C

Appendix C

Construction Phase Treatment Measures

Superseded/repealed from 1 November 2021 – refer to https://www.dit.sa.gov.au/standards/environment

This appendix describes a range of treatment measures - of both structural and non-structural nature - for managing soil erosion and drainage on construction sites. The measures described are primarily for use during construction. However, many may be retained or modified for use during the project's operations phase. An example would be a sediment detention basin, operated during construction, which is also to function after project completion as a permanent measure - for example, as a sedimentation pond upstream of a constructed wetland. Where potential exists to use "temporary" construction phase measures as long-term measures, this is referred to in the text.

Key references are provided at the end of the description of each treatment measure which contain additional material that may aid in understanding and designing the measure. The reference document NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction* provides very useful coverage of many of the listed construction phase treatment measures.

C1 Soil Erosion and Drainage Management Plan Checklist

There is a high risk of erosion and generating sediment pollution during construction. Measures needed to manage the site should be assessed at the planning, design and contract preparation stages and on risk sites a Soil Erosion and Drainage Management Plan (SEDMP) must be prepared. The successful tenderer should expand on this document, or on low risk sites prepare their own SEDMP to demonstrate that they will adequately manage site soil erosion and drainage during construction. The following provides a checklist for aspects that should be considered when preparing a SEDMP. This involves:

- ❖ Planning and scheduling construction activities to manage erosion risk. Where feasible site measures should be designed to protect the site from 1 in 5 year ARI storm events.
- ❖ Installing appropriate erosion and sediment control structures and strategies using a treatment train approach.
- ❖ Stabilising and rehabilitating all disturbed areas.
- ❖ Identifying responsibilities for erosion management and implementation of the SEDMP on site. This includes the availability of suitably qualified expertise.
- ❖ Implementing a regular inspection and monitoring program
- ❖ Ensuring site workers, subcontractors and delivery drivers are made aware of their responsibilities in relation to erosion and water quality protection. Consider installing information signs at key places throughout the site.

Install erosion control measures to avoid scouring

SITE NOTICE

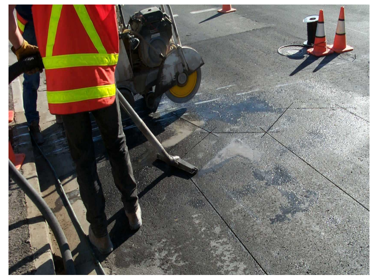
Erosion and sediment control measures exist on this site:

- All soil disturbance must be minimized
- All sediment is to be contained on site.

Soil Erosion and Drainage Management Plan Checklist

Earthworks

- ❖ Undertake earthworks in a manner that conserves topsoil and minimises disturbance. Separate topsoil and store for use in rehabilitation.
- ❖ Minimise the amount of soil disturbance beyond the limit of approved development.
- ❖ Where possible, avoid disturbance to areas of high or extreme erosion risk.
- ❖ Use appropriate treatment measures to treat runoff.
- ❖ When necessary, install erosion and sediment control structures before commencement of site disturbance and construction works.
- ❖ Schedule earthworks to retain as much protective ground cover as possible at all times.
- ❖ Program site stabilisation and revegetation as soon as possible after completion of earthworks.



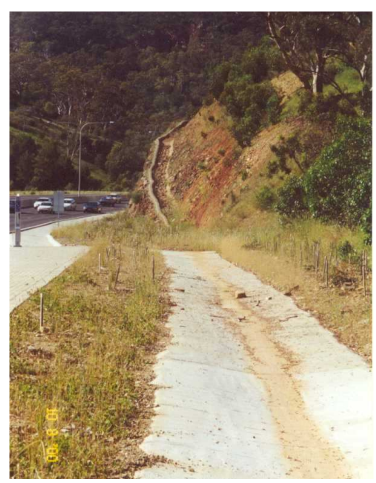
Wet Vacuum during bitumen cutting to reduce the risk of runoff entering the stormwater system

Drainage

- ❖ Divert off site and ”clean” drainage around disturbed areas.
- ❖ Intercept and redirect runoff on the site to protect exposed areas.
- ❖ Where appropriate, install sediment detention basins early so that site drainage can be directed to them as soon as possible.
- ❖ Consider the impact of all works including minor works such as service trenches, pavement cutting etc.

