DEVELOPMENT DESIGN SPECIFICATION

D7

EROSION CONTROL AND STORMWATER MANAGEMENT

CLAUSE CONTENTS PAGE

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. ***Erosion***

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

3. After construction is complete and the site fully rehabilitated, permanent water quality control structures and features commence their role. These include trash racks, gross pollutant traps, wet retention basins and the creation of, or increase in size, of wetlands. ***Water Quality***

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 at 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 that is 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 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

D5	-	Stormwater Drainage Design
C211	-	Control of Erosion and Sedimentation
C273	-	Landscaping

(b) NSW State Legislation

Protection of the Environment (Operations) Act 1997
Catchment Management Act 1989
Dams Safety Act, 1978
Soil Conservation Act, 1938
Water Management Act 2000
Water Act, 1912

(c) 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

(d) State Authorities

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).

NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) (formerly Department of Land and Water Conservation (DLWC))
- Urban Erosion and Sediment Control.

State Environmental Planning Policy No.14 - Coastal Wetlands.

(e) Other

Wyong Shire Council
- 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

D7.04 PLANNING & CONCEPT DESIGN

1. Assess the physical characteristics and limitations of soils, landform and drainage of the site and plan the subdivision accordingly. ***Site Characteristics***

2. A design shall be submitted to Council with the development application for all developments. ***Design Submission***

D7.05 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 Construction Certificate Application. 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. ***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.

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 re-grading
- 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 the areas to be disturbed
- revegetation program
- procedures for maintenance of erosion and sediment control
- details for staging of works

Approval

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. These qualifications shall be made available to the Council's Development Engineer for review upon request.

Additional Works

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

EROSION CONTROL

D7.06 BUFFER ZONES

Filters

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

Performance

2. Buffer zone performance increases as catchment area and slope gradient decreases. Thirty-metre-wide buffer zones generally provide adequate protection. The minimum width of buffer zones for various slopes is provided in the following table.

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

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 source points 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***

D7.07 "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." ***Signposting***

D7.08 DIVERSION WORKS

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

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. ***Pipelines***

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

   (a) The drain should preferably be dish shaped with batter grades of less than 2:1 ***Drain Shape***

   (b) If a piped system is selected its design capacity shall be a minimum of the capacity nominated in the Development Design Specification (D5) STORMWATER DRAINAGE. ***Pipe Capacity***

5. Diversion works are designed to carry peak flows at non-erosive velocities in bare soil, vegetated or lined drains/banks. ***Peak Flows***

6. Generally, the channel should be lined with turf. However, where velocities are in excess of 2m per second, non erosive linings such as concrete, geotextiles, grouted rock etc or velocity reducers (check dams etc) are required. ***Non-Erosive Linings***

