure 4 – Typical spillway profile

Table 4 – Weir equations for spillways with a short crest length

Weir cross sectional profile	Side slope (H:V)	Weir equation
Trapezoidal where : b = base width and m = side slope	1:1	$Q = 1.7\, b\, H^{1.5} + 1.26\, H^{2.5}$
	2:1	$Q = 1.7\, b\, H^{1.5} + 2.5\, H^{2.5}$
	3:1	$Q = 1.7\, b\, H^{1.5} + 3.8\, H^{2.5}$
	4:1	$Q = 1.7\, b\, H^{1.5} + 5.0\, H^{2.5}$
	m:1	$Q = 1.7\, b\, H^{1.5} + 1.26\, m\, H^{2.5}$

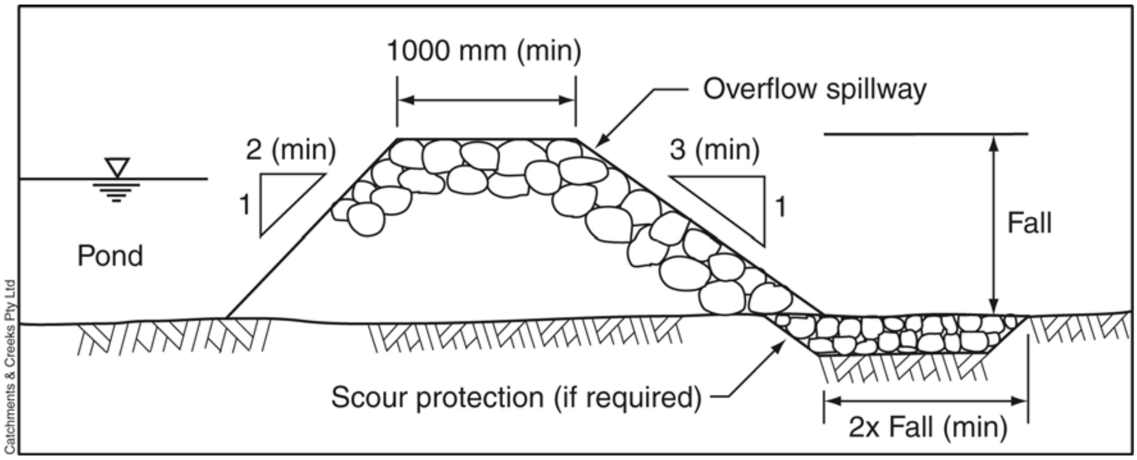

Figure 5 – Typical profile of rock-lined overflow spillway

Table 5 provides the head–discharge relationship for a trapezoidal weir with 2:1 (H:V) side slopes and base width (b).

Table 5 – Inlet weir capacity for trapezoidal chute with 2:1 side slopes [L/s]

Head (H) required upstream of the chute entrance (m)	Crest width (b) of a rectangular chute (m)				
	b = 0.3	**b = 0.5**	**b = 1.0**	**b = 1.5**	**b = 2.0**
0.1	24	35	62	89	115
0.2	91	121	197	273	349
0.3	208	265	405	540	680
0.4	385	470	685	900	1,115
0.5	625	745	1,045	1,345	1,645
0.6	940	1,095	1,490	1,885	2,280

Photo 2 – Siphon pipe overflow system

Photo 3 – Rock-lined overflow spillway

Design procedure for a stilling pond:

Step 1 Determine the maximum inflow volume (**V**).

The maximum inflow volume represents the maximum volume of treated water during a single treatment (batch) cycle.

The minimum desirable batch cycle time is generally 18 hours.

Step 2 Determine the critical sediment particle size based on the required treatment standard.

If a treatment standard has not been set, then consider adopting a critical particle size of 0.02mm. Otherwise, determine the maximum stilling pond surface area based on space limitations.

Step 3 Determine if an overflow spillway will be required. An overflow spillway may not be required if the inflow volume will be strictly regulated to prevent overflows.

If an overflow spillway is required, nominate the type of overflow spillway system. Typically the overflow system consists of either an overflow pipe or a rock-lined spillway. Refer to Section (b) of this fact sheet for design guidelines.