Treatment Train Approach

- ❖ Use a treatment train approach to minimise erosion and velocity of runoff to reduce the need, size and cost of sediment collection basins. For example:
  - Locate catch (diversion) drains above proposed cuttings where upslope drainage is into the cutting area.
  - Construct diversion drains to protect slopes by directing intercepted drainage to a stable outlet.
  - Construct batter toe or catch drains to collect runoff from batter slopes. Direct to drainage system or watercourse.
  - Protect minor drainage lines to slow water velocities and filter sediment with measures such as sand bags, hay bales, silt fences, gabions or local materials. Typically, these are suitable for drainage areas of less than 0.5 ha.



Catch Drain
Adelaide – Crafers Project

- Construct level spreaders to convert concentrated flows to sheet flow at non-erosive velocities. Direct sheet flow across stabilised, vegetated areas.
- Where conditions permit, use grass filter strips as a simple sediment trapping measure. These are more effective on low gradient slopes.

Treatment train approach. Gray Street

❖ Where possible retain or convert site treatment measures for operations phase water quality treatment. Sediment detention basins may be either temporary, or can be integrated into the operations-phase treatment system. For example, a sediment basin used in construction may be converted at a later stage into a sediment trap upstream of a wetland system.

Site Facilities

❖ Ensure site facilities such as depots, access tracks, stockpile sites etc are identified and established in appropriate locations.

❖ Ensure sediment controls around these areas where an erosion risk exists.

❖ Ensure sediment controls at site exits such as shaker ramps, washdown bays or street sweeping to minimise off site sediment from vehicles.

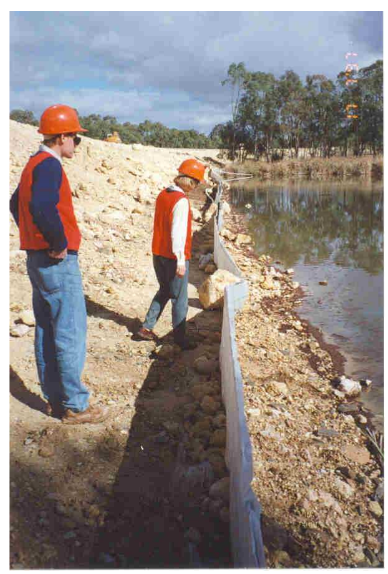
Shaker Ramp

Landscaping and rehabilitation

- Begin rehabilitation of all disturbed areas as soon as possible after final land formation for each area. Options available include installation of the permanent landscape or a temporary cover of a sterile or non-seeding grass species (e.g. sterile rye grass), chipped or mulched vegetation, biodegradable mats or soil binders.

Inspection and monitoring

- Regularly inspect and maintain all treatment devices on site. Check that suitable site measures are in place prior to rain events. After each significant runoff event, inspect for damage or clogging by silt or debris and replace or clean out as necessary.
- Ensure temporary drainage measures such as diversion channels are in place on site at the end of each day, particularly if rain is forecast.



Regularly inspect and maintain treatment devices

- Ensure all EPA site licence conditions are complied with.
- On sensitive sites, where appropriate, or where required by contract or licence conditions, undertake water quality monitoring to effectively manage the site. Such monitoring should be undertaken simultaneously up stream and down stream of the site and include stream flow. For a guide to the extent and frequency of monitoring refer to the Transport SA (2002) *Water Quality Monitoring Manual for Construction Sites*.
- Inspection and management measures should be documented as part of the records of implementation of the SEDMP and Weekly Site Reports and be made available to the contract manager. It should include details of rainfall; water quality testing (if required); the effectiveness of site management measures and any modifications proposed; and other matters which contribute to the level of performance of work practices.
- If inspection and monitoring indicates a notable failure in the Erosion and Sediment Control Program, the source of the failure should be investigated and remediation measures undertaken and procedures modified, as appropriate.

Site Waste Management

❖ Minimise the risk of pollution from other construction activities by:

- Appropriate disposal of wastes
- Undercover storage and suitable bunding of materials such as paints, chemicals, fuel etc.
- Suitable disposal of washdown waters from cleaning vehicles
- Discharge of wastewater and wash water in an approved manner to a sewer (if applicable), or approved disposal site.

