SEDIMENT MANAGEMENT ON CONSTRUCTION SITES

COMPLYING WITH THE SPP (July 2017) TECHNICAL NOTE FOR LOCAL GOVERNMENT DEVELOPMENT ASSESSMENT & COMPLIANCE OFFICERS

- REASONS FOR THE NEW SEDIMENT MANAGEMENT DESIGN OBJECTIVE
- DEMONSTRATING COMPLIANCE
- QUICK REFERENCE TOOLS
- SIMPLE DEEMED TO COMPLY SOLUTION FOR SMALL SITES (<2Ha)

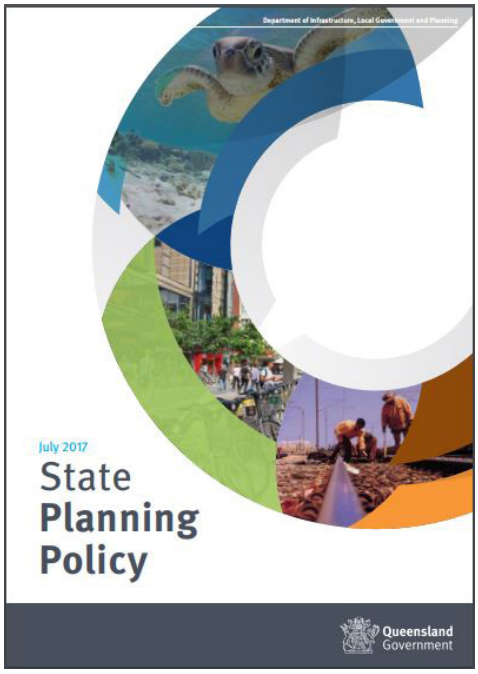
1. INTRODUCTION

The State Planning Policy 2017 (DILGP, 2017) came into effect on the 3rd July 2017and introduces a new stormwater management design objective for sediment control on construction sites.

New Operational Works applications which are for urban purposes and which involve disturbing a land area of 2500m2 or greater in size must comply with the new design objective.

The new design standard recognises there are alternative technologies available and proven in the Queensland context that can achieve the new design objective without necessarily increasing cost or land area requirements.

The purpose of this Technical Note is to assist Local Government (and Industry) by explaining the reason for the new design objective and to provide practical tools to help implement the change.



Queensland Government State Planning Policy 2017

All exposed areas greater than 2500 m² must be provided with sediment controls which are designed, implemented and maintained to a standard which would achieve at least 80% of the average annual runoff volume of the contributing catchment treated (i.e. 80% hydrologic effectiveness) to 50mg/L Total Suspended Solids (TSS) or less, and pH in the range (6.5–8.5)

(Appendix 2, Table A)

Photo Credit: Turbid Water Solutions

2. REASONS FOR THE NEW DESIGN OBJECTIVE

Prior to the release of the SPP 2017, sediment basins (termed henceforth as 'traditional sediment basins') operated as batch systems. These systems were designed to capture a specific volume of runoff from the design rainfall event. The design rainfall event was typically the 5-day 80th or 85th percentile rainfall depth (mm).

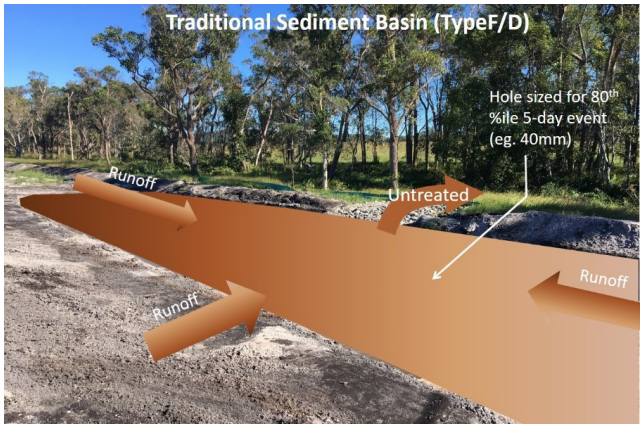
Traditional sediment basins work by having the storage empty prior to the rainfall event. Runoff during the event fills the basin and any excess runoff passes over the basin spillway untreated. Following the event, the captured water is treated (often with a chemical flocculant/coagulant). Once the discharge standard is achieved for the water in the basin (50mg/L TSS), the basin is emptied in readiness for the next rainfall event.

This process is illustrated in Figure 1.