Guidelines on the design of an energy dissipater (if required) can be found in the separate fact sheets for either *'Chutes – General'*, or *'Energy Dissipaters'*.

Step 4 Nominate the maximum water depth.

If an overflow spillway is required, then determine the maximum pond overflow water level (based on overflow spillway design), and the minimum embankment height (based on a minimum freeboard of 100mm).

Unless otherwise specified, select a maximum water depth no less than 0.3m.

Step 5 Estimate the likely water temperature within the settling pond during its operation.

Determine the theoretical settling velocity of the critical particle size from Table 1.

Determine the minimum settling time based on the maximum pond depth (prior to overflow) and the theoretical settling velocity (ensure appropriate units are used).

Step 6 Determine the total batch time, that being the total of the fill time, settling time, and decent time. Compare the batch time with the assumptions made in Step 1 and repeat analysis as necessary.

Step 7 Nominate the internal and external bank slopes based on the recommendations of a geotechnical report or Table 2.

Step 8 Determine if an inlet baffle will be required. In most cases, an inlet baffle will not be required—in fact, if not appropriately designed, an inlet baffle can increase the complexity of the sediment decent process.

If an inlet baffle is required, then refer to the separate *Settling Pond* fact sheet for design guidelines.

Description

Typically a temporary above ground pond formed by a ring bank, or a below ground pond similar to a traditional sediment basin.

Stilling ponds differ from *Settling Ponds* in that they are not free draining. De-watering is normally achieved through the use of a pump or siphon.

Stilling ponds are the de-watering equivalent of a 'wet' sediment basin.

Purpose

Used for the treatment of batch flow de-watering operations.

Commonly used for the de-watering of groundwater inflows from excavations at the commencement of a new working day, or the de-watering of excavations following storms.

Limitations

Best used when de-watering volumes are well defined.

Advantages

Good control of discharge quality.

Allows the use of chemical coagulants.

Usually more effective than a *Settling Pond* or *Filter Pond*.

Disadvantages

Does not allow continuous inflows.

Stilling ponds can be significantly larger than *Settling Ponds*.

Can be expensive to construct, if used on short-term jobs.

Special Requirements

Requires a decanting system that will not re-suspend the settled sediment.

Site Inspection

Check for leakages through the embankment (e.g. piping failures).

Check discharge water quality.

Materials (embankment)

- Earth fill: clean soil with Emerson Class 2(1), 3, 4, or 5, and free of roots, woody vegetation, rocks and other unsuitable material. Soil with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Class 2(1) should only be used upon recommendation from geotechnical specialist. This specification may be replaced by an equivalent standard based on the exchangeable sodium percentage.

Installation

1. Refer to approved plans for location, size, and construction details. If there are questions or problems with the location, size 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. If the proposed earth embankment exceeds a height of 1m, then clear, grub and strip topsoil from the embankment footprint. Appropriately scarify (roughen) the earth and/or excavate a cut-off trench along the centreline of the embankment.
4. Ensure the fill material contains sufficient moisture so it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction.
5. Place fill material in 150 to 250mm continuous layers over the entire length of the fill area and then compact it. Unless otherwise specified on the approved plans, compact the soil at about 1-2% wet of optimum and to 95% modified or 100% standard compaction.
6. If required by the plans, install an appropriate inlet baffle.
7. Install all appropriate measures to minimise safety risk to on-site personnel and the public caused by the presence of the pond. Avoid the use of steep, smooth internal bank slopes.

Maintenance

1. Inspect the pond regularly and at least daily during de-watering operations. Make repairs as needed to the pond, its outlet system and embankments.
2. Check the embankment for leaks, and repair as necessary.
3. Check the embankment for excessive settlement, slumping of the slopes and make all necessary repairs.
4. Clean out accumulated sediment as required and place in a suitable disposal area.
5. Do not dispose of sediment in a manner that will create an erosion or pollution hazard.

Removal

1. Remove all materials and collected sediment and dispose of in a suitable manner that will not cause an erosion or pollution hazard.
2. Rehabilitate/revegetate the disturbed ground as necessary to minimise the erosion hazard.