Minimise risk of pollution by appropriate storage and bunding of materials

Staff Responsibilities

- Ensure that responsibilities for implementation of the SEDMP are clearly identified.
- Ensure appropriate environmental expertise is available.
- Ensure staff and subcontractors are aware of their responsibilities through appropriate induction and training programs.
- Ensure the SEDMP is implemented and maintained as specified.

References and Further Information

EPA SA (1997) *Stormwater Pollution Prevention: Code of Practice for Local, State and Federal Government*.

C2 MINOR SEDIMENT TRAPS

Description

Minor sediment traps, or sediment filters, refer to a family of small coarse-sediment trapping devices that can be used in a wide range of situations to slow water velocity and settle out coarse sediment. They are frequently used in a series, down drainage lines or may be used around drainage entrance points. Site materials can often be used to create these temporary traps.

Measures include:

- Straw bale, sand bags, or minor traps using local materials.
- Sediment fences.
- Side entry inlet filters: mesh and gravel "sausage", or geotextile and wire construction.
- Grass filter strips

Use site materials to create sediment traps

Sediment retention traps should always be maintained so that less than 30% of their design capacity is lost to sediment pollution.

Straw bales, sand bags

These are only effective to manage runoff on small catchments and may be used in series in drainage lines. They must be installed correctly so that water is slowed and does not divert around the structure. Straw bales must be weed free. Figure C2-1 demonstrate the use and installation of Straw Bales.

Sediment caught in straw bales
Adelaide – Crafers project

Sediment fences

Geotextile filter fences are used to protect exposed surfaces such as fill slopes from sheet flow and can be used around the base of stockpiles. They should be capable of withstanding erosive forces from the design ARI storm event (typically 1 in 5 years). NSW Environment Protection Authority (1996) recommends that contributing catchment areas must be small enough to constrain the maximum flow at any point to no more than 40 litres/sec/metre width of overland flow, during the design event. This may be achieved by segmenting the catchment into smaller sub-catchments, using sediment fences constructed along contours and with periodic small returns as per Figure C2-2. Ensure the fence base is snugly fitted and securely fixed to the ground surface.

Silt fences used in series

Side entry inlet filters

Such filters are effective when managing small amounts of water or sediment, for example when bitumen or concrete cutting, or small excavations. Details of inlet devices are provided in Figures C2-3 and C2-4. Their installation at any particular location is a matter of day-to-day decision making by the site manager and should be supplementary to primary sediment control devices. They should not be sited where they may divert water away from its intended course during a large storm event.

Grass filter strips

Filter strips are grassed or vegetated areas that treat shallow overland flow before it enters the drainage network. These vegetated areas help to slow flows, settle out coarse sediment and allow infiltration into the soil.

These are suitable for gentle slopes, or may be used with flow spreaders (see Figure C2-5.

References and Further Information

- EPA SA (1997) *Stormwater Pollution Prevention - Code of Practice for Local, State and Federal Government.* Section 5.
- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. Section 6.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79, ISBN 0 7310 3809 6.