Figure 1 – Steps in Traditional batch sediment basin operation

STEP 1

Basin empty prior to rainfall

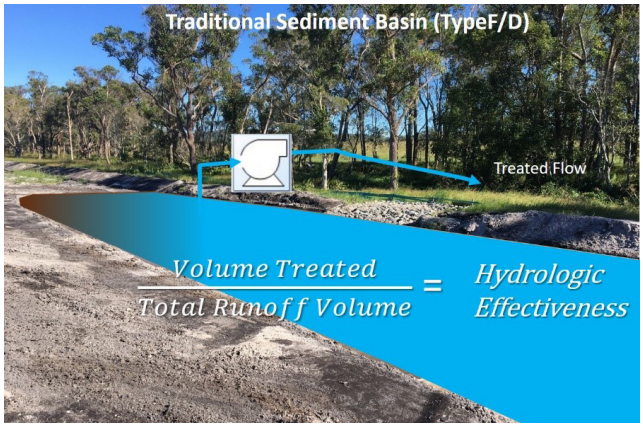


STEP 2

Runoff fills basin. Once full, excess runoff is discharged over basin spillway

STEP 3

Once the event is complete, captured water is treated to discharge standard (50mg/L TSS)



STEP 4

Basin is emptied in readiness for next rainfall event

Images Courtesy of: Turbid Water Solutions

2.1 TRADITIONAL SEDIMENT BASINS

For many years, Erosion and Sediment Control practitioners in Queensland have observed that traditional sediment basins designed and operated to the previous design standard (which was to capture the runoff volume generated by a 5-day 80th or 85th % ile rainfall event and to treat and release that volume within five days from the last runoff event into the basin) would regularly result in the un-controlled discharge of highly-turbid water, particularly during the wet season. This lead a number of practitioners to question how effective traditional sediment basins are at protecting downstream water quality from fine sediment and turbidity.

Studies (Rowlands and Leinster, 2015; Robson, 2015) were undertaken to provide a more meaningful measure of the effectiveness of tradition sediment basins. These studies used the term 'hydrologic effectiveness' to report basin performance, which is simply the percentage of total runoff which is able to be treated to the discharge standard by the basin. By undertaking simulation using long-term (10 years) of rainfall data, estimates of hydrologic effectiveness demonstrated that traditional sediment basins operated in coastal regions of Queensland were largely ineffective (Table 1).

Table 1 Performance estimates for Traditional batch sediment basins

Location	5-day 80th %ile Rainfall depth (mm)	Hydrologic Effectiveness	5-day 85th %ile Rainfall depth (mm)	Hydrologic Effectiveness
Weipa	35.8	11%	46.2	14%
Cairns	56.2	20%	74.1	26%
Townsville	43.8	22%	57.1	26%
Mackay	43.8	27%	57.1	31%
Caloundra	40.6	34%	52.7	41%
Sydney	*29.7*	*38%*	*38.8*	*44%*
Canberra	*20.4*	*60%*	*25.1*	*68%*
Melbourne	*20.6*	*65%*	*25.4*	*71%*

Table 1 shows the performance of traditional sediment basins decreases as you move further North and highlights the shortfalls of the previous design standard. The reason traditional sediment basins are so ineffective in coastal Queensland in particular is because rainfall often occurs in consecutive events which do not allow sufficient time for the batch process which traditional sediment basins employ to be completed.

The new design objective addresses the unsatisfactory performance of traditional sediment basins by making 80% Hydrologic Effectiveness the minimum standard for sediment controls on all exposed areas greater than 2500m2. The new design objective brings construction phase sediment management in-line with current stormwater quality management design objectives for the post-construction (operational) phase of land development.

3. DEMONSTRATING COMPLIANCE

The new stormwater management design objective for sediment control differs significantly from previous design objectives as it is entirely performance-based and not linked to any one specific technology. This provides industry with the flexibility to innovate whilst also having a clear performance outcome which is required to be achieved. However, for many smaller developments, a simple deemed-to-comply solution which can be readily adopted may be preferred.

A discussion on the range of possible compliance approaches as well as simpler deemed-to-comply approaches are provided below.

3.1 FLEXIBLE COMPLIANCE APPROACHES

There are a range of available technologies and approaches which may be utilised and which are accepted as achieving compliance with this design objective as follows:

High Efficiency Sediment (HES) Basins:

Install and operate Type-A or Type-B sediment basins designed in accordance with IECA (2016 addendum), described as High-Efficiency Sediment (HES) basins. These are sediment basins which have automated dosing of chemicals which assist flocculation/coagulation of fine and dispersive sediment and which operate on a continuous-flow basis. Type-A basins incorporate a floating decant as the primary outlet while Type-B basins can remain full between events and have only a spillway outlet. These basins are described more fully in Section 3.2.

Large Traditional Sediment Basins:

Traditional sediment basins (Type D) designed in accordance with IECA (2008) will not comply with the new stormwater management design objective for sediment control. Modified batch basin designs may be possible for some sites, however for most sites the batch basins would need to be impractically large or require impractical treatment and dewatering strategies to meet the new design objective. Table 2 shows the minimum size of a traditional sediment basin to comply with the new design objective.

