# ENGINEERING DESIGN SPECIFICATION

# D7

# EROSION CONTROL and STORMWATER MANAGEMENT DESIGN

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# ENGINEERING DESIGN SPECIFICATION D7

# *EROSION CONTROL AND STORMWATER MANAGEMENT*

## *GENERAL*

## D7.01 SCOPE

1. Virtually all construction activity that requires the disturbance of the soil surface and the existing vegetation naturally predisposes the construction site to erosion. This in turn leads to sediment loss in the resultant run-off water. Up to 2500 tonnes of sediment can erode each year from one hectare of exposed work site. ***Erosion***

2. Since such soil disturbance is a necessary part of development, it is essential therefore to develop measures that reduce the erosion hazard of any particular construction activity. Having done that, it is necessary to control run-off water, which carries the sediment, in such a way as to reduce the amount of that sediment leaving the site to an acceptable level. ***Reduce Sedimentation***

3. It is recognised that some site-specific problems may require modification to the standard specifications outlined here. In these cases, the soil and water management plan can reflect the site specific requirements provided the appropriate authority has been consulted eg Council, Environment Protection Authority, Department of Land and Water Conservation.

## D7.02 AIMS

1. Limit/minimise the amount of site disturbance. ***Site Disturbance***

2. Isolate the site by diverting clean upstream "run-on" water around or through the development where possible. ***Diversion Works***

3. Control runoff and sediment movement as its point source rather than at one final point. ***Point Source***

4. Stage earthworks and **progressively revegetate** the site where possible to reduce the area contributing sediment. This in turn increases the efficiency and effectiveness of the entire sediment control system while decreasing the number and size of controls required. ***Progressive Revegetation***

5. Provide an effective major stormwater system economical in terms of capital, operational and maintenance costs, incorporating water quality controls. ***Major Stormwater***

6. Retain topsoil for effective revegetation works. ***Topsoil***

7. Locate sediment control structures where they are most effective and efficient. ***Sediment Structures***

## D7.03 PLANNING AND CONCEPT DESIGN

1. Assess the physical characteristics and limitations of soils, landform and drainage of the site and plan the subdivision accordingly. Select a design which is compatible with the natural site conditions. If sewerage is unavailable, assess the onsite disposal of effluent, consider legislative requirements. ***Site Characteristics***

2. A concept design shall be submitted with the development application to Council for all developments. This will assist in assessing the impact of the development on the site. ***Concept Design***

For this concept design:

a) Prepare a diagram showing

- existing contours
- existing vegetation
- location of existing natural and artificial drainage lines and water courses
- hazard areas such as soils with severe limitations, steep slopes, swamps, flood plains
- existing structures
- proposed road and parking areas
- proposed development layout
- vegetation to be retained onsite
- soils data
- proposed location of water pollution control ponds if required.

b) Provide the following information (either on the diagram or in writing) relating to soil and water management

- vegetation buffer strips and drainage reserves located between areas of development and waterways
- temporary erosion and sediment control structures. These may include diversion banks, sediment basins, sediment raps and sediment fences
- permanent gross sediment and pollution traps, trash racks and stormwater pollution control ponds
- land clearing and contouring
- drainage facilities such as retarding and detention structures and stormwater easements
- discharge of stormwater from the site into natural drainage lines
- location of effluent disposal areas if appropriate

c) Provide a geotechnical study of the whole site in areas identified as being prone to mass movement or in areas where onsite effluent disposal may cause problems.

## D7.04 DETAILED DESIGN

1. After development consent is given an erosion and sediment control/water management plan shall be submitted to Council as part of the detailed engineering design. This plan must give all details for erosion, sediment and pollution controls. Note: **This design shall be site specific** and not a generalisation of erosion control philosophy. It should also form part of the contract specifications for a contractor to comply with during construction. ***Site Specific***

2. Detailed designs shall include scaled drawings (no larger than 1:1000) and detailed specifications/diagrams which can be readily understood and applied on site by supervisory staff. ***Detail Design***

Items to be included, but not limited to, shall be –

- existing and final contours
- the location of all earthworks including roads, areas of cut and fill and regrading
- location of access haulage tracks and borrow pits
- location and design criteria of erosion and sediment control structures
- location and description of existing vegetation
- proposed vegetated buffer strips and "no access" areas
- location of critical areas (vegetated buffer strips, drainage lines and structures, water bodies, unstable slopes, flood plains and seasonally wet areas)
- type and location of diversion works to direct uncontaminated run-on around areas to be disturbed
- revegetation programme
- procedure for maintenance of erosion and sediment control
- details for staging of works

3. No site works shall commence prior to approval of the detailed engineering design. All works are to be carried out in accordance with the approved management plan. Its implementation must be supervised by personnel with appropriate qualifications and/or experience in soil conservation on construction sites. ***Approval***

4. Notwithstanding the foregoing, Council may require erosion or sediment control works to be carried out additional to or instead of those works specified in the approved plan, should circumstances change during construction. ***Additional Works***

5. Examples of a proposed subdivision construction site detailing locations of water quality structure, sediment and erosion control devices is provided as Figures D7–1, D7.2 and D7.3. This may be used as a guide when preparing a detailed design. Guidance from Council Officers should also be sought. ***Example Design***

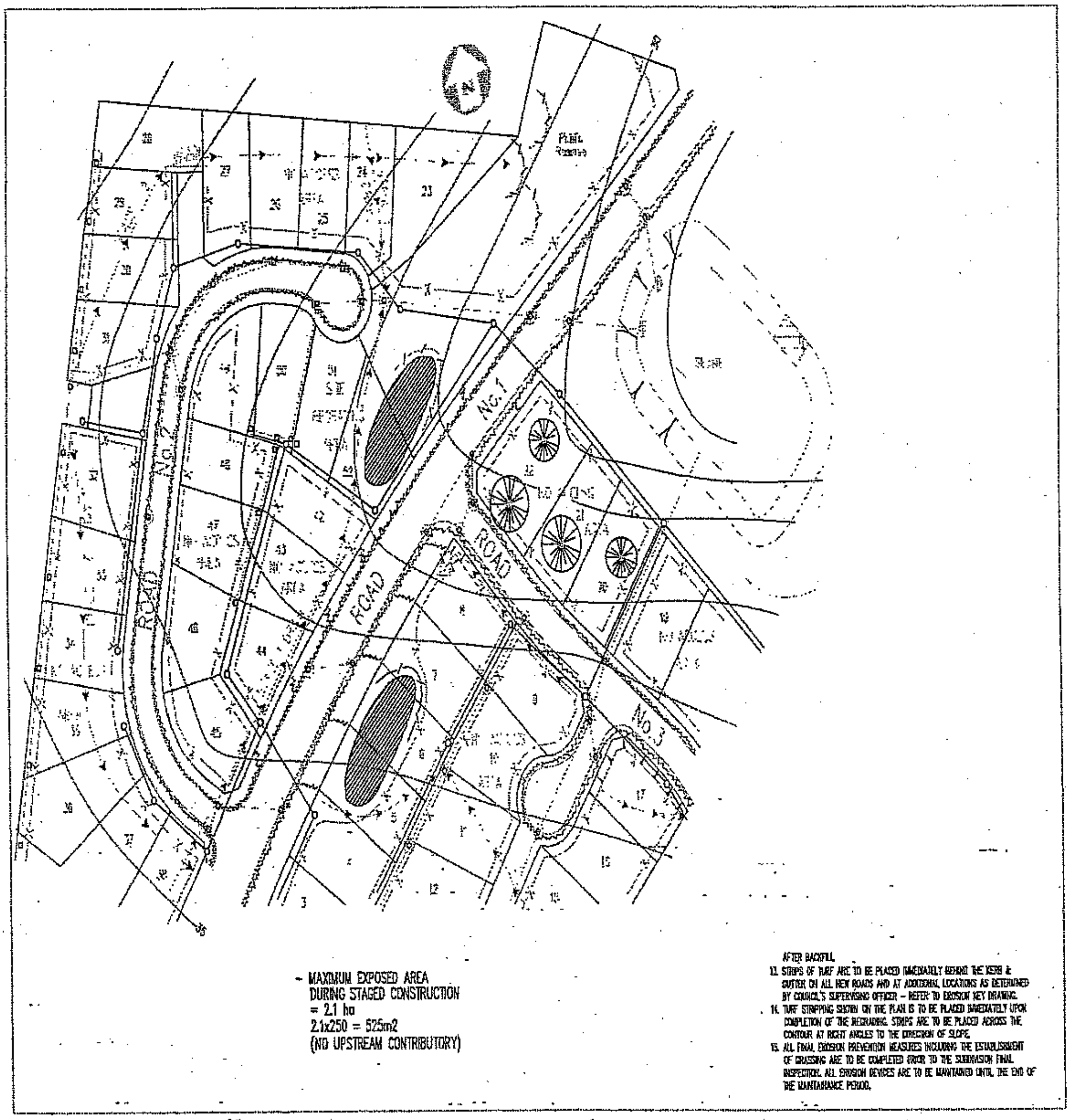



*Figure D7.1*

**Example Sketch Plan for Erosion & Stormwater Management**

# THE LOCATION, DESIGN AND TREATMENT OF EROSION CONTROLS

## D7.05 BUFFER ZONES

1. Buffer zones are corridors of vegetation adjacent to waterways or disturbed areas. The vegetation filters suspended solids and reduces the nutrient levels in run-off. Wetlands, stream and rivers adjacent to construction sites shall be protected by buffer zones. *Filters*

2. Buffer zone performance increases as catchment area and slope gradient decreases, see Table 7.01. 30 metre wide buffer zones generally provide adequate protection. *Performance*

| Slope % | Buffer Width in Metres |
|---|---|
| 2 | 15 |
| 4 | 20 |
| 6 | 30 |
| 8 | 40 |
| 10 | 50 |
| 12 | 60 |
| 14 | 70 |

Table 7.01

3. Buffer zones can reduce the need for other erosion and sediment control measures. However, contaminated water in a concentrated form will require treatment both at its sources point and final disposal. *Contaminated Water*

4. A fence shall be used to exclude traffic from buffer zones to prevent damage to the vegetation, particularly during any construction phase. *Fencing*

## D7.06 "NO ACCESS" AREAS

1. It is Council's Policy to conserve as much existing vegetation in new developments as possible. *Conserve Vegetation*

2. The landscape plan shall incorporate as much existing native vegetation as possible.

3. The "no access" fence locations shall be shown on the detailed design. These locations will be approximate only as machinery type, topography etc will determine actual on site location. *No Access*

4. Fenced areas shall be clearly signposted "No Access Area".

## D7.07 DIVERSION WORKS

1. Diversion works may be in the form of earth drains and banks, hay bales, sand bags or even pipelines and may be permanent or temporary. *Diversion Types*

2. Such techniques are used to divert the upstream run-on water around the site. Such flows shall discharge to a formal drainage point or open areas where level spreader banks should ensure a broad water spread. *Discharge Point*

***Pipelines***

3. Pipelines may also be used to convey such run-on through the development site, and discharge the flow to a formal drainage point/dissipater if necessary. Such pipelines may also form part of the overall final drainage system.

***Drain Shape***

4. Design of the diversion system should suit the following:-

   i) Design the works to be stable with the following criteria:

   - the design storm frequency chosen should relate to the damage that would occur if the structure failed.
   - the minimum design standard, however, shall be the 1:5 year duration storm event.
   - show catchment size and design standard used.
   - earthen open channels are to be shallow. Specify grade and design flow velocities which are not to exceed the velocities given as follows:
     - Table drains with grades less than 5% shall be shaped to a uniform dish cross section placed with 75–100mm of topsoil, track machine rolled, fertilised and seeded.
     - Table drains with grades 5 to 10% shall be treated similarly to those having less than 5% grade but with the addition of a layer of Jutemaster TM or Fire Mulch over the topsoil.
     - Table drains with grades greater than 10% shall be uniformly shaped and lined with either concrete, rock and cement grout or shotcrete. The road bitumen seal for those section is to be widened to the edge of the lining.
     - Seed mix required

| | | |
|---|---|---|
| Seed mix required | Japanese Millet | 20kg/ha |
| | Kangaroo Valley Rygrass | 5kg/ha |
| | Hafia White Clover | 5kg/ha |
| | Seaton Park White Clover | 5kg/ha |
| | Carpet Grass | 5kg/ha |
| | Fertiliser with Grower 11 | 400kg/ha |

***Pipe Capacity***

   ii) If a piped system is selected its design capacity shall be a minimum of the capacity nominated in the stormwater drainage section of this specification.

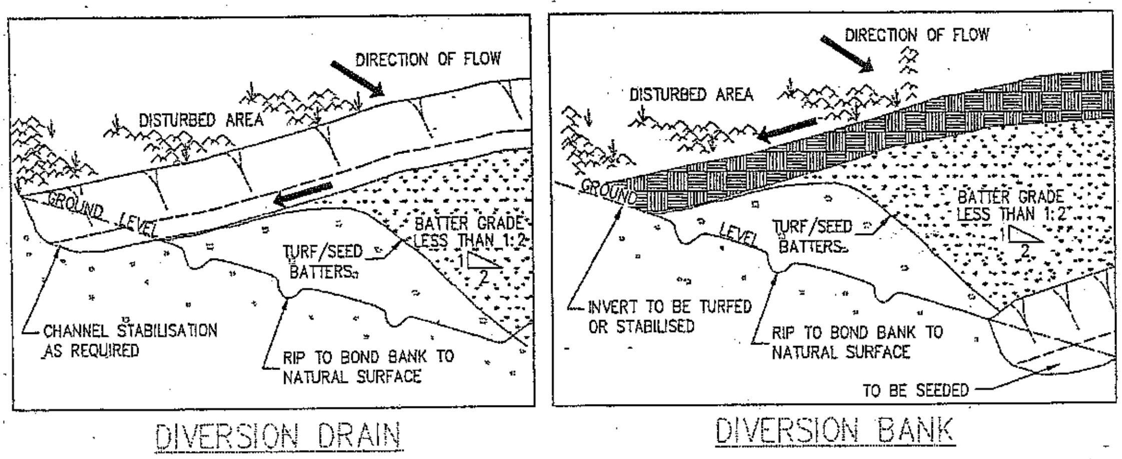



*Figure D7.2*

**Diversion Drains/Banks**

## D7.08 DROP DOWN DRAINS

1. These are temporary or permanent drains which divert concentrated run-off down slopes such as road batters without causing erosion. They usually consist of a dished earth drain smoothly shaped, consolidated and lined with a variety of materials or they may be a flexible/rigid pipe or half pipe. ***Lined Drains***

2. Drop down drains consisting of rigid, or flexible, pipes are very effective as a temporary measure during road construction used in association with an earth windrow (or bund wall) along the top edge of the batter. Run-off flowing along the windrow is directed to the pipe by which water is conveyed down the batter. It is a simple matter to extend the pipe as the batter rises. ***Piped Drains***

3. Drop down drains shall have sufficient capacity for a minimum 1 in 5 year peak flow without eroding. Energy dissipaters may be required to reduce the flow velocity at the outlet of the drop down drain. ***Capacity***

## D7.09 STOCKPILES

1. Location of stockpiles shall be indicated on the approved engineering plans. ***Approved Plan***

2. Stockpile sites shall be located: ***Location***
   i) Clear of existing or proposed drainage lines.
   ii) Clear of areas likely to be disturbed during construction.
   iii) Clear of the drip zone of trees.
   iv) Preferably on reasonably flat areas.

3. Stockpiles must be protected from erosion and sediment loss by: ***Erosion Protection***
   i) The installation of diversion works.
   ii) The use of silt fences, hay bales etc or other approved controls on the downstream side.
   iii) Compaction.
   iv) Revegetation if left exposed for longer than 30 days (refer to Construction Specification for seed mix).

4. Site topsoil shall be isolated from subsoil material in separate stockpiles. ***Separate Stockpiles***

## D7.10 SEDIMENT BASINS/TRAPS/DAMS

1. Sediment traps are either permanent or temporary sediment control devices that intercept sediment and run-off usually at the final discharge point of the site and are to be used only on sites greater than 0.5 hectares. ***Sediment Control***

2. Design all structures which will be in place for longer than five days, to be stable and designed using the following criteria.
   - The design storm frequency chosen should relate to the damage that would occur if the structure failed.
   - The effectiveness of sediment retention basins is greatly influenced by the nature of the soil material at the sediment source. Soils that are dispersible and require flocculation are those where more than 10% of the soil material is

dispersible clay, particles finer than 0.002mm. Soils are classified into two groups based on texture:

Type C less than 33% are finer than 0.02mm

Type F more than 33% are finer than 0.02mm

3. Basin design criteria. Capacities greater than those indicated as follows:

*Type C Soils*

- the maximum volume of water that will enter in 6 minutes in a 5 year ARI one hour storm event; and
- that indicated by USLE and indicating the volume of subsoil materials likely to enter over a one year period when the vegetative cover and top soil are removed.