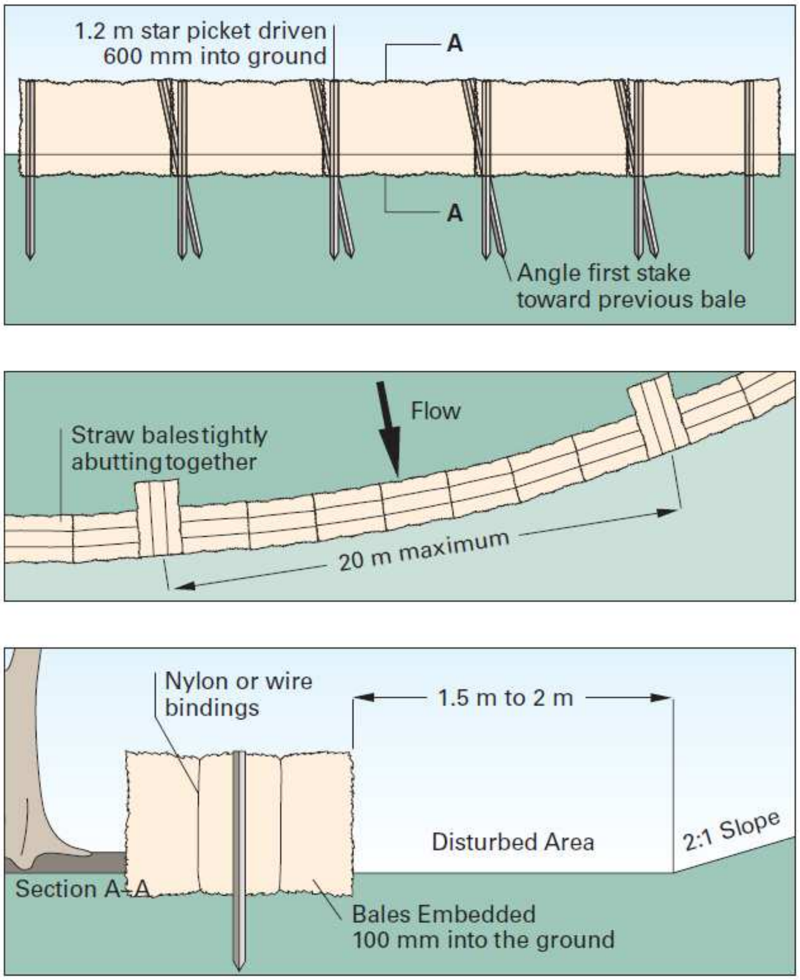


Figure C2-1 Straw Bale Filter

(Source: NSW Dept of Housing 1998)

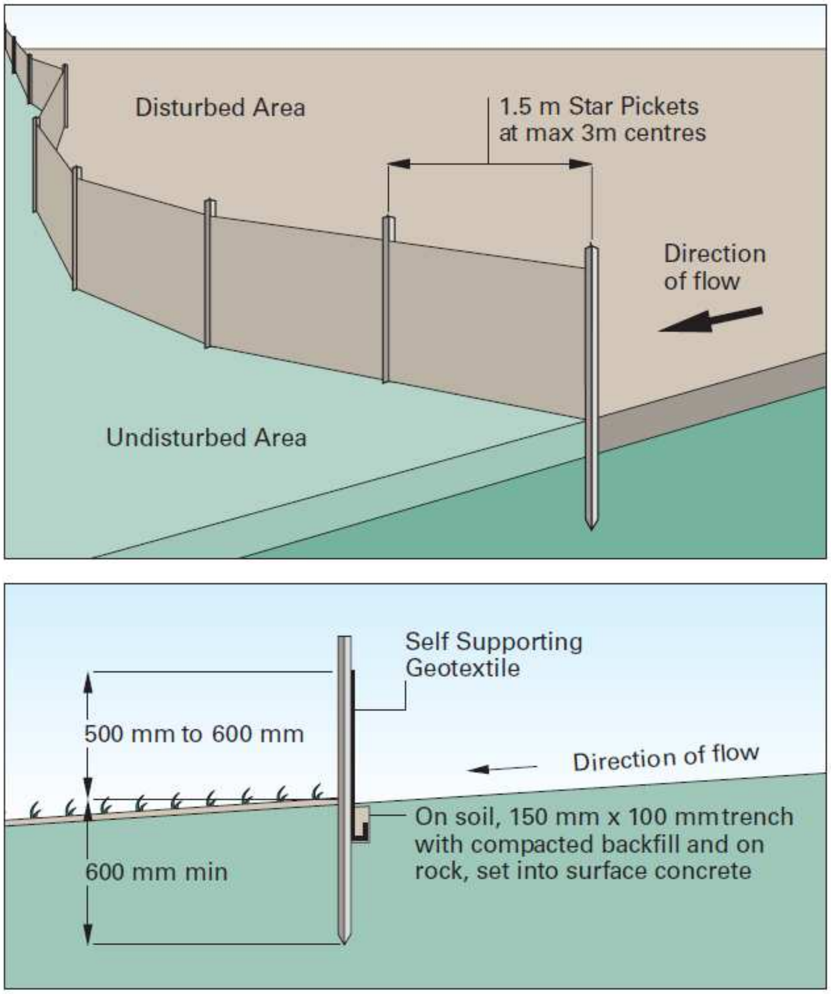


Figure C2-2 Sediment Fence

(Source: NSW Dept of Housing 1998)