Total Capture:

For flat sites, with no external catchment, perimeter bunding may be appropriate where it can be shown that the bund height is sufficient to capture the anticipated (average) wet season rainfall completely (i.e. total capture). A simple water-balance calculation and earthworks sections showing the bund arrangements and capture volumes will be sufficient to show that this strategy can be implemented. However careful consideration will be required for how this strategy can continue to operate beyond earthworks stage to when civil construction is being undertaken or nearing completion.

Photo Credit: Turbid Water Solutions

Alternative Innovative Measures:

Alternative measures may be implemented where it can be shown through long-term water-balance modelling that the measures will achieve the release criteria of 50mg/L TSS for at least 80% of the average annual runoff volume. This would need to be documented and justified in the ESC Plan.

Erosion Control:

Effective erosion control can be implemented in lieu of requiring sediment control specified above. For small areas, which are unable to drain to a basin, this could be achieved by implementing contingency measures prior to rainfall, such as covering exposed soil with blankets (mulch or synthetic) or spray-on soil binders. In these circumstances, the erosion controls must result in an effectively stabilised surface prior to rainfall to justify the exclusion of sediment controls.

The proponents Erosion and Sediment Control (ESC) Plan must clearly state which compliance approach is proposed to meet the new sediment control design objective and supporting calculations are to be provided. The practicality of each approach should be carefully considered. Additionally, the ESC Plan should include an operating strategy that clearly outlines the methods and resources that will be employed to successfully operate the identified controls to achieve the new sediment control design standard. The operating strategy should be practicable and achievable.

Table 2 Minimum Size of Traditional Sediment Basins to comply with SPP 2017

Location	Traditional Sediment Basin Size (m3/Ha)
Gold Coast	1600
Brisbane	1200
Ipswich	750
Toowoomba	700
Caloundra	1200
Nambour	1700
Bundaberg	1700
Mackay	>3000
Townsville	*N.A*
Cairns	*N.A*
Weipa	*N.A*
Lockhart River	*N.A*

Locations in italics cannot use traditional sediment basins to comply with the new SPP 2017 design objective.

3.2 TYPE A AND TYBE B HES BASINS

The design procedures for Type A and Type B HES basins are documented in IECA (2016 Addendum). It should be noted however this is a national guideline so is not specifically aimed at meeting the design objective of the Queensland SPP.

Modelling has therefore been undertaken and it has been confirmed that Type A and Type B basins designed in accordance with IECA (2016) will achieve the SPP design objective and so are a suitable solution to achieve compliance with this policy.

The following points should be noted when following the IECA (2016 Addendum) procedures:

TYPE-A HES:

- IECA (2016 Addendum) limits the low-flow decant rate to 9L/s/ha. This rate is well below optimum for high rainfall-intensity locations and will result in excessive basin size (e.g. Cairns, Mackay). It is recommended that specialist advice be sought if designing Type-A HES basins in these locations

TYPE B HES:

- The use of an effective and fast-acting coagulant or flocculant is critical for the success of both Type-A and Type-B HES basins. The design settling rate (laboratory settling rate) must be set at no more than 0.6m/hr. This is to provide a degree of safety in the sizing of the settling zone volume. The coagulant or flocculant to be used in the basin is to meet or exceed this design settling rate.