*Type F Soils*

- and or where more than 10% of the soil materials at the sediment source are comprised of dispersible fines
- to contain the whole of the 1 in 3 year 2 hour ARI normal time of concentrations event from the whole of the contributing catchment area.
- shall be provided with an additional 10 to 30% storage volume for likely sediment deposition.

3. Operation of the basins should ensure that where possible, water has drained from them by the commencement of the next storm event. This can be achieved:

i) with dry, above ground basins on Type C soils, through a filtered outlet system; and

ii) with wet basins and below ground tanks, by pumping out 36 to 48 hours after each event. Use a floating inlet on the pump to overcome sucking up any settled sediments.

5. Where sediment sources contain more than 10% of dispersible materials, it is necessary to dose with chemical flocculant agents such as gypsum to accelerate settlement. Gypsum should be applied over the surface waters in a slurry form at the rate of 32kg per 100 cubic metres of stored water within hours of the storm event and drained 36 hours to 48 hours later providing the suspended sediment concentrations are in accordance with the EPA standards.

6. The basin capacity and design criteria shall meet the following. **Basin Criteria**

i) The capacity shall be measured below the invert of the lowest incoming flow. Otherwise pipelines and associated works will be affected.

ii) A secondary or emergency stabilised spillway must be provided to prevent overtopping of the structure. This shall be directed to a safe overland flow path.

iii) The basin shall have a minimum of 0.5 metres freeboard above the level of the spillway.

iv) The basin shall be surrounded by a manproof fence with lockable gates.

v) An all weather access must be provided to the basin for maintenance

vi) The basin shall have an arbitrary length to width ratio of between 2 and 3:1. This encourages soil particle settlement. The entry and exit points should be located at the opposite ends of the basin

vii) If this is not possible some form of approved baffles shall be installed to minimise short circuiting of the flow

viii) Discharge of the basin shall be via a perforated riser encapsulated by a filter device for a dry basin.

ix) Internal basin batters shall be a maximum of 3:1 and external batters a maximum of 2:1.

x) All disturbed areas including batters shall be topsoiled and seeded.

7. Permanent wet basin designs slightly vary from the above. Refer to the Stormwater Quality Control Section. ***Permanent Wet Basins***

## D7.11 SEDIMENT TRAPS/BARRIERS FOR MINOR CATCHMENTS

1. These are silt retention/filtering structures of a temporary nature used in situations where the catchment does not exceed 0.5ha.

2. Such sediment traps/barriers generally consist of: ***Filtering Structures Barrier Types***

i) silt fences

ii) hay bales

iii) blue metal groynes/sausages

iv) filter fabric located beneath stormwater grates

v) gabions

vi) or a combination of the above

3. The choice of material and type of treatment will depend on the size of the catchment, the location and the structure being treated such as: ***Location of Structure***

i) surface inlet pits

ii) kerb inlet pits.

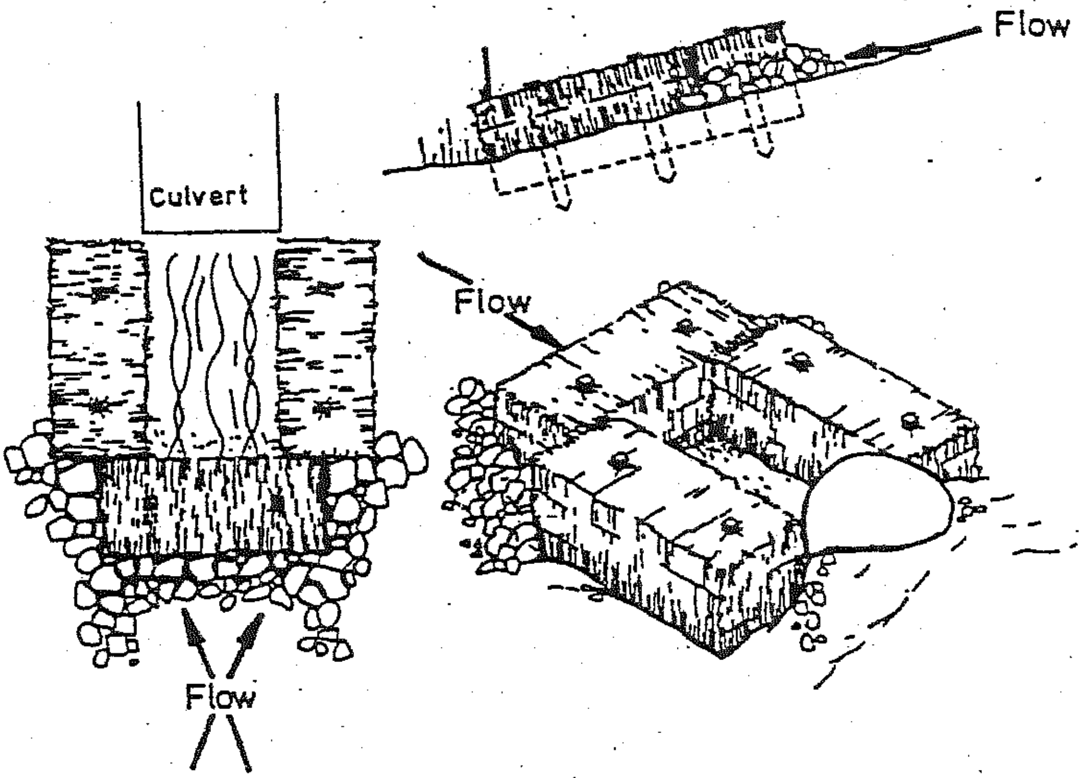
iii) catch drain disposal areas

iv) culvert inlets and outlets

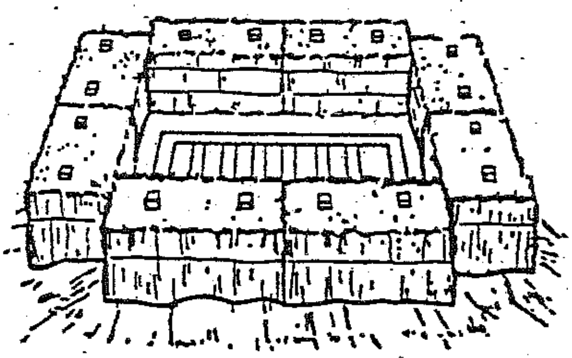
v) minor construction/earthwork sites

vi) check dams/velocity reducers etc.

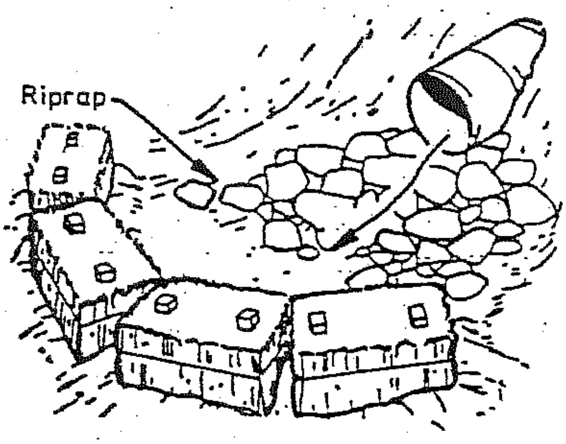
See figures D7.3 to D7.14




Culvert Inlet Sediment Trap



Drop Inlet Sediment Trap




Culvert Outlet Sediment Trap

NOTE:

1. All bales embedded to a depth of 100 to 200mm.

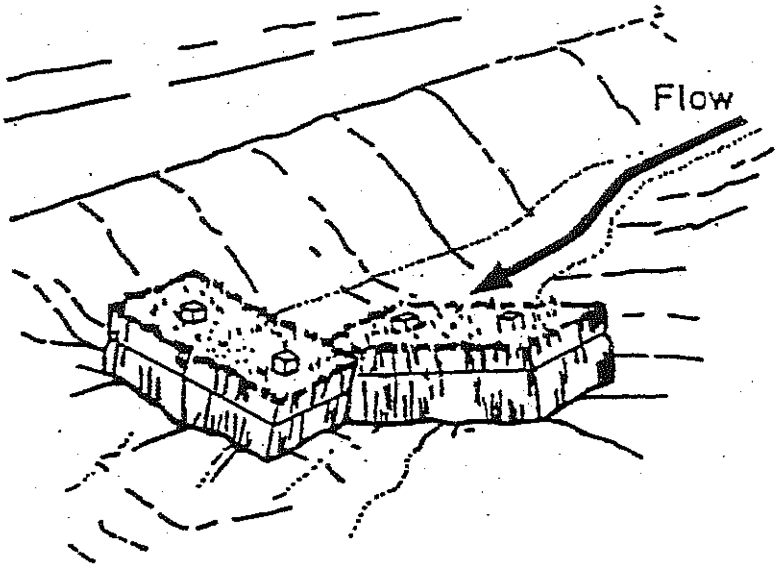
2. Bales to be staked with stakes 50mm square and 900mm in length.