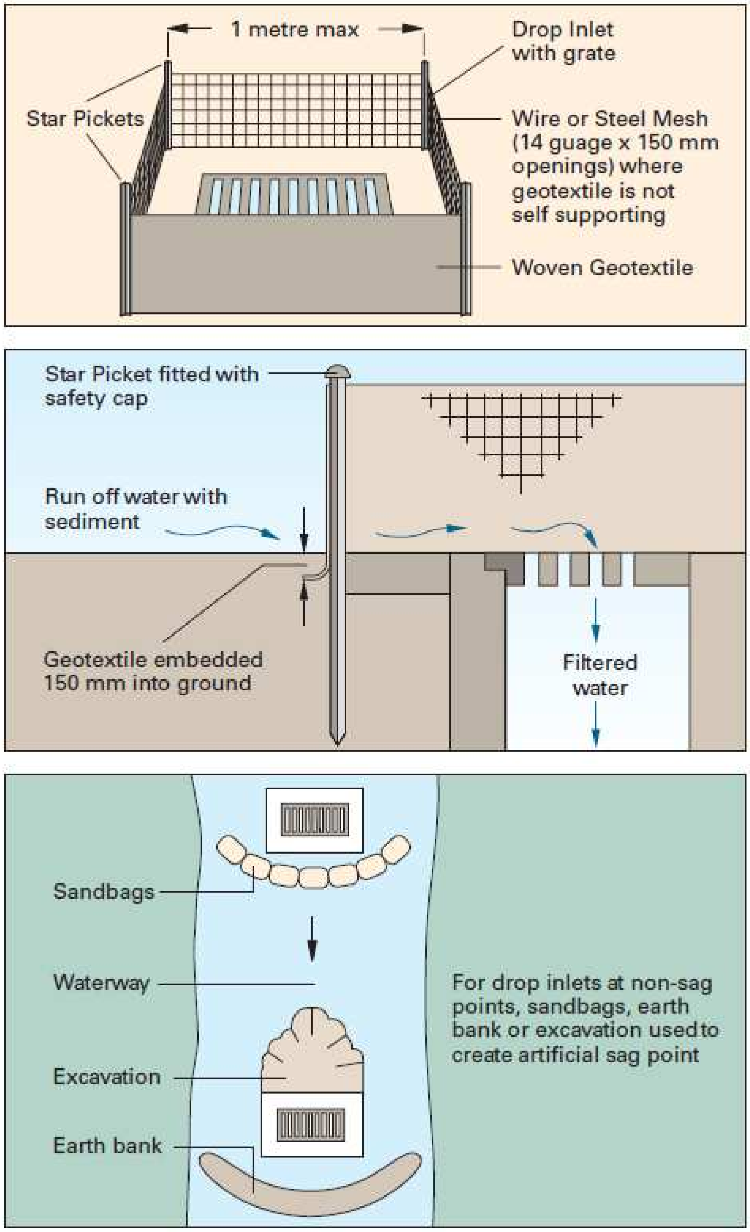


Figure C2-3 Geotextile Inlet Filter

(Source: NSW Dept of Housing 1998)

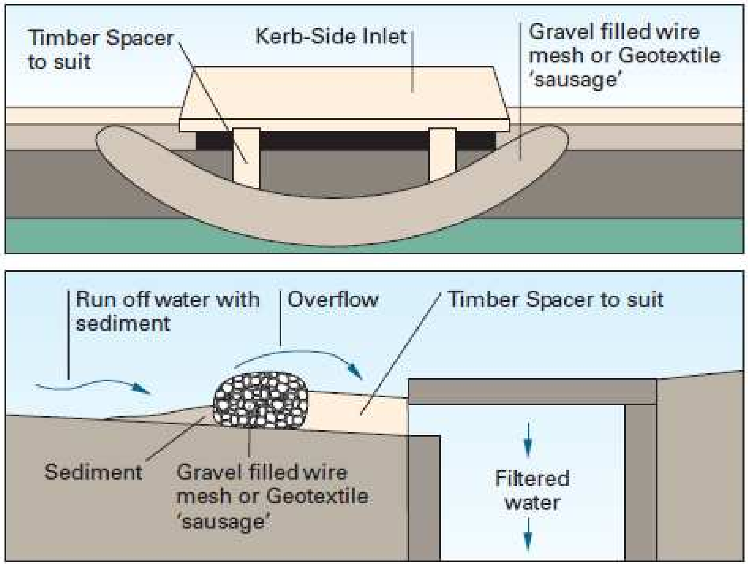


Figure C2-4 Mesh and Gravel Inlet Filter

(Source: NSW Dept of Housing 1998)