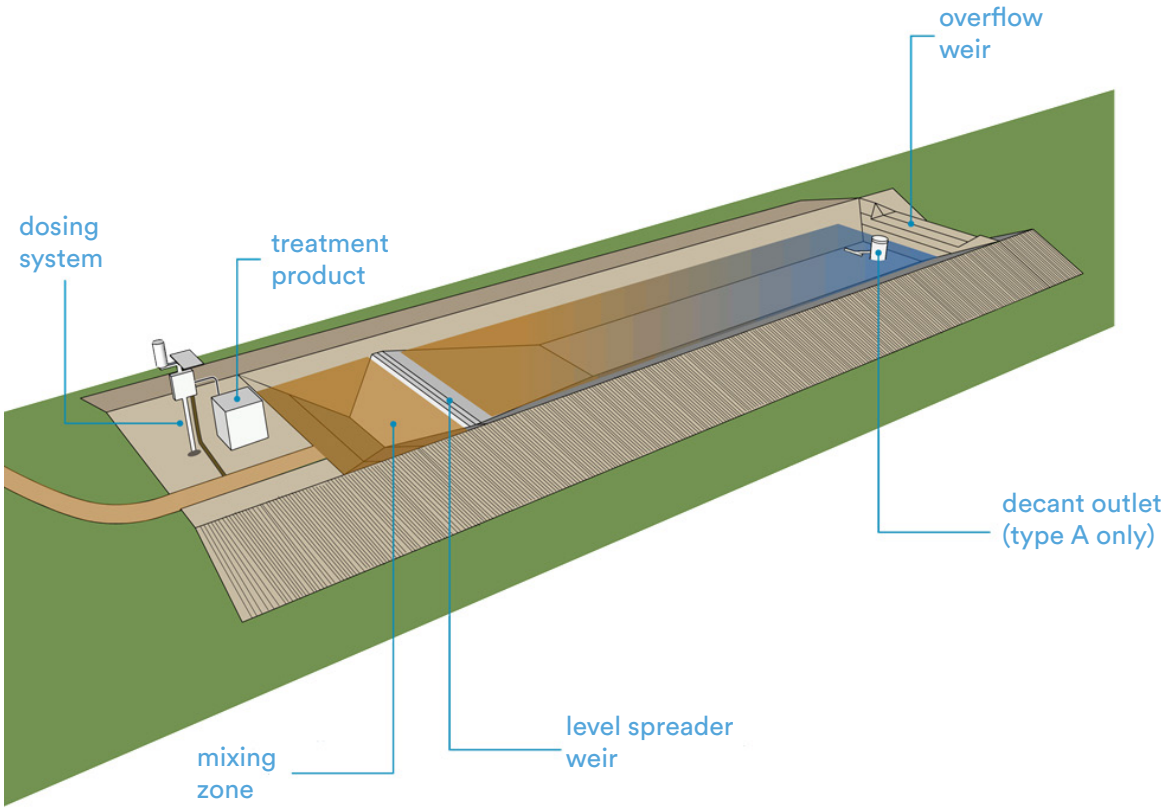
- The scour velocity checks (steps 5B, 6B in IECA, 2016 Addendum) are to be undertaken as informative only. If resuspension through scour is identified as a potential issue, then this is best addressed through monitoring basin performance and retrofitting permeable baffles if resuspension is observed.

- Type B basins should only be provided for a maximum catchment area of 5Ha or a design treatment flowrate of 250L/s. Where greater catchment areas are involved, consideration should be given to implementing a number of distributed systems or implementing an alternative arrangement where flow into the settling zone can be regulated to below 250L/s. If neither of these options is available, then specialist advice should be sought on dosing and flow management.

Photo Credit: Turbid Water Solutions

HOW HES BASINS WORK

High Efficiency Sediment (HES) basins work on a continuous-flow basis rather than the batch process that traditional sediment basins operate by. This means that treatment and discharge occur throughout a rainfall event rather than at the end of an event. This continuous-flow approach offers many advantages; the main one being that a much greater volume of runoff can be treated for a given basin size, compared to traditional batch basins.



KEY COMPONENTS

DOSING SYSTEM:

An automated system is provided at the start of the basin to deliver a dose of chemical coagulant or flocculant to enhance the settlement of fine and dispersive sediment. The dosing system can be either triggered by rainfall or can be based on incoming flowrate.

MIXING ZONE:

This is the first cell of the basin and is where the majority of mixing of the coagulant or flocculant with runoff occurs and is also where the majority of coarse sediment is deposited.

LEVEL-SPREADER/WEIR:

The level-spreader acts to distribute the flow across the full width of the basin so that velocities are minimised and settling is enhanced.

SETTLING ZONE:

This second cell of the basin is where settling of fine and dispersive sediment occurs. The fine particle size and slow settling velocities require this cell to be large so that non-turbulent settling can occur. initial estimates of settling zone volume for a number of locations in Queensland are provided in Table 3. These initial estimates can be used for early planning purposes or may also be accepted by Local Governments as 'deemed-to-comply' solutions for smaller scale developments up to 2ha. Practitioners are advised to check with the relevant Council.

OUTLET STRUCTURES:

There are two different types of HES basins specified in IECA (2016 Addendum) – Type A and Type B. The main difference between these types is the outlet structure. Type A basins have a floating-decant as the primary outlet which 'skims' water from the top of the water column and allows the basin to be largely emptied between events. Type B has only a spillway outlet and remains full following an event.

Image Courtesy of: Turbid Water Solutions

Table 3 Initial Estimates of Settling Volume for HES Basins

Location	Type A Settling Volume (m^3/ha)	Type B Settling Volume (m^3/ha)
Ipswich	140	270
Toowoomba	110	260
Gold Coast (Southport)	350	330
Brisbane	200	310
Redcliffe	250	330
Sunshine Coast	340	350
Bundaberg	260	400
Gladstone	230	320
Rockhampton	200	330
Mackay	430	360
Townsville	330	310
Cairns	660	360

3.3 SIMPLE DEEMED-TO-COMPLY SOLUTION

For sites with total disturbance area less than 2Ha and where all inflows can be directed to a single point, a simple deemed-to-comply solution could be implemented. This procedure is based on the IECA (2016 Addendum) Type-B HES basin but has been simplified in recognition of the lower-risk and fewer design resources available to smaller sites..