TEMPORARY HAY BALE SEDIMENT TRAPS AT CULVERT INLETS AND OUTLETS

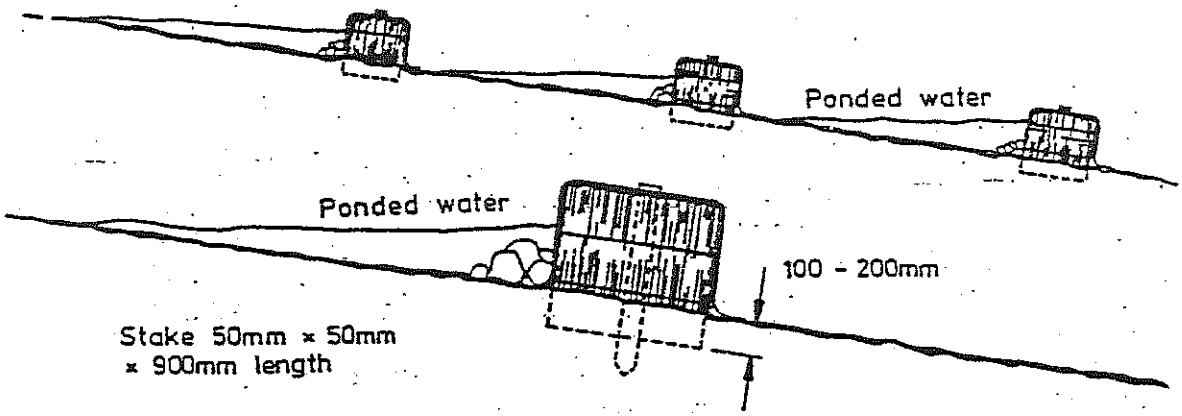
*Roads and Traffic Authority, N.S.W.*

*Fig. D7.3*

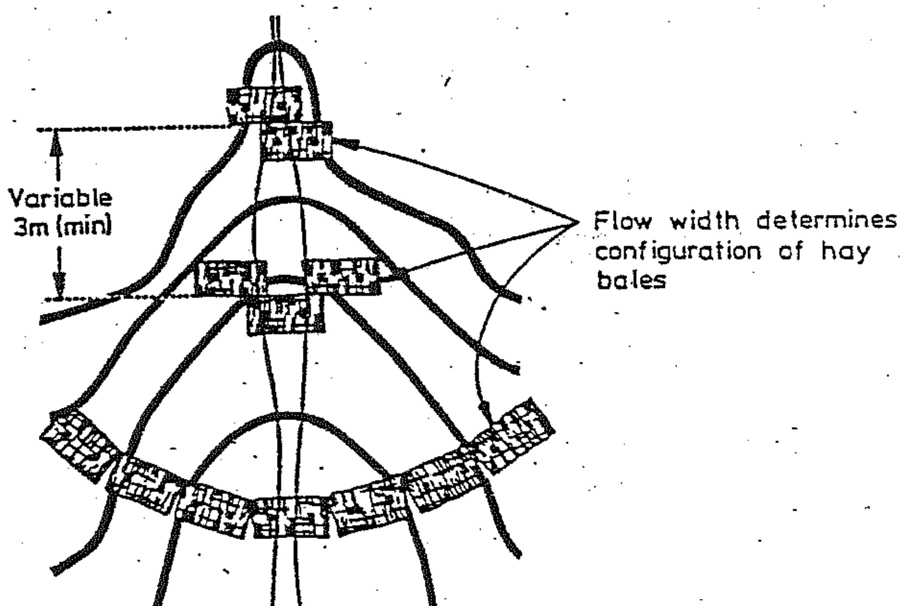
8-59




Hay Bales in Depressed Medians or Drains



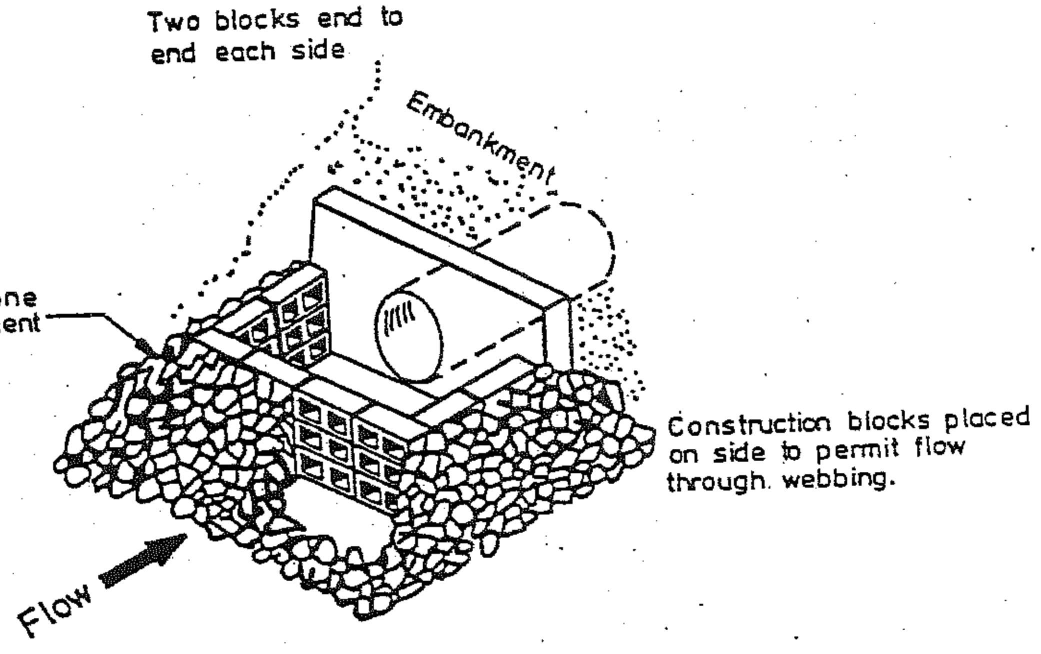

Profile View of Check Dams



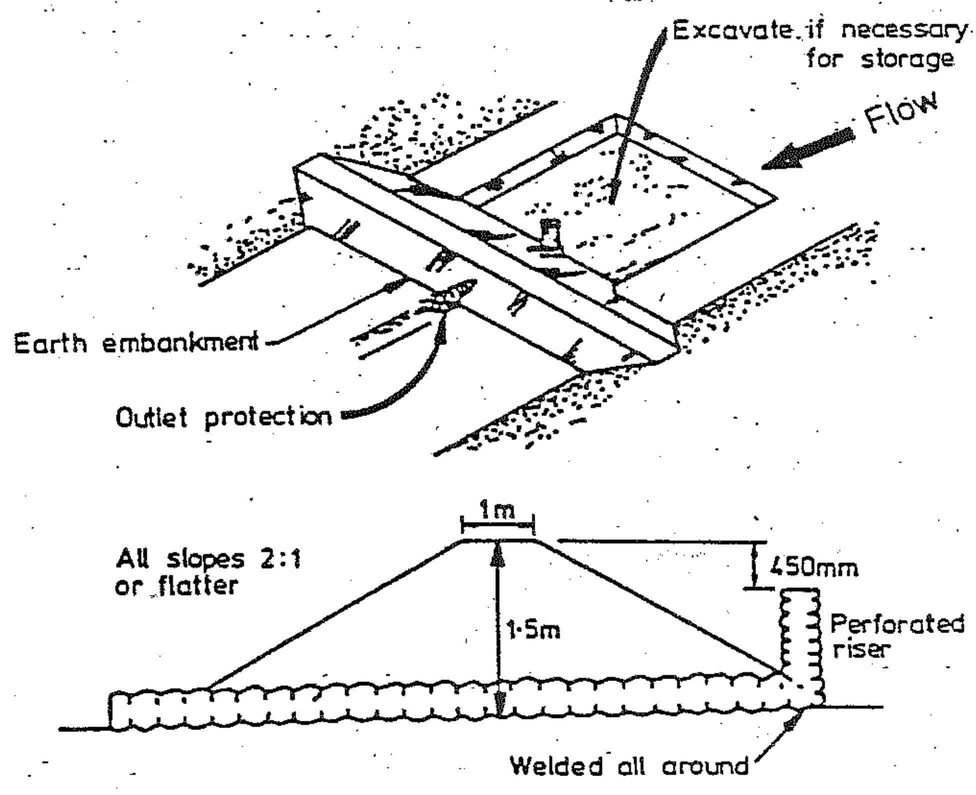

Effect of Flow Width on Configuration

HAY BALE CHECK DAMS

*Fig. D7.4*




**Culvert Inlet Sedimentation Trap**

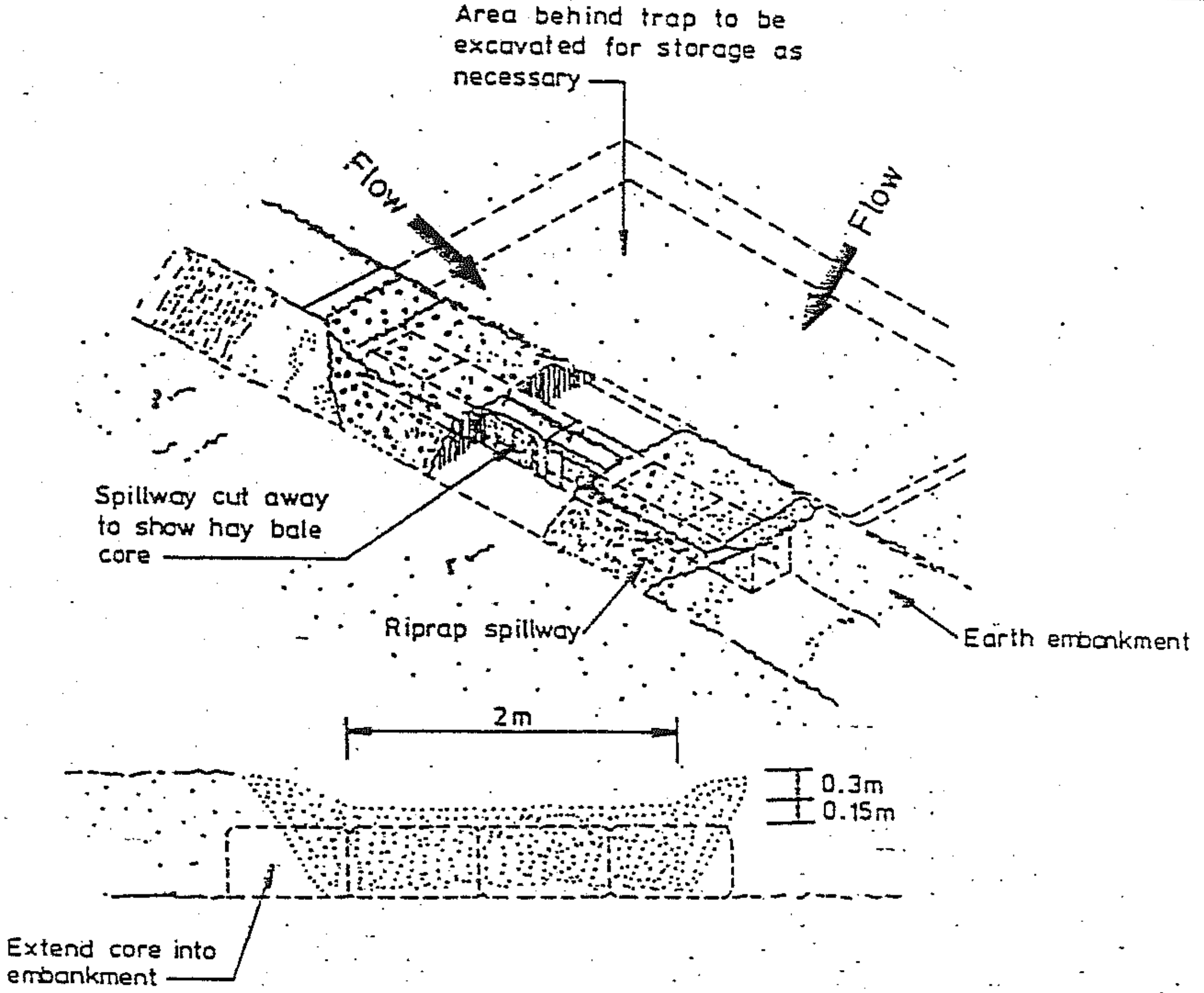



**Pipe Outlet Sediment Trap**

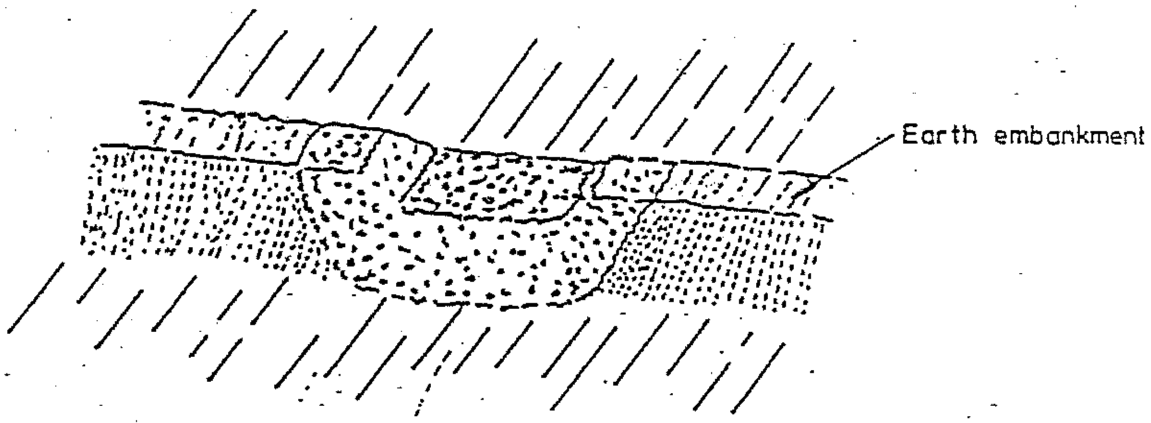
## OTHER FORMS OF SEDIMENT TRAPS

*Roads and Traffic Authority, N.S.W.*

*Fig. D7.5*




Gravel Outlet With Hay Bale Core

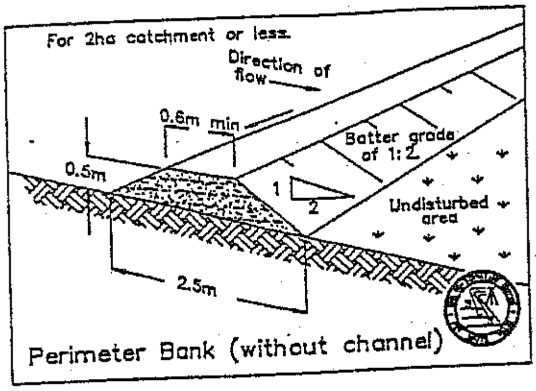



Outlet Using Riprap Only

SEDIMENT TRAP SPILLWAYS

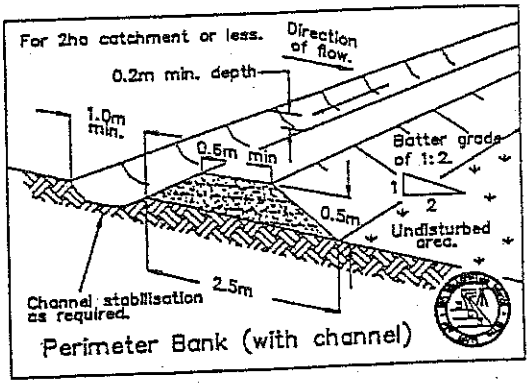
*Roads and Traffic Authority, N.S.W.*

*Fig. D7.6*



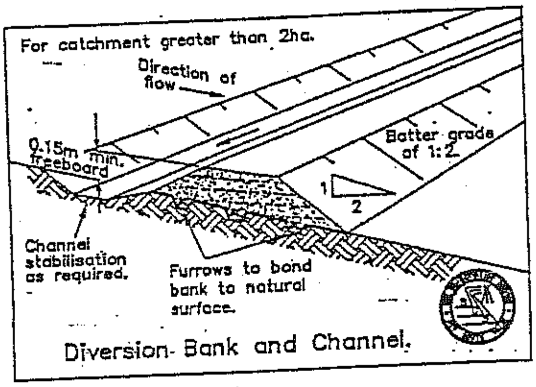
Perimeter Bank (without channel)

3.dwg



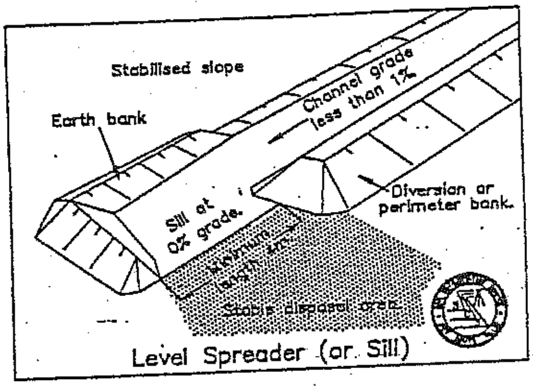
Perimeter Bank (with channel)

4.dwg



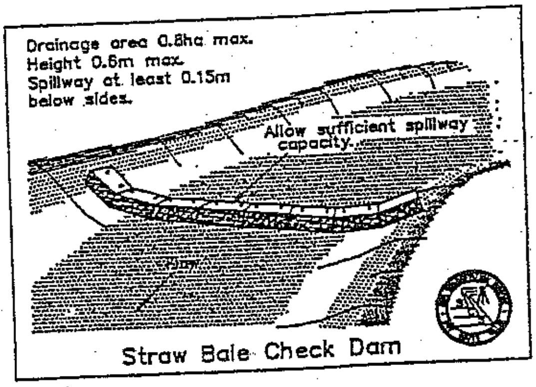
Diversion Bank and Channel.

5.dwg



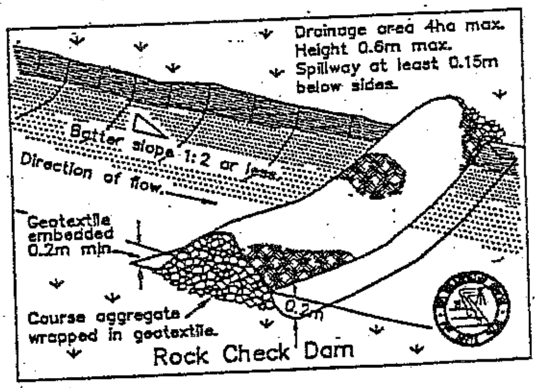
Level Spreader (or Sill)

6.dwg



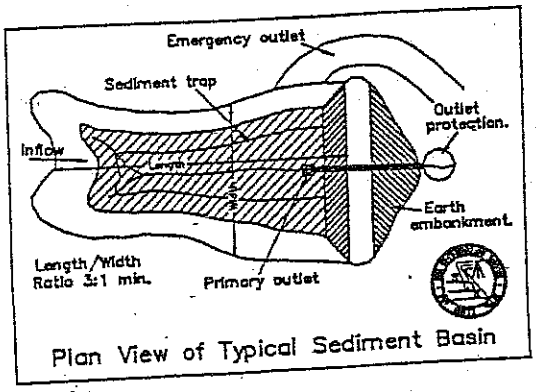
Straw Bale Check Dam

8.dwg



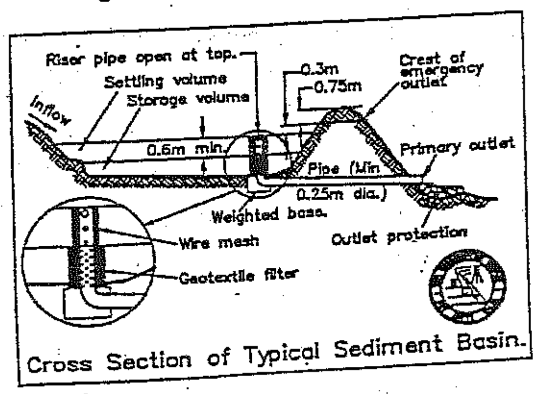
Rock Check Dam

9.dwg



Plan View of Typical Sediment Basin

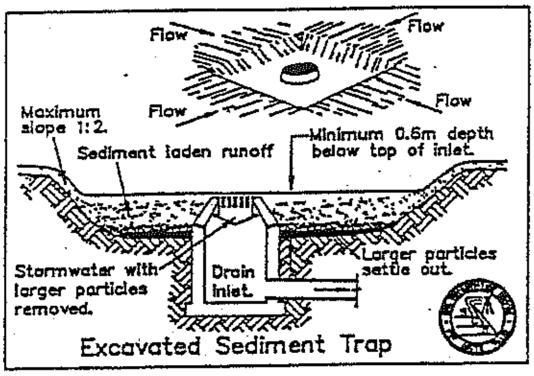
10.dwg



Cross Section of Typical Sediment Basin.

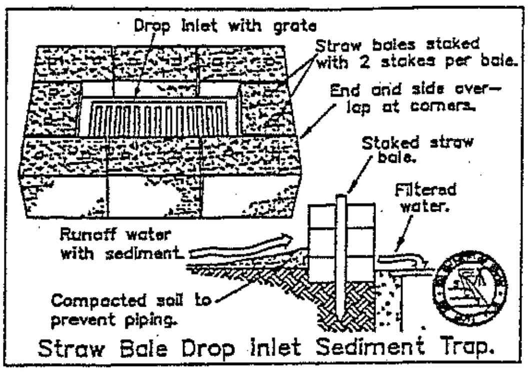
11.dwg

*Fig. D7.7*



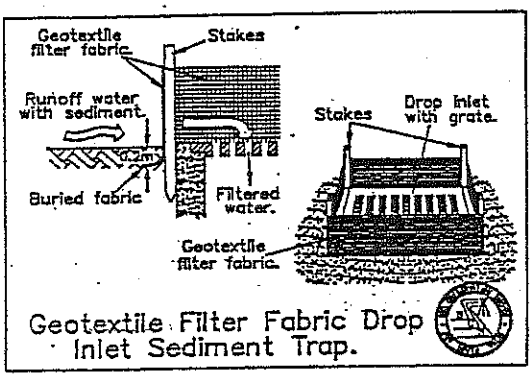

Excavated Sediment Trap

12.dwg



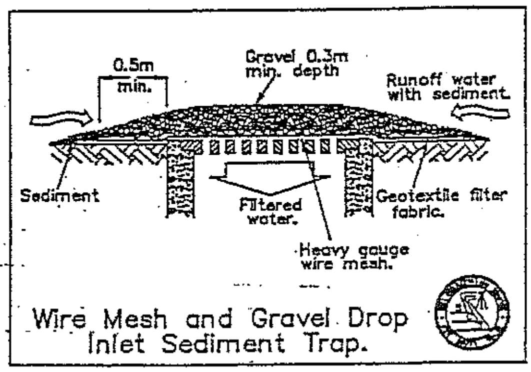

Straw Bale Drop Inlet Sediment Trap.

14.dwg



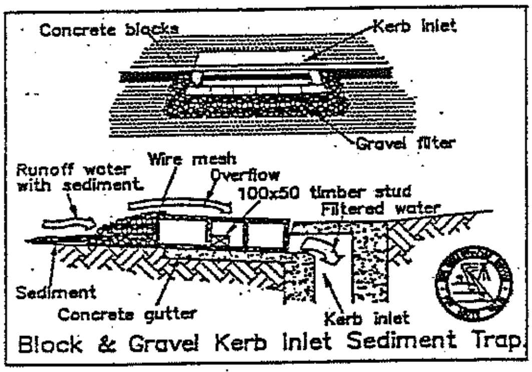

Geotextile Filter Fabric Drop Inlet Sediment Trap.

15.dwg



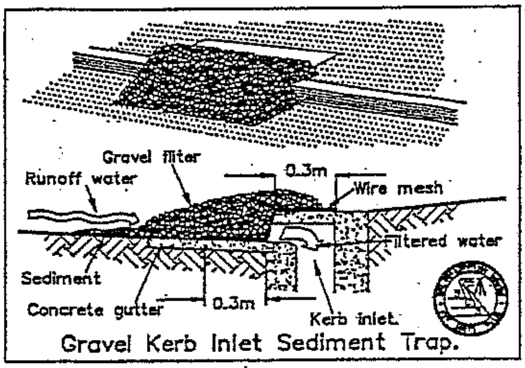

Wire Mesh and Gravel Drop Inlet Sediment Trap.