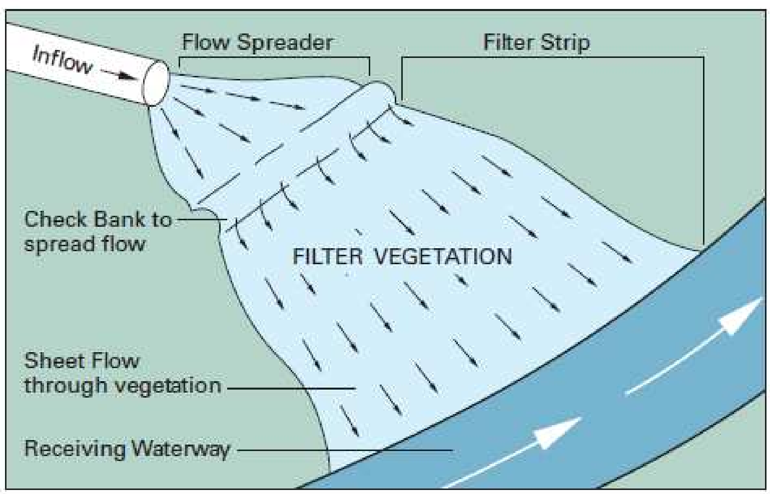


Figure C2-5 Grass Filter Strip

(Source: CSIRO 1999)

C3 EARTH BANKS and CATCH DRAINS

Description

Earth banks, or diversion banks, are formed at a shallow, non-erosive grade to convey water away from situations where it is otherwise likely to cause erosion damage. On construction sites, they can be used to divert ”clean” on-site or upslope water, away from areas disturbed by construction, towards safe discharge sites that are protected by grass or other form of surface protection. They can also be used to divert “dirty” water to sediment traps or basins. Two types are described:

- **Low flow earth banks and catch drains**. Low flow earth banks are temporary banks that are easily formed, removed and re-built. They are intended for temporary use around the site to control and divert sheet flow during storms, and to keep runoff away from critical work areas. They might be removed each day to allow for construction activity, and replaced whenever the site is closed and unattended for more than about four hours. Catch drains are shallow drains that reduce overland flow and encourage infiltration. They may be used instead of low flow banks, but are commonly used with them, as material excavated for the catch drain may be used to form an adjacent downslope earth bank.

- **High flow earth banks**. These have a longer life than low flow banks. They are used to protect larger areas and convey larger flows than low-flow earth banks. They are structures which should be designed and installed in accordance with specifications included in the Work Plan.

Low Flow Earth Banks and Catch Drains

Low flow earth banks should be restricted to catchments having bank lengths of 125 metres, and slope lengths of 80 metres, as per Figures C3-1.

They are used to:

- Intercept “clean” run-on water from undisturbed, upslope lands.
- Divert water from cut or fill slopes.
- Intercept spring water, especially from areas with a mass movement hazard.
- Break up long slopes into sections less than 80 metres long to subdivide storm runoff into manageable volumes.
- Provide a general stormwater conveyance system around construction areas.

The practice is particularly useful in preventing erosion and carrying runoff to sediment traps before a permanent stormwater system is in place.

Key Points

Preparation of earth bank and catch drain construction should involve the following:

- Locating banks and drains on contour, avoiding the removal of trees and shrubs if possible.

- ❖ Where it is not possible to retain trees, remove them, including stumps and other debris that might otherwise impede the flow of water.
- ❖ Shape the drain and mound topsoil for the earth bank.
- ❖ The drain invert or water-flow path at the base of the bank must be protected from water scour by surface stabilisation or installation of geotextile protection.