The following parameters should also be adopted for deemed to comply solutions:

a) Provide basin settling volume sized as per Table 3

b) Average settling zone depth of 1-2m

c) Sediment storage volume sized as 30% of settling volume

d) Length-width ratio 3:1

e) spillway design as per IECA (2016 Addendum) or conservatively set to full basin width and with 500mm freeboard to basin embankment

f) forebay sized as 10% of the settling zone volume and with flow-distribution weir (level-spreader) set 100-200mm above outflow spillway level

g) Provide rainfall-activated flocculant/coagulant dosing system on the single inflow point to the basin forebay. The dosing system is to be re-supplied with flocculant/coagulant after each rain event, or as required based on the coagulant storage capacity of the selected dosing unit, to ensure subsequent events will be treated.

h) Select and supply a flocculant/coagulant determined through jar test conducted as per IECA (2016 addendum) Section B3 which achieves a minimum settlement clarity of 150mm within 15 minutes

A standard drawing showing the above suggested deemed-to-comply solution for small catchments (<2ha) is provided in Appendix A.

Photo Credit: Turbid Water Solutions

4. DEMONSTRATING COMPLIANCE – IN THE FIELD

Successful implementation of the new sediment control design objective will require the commitment of all parties undertaking land development, including Developers, Consultants and Contractors. It is important in the interests of creating a level-playing-field that Councils actively regulate sites and take action in relation to those sites which are not complying or not actively adapting measures to achieve compliance.

The Department of Environment and Science (formerly Department of Environment and Heritage Protection) has produced Standard Work Method Statements which are used by the Department and may be referred to by Local Government in the field to determine if construction sites are meeting environmental obligations under the Environmental Protection Act 1994. The Department has updated their Work Method Statement to reflect the new sediment design objective and it is available for download here

https://www.ehp.qld.gov.au/water/policy/erosion-sediment-control-construction-sites.html#updated_procedural_guides_for_consultation

Photo Credit: Turbid Water Solutions

5. DRAFT STANDARD CONDITIONS

The following is suggested standard conditions that could be used by Councils when assessing and approving development applications that trigger the new design objective.

REC and MCU

In conjunction with the development application for Operational Works, provide a concept ESC plan prepared in accordance with (enter Council's relevant Planning Scheme Policy) and specifically identifies how the Construction-Phase stormwater management design objectives of the State Planning Policy 2017 (Appendix 2 Table A) will be achieved

OPW

Sites with catchments <2Ha

Prescribed Water Contaminants (as defined in the Environmental Protection Act 1994) must not be released from the site or to waters within the site, or be likely to be released should rainfall occur, unless all reasonable and practicable measures are taken to prevent or minimise the release and concentration of contamination. These measures must be designed, implemented and maintained in accordance with "Best Practice Erosion and Sediment Control" published by the International Erosion Control Association (Australasian Chapter) (IECA, 2008) and are to additionally include high-efficiency sediment basins for every disturbed site catchment in excess of 2500m2 in area. Such high-efficiency sediment basins are to be provided in accordance with the "TYPE B DEEMED TO COMPLY" provided in Appendix A of the Water by Design document titled "Sediment Management on Construction Sites" (WbD, 2018)

Sites with catchments >2Ha

Prescribed Water Contaminants (as defined in the Environmental Protection Act 1994) must not be released from the site or to waters within the site, or be likely to be released should rainfall occur, unless all reasonable and practicable measures are taken to prevent or minimise the release and concentration of contamination. These measures must be designed, implemented and maintained in accordance with "Best Practice Erosion and Sediment Control" published by the International Erosion Control Association (Australasian Chapter) (IECA, 2008) and are to additionally include high-efficiency sediment basins for every disturbed site catchment in excess of 2500m2 in area. Such high-efficiency sediment basins are to be provided as either Type-A or Type-B basins in accordance with the specifications contained in the "Best Practice Erosion and Sediment Control – Appendix B Sediment Basin Design and Operation" published by the International Erosion Control Association (Australasian Chapter) (IECA, 2016, draft)

Photo Credit: Turbid Water Solutions

REFERENCE LIST

Department of Infrastructure, Local Government and Planning. (2017). *State Planning Policy 2017*

International Erosion Control Association. (2008). *Best Practice Erosion and Sediment Control*

International Erosion Control Association. (2016 Addendum). *Appendix B – Sediment basin design and operation (draft)*

Robson., K. (2015) *An assessment of the performance of current best practice sediment basins vs. high efficiency sediment basins based on modelling and field studies.* Stormwater Queensland Conference. Toowoomba