7. Typical arrangements of diversion drains and banks are shown in Figure D7-1.

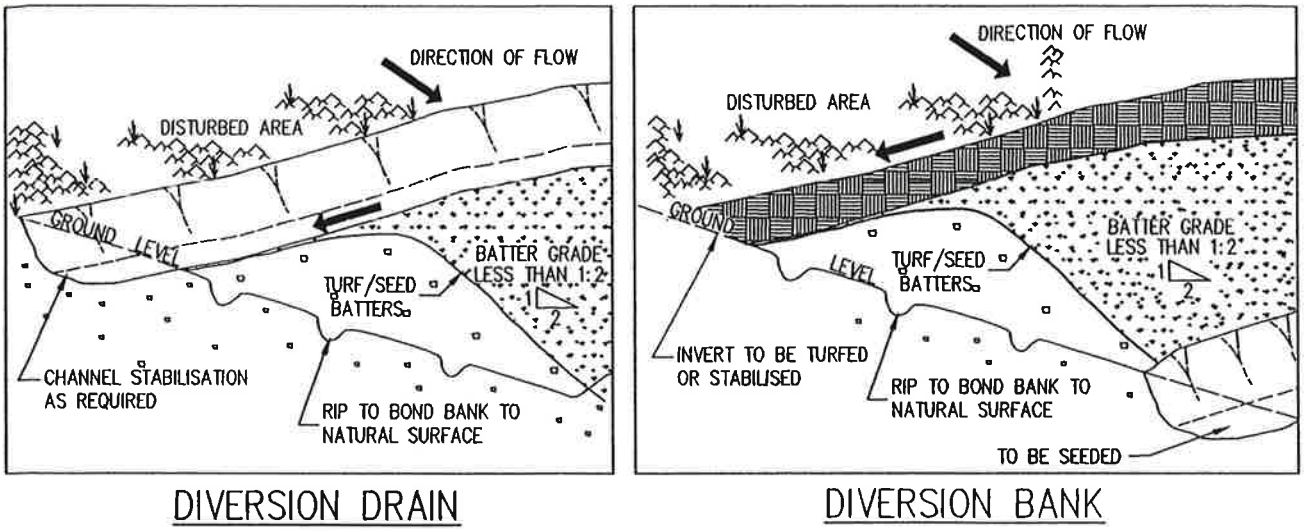


Figure D7-1 - Diversion Drains/Banks

D7.09 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 or rigid, or flexible pipes and 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 through 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***

D7.10 STOCKPILES

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

2. Stockpile sites shall be located: ***Location***

   (a) Clear of existing or proposed drainage lines.

   (b) Clear of areas likely to be disturbed during construction.

   (c) Clear of the drip zone of trees.

   (d) Preferably on reasonably flat areas.

3. Stockpiles must be protected from erosion and sediment loss by: ***Erosion Protection***

(a) The installation of diversion works.

(b) The use of silt fences, hay bales etc or other approved controls on the downstream side.

(c) Compaction.

(d) Revegetation if left exposed for longer than 30 days (refer to Landscaping Construction Specification for seed mix).

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

D7.11 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. ***Sediment Control***

2. They are formed by excavation and/or by constructing embankments. ***Construction***

3. There are two types, wet and dry basins. ***Types***

4. Sediment traps shall preferably not be located directly upstream of residential areas. ***Location***

5. Basin designs must comply with the following: ***Design Criteria***

(a) Volume/capacity of the trap shall be 250m^3/ha of disturbed site including the building areas.

(b) An allowance of 50m^3/ha is required if diversion controls are not used to direct clean upstream water from outside the site away from construction areas.

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

(d) 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.

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

(f) The basin shall be surrounded by a manproof fence fitted with lockable gates.

(g) An all weather access must be provided to the basin for maintenance.

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

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

(j) Discharge of the basin shall be via a perforated riser encapsulated by a filter device for a dry basin. Wet basins shall be flocculated by dosing with gypsum and pumped.

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

6. Permanent wet basin designs vary slightly from the above. Refer to the Stormwater Management Section of this Specification. ***Permanent Wet Basins***

D7.12 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. ***Filtering Structures***

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

(a) silt fences
(b) hay bales
(c) blue metal groynes/sausages
(d) filter fabric located beneath stormwater grates
(e) gabions
(f) 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***

(a surface inlet pits
(b) kerb inlet pits
(c) catch drain disposal areas
(d) culvert inlets and outlets
(e) minor construction/earthwork sites
(f) check dams/velocity reducers etc.

D7.13 LEVEL SPREADERS

1. Level spreaders are outlets or "sills" having a level cross section. They convert erosive, channelled 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 per cent for a minimum of 8 metres. The outlet or "sill" width depends on the 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 similar. ***Design Criteria***

D7.14 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 coarse 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 roadway each day or before rain. Drawbars etc shall be cleaned off after dumping and before ***Types***

starting each journey.

4. If a shaker grid is used, this should be so placed as to ensure that vehicles when crossing the grid have sufficient speed to shake 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 width 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***

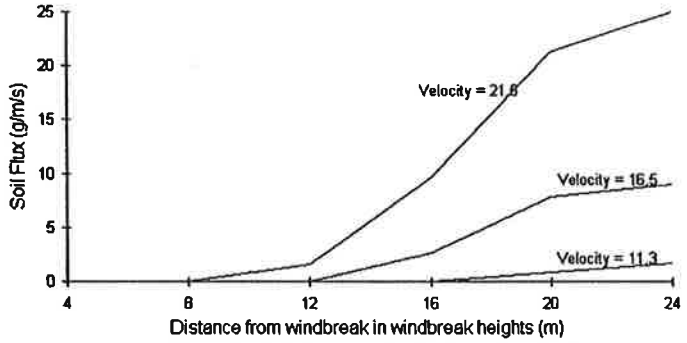
D7.15 WIND EROSION/DUST CONTROL

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***

(a) limiting the area of land 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); and/or

(b) 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 D7-2.