High Flow Earth Banks

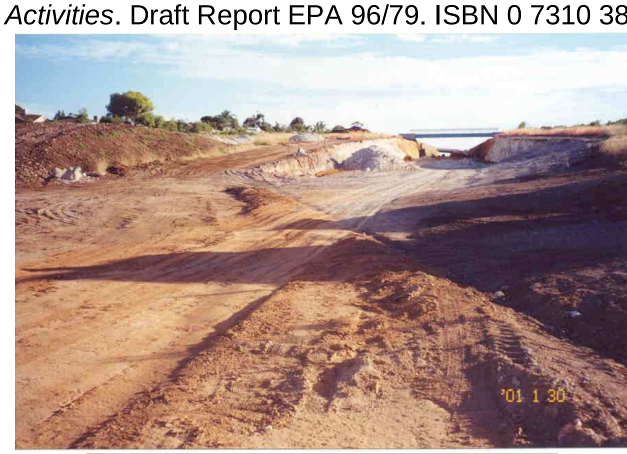
High flow diversions are comprised of compacted earthen bund, with a minimum height of 500 mm and downslope catch drain or channel with a depth of 300 mm. The drain should be parabolic or trapezoidal in shape, unless otherwise specified in the Site Work Plan, with a width of at least one metre. They are permanent or semi-permanent site structures, and need to be protected from erosion by revegetation or other stabilising measures. High flow earth banks have a longer service life and handle larger catchment areas (for example, NSW Department of Housing (1998) suggests greater than 1 ha for coastal NSW). They must be built to a more formal construction specification than low flow banks, as per Figure C3-2.

Key Points

- ❖ Construction specifications should include details of: drain width and depth, bank heights and width, crest width, freeboard, outlet width, grades of cut and fill batters, details of the discharge area (e.g. surface conditions and level spreader details), means of stabilising the channel bed and bank, and keying the bank into the natural ground surface. These parameters should be outlined on diagrams included in the Work Plan.
- ❖ Inspect high flow banks weekly and before forecast rainfall, and shortly after actual large rain events.

References and Further Information

- EPA (1997) *Stormwater Pollution Prevention - Code of Practice for Local, State and Federal Government*. Section 5.
- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. Section 5.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6



Temporary catch drain

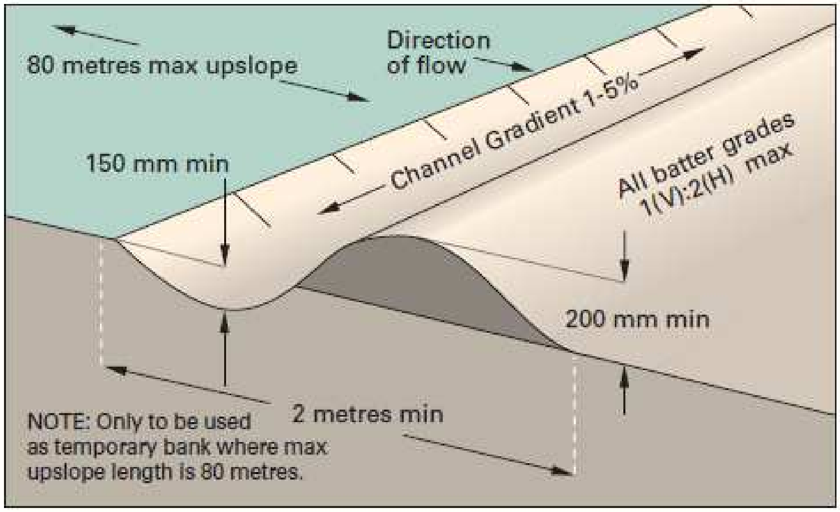


Figure C3-1 Catch Drain

(Source: NSW Dept Housing 1998)