16.dwg



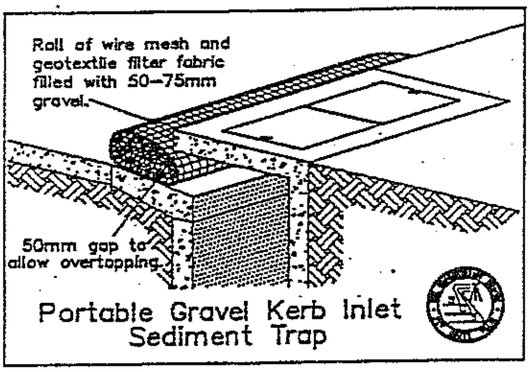

Block & Gravel Kerb Inlet Sediment Trap

17.dwg



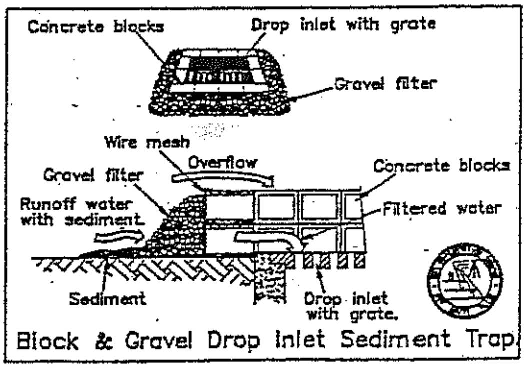

Gravel Kerb Inlet Sediment Trap.

18.dwg




Portable Gravel Kerb Inlet Sediment Trap

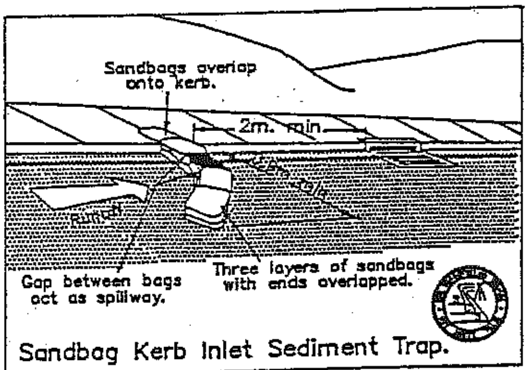
19.dwg




Block & Gravel Drop Inlet Sediment Trap

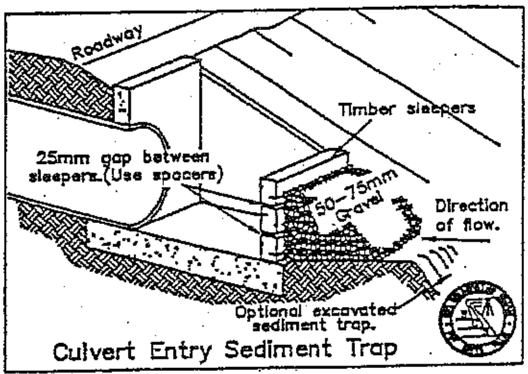
20.dwg

Fig. D7.8



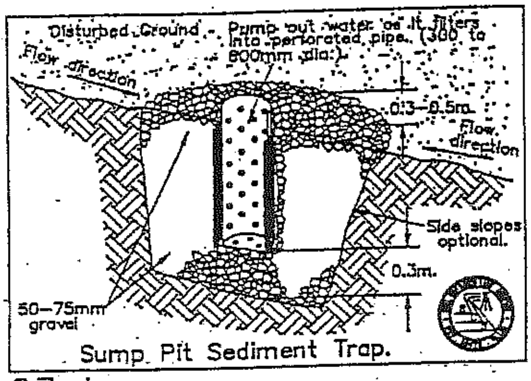

Sandbag Kerb Inlet Sediment Trap.

21.dwg



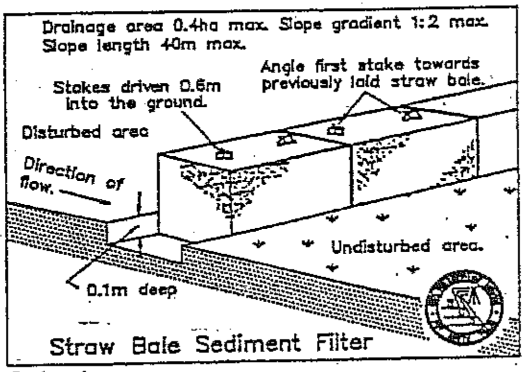

Culvert Entry Sediment Trap

22.dwg



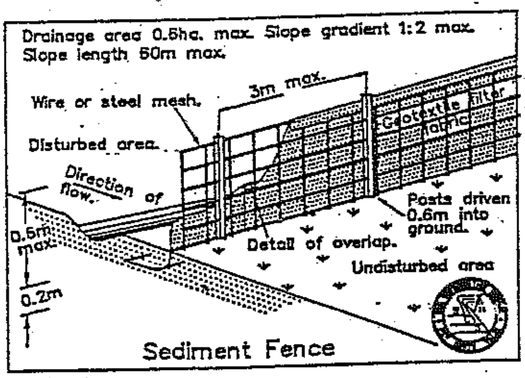

Sump Pit Sediment Trap.

23.dwg



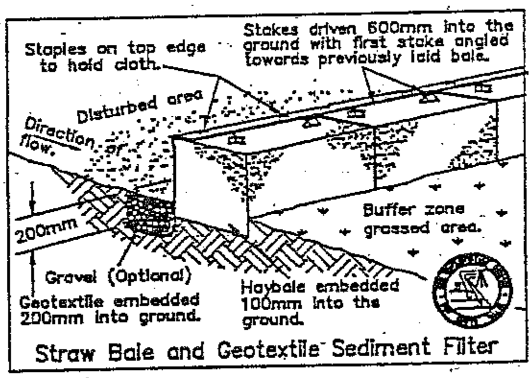

Straw Bale Sediment Filter

24.dwg



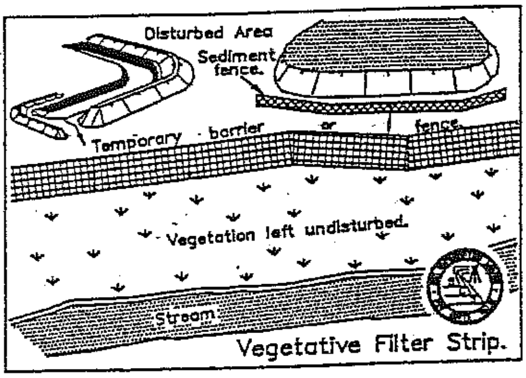

Sediment Fence

25.dwg



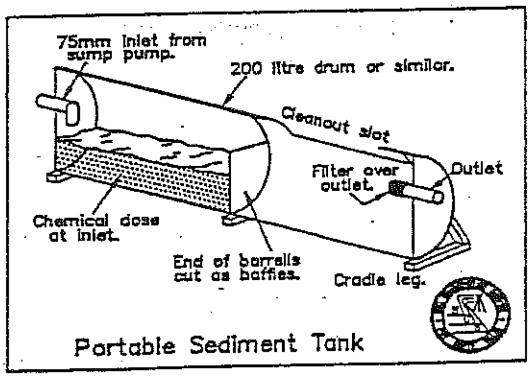

Straw Bale and Geotextile Sediment Filter

26.dwg




Vegetative Filter Strip.

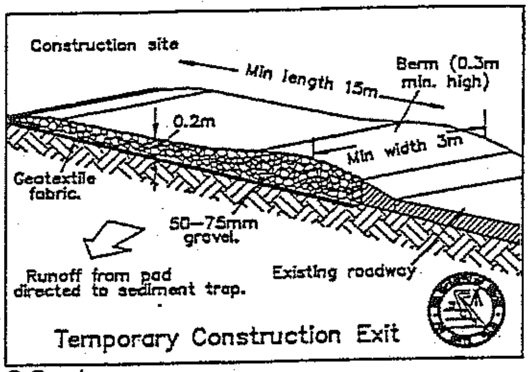
27.dwg




Portable Sediment Tank

28.dwg

*Fig. D7.9*




29.dwg

Fig. D7.10

# STANDARD SYMBOLS

# EROSION AND SEDIMENT CONTROL PLANS

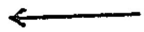
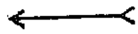
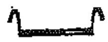
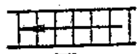
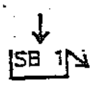
| | |
|---|---|
| Perimeter Bank .................................. |  |
| Diversion Bank .................................. |  |
| Level Spreader .................................. |  |
| Waterway – natural grassed .......... |  |
| – constructed grassed ..... |  |
| – constructed grass with check dam. .................. |  |
| Sediment Basin .................................. |  |
| Sediment Trap .................................. |  |
| Sediment Fence .................................. |  |
| Straw Bale Sediment Filter .................. |  |
| Temporary Construction Exit ............... |  |
| Vegetative Filter Strip ..................... |  |
| Soil Stock Pile .................................. |  |
| Limit of Clearing and Grading .......... | —XX— |
| Catchment Boundary .......................... | —C——C— |

*Fig. D7.11*

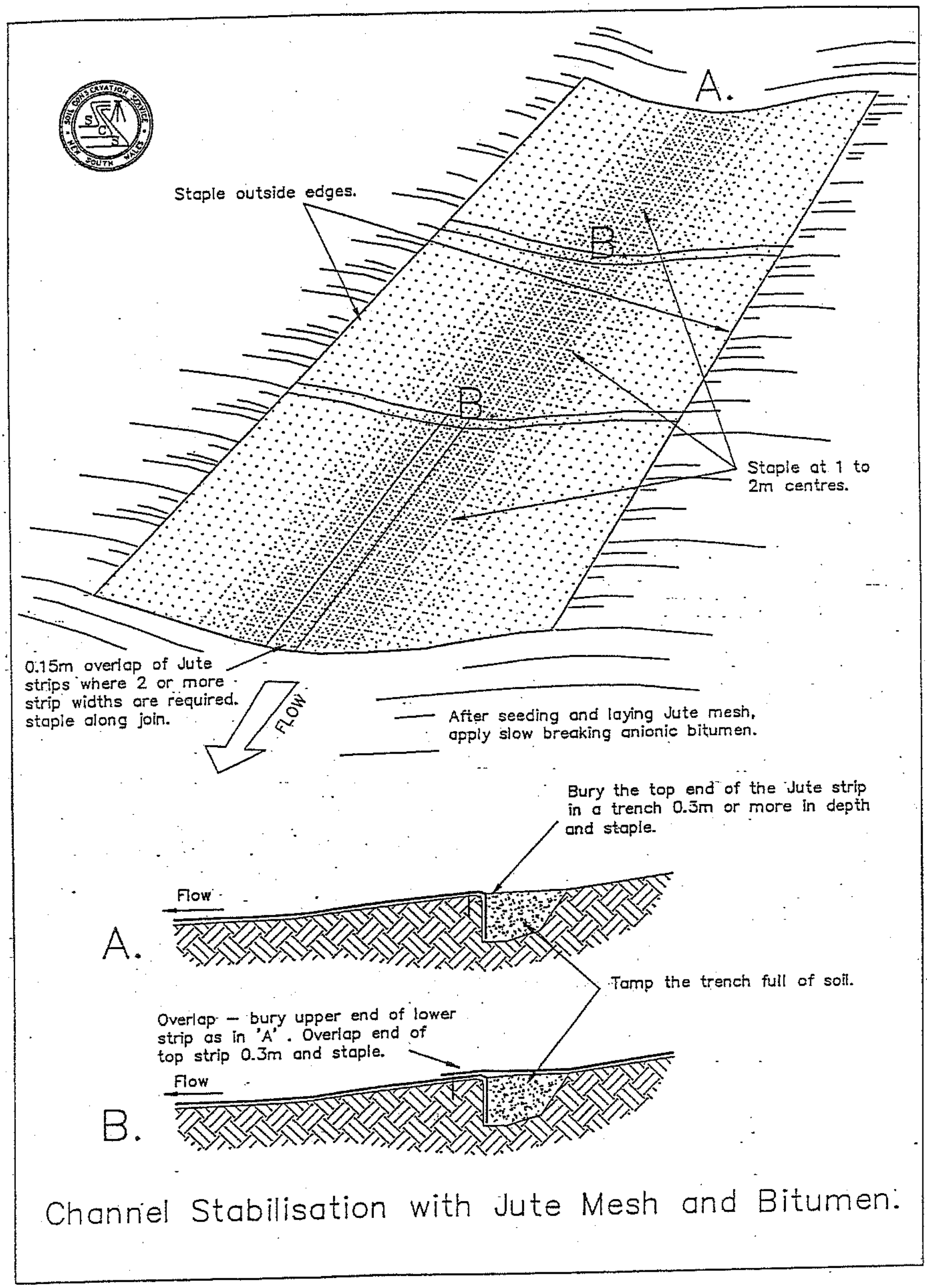
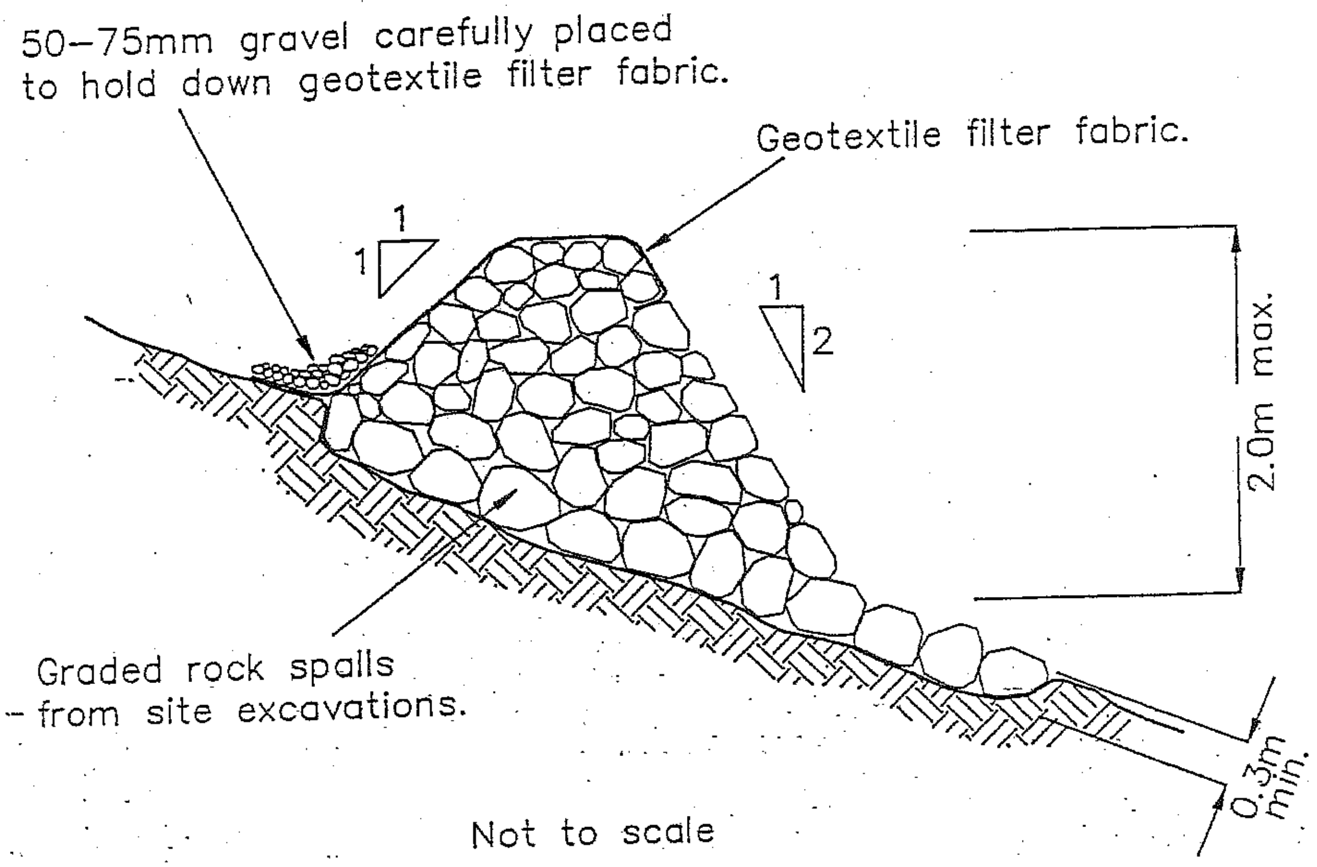

SOIL CONSERVATION SERVICE NEW SOUTH WALES
A.
Staple outside edges.
B.
B
Staple at 1 to 2m centres.
0.15m overlap of Jute strips where 2 or more strip widths are required. staple along join.
FLOW
After seeding and laying Jute mesh, apply slow breaking anionic bitumen.
Bury the top end of the Jute strip in a trench 0.3m or more in depth and staple.
Flow
A.
Tamp the trench full of soil.
Overlap — bury upper end of lower strip as in 'A'. Overlap end of top strip 0.3m and staple.
Flow
B.
Channel Stabilisation with Jute Mesh and Bitumen.