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

Figure D7-2 - 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***

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

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

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

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

D7.17 EXTERNAL SITE REQUIREMENTS

1. Sediment control devices or stabilising works shall be provided outside construction sites where necessary or as directed by the Councils Development Engineer. ***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 works. ***Written Permission***

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

STORMWATER MANAGEMENT

D7.18 GENERAL

1. Most developments mean a change in land use and are 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***

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

(b) 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.

(c) 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 large proportions of nutrients adhere to the sediments, and therefore settle out. Other nutrients are removed by microphytic vegetation as part of the plant food chain.

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

Excess Nutrients

2. Excess nutrients (N, P) lead to eutrophication 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.

First Flush

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, oils, detergents, etc to the same extent as occurs in more rural environments.

D7.19 WET RETENTION BASINS/PONDS

Maximise Infiltration

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

Location and Size

2. A wet retention basin can be located either on-line or off-line as shown in Figure D7-3. Its capacity 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 per cent 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.

Basin Efficiency

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

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

(b) The basins should have side slopes of approximately 1 in 5. This provides for safety and encourages macrophyte growth around edges facilitating nutrient uptake.

(c) 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).

(d) 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.

(e) 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.

Construction and Maintenance

4. Basins 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.

5. (a) 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***

(b) An all weather access track shall be provided to the basin for maintenance works. ***Access Track***

(c) A risk assessment shall be conducted and submitted with the design, to determine the need for fencing or otherwise protecting the basin from public access ***Access Restriction***

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 determined by conducting standard settling tests or from 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***

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

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

D7.20 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, they shall be constructed upstream of all permanent retarding basins and/or wetlands that have a capacity greater than 5,000 cubic metres, and elsewhere as required by Council. ***Environmental Quality***

2. Generally, the design criteria should ensure: - ***Design Criteria***

(a) Vertical bar screens with clear bar spacing of 65 mm;

(b) The length of the rack is consistent with the channel dimensions and causes minimal damage when overtopped;

(c) They are as large as practicable while considering all other design criteria - a maximum height of 1.2 metres is suggested;

(d) 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);