Rowlands., L. and Leinster., S. (2015) *Sediment basin performance – is it as good as you think and does it really matter?* Stormwater Queensland Conference. Toowoomba

USEFUL LINKS

water by design an initiative of Healthy land & water **www.**waterbydesign.com.au

ESC Program - https://waterbydesign.com.au/esc

Sediment Management on Construction Site (This document)
https://waterbydesign.com.au/download/sediment-management-on-construction-sites

IECA International Erosion Control Association AUSTRALASIA www.austieca.com.au

All Resources - https://austieca.com.au/publications/resources

Queensland Government **Department of Environment and Sustainability**

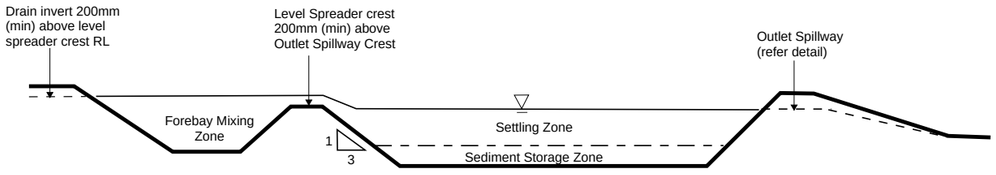
ESC information - https://environment.des.qld.gov.au/management/water/urban-stormwater/erosion-sediment-control

Image Courtesy of: Turbid Water Solutions

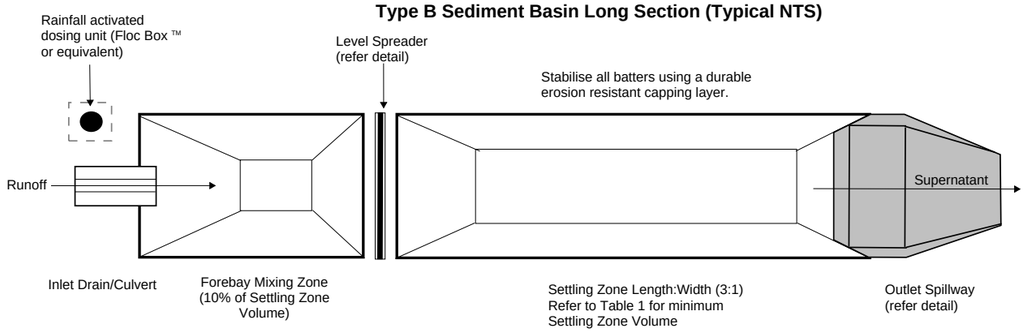
APPENDIX A

TYPE B DEEMED TO COMPLY

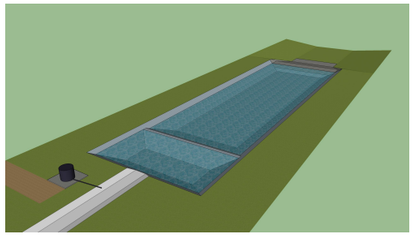
Standard Type B High Efficiency Sediment Basin
for Small Catchments (<2ha)



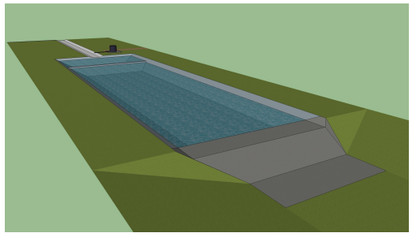
Type B Sediment Basin Long Section (Typical NTS)



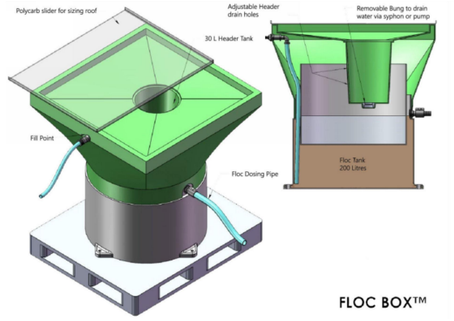
Type B Sediment Basin Plan View (Typical NTS)



Basin Perspective (looking downstream)



Basin Perspective (looking upstream)