*Fig. D7.12*


50–75mm gravel carefully placed to hold down geotextile filter fabric.
Geotextile filter fabric.
1
1
1
2
2.0m max.
Graded rock spalls – from site excavations.
0.3m min.
Not to scale

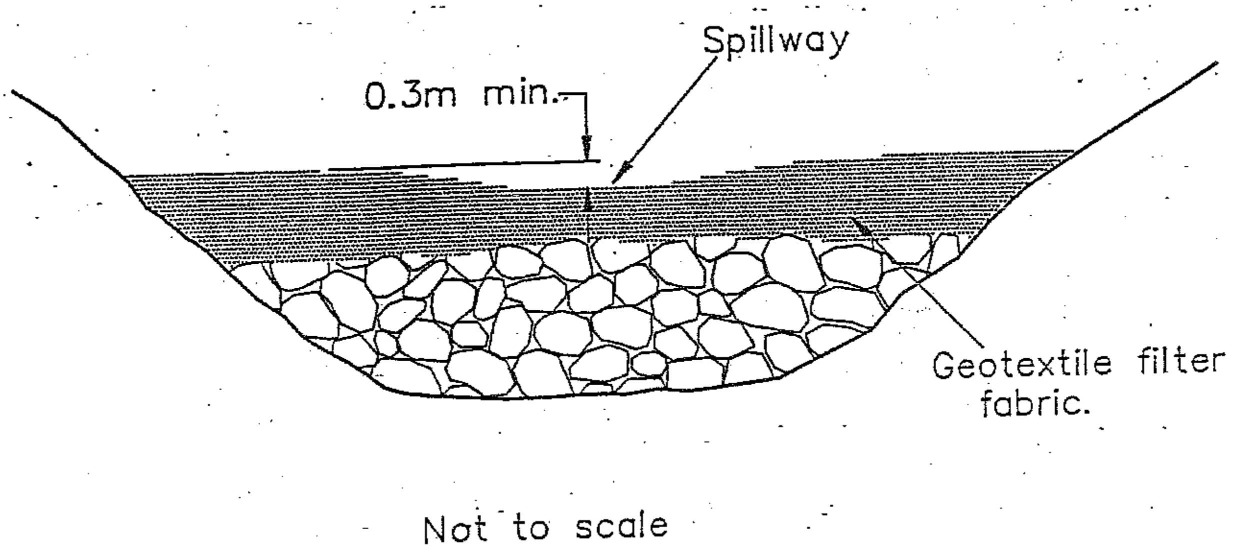

Spillway
0.3m min.
Geotextile filter fabric.
Not to scale

*Fig. D7.13*

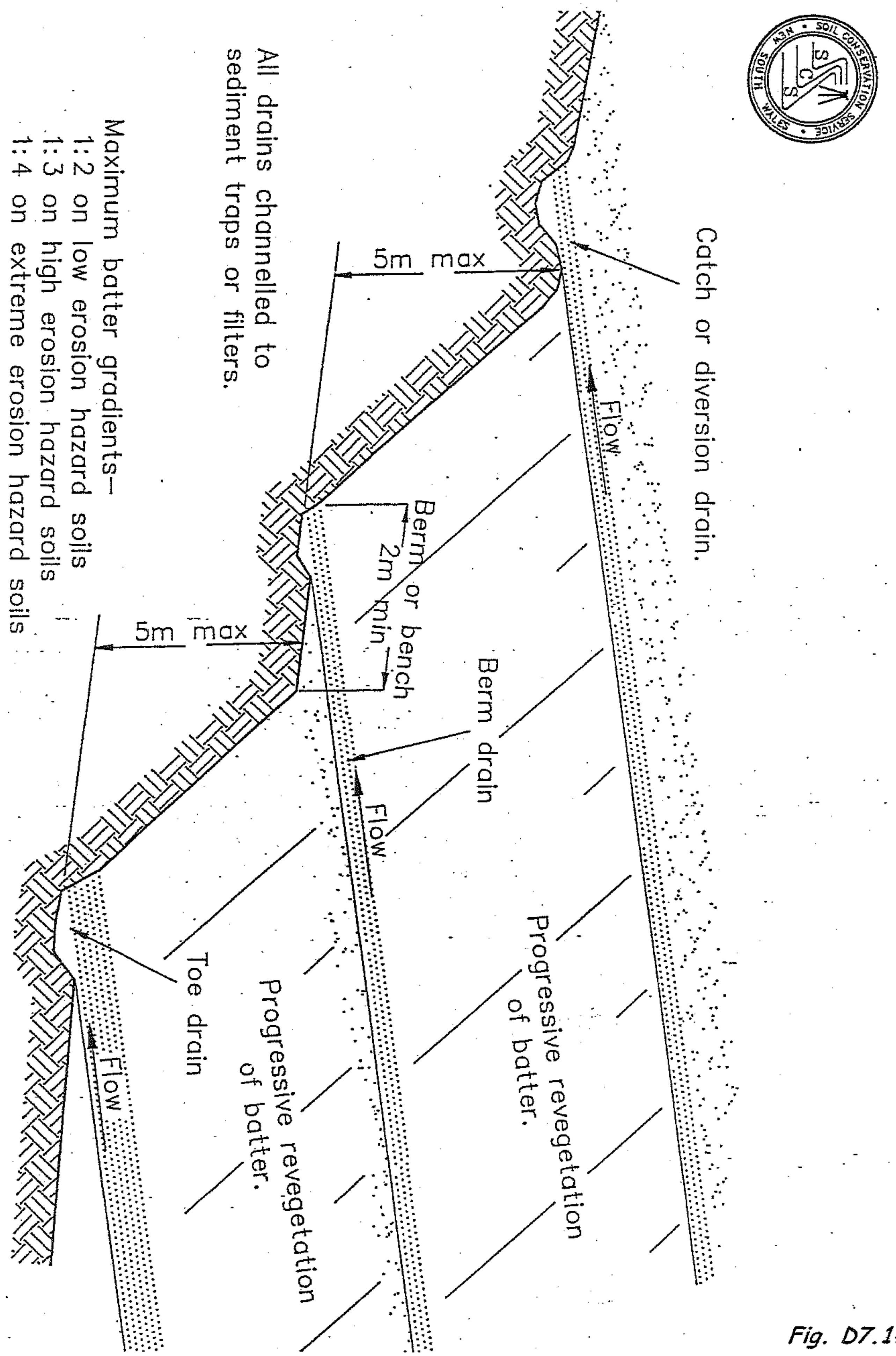

All drains channelled to sediment traps or filters.
Maximum batter gradients—
1:2 on low erosion hazard soils
1:3 on high erosion hazard soils
1:4 on extreme erosion hazard soils
Catch or diversion drain.
5m max
5m max
Flow
Flow
Flow
Berm or bench
2m min
Berm drain
Toe drain
Progressive revegetation of batter.
Progressive revegetation of batter.

*Fig. D7.14*

## D7.12 LEVEL SPREADERS

1. Level spreaders are outlets or "sills" having a level cross section. They convert erosive channelised flows into non-erosive sheet flow. ***Convert Flows***

2. Level spreaders can only be used to dissipate flows from small catchments. The area below the outlet should be stable and of even cross section so that the water will not re-concentrate into channels. ***Location***

3. To reduce flow velocity before the spreader, the channel grade shall not exceed 1% for a minimum of 8 metres. The outlet or "sill" width depends on contributing catchment, slope and ground conditions. The minimum width should be four metres, and the maximum width 25 metres. Final discharge should be over a level surface, which may require stabilising by turfing or seeding and fertilising or perhaps lining with a geotextile fabric or something similar. ***Design Criteria***

## D7.13 THE LOCATION OF SHAKEDOWN AREAS AND ACCESS STABILISATION

1. Access to construction sites shall be limited to a maximum of two locations. ***Number of Accesses***

2. Such access locations shall require Council approval. ***Location Approval***

3. Shakedown areas or access stabilisation shall comprise a bed of aggregate on filter cloth or a metal bar cattle grid located at any point where traffic enters or leaves a construction site. Stabilised accesses reduce or eliminate tracking of sediments onto public rights of way or streets. Should such tracking occur the contaminants must be swept off the road way each day or before rain. Clean off draw bars etc after dumping and before starting journey. ***Types***

4. If a shaker grid is used, this should be so placed as to ensure the vehicles when crossing the grid have sufficient speed to "shake the mud" or other contaminants such as gravel from the vehicle. It must not be placed where the vehicle is slowing to enter a roadway. Cattle grids shall be a minimum length of 7 metres. ***Cattle Grid***

5. A stabilised access comprises a vehicular pathway suitably constructed to facilitate the collection of any site debris in order to prevent such material leaving the site. Stabilised accesses are generally used on small sites. The entrance shall be at least 15 metres long with a minimum width of 3 metres for a one way entrance and 6 metres for a two way entrance. ***Stabilised Access***

6. Surface water flowing to the street entrance/exit must be piped under the access, or a berm constructed to direct surface flow away from the exit. ***Flow Control***

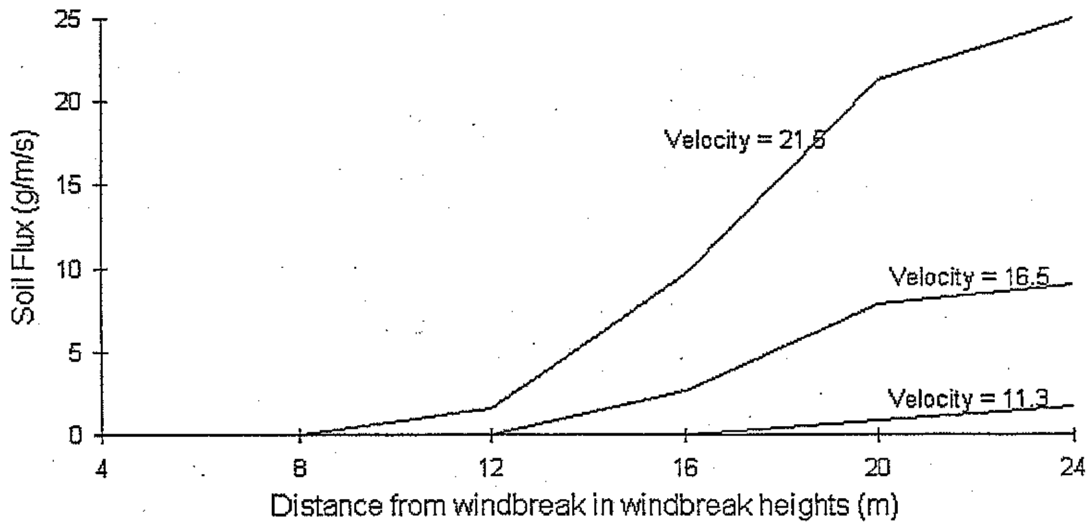
## D7.14 WIND EROSION/DUST CONTROL

1. Research has demonstrated average dust emission rates of over 2½ tonnes per hectare per month at urban construction sites. This erosion rate is unacceptable. ***Erosion Rate***

2. Various measures are available to minimise such emissions, including: ***Treatments***

   i) limiting the area of lands exposed to erosive forces through phasing works/progressive revegetation and/or provision of a protective ground cover and/or keeping the ground surface damp (not wet); or the use of dust suppressants and/or

ii) on building sites, installing a barrier fence on the windward side – effective to a distance of 15 times its height, assuming an acceptable soil flux of 5 grams per metre per second. See Figure D7–15




**Effect of distance from windbreak on soil loss, wind blowing at less than 90 to the windbreak.**

*Figure D7.15*

**Pollution Control**

## D7.15 REQUIREMENTS FOR BUILDING SITES

1. The clearing of vegetation and preparation of building pads is to be undertaken in the last stages of the development when the majority of the site has been effectively revegetated. ***Site Clearing***

2. When the development calls for the construction of a number of buildings, the sediment trap/s and other appropriate sediment controls shall remain operational. ***Development Control***

3. Cross/catch drains shall be installed on long or steep unpaved driveways, disposing run-off to stable areas. ***Driveway Control***

4. Where a majority of the lot is disturbed the following controls or measures shall be undertaken: ***Lot Control***

   i) Silt fences, located around the downstream sides of the lot.

   ii) Sediment traps/barriers to be provided to all on-site and adjacent stormwater inlets.

   iii) Only one site access to be provided. This may require treatment to prevent soil being tracked from the site.

   iv) All subsurface drainage for roofing must be in place prior to the installation of the roof and gutter so downpipes can be immediately connected.

   v) Locate any stock piles of road, gravel etc to ensure that the material does not spill onto the road pavement or is not in a drainage line or water course.

   vi) Promptly stabilise driveways and all disturbed areas.

   vii) Ensure proper disposal of all onsite waste building materials.

viii) Do not place soil or substitute material in the gutter to provide allotment access.

## D7.16 EXTERNAL SITE REQUIREMENTS

1. Sediment control devices or stabilising works shall be provided outside construction sites where necessary or as directed by the Superintendent. ***Necessary Controls***

2. Where increased stormwater run-off is likely to accelerate erosion of any downstream watercourse, the necessary remedial work shall be provided concurrently with other sediment and erosion requirements. ***Accelerate Erosion***

3. Where sediment is likely to be transported from the site, all immediate downstream drainage inlets shall have appropriate controls installed. ***Downstream Controls***

4. If such works require entry onto private property, written permission shall be obtained prior to the entry and commencement of such work. ***Written Permission***

5. All disturbed areas on private property to be reinstated to original condition and to the satisfaction of the owner. ***Reinstated***

## *THE LOCATION DESIGN AND TREATMENT OF STORMWATER MANAGEMENT*

## D7.17 STORMWATER MANAGEMENT – GENERAL

1. Most urban developments mean a change in land use from rural to urban and then is usually accompanied by a decline in stormwater quality. This applies to the long term as well as during the short term construction phase. The main components required to enhance stormwater quality are as follows:– ***Main Components***

   i) Buffer Zones and Filter Strips, being grassed, or similarly treated areas to facilitate the natural assimilation of water pollutants and reduce run-off.

   ii) Gross Pollutant Traps (GPT) designed to intercept litter and debris to maintain visual quality in downstream waterways, and to reduce the coarse sediment load on downstream water management structures.

   iii) Wet Retention Ponds are permanent sediment ponds designed to allow particulate matter to settle out. They operate under both sedimentation and macrophyte regimes. Note that a large proportion of nutrients are removed by macrophytic vegetation as part of the food chain.

   iv) Wetland (Nutrient) Filter to enhance the removal of fine sediment and nutrients from stormwater run-off, and are largely dependent on biochemical removal mechanisms (ie nutrients taken up as part of the plant food chain).

2. Excess nutrients (N, P) lead to neutrophication of waterways. This can cause uncontrolled growth of algae, water weeds, etc which can deplete oxygen levels, kill resident flora and fauna, and reduce recreational appeal. However waterways do have a natural capacity to assimilate nutrients in small to moderate amounts as initial flows have. ***Excess Nutrients***

3. It is essential to treat the "first flush" of stormwater as these initial flows from urban areas have relatively high pollutant loads. Such heavy pollution results from significant areas of impervious surfaces which do not assimilate pollutants such as dust, fertilisers, pesticides, detergents, etc to the same extent as occurs in more rural environments. ***First Flush***

## D7.18 WET RETENTION BASINS/PONDS

1. Basins designed for water quality control should maximise the extent of settling. In general quiescent conditions and infiltration should be maximised. ***Maximise Infiltration***

2. A wet retention basin can be located either on-line or off-line. Its capacity however needs to be considerably greater if it is located on-line. The wet retention basin usually has some form of energy dissipation at the inlet or a sufficient length-to-width ratio (greater than 2:1) to prevent short circuiting of flow across the pond, although its shape may vary considerably. The pond may vary in size, but it usually has a minimum surface area of about 1% of the total catchment area. At a depth of 2.5 metres, this provides a storage volume approximately equal to the maximum total run-off from a 1 in 1 year storm. Basins may be installed as smaller multiple units (in series) or as large single units. ***Location and Size***

3. Other design guides that will make the basin efficient in removing particles and provide for public safety, include the following. ***Basin Efficiency***

   i) The minimum depth should be not less than 1.5 metres with an average depth of 2.5 metres. This discourages macrophyte growth in the deeper portions of the pond and also the breeding of mosquitoes.

   ii) The basins should have side slopes of approximately 1 in 8. This provides for safety and encourages microphyte growth around the edges facilitating nutrient uptake.

   iii) The maximum velocity through the pond based on a 1 in 1 year storm should not exceed 0.3 metres per second (at 2.5 metres depth, this is the maximum practical flow velocity at which optimum sediment removal can be achieved).

   iv) A minimum freeboard of 0.3 metres should be provided between a restricted discharge outlet for the pond and a storm overflow weir. This discharge outlet should be designed so that the weir overtops on average three times per year.

   v) Inlet and outlet structures should be located at extreme ends of the basin, with short circuiting of flow further minimised by the use of baffles.