(e) The structure drains by gravity to a dry condition; and

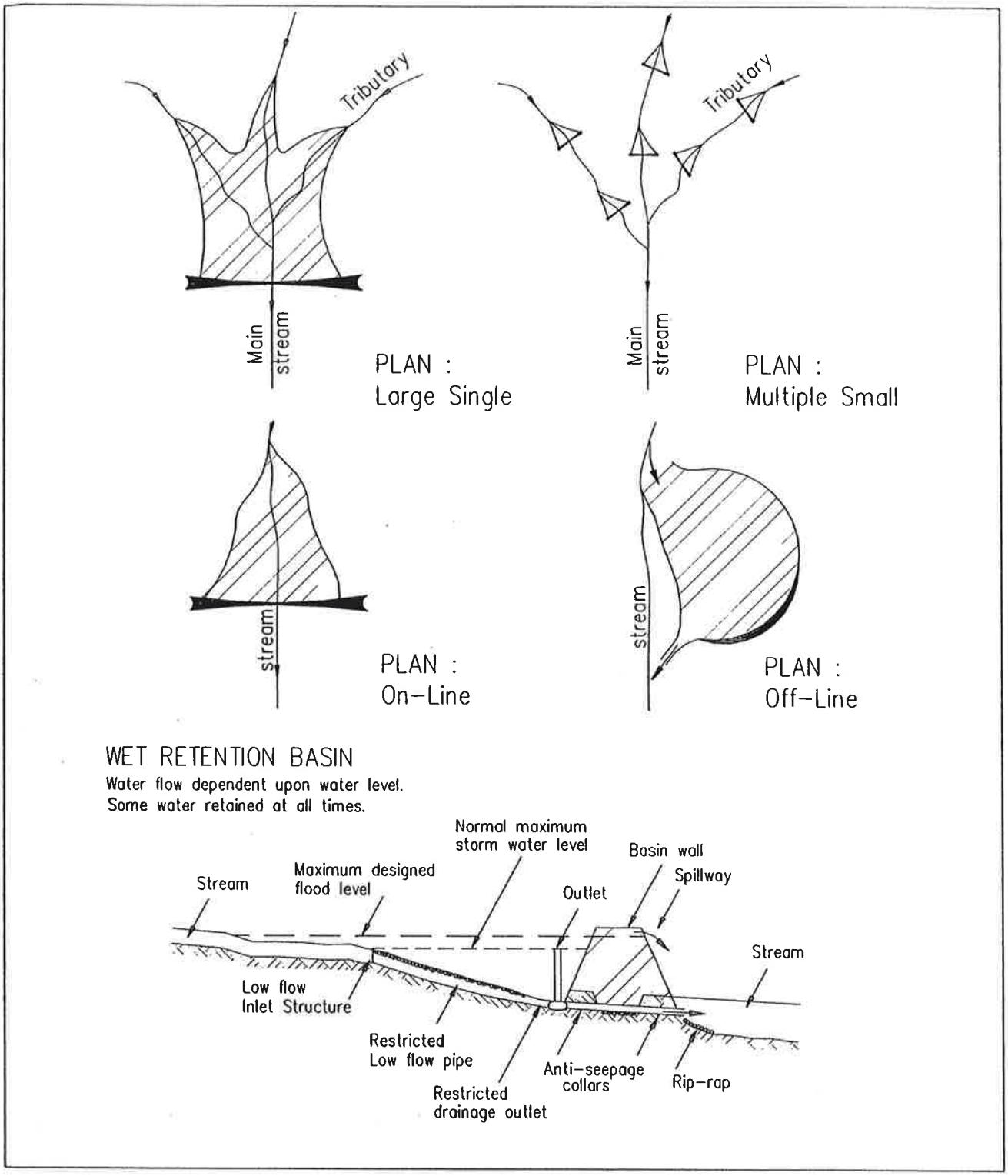
(f) Adequate access for maintenance and which permits the use of mechanical

equipment.

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

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

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



DESIGN OF WET RETENTION BASINS

Figure D7-3 - Configuration and Design of Wet Retention Basins

D7.21 GROSS POLLUTANT TRAPS

Description

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

Applications

2. GPTs 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.

Definition

3. GPTs can be defined as major or minor:

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

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

Sediment Interception

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, taking into account any likely backwater effect from a blocked trash rack.

Capacity

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

Maintenance Requirement

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

D7.22 WETLANDS

Depth and Batters

1. Wetlands used for improvement of urban run-off quality can be either natural or artificial. They necessarily have to be shallow. Growth of emergent aquatic plants (reeds, etc) should be encouraged through utilising side slopes of very low gradient (1 in 8 or less). A large percentage (greater than 25 per cent) of any permanent water should be less than 1 metre deep. The remainder of any open water should have a depth of not greater than 2 metres, which will allow submerged plant growth. Figure D7.4 shows a typical wetland arrangement.

SEPP No 14

2. 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.

Efficiency

3. Wetlands, like retention basins, operate more effectively when higher contact time between the pollutants and the biota of the wetland is provided. Thus, like retention basins, wetlands will be more efficient when used in conjunction with upstream flow retardation basins that will maintain run-off closer to pre-development levels.

Water Levels

4. A structure should be included to allow manipulation of water levels in the wetland. This will enable control of microphytes, insect populations and facilitate dredging.

5. 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***

6. 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***

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

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

(b) Acts as an infiltration area for surface run-off.

(c) Provide flood protection and secondary assimilation of pollutants.

8. 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***

9. Provision shall be made for vehicular access for future maintenance. ***Maintenance Access***

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

11. In open water zones, rooted emergent macrophytes appear to be more efficient than substrate microphytes (plants that are attached to the bottom of the water but which do not emerge). This is because the emergent aquatic plants act as an oxygen pump, taking oxygen from the atmosphere into their roots and eventually into the water and so making it available for bacteria and attached algae, which grow on the roots of the emergent plants. In the crushed rock zones, emergent aquatic plants are the only types of macrophytes that will grow. These plants will also act as oxygen pumps, and facilitate biological uptake of nutrients and the breakdown of organic matter by bacteria that grow on their roots. ***Microphyte Types***