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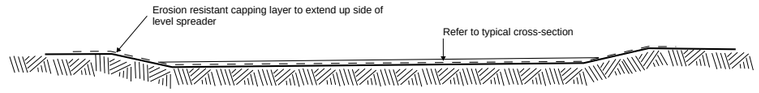
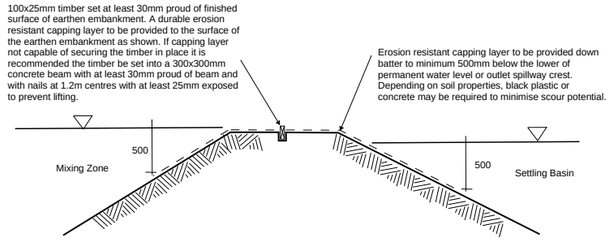
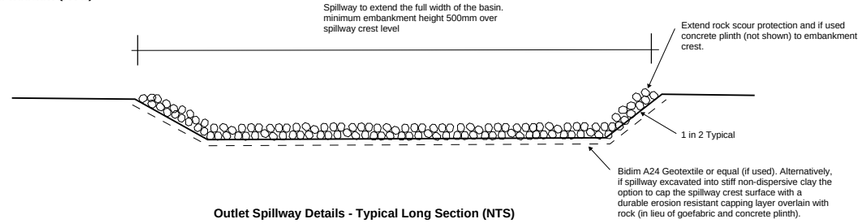


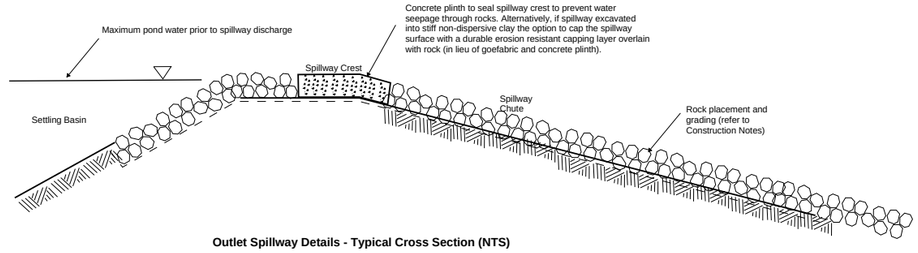


Level Spreader Details - Typical Long Section (NTS)

Level Spreader Details - Typical Cross Section (NTS)



Outlet Spillway Details - Typical Long Section (NTS)



Outlet Spillway Details - Typical Cross Section (NTS)

Notes:

Auto Doser

1. Installed to manufacturers specification.
2. Doser and supply of flocculant to be provided on level pad within 10m of dosing point.
3. All-weather access track to be provided to doser.

Basin construction:

Materials-

5. 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.
6. Spillway rock: hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d50) rock size. Large rock should dominate, with sufficient small rock to fill the voids between larger rock. the diameter of the largest rock should be no larger than 1.5 times the nominal rock size. The specific gravity should be at least 2.5.
7. Durable erosion resistant capping to manufacturers specifications. if Geotextile fabric used it is to be heavy duty, needle-punched, non-woven cloth, minimum 'bidim' A24 or equivalent.

Construction-

8. Notwithstanding any description contained with approved plans or specifications, the Contractor shall be responsible for satisfying themselves as to the nature and extent of the specified works and the physical and legal conditions under which the works will be carried out. This shall include means of access, extent of clearing, nature of the materials to be excavated, type and size of mechanical plant required, location and suitability of water supply for construction and testing purposes, and any other likely matters affecting the construction of the works.
9. Refer to approved plans for location, dimensions, and construction details. If there are questions or problems with the location, dimensions, or method of installation, contact the engineer or responsible on-site officer for assistance.
10. Before starting any clearing or construction, ensure all the necessary materials and components are on the site to avoid delays in completing the sediment basin once works begin.
11. Install requires short term sediment control measures downstream of the proposed earthworks to control sediment runoff during construction of the basin.
12. The area to be covered by the embankment, borrow pits and incidental works, together with an area extending beyond the limits of each for a distance not exceeding five (5) metres all around must be cleared of all trees, scrub, stumps, roots, dead timber and rubbish and disposed of in a suitable manner. Delay clearing the main basin area until the embankment is complete.
13. Ensure all holes made by grubbing within the embankment footprint are filled with sound material, adequately compacted, and finished flush with the natural surface.

Cut-off Trench-

14. Before construction of the cut-off trench or any ancillary works within the embankment footprint, all grass growth and topsoil must be removed from the area to be occupied by the embankment and must be deposited clear of this area and reserved for topdressing the completed embankment.
15. Excavate a cut-off trench along the centre line of the earth fill embankment. Cut the trench to stable soil material, but in no case make it less than 600mm deep. the cut-off trench must extend into both abutments to at least the elevation of the outlet spillway crest. Make the minimum bottom width wide enough to permit operation of the excavation and compaction equipment, but in no case less than 600mm. Make the side slopes of the trench no steeper than 1:1 (H:V).
16. Ensure all water, loose soil, and rock are removed from the trench before backfilling commences. The cut-off trench must be backfilled with select earth-fill of the type specified for the embankment, and this soil must have a moisture content and degree of compaction the same as specified for the core zone.
17. Material excavated from the cut-off trench may be used in the construction of the embankment provided it is suitable and it is placed in the correct zone according to its classification.