4. They should be constructed prior to the commencement of any site clearing or construction works, and should be de-silted when the level of sediment reduces the average water depth to less than 1.5 metres. ***Construction and Maintenance***

5. i) It may be desirable for the designer of an urban retention basin to incorporate an outlet device that enables dewatering of the basin. This simplifies de-silting, enabling earthmoving equipment to be used for de-silting operations. ***Outlet Design***

   ii) An all weather access track shall be provided to the basin for maintenance work. ***Access Track***

6. It is generally necessary to incorporate a gross solids trap and trash rack facility on major discharges into the retention basin. This prolongs the life of the basin and prevents the accumulation of litter. ***Trash Racks***

7. Basins should be surrounded by buffer zones, typically comprising grassed foreshores of not less than 20 metres between the nearest development and the basin. This allows for some infiltration of drainage from developments, permits the drainage authority scope to develop aesthetic surrounds and reduces the likelihood of over the fence dumping of rubbish. ***Buffer Zones***

8. The settling velocity of particles should service as the basis for design. This, of course, can only be found by conducting standard settling tests or from a knowledge of local soil characteristics. The surface area of the required basin can then be determined from design settling velocities (Randall et al 1982). ***Particle Settling***

9. Wet retention basins are regarded as impoundments and normal dam safety requirements should be met. A dam may be prescribed under the Dams Safety Act, 1978, depending on the recommendations of the NSW Dams Safety Committee. A dam is normally prescribed if it is: ***Basin Classification***

   i) 10 metres or more in height and has a storage capacity of more than 20 megalitres; or

   ii) 5 metres or more in height and has a storage capacity of 50 megalitres or more.

10. If the wet retention basin is a prescribed dam, the Dams Safety Committee will maintain an interest in the dam, will seek information from its owner and will require that reports be prepared on the dam and submitted to the Committee. ***Dam Safety Committee***

## D7.19 TRASH RACKS

1. Trash racks are usually permanent structures which intercept trash and other debris to protect the aesthetic and environmental quality of water. Where appropriate, construct them upstream of all permanent retarding basins and/or wetlands which have a capacity greater than 5,000 cubic metres, and elsewhere as required by Council. ***Environmental Quality***

2. Generally, their design criteria should ensure:– ***Design Criteria***

   i) vertical bar screens with bar spacing of 65mm clear;

   ii) the length of the rack is consistent with the channel dimension and cause minimal damage when overtopped;

   iii) they are as large as practicable while considering all other design criteria – a maximum height of 1.2 metres is suggested;

   iv) a structure which remains stable in at least the 20 year ARI event, and is unlikely to cause flooding on adjacent lands as a result of the rack becoming completely blocked in the 100 year ARI event (analysis should include investigation of backwater effects and any consequent flooding);

   v) the structure drains by gravity to a dry condition; and

   vi) adequate access for maintenance and which permits the use of mechanical equipment.

3. Where associated with outlet structures for small sediment basins or constructed wetlands, they can be relatively simple in design. ***Associated Structures***

4. Trash racks may be incorporated in the design of gross pollutant traps. ***Gross Pollutant Traps***

5. Trash racks shall be checked periodically and all debris and silt removed. ***Maintenance***

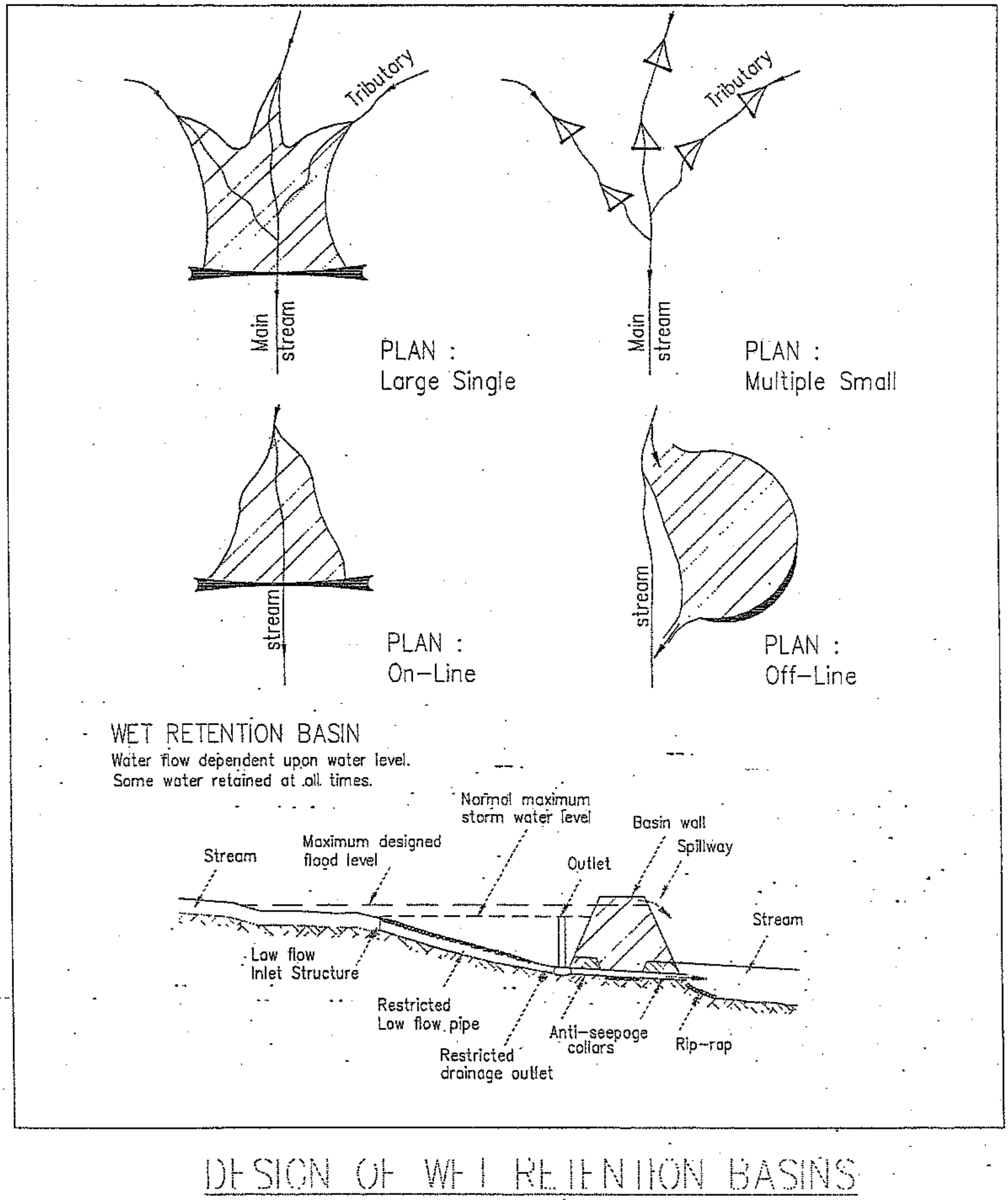



*Figure D7.16*

**Configuration and Design of Wet Retention Basins**

## D7.20 GROSS POLLUTANT TRAPS

1. Gross pollutant traps (GPTs) are permanent structures used to trap coarse sediments, trash, litter, and other floating materials. Usually, they are located upstream of constructed wetlands and receiving waters. They consist of an energy dissipater at the upper end, concrete sediment trap and trash rack at the lower end. Sometimes a "mini" wetland is incorporated at the downstream end. ***Description***

2. These traps have restricted application and each should be justified on individual merits. They have high construction costs and are generally unable to trap silt and clay sized particles other than in relatively small storm events (eg one year ARI, critical duration storm event). Nevertheless, in some specialised situations their use might be justified, especially where a significant proportion of the bed load consists of particles coarser than 0.04mm (sandy soils) and/or where their construction/maintenance cost can be justified when compared with more conventional sediment retention basins. ***Applications***

3. GPTs can be defined as major or minor: ***Definition***

   i) major gross pollutant traps can be located on major floodways and waterways to intercept medium to high flows; and

   ii) minor, enclosed gross pollutant traps can be located at heads of major floodways and/or where stormwater discharges into floodways or water bodies.

4. Design traps to intercept at least 75 per cent of sediment with a grain size of 0.04mm or greater under average annual runoff conditions. Further, ensure peak flow velocities are less than 0.3 metres per second in the 1 year ARI storm event, and taking into account any likely backwater effect from a blocked trash rack. ***Sediment Interception***

5. The structure should have sufficient capacity and stability to discharge the inlet flow with the trash rack fully blocked without flooding adjacent properties. ***Capacity***

6. Ensure GPTs are capable of gravity drainage to a dry condition for periodic cleaning and maintenance if at all possible. ***Maintenance Requirement***

## D7.21 RELEVANT LEGISLATION

1. State Environmental Planning Policy 14 aims to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of New South Wales. The restrictions on development of these lands are that a person shall not: ***Coastal Wetlands SEPP 14***

   a) clear that land;

   b) construct a levee on that land;

   c) drain that land; or

   d) fill that land;

   except with the consent of the Council through a development application and the concurrence of the Director of the Department of Planning.

2. The Native Vegetation Conservation Act, 1997 came into effect on 1 January 1998 and streamlines native vegetation management in NSW. The Act replaces SEPP 46, Protection and Management of Native Vegetation and incorporates native vegetation clearing controls previously contained in the Soil Conservation Act, 1938, Western Lands Act, 1901, Crown Lands Act, 1989 and Forestry Act, 1916. ***Management Native Vegetation***

The components of the Act relevant to the development of subdivisions are:

- To provide for the conservation and management of native vegetation;
- To protect native vegetation of high conservation value;
- Prevent inappropriate clearing of vegetation;
- Legislative controls over tree destruction through the categorisation of State Protected Lane which is divided into 3 categories

  a) land that is in excess of 18 degrees slope (Category A)

  b) land in or within 20 metres of the bed or bank of a prescribed stream (Category B) and

  c) land that is defined as environmentally sensitive (Category C)

- The Act also specifies certain types of clearing and land which is excluded from the legislation.

3. *Rivers and Foreshores Improvement Act of 1948*, Excavation or placement of fill in and within 40 metres of any watercourse or foreshore. The Rivers and Foreshores Improvement Act provides for the control of activities that have the potential to cause adverse impacts to waterways and waterbodies. The Act applies to natural and artificial water bodies and the bank, shore or bed of these bodies, adjacent land within 40 metres of the top of their banks or shores and associated deposits of material (protected land). ***Excavation or Soil Removal within 40 metres of Any Watercourse or Foreshore***

As Part 3A permit is required to be obtained from the Department of Land and Water Conservation for any excavation on, in or under protected land or for the removal of material from protected land or to do anything that might obstruct or detrimentally affect water flow (eg structures or fill). Each permit has conditions that are specific to the type of activity being undertaken to ensure that no adverse impacts upon the riverine environment and to manage an environmentally acceptable outcome.

The Department encourages landowners/proponents to consult in relation to information and requirements that may assist in granting a permit.

4. Soil Conservation Act of 1938 provides for the conservation of soil and farm water resources and for the mitigation of erosion. Under Section 15A of the Act, if the Department of Land and Water Conservation is of the opinion that: ***Creation of Erosion***

- Any act or thing done or proposed to be done on or in relation to any land; or
- The failure to do any act or thing on or in relation to any land,

has caused or is likely to cause soil erosion or land degradation on that land or on other land and that the erosion or degradation or its effects can be mitigated or avoided, the Department may serve a notice on the owner, or occupier of the land, require that the owner or occupier, within the time specified in the notice, to

- Abstain from doing or
- Do or permit to be done

Such acts and things as may be specified in the notice.

## D7.22 SOIL AND WATER MANAGEMENT PLAN CHECKLIST

1. The following checklist is provided when preparing a Soil and Water Management Plan ***Checklist***

   Depth of topsoil

   Identification of subsoil to be disturbed during construction in accordance with the following:

   - Unified Soil Classification Symbol (USCS)
   - Emerson Aggregate Test (EAT) Class 1, 2 or 3
   - Particle size analysis
     - clay < 0.002mm
     - silt < 6.002 to 0.02mm
     - gravel 2–75mm
   - Soil type
     - Type C < 33% finer than 0.02mm
     - Type F > 33% finer than 0.02mm
   - Soil Erodibility (K factor used in the Universal Soil Loss Equation USLE)
   - Dispersion Percentage of particle finer than 0.05 (insignificant < 10%; significant > 10% dispersible.
   - Critical coagulation
     - only relevant for significant dispersible soils
     - is the amount of flocculant required for flocculation
   - pH
   - Schedule of operations
   - Vegetable buffer strips and drainage reserves
   - Topsoil stockpiles
   - Diversion works necessary to prevent runoff from entering the site
   - Temporary erosion and sediment controls
   - Permanent sediment and pollution controls
   - Land clearing
   - Drainage facilities
   - Earthworks
   - Roads and parking areas
   - Installation of service facilities
   - House and building construction
   - Final rehabilitation and landscaping

- Other considerations;
- Legal
- Landslip potential
- effluent disposal

## D7.23 WETLANDS

1. The selection of pond or wetland type and their shape, depth, area, volume and edge treatment, will be a reflection of the catchment determined pollutant reduction target, the treatment train context, the siting constraints and opportunities, and the water pollutant interception processes. See Figure D7–17. ***Background***

   Categories of ponds and wetlands comprise:

   - ponds/wetlands located in-stream or off-stream
   - wet basins, dry basins, mixed (wet detention) basins
   - ponds with inlet and littoral zone emergent plants
   - wetlands with extensive emergent plants across surface area
   - perennial or ephemeral wetlands

2. Pollutant removal within wetlands occurs through two mechanisms and conditions to optimise these should be the focus of any design.

   - sedimentation occurs through a reduction in velocity and the subsequent settlement of the suspended solids. Coarser sediments settle first and accumulate near the inlets. Consequently, design strategies should address maintenance in this area;
   - biological uptake allows nutrients, present in the runoff to be removed from the system. Basically soluble nutrients are converted to biomass by the plants and upon death or senescence these nutrients are returned to the sediment as litter. They are then consumed by bacteria. Designing for biodiversity ensures the viability of this pathway.

3. The selection of the pond or wetland volume is made on the basis of providing the hydraulic retention time (volume) necessary to maximise the sedimentation and interception of fine suspended particles and their adsorbed nutrients, metals and toxicants, necessary to meet the pollutant reduction target. ***Volume***

   In some cases, the pond or wetland may also be required to attenuate peak downstream flows by temporary detention of flood flows, requiring the provision for storage of water volume over and above the retention volume. Because of outlet and/or spillway energy losses, some hydraulic head loss is involved in the discharge of peak flows, causing further temporary ponding of water in the pond or wetland.

   The maximum available elevation of water is usually limited either by area constraints such as property boundaries adjacent to the site, or by hydraulic backwater constraints in respect to maintaining free flow pipes, or upstream properties clear of flooding

4. The selection of the design depths is a compromise between maximising hydraulic retention time (volume) and minimising propensity (depth) for thermal stratification (exacerbation of sediment remobilisation of pollutants). The selection of pond depth is also guided by the euphotic depth beyond which macrophyte growth is constrained. ***Depth***

Monitoring of temperature profiles within ponds and wetlands indicates that systems having an elevated turbidity are prone to thermal stratification under high summer solar radiation and low wind conditions. Stratification prevents the transfer of oxygen to sediments, thereby exacerbating oxygen depletion – pollutant re-mobilisation conditions following events. Stratification is also a condition which favours the dominance of nuisance blue-green algae in ponds and wetlands.