12. A variety of plant species should be planted in artificial wetlands to achieve efficient colonisation and maximise pollutant removal. Establishment of plants should be through transplantation of seedlings during spring and early summer. ***Revegetation***

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

14. 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***

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

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

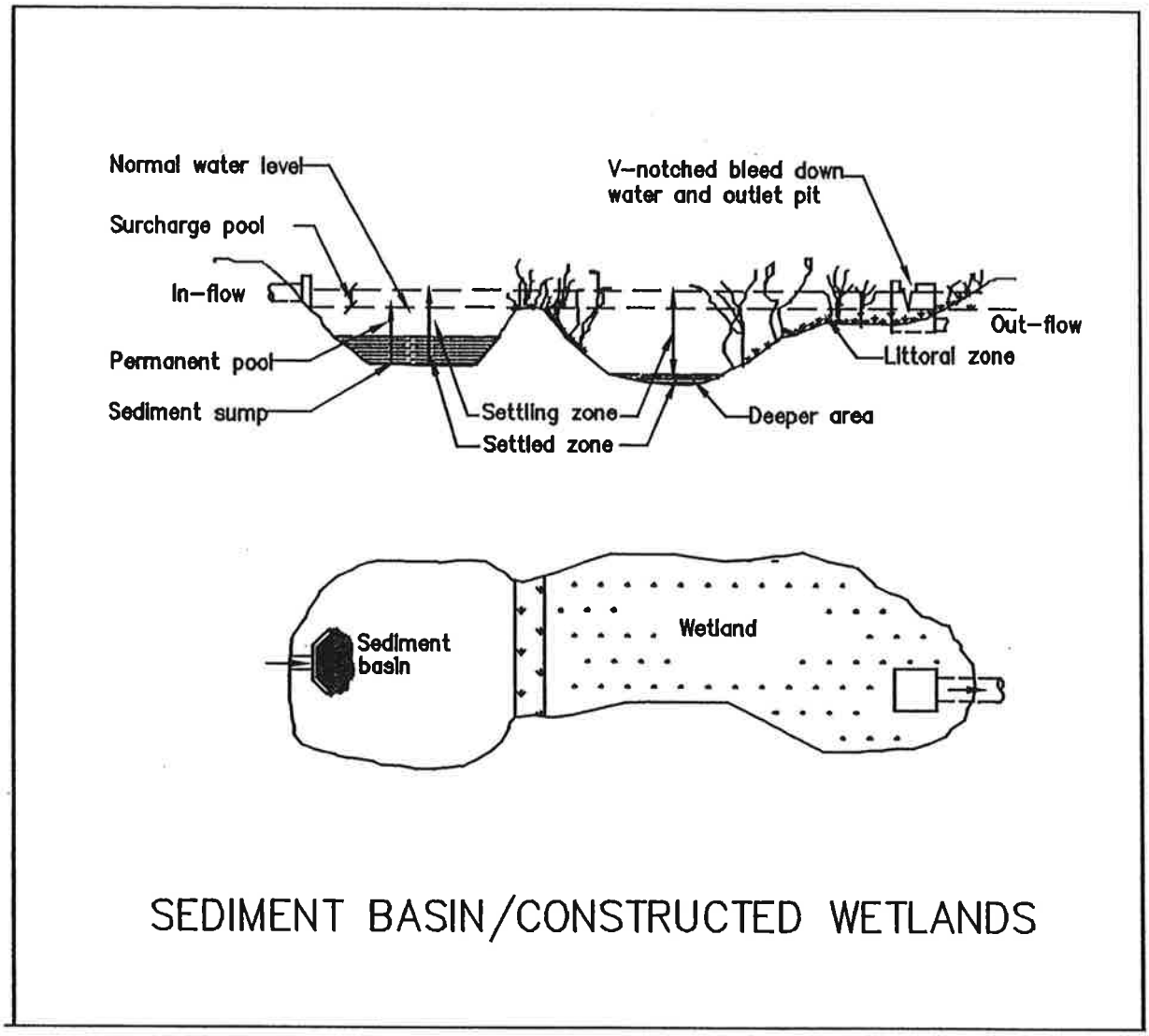


Figure D7-4 - Sediment Trap/Constructed Wetland