Embankment-

18. Scarify areas on which fill is to be placed before placing the fill.
19. Ensure al fill material used to form the embankment meets the specifications certified by a soil scientist of geotechnical specialist.
20. The fill material must contain 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. Place fill material in 150 to 200mm continuous layers over the entire length of the fill area and then compact before placement of further fill.
21. Unless specified on the approved plans, compact the soil at about 1% to 2% wet optimum and to 95% modified or 100% standard compaction.embankment to an elevation 10% higher than the design height to allow for settling
22. Where both dispersive and non-dispersive classified earth-fill materials are available, non-dispersive earth-fill must be used in the core zone. the remaining classified earth-fill materials must only be used as directed by the site superintendent.
23. Where specified, construct the embankment to an elevation 10% higher than the design height to allow for settling; otherwise finished dimensions of the embankment after application of the durable erosion resistant capping layer must conform to the drawing with a tolerance of 75mm from specified dimensions.
24. Ensure debris and other unsuitable building waste is not placed within the earth embankment.
25. After completion of the embankment all loose uncompacted earth-fill material on the upstream and downstream batter must be removed prior to applying the durable erosion resistant capping layer.
26. Apply durable erosion resistant capping layer to all exposed earth as directed within the approved plans.

Spillway construction-

27. The spillway must be excavated as shown on the plans, and the excavated material if classified as suitable, must be used in the embankment, and if not suitable it must be disposed of into spoil heaps.
28. Ensure excavated dimensions allow adequate boxing-out such that the specified elevations, grades, chute width, and entrance and exit slopes for the emergency spillway will be achieved after placement of the rock or other scour protection measures as specified in the plans.
29. Place specified scour protection measures on the emergency spillway. Ensure the finished grade blends with the surrounding area to allow a smooth flow transition from spillway to downstream channel.
30. If a synthetic filter fabric underlay is specified, place the fabric directly on the prepared foundation. if more than 1 sheet of filter fabric is required, overlap the edges by at least 300mm and place anchor pins at minimum 1m spacing along the overlap. bury the upstream end of the filter fabric a minimum 300mm below ground and where necessary, bury the lower end of the fabric or overlap a minimum 300mm over the next downstream section as required. Ensure the filter fabric extends at least 1000mm upstream of the spillway crest.
31. Take care not to damage the fabric during or after placement. If damage occurs, remove the rock and repair the sheet by adding another layer of fabric with a minimum overlap of 300mm around the damaged area.3If extensive damage is suspected, remove and replace the entire sheet.
32. where large rock is used, or machine placement is difficult, a minimum 100mm layer of fine gravel, aggregate, or sand may be needed to protect the fabric.
33. Placement of rock should follow immediately after placement of the filter fabric. Place rock so that it forms a dense, well graded mass of rock with a minimum of voids. the desired distribution of rock throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement.
34. The finished slope should be free of pockets of small rock or clusters of large rocks. Hand placing may be necessary to achieve the proper distribution of rock sizes to produce a relatively smooth, uniform surface. the finished grade of the rock should blend with the surrounding are. No overfall or protrusion of rock should be apparent.
35. Ensure that the final arrangement of the spillway crest will not promote excessive flow through the rock such that the water can be retained within the settling basin at the elevation no less than 50mm above of below the nominated spillway crest elevation.

Establishing the settling pond-

36. The area to be covered by the stored water outside of the limits of the borrow pits must be cleared of rubbish. Trees must be cut down stump high and removed from the immediate vicinity of the work.
37. Establish all required inflow chutes and inlet baffles, if specified, to enable water to discharge into the basin in a manner that will not cause soil erosion or the re-suspension of settled sediment.
38. Install a sediment storage level marker post with a cross member set just below the top of the sediment storage zone (as specified on the approved plans). Use at least a 75mm wide post firmly set into the basin floor.
39. If specified, install internal settling pond baffles. Ensure the crest of these baffles is set level with, or just below, the elevation of the emergency spillway.
40. Install all appropriate measures to minimise safety risk to on-site personnel and the public caused by the presence of the settling pond. Avoid steep, smooth internal slopes. Appropriately fence the settling pond and post warning signs if unsupervised public access is likely or there is considered to be an unacceptable risk to the public.

Table 1 - Settling Zone Volume

Location	Type B Settling Volume (m^3/ha)
Ipswich	270
Toowoomba	260
Gold Coast (Southport)	330
Brisbane	310
Redcliffe	330
Sunshine Coast	350
Bundaberg	400
Gladstone	320
Rockhampton	330
Mackay	360
Townsville	310
Cairns	360

Standard Type B High Efficiency Sediment Basin for Small Catchments (<2ha)