5. In the case of sedimentation of fine suspended particles, the area which in association with available depth, is necessary to achieve the required hydraulic retention time (volume) or in the case of absorption of fine colloidal and dissolved pollutants, the area necessary to achieve the required biofilm contact time, in order to meet the pollutant reduction targets. An additional area will be required to accommodate the additional detention ponding requirements and discharge hydraulic head loss of outlets or spillways requirements. ***Area***

6. The pond or wetland shape is determined on the basis of

- the minimisation of the potential for flow short circuiting, the enhancement of mixing throughout the pond or wetland
- the depth relationships necessary to secure the desired proportion of macrophyte zones and clear water zones
- the topographical and land use constraints of the site, and
- the landscape criteria.

Ponds should have a length to width ratio of 3:1. The role of islands in enhancing flow distribution by preventing short circuiting are illustrated in the Figure D7.11.

7. The selection of shoreline profile needs to address a number of design requirements, including: ***Cross sections***

- maintenance of free draining slopes such that retention of isolated pockets of water (potential for mosquito nuisance in situations where predation is excluded) do not occur
- slope capable of withstanding wave action without serious erosion, for local soils, wave height (wind fetch and strength) and edge vegetation
- safety against drowning, avoid steep slopes or sudden drops which might present a hidden trap for users
- the shoreline is to have side slopes of very low gradient (1 in 8 or less).

8. In the case of constructed wetlands for surface water management, there are four considerations in respect to the sediments: ***Soil substratum***

- to avoid or remove soils high in organic material, nutrients, metals or toxicants, which are likely to impose a high BOD loading on the pond or wetland upon initial filling, potentially leading to mobilisation of nutrients, metals and toxicants and their release into the water column;
- to establish a substrate conducive to a healthy growth of macrophytes within macrophyte designated areas (optimum condition being a loamy soil having a medium organic content, and a depth of 200mm);
- the selection of a soil grading which provides a large absorption capacity in respect to adsorption of nutrients (high concentration of clays, iron, aluminium);
- the minimisation of cost.

The final selection will be a compromise between these factors.

9. The selection and planting of macrophytes is required to address three functions: ***Emergent Submergent***

***Plants***

- to assist in the even distribution and calming of flows, to enhance sedimentation in the case of fine suspended particulate systems
- to maintain transfer of oxygen to sediments in systems where there is a potential for thermal stratification (depths > 0.5m for elevated turbidity systems during high solar radiation and low wind periods)
- to provide a substrate for algal and microbial biofilm biomass, necessary to absorb fine colloidal and dissolved nutrients and toxicants for wetland system.

There is a need to limit pond depths to less than the euphotic depth ($Z_{euph}$) for designated macrophyte zones. This is typically 0.1m to 0.8m deep. In addition, attention is required to the nature of the sediment (or substrate) into which macrophytes are to be planted. Sandy loam soil provides the optimum condition for macrophyte propagation. There is also a need to avoid zones of high velocity (>2m/s) or high sedimentation rates in order to maintain macrophyte viability. The selection of species is guided by species common to the area and suitable for the conditions proposed for the pond or wetland.

***Embankment Design***

10. The construction of embankments are normally required to create the water impoundment forming the pond or wetland. Embankments for urban water pollution control ponds or wetlands normally comprise roller compacted earth embankments. Soil for the embankments is selected so as to form an impermeable barrier to water seepage (clays) and provide the stability necessary to withstand the hydraulic pressure of water under the design storm event conditions. Typically, this requires the use of a sandy clay material, placed and compacted in layers, to form an embankment having upstream and downstream slopes of 1:3 and a crest of 2m (or greater) width. Geotechnical surveys are required to assess suitability of local soils for embankment construction and the treatment of the foundation requirements. Embankments may also be designed to provide vehicle, cycle and pedestrian crossing.

In cases where a natural rock stream bed and banks occurs, or where a large spillway capacity is required, it may be cheaper to form a simple concrete or mortared rock overflow weir.

Where it is proposed to discharge storm flows over the embankment, special attention is required in relation to armouring the compacted soil against scouring. This may require the installation of geo-fabric and grass vegetation, or the installation of geo-fabric and a crushed rock layer.

***Spillway Design***

11. Spillways are required to accommodate the design flood, and thereby protect the earth embankment from washout by the flood. In situations of embankments > 10m in height and 20 Ml storage, or >5m in height and 50Ml storage, the dams are designed as high hazard dams, and are required to be referred to the State or Territory Dam Safety Officer for assessment. The Australian National Committee on Large Dams requires the adoption of a design flood frequency of 1 in 10,000 years where there are urban areas within a failure flood zone downstream.

The range of possible spillways comprise:

- a large concrete pipe rise and conduit through one of the abutments (Morning Glory Spillway);
- a concrete weir and drop chute, either within the embankment or one of the abutments;
- a grassed chute located on one of the abutments, graded so as to withstand occasional flows without erosion;
- overtopping of grassed and geo-fabric stabilised embankments in the case of low <3m embankments.

In view of the high cost associated with large concrete spillway structures, a common solution is the adoption of a small concrete spillway as the primary spillway (with a capacity to accommodate up to the 1:100 years return frequency storm event) and a grass stabilised earth cannel as the secondary spillway (to accommodate the flows in excess of the primary spillway capacity, up to the design flood discharge).

12. A structure should be included to allow manipulation of water levels in the wetland. This will enable control of microphyte, insect populations and facilitate dredging. ***Water Levels***

13. Spillway capacity is designed as a broad crested weir ***Spillway Capacity Design***

$Q = C \times L \times H^{1.5}$

Where C is discharge coefficient (1.7)
L is length of weir (m)
H is depth of water over crest weir (m)
q is discharge in $m^3/s$

Earth or rock side channel

Mannings formula: $v(m/s = {}^1/_n \times r^{0.67} \times s^{0.5}$; $Q(m^3/s) = v \times A$

Where r is hydraulic radius = $^{(\text{depth} \times \text{breadth})}/_{(\text{breadth} + 2 \times \text{depth})}$
v is velocity in metres per second
n is Mannings friction coefficient (0.02 for smooth grassed channel)
n is Mannings friction coefficient (0.03 for rough rock channel)
s is the hydraulic gradient
Q is the discharge in m3/s
A is the cross sectional area of flow ($m^2$)

14. Where the discharge into a pond or wetland is via a concrete pipe or channel, elevated discharge velocities are liable to cause erosion in the inlet area and to compromise the full mixing within the impounded area. Zones of stabilisation (rock) may be required to protect the pond or wetland bed against scouring and the use of deflectors may be required to ensure dispersion of flows throughout the pond or wetland. ***Inlet Arrangement***

15. Outlets may be required to maintain base flows downstream, or to facilitate drainage of the pond or wetland in the event of a requirement to empty them. Outlet arrangements commonly comprise a small diameter pipe through an abutment or into a spillway structure, with a gate or valve on the inlet or outlet to control flow rates ***Outlet Arrangement***

Outlet Pipe capacity (pipe full – under pressure):

Hazen Williams formula: $Q(m^3/s) = 2.8CD^{2.63}S^{0.54}$;

Where $Q$ = discharge on $m^3/s$
C is Hazen-Williams Coefficient (140 for steel or concrete pipe)
D is diameter of pipe in metres
S is hydraulic gradient = water head/length

All wetlands must be capable of self draining.

16. In view of the large proportion (80 to 95%) of total sediment in the >80μm size, it is operationally more economical and less disruptive socially and ecologically, to intercept course sediment and trash in a dedicated gross pollutant trap upstream of the pond or wetland. ***Control Gross Pollutants***

17. Run a rainfall-runoff and pollutant export model for daily rainfall records for an average rainfall year, 1 in 5 years wet year and 1 in 5 years dry year, using export models such as AQALM. Present exports and interception as a function of a range of climatic conditions. ***Comprehensive Analysis***

18. Analysis indicates that given the much greater frequency of smaller events, in long term loading terms, interception of all storms up to the 1 in 2 year return frequency will secure 70 – 80% of pollutant exports, while interception of all storms up to the 1 in 5 year frequency will secure 90 – 95% of pollutant exports. ***Approximate Method***

Two approaches are commonly used; the design storm frequency based approach, and the annual rainfall x the average number of major rainfall events/year.

19. ***Design Storm Frequency Approach***

| Return Period | No. of Events | Volume | Pollutant Loading | Interception % | Interception (kg) |
|---|---|---|---|---|---|
| 10 yrs | 1 | | | | |
| 5 yrs | 1 | | | | |
| 2 yrs | 3 | | | | |
| 1 yr | 5 | | | | |
| yrs | 10 | | | | |
| 0.25 yrs | 20 | | | | |
| 0.125 yr | 20 | | | | |
| Total | | | | | |

Long term interception rate = Σinterception/Σloads

20. Average annual rainfall = 630mm – 80% occurs in falls > 10mm (500mm) ***Average Annual Rainfall Approach***

Average number of rainfall events/yr > 10mm <20mm = 20 (300mm)

Average number of rainfall events/yr > 20mm = 7 (200mm)

21. Where wetlands are natural, the provisions of State Environmental Planning Policy No 14 – Coastal Wetlands, should be consulted. This policy protects wetlands from clearing, construction of levees, draining and filing, but does not prevent wetlands being used for run-off control provided safeguards and operation control ensures their continued viability. ***SEPP No 14***

22. Where possible, small islands or shoals should be constructed in the upstream areas of the wetland to reduce water velocities, prevent short circuiting and promote aquatic plant growth. ***Short Circuiting***

23. The performance and life of wetlands, like wet retention basins, will suffer if they are not protected from trash and large particles. It is therefore recommended that trash racks/gross sediment/pollution traps be installed upstream of the wetland. ***Wetland Protection***

24. Wetlands need to be surrounded by a buffer at least 20 metres wide in order to:– ***Buffer Zones***

i) Restrict access to maintenance vehicles by the installation of an all weather track with a lockable device.

ii) Acts as an infiltration and secondary assimilation of pollutants.

iii) Provide flood protection and secondary assimilation of pollutants.

These areas are best planted with vegetation native to the area, but they can be used as grassed areas and an aesthetic feature. ***Native Vegetation***

25. Work in the ACT indicates rates of removal of phosphorous and particles in ***Results ACT***

wetlands are higher than for wet retention basins.

26. In designing wetlands, it is recommended that, as an interim guide, the surface area of the wetlands be a minimum of 0.5% of the catchment which it serves. If wetlands are used in conjunction with wet retention basins, this percentage can be proportionately lowered by allowing for the surface area of the installed wet retention basin. ***Surface Area***

27. Artificial water bodies require an Environmental Impact Statement when: ***EPA Act Regulations***

- it has a maximum aggregate surface area of water of more than 0.5 hectares located:
  - in or within 40 metres of a natural waterbody, wetland or an environmental sensitive area; or
  - in an area of:
    - highwater table; or
    - acid sulphate, solic or saline soils; or
- with a maximum aggregate surface area of water of more than 20 hectares or a maximum total water volume of more than 800 megalitres.

28. There are basically three types of growth forms in waterplants. ***Microphyte Types and Planting***

- free floating
- emergent
- submerged

Species which free float on the surface severely reduce the desirable character of the wetland and should be removed eg Salvinia, Eichhornia. Submerged freefloating plants are much less of concern, but are difficult to cultivate, eg Lemna triaulea, Riccia, Utriculara. Most constructed wetlands select emergent plants and select their species from what is suitable and available. All planting is to be on an even graded uniform bed. Planting of any constructed wetland should be undertaken between September and December so as to give the plants some opportunity to establish in one season and a limited opportunity to fill in gaps which may appear. Generally, it is recommended that a mixture of native species be planted. The more diverse the species composition, the more resilient and durable the wetland is likely to be, the easier it will be to manage and the lower the likelihood of any species spreading from the wetland causing problems to the surrounding area. There are some native colonising species eg Typha spp.; Cumbungi which are classed as weeds. It is very difficult to maintain a desired mix of weedy species. Plants from the following list should be considered.

<u>Phragmites autstralis</u>. Once established is very hardy and grows very densely. Tolerates drying for substantial periods. Planted >5m$^2$.

<u>Bolboschoenus fluviatilis, B. caldwallii and B. medianus</u>. Quick growing but can swamp other species. Planted 1–2/m$^2$ for seadlings 1/m$^2$ for bulbs. Specify 50% of bulbs to produce plants.

<u>Cyperus exaltatus</u>. Quick growing species but not very persistent, planted for quick result, not for the long term planted 5/m2 or mixed with other species.

<u>Eleocharis sphacelata</u>. Provides a species diversity, is very unpredictable, can disappear over a few years, after taking decades to thicken up. Good water bird feed. Planted >5/m$^2$ or mixing with Cyperus exaltatus.

<u>Schoenoplectus validus</u>. Useful for the mid and long term. Spreads well. Planted 5/m$^2$

Treglochin procerium. Includes 12 different species. Slow to establish. Plants are very hardy and once established can tolerate drying for several months. Planted > $5/m^2$.

Schoenoplectus liittoralis. Similar but more salt tolerant.

Baumea articulata. A slow spreader but a proven long term species. Planted $>5/m^2$ mix with Cyperus exaltatus.

Paspalum distichum. Spreads quickly by seed and runner. Can be planted with occasional sprig or seedling scattered through the wetland.

Alisma plantago-aquatica. Quick growing, easy to establish from seed.

Cladium porcerum. Large growing sedge, grown for decorative purposes $1–2/m^2$

Juncus australis, J. usitatus. Two good edge species which are hardy, tolerate periodical flooding and extended dry periods 2–3/linear metre.

Lepironia articulata. Large clumps, hardy and tolerates deep water when mature and long dry periods – $1–2/m^2$

Philydrum lanuginosum. Quick early grower. Not particularly persistent but will self seed in bare areas $3/m^2$

Gahnia sieberiana. Large tussocks, can cut hands, good hardy edge species which can tolerate intermittent flooding and long dry periods. Good for controlling access $1/m^2$

Carex fascicularis, C. appressa. Tough edge plant which protects banks and can survive long dry periods. 1–4/linear metre.

**Desirable Exotic Species**

Potamogeton spp.

Ottelia ovalifolia

Persicaria spp.

Myriophyllum spp. Other than M. aquaticum

Juncus usitatus

Cyperus difformis plus some other native spp.

**Unacceptable Exotic Species**

All noxious weeds

Alternanthera philoxeroides, Alligator Weed

Eichhornia crassipes Water Hyacinth

Salviania molesta Salvinia

Ludwigia peruviana

Gymnocoronis spilanthoides Senegal Tea

Juncus acutus

Myriophylum aquaticum

29. Wetlands will serve other purposes than just improving a quality of urban run-off. They will serve to attract a large range of biota and bird habitat. In areas where they have been installed, they have become an aesthetic feature. Indeed, this may

***Aesthetic Feature***

present problems as surrounding communities may resist efforts by the controlling authority to de-silt the wetland.

30. To minimise mosquito problems, limit expanses of water with more than 50 per cent shading and ensure no sections of water become isolated from the main body. ***Insect Problems***

31. Islands are highly beneficial as wildlife refuges, especially for birds. Their design should consider the effects on changes in water levels. ***Wildlife Refuge***

32. Stock ponds with selected native fish to improve the water quality (not for sport), especially species which will control mosquito larvae and select zooplankton in preference to phytoplankton. Avoid use of fish which are bottom feeders (carp). ***Native Fish***

33. Wetland sites if to function should have soils having the following characteristics: ***Pond Soils***

- desirable soil permeability of 10–6 – 10–7m/s
- sandy clays loams are suitable
- clay soils are acceptable with the addition of top soil for the establishment of plants
- chemical characteristics, pH (6–8), determine phosphorus adsorption valve.

34. A management operations plan is to be submitted with the wetland design detailing the following: ***Management Plan***

- initial operation with attention to water level and weed infestation;
- normal operation – water levels should be monitored especially during rain fall events monitoring and recording of wetland performance and condition.
- Hydraulic management, ensure even flow across wetland, short circuiting reduces performance, any deterioration of hydraulic conditions must be rectified by removing restrictions.
- Inspections – at least weekly, always after a flood or storm, look for build up of litter, sediments, constricting plant growth, plant condition, damage to wetland, observe flow patterns for short circuiting. Initiate rectification to any problems.
- Litter management, inspection of gross pollution traps, litter can clog wetland, cause short circuiting, cause increase in hydraulic pressure on plant stands and potential flattening.
- Sedimentation management. Excessive sediment build up >25% of original water depth is a problem, remove in strips across wetland. The removal method to cause minimum disturbance to wetland. Recommission as per planting and commissioning procedure.
- dry period management – maybe influx of birds and animals could cause impact on wetland possible need for irrigation, potential infiltration by plants tolerant to less water.
- Flood management – wetland plants can survive inundation for periods of time depending on species and maturity, main problem is erosion by high velocity, increased pollutants, litter and sediments. Inspect after flood and rectify damage.
- Harvesting – benefits doubtful for effort, short term changes to nutrient balance, some nutrients removed with plants. Regrowth can increase short term uptake but net removal of wetland less during regrowth. Loss of biofilm can reduce wetland performance short term. Nutrients released in stirring sediments – main purpose is for short circuiting reduction and as a byproduct of sediment removal.
- Dewatering – gradual reduction of water level maintaining a water regime for plant survival. Irrigation may be necessary if dewatered for long periods > 1 or

2 days.

- Plant management and replacement, best results occur with optimum knowledge and care. When problems occur ensure reason determined and rectification carried out as well as prevention of future incidents. Small variations will generally balance out, large changes may need intervention. For rehabilitation follow construction and establishment guidelines.
- Monitoring design to suit system and purpose. Water quality – suspended solids; BOD; nutrients; phosphorus total, Po4; nitrogen TKN, Nox, NH4–N, pH, bacteria, total faeca coli, streptococci conductivity, chlorophylla, temperature, dissolved oxygen, secchi disc depth, turbidity.

***Comparison Wetland Designs***

38. Comparison of four typical wetland designs was undertaken by Schueler in 1992 and the extract is provided in Fig. D7.18 to D20.

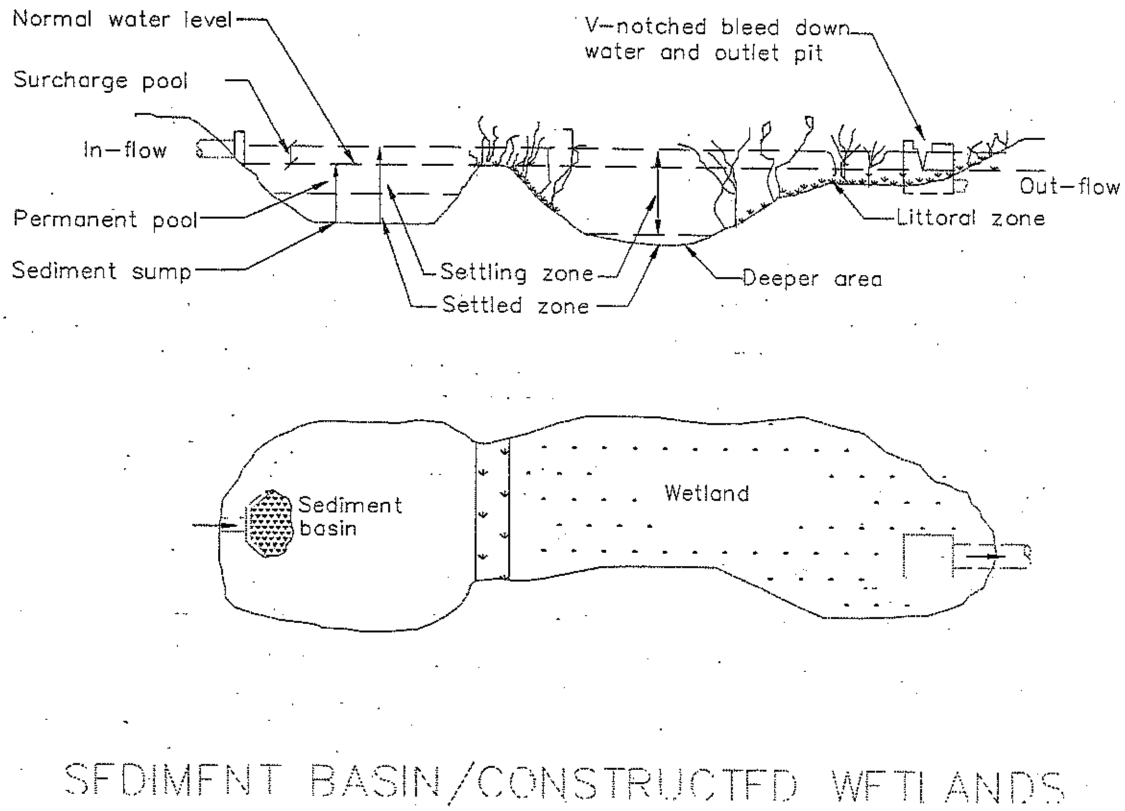



*Figure D7-17*

**Sediment Trap/Constructed Wetland**

## COMPARISON OF STORMWATER WETLAND DESIGNS

Schueler (1992) reported on four typical wetland designs, copies of the plan views and profiles of these wetlands have been complied on the following pages. He found that the selection of a particular design is usually dependent on three factors:

1. Contributing catchment area;
2. Available space: and
3. Desired environmental function for the wetland.

***Attributes of a Constructed Wetland System in Relation to Water Quantity, Water Quality and Wildlife Functions***

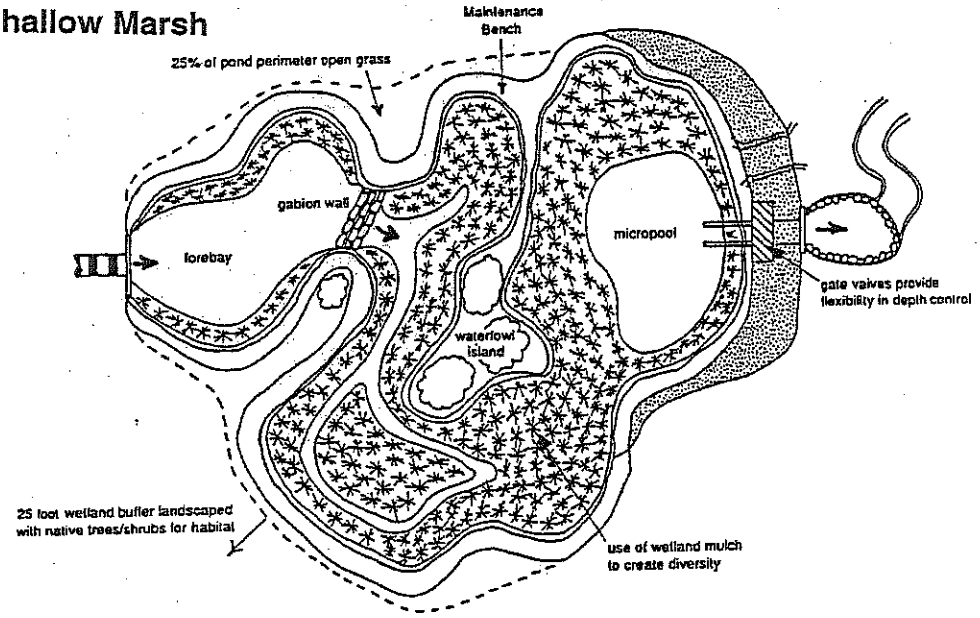
| System Attribute | Purpose/Function |
|---|---|
| Location/Hydrology | Suitable hydrology and topography contiguous to streams and other wetlands. |
| Forebay (frequent maintenance) | Settling, short-term storage of contaminants and trash separation. |
| *Wetland Area (minimal maintenance)* | Storage of water, control peak flows, water quality polishing, long term storage of contaminants, wildlife and aesthetics. |
| *Wetland Vegetation* | Storage of contaminants, promote bio-geochemical processes, filtration, wildlife and aesthetics. |
| Wet Pond in Wetlands | Habitat for wildlife |
| 10–14 Day Detention | Aerobic decomposition, anaerobic decomposition (denitrification). |
| Organic Soils | Storage of contaminants-adsorption, anaerobic decomposition (denitrification), water storage). |
| Emergent/Woody Plants | Succession from emergent to woody trees, long-term storage of contaminants, plant diversity for wildlife benefit. |
| Wet/Dry Compartments | Flooded shallow wetland areas, deeper areas for open water, diversity of functions, maximise denitrification. |

(after Shaver & Maxted, 1994)

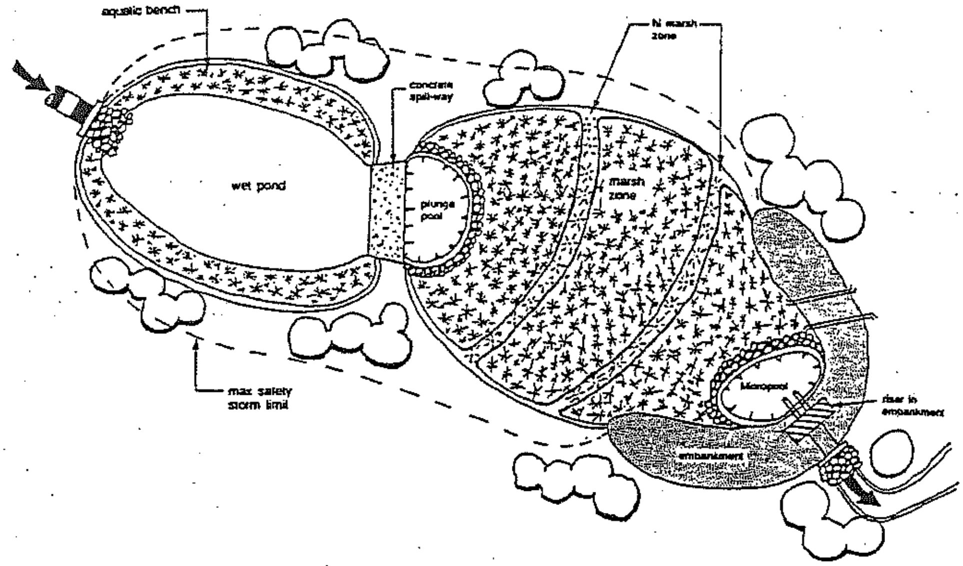
*"The runoff storage, complex microtopography and emergent plants in the stormwater wetlands together form an ideal matrix for the removal of urban pollutants."* (Schueler, 1992) Stormwater wetlands should not be seen as the solution to runoff pollution. Without source controls and/or large surface areas they can only buffer the impacts of pollutants on the receiving waters.

*Fig. D7.18*

## Design No. 1 – The Shallow Marsh




## Design No. 2 - The Pond/Wetland System




## Design No. 3 - The Extended Detention (ED) Wetland

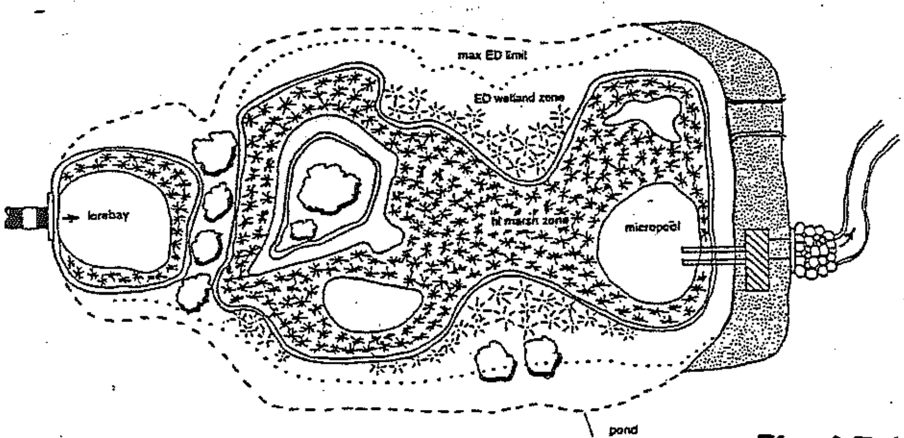
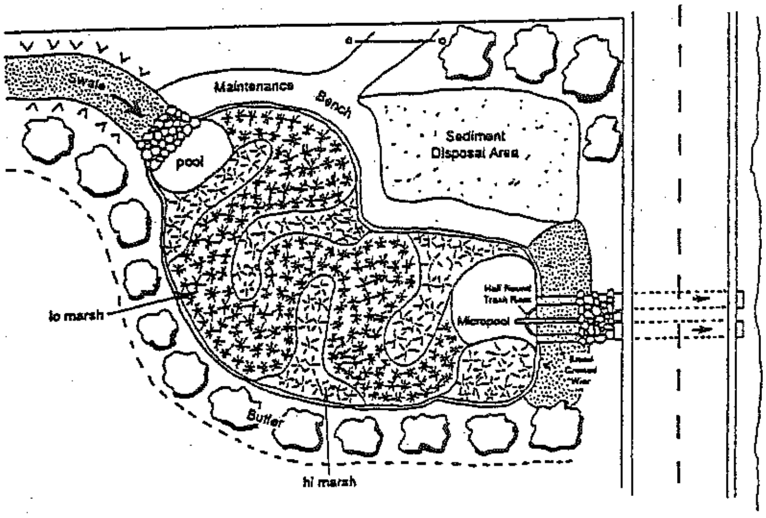
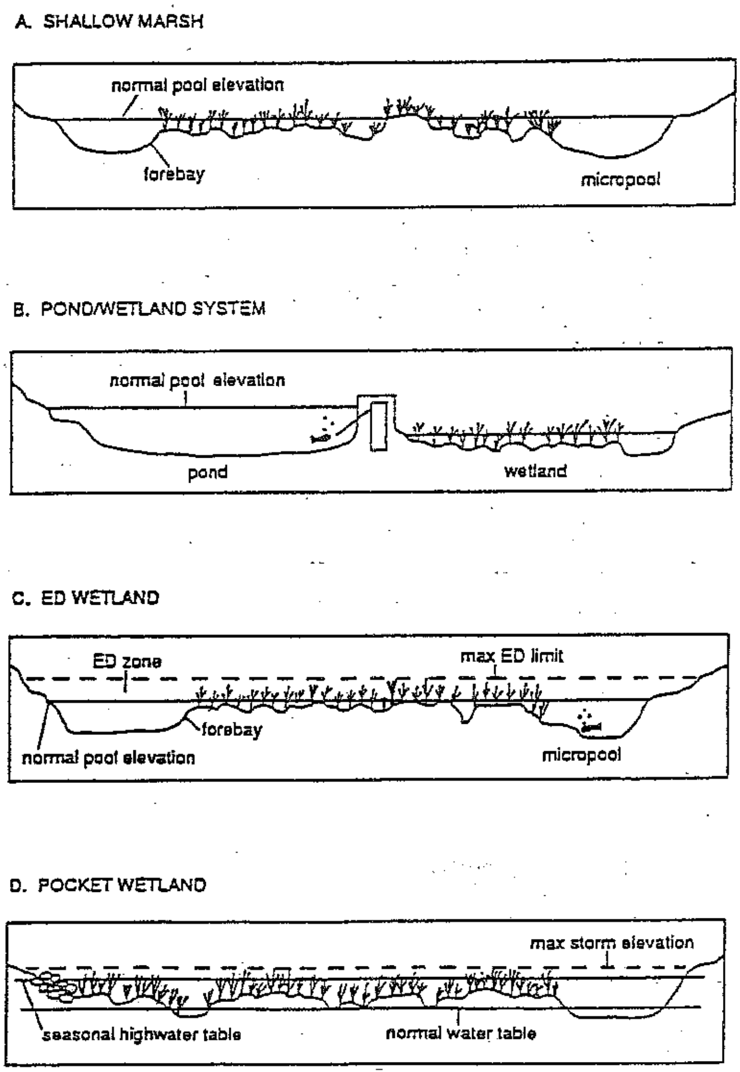



*Fig. D7.19*

## Design No. 4 – The Pocket Stormwater Wetland




## Comparative Profiles of the Four Stormwater Wetland Designs




*Cross-sectional profiles of the four stormwater wetlands are not drawn to scale. In Panel A, the majority of the shallow marsh is devoted to shallow depths that support emergent wetland plants. The pond/wetland system (Panel B) is composed of deep and a shallow pool. In ED wetlands (Panel C), the runoff stormwater of the wetland is augmented by temporary, vertical ED storage. Pocket wetlands (Panel D) are excavated to the groundwater table to provide a more or less constant water elevation.*

*Fig. D7.20*

# REFERENCE AND ACKNOWLEDGMENTS


**ACT Government Publications**

- Design Manual for Urban Erosion and Sediment Control – July 1988
- "Protecting the Murrumbidgee from the Effects of Land Development"
- "Guidelines for Erosion and Sediment Control on Building Sites"
- Implications for Building Construction
- Pollution Control on Residential Building Sites (Brochures)
- Field Guide – Erosion and Sediment Control
- Australian Journal of Soil and Water Conservation – Vol 3, Number 1

**NSW Department of Housing**

- Soil and Water Management for Urban Development

**Roads and Traffic Authority**

- Erosion and Sedimentation Design Considerations

**Soil Conservation Service**

- Erosion and Sediment Control – Model Policy and Code of Practice (Discussion Paper)

**Wyong Shire Council**

- Internal Documents
- Techniques of Erosion and Sediment Control (June 1992 & October 1993)

**Presentation Papers by Mr Noel Nebauer**

- Flood Mitigation Conferences – Bankstown & Taree
- Sediment and Erosion Control Seminars – Service Authorities