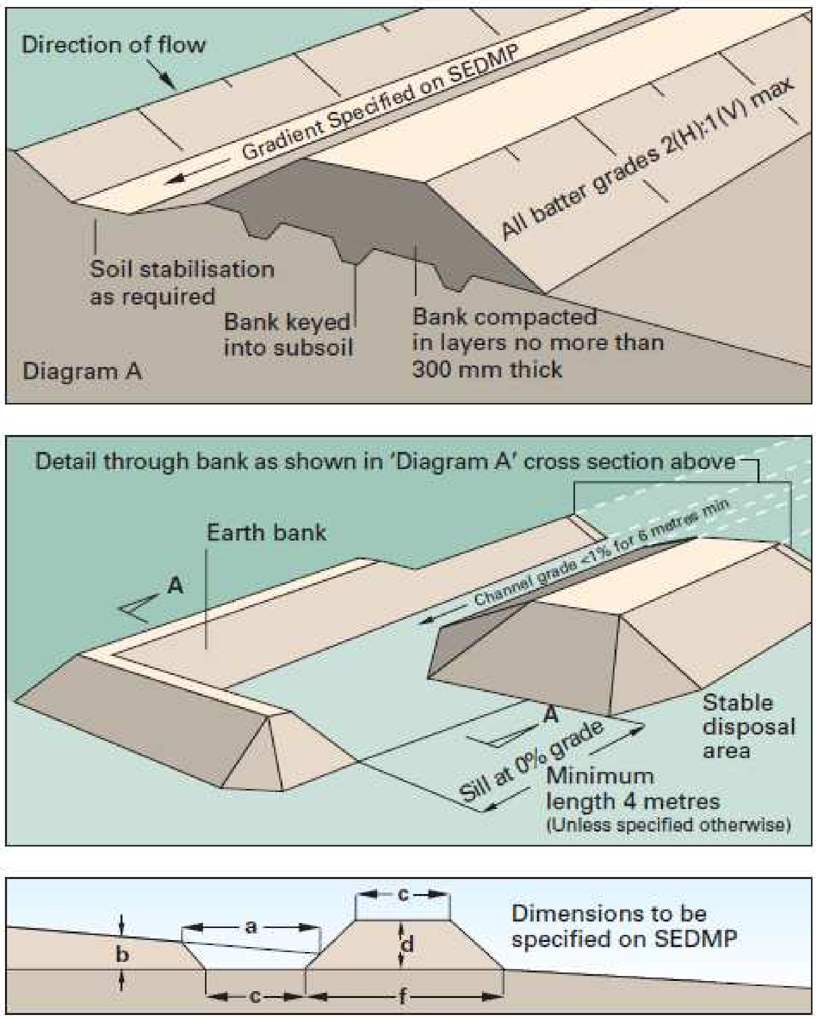


Figure C3-2 Earth Bank (High Flow)

(Source: NSW Dept Housing 1998)

C4 SEDIMENT SETTLING BASINS and PONDS

Description

Sediment control basins should be installed on all construction sites where there is a risk of significant sediment laden runoff. They should be installed before disturbance commences, and remain functional until site works are completed and the site re-stabilised. Sediment basins form the last “line of defence” against sediment discharge.

Basin Type Selection Procedure

The design, size and operation of sediment basins depends on:

- ❖ How much rainfall is likely to occur.
- ❖ The types of particulates required to be retained in the basin.
- ❖ The area of land disturbed.

There are two main basin types each of which fulfills a different function, and it is important to consider which will be most appropriate to the site. Wet detention basins are designed to operate by settling sediment over a long period of time, either with or without sediment flocculation. Dry basins are designed for coarser sediments and the detention time is much less. The NSW Department of Housing (1998) details a basin type selection procedure, which is summarised below:

- ❖ **Step 1**: By "field" Emerson or if necessary, laboratory test, determine if inflow soil matter will be more or less than 10% dispersive. If it is more than 10 percent dispersive, employ a wet sediment settling basin with flocculation.
- ❖ **Step 2**: If the soil type determined in step 1 is less than 10% dispersive determine, by laboratory test, if more or less than 33% of the soil is finer than 0.02 mm. If it is finer, employ a wet sediment settling basin without flocculation.
- ❖ **Step 3**: If less than 33% of the soil is finer than 0.02 mm, employ a dry sediment settling basin.

Wet Sediment Settling Basins (fine sediment retention and flocculation basins)

These are non-draining structures which may take the form of a formal concrete basin, or - more likely when used for temporary construction use, as a less formal (usually earth), ponds. Their function is to retain coarse, and some fine, sediment, to improve quality of water leaving the basin. Wet sediment basins may be either earth-constructed, or lined basins. When necessary (see basin selection type, above) they should be utilised as flocculation basins. NSW Department of Housing (1998) suggests the basic volume design sizing of wet sediment settling basins with or without flocculation are identical although, naturally, there are operational differences. Advantages of wet sediment basins are:

- ❖ They are simple to construct, as per Figure C4-1.
- ❖ Removal of coarse sediment loads, and some finer sediment. Enhanced removal by flocculation.
- ❖ Ability to trap some floating hydrocarbons, if a suitable outlet type is installed.

Wet sediment settling basins may be installed as a measure for controlling sediment during construction, or intentionally designed for use both during construction and, later, for converting into a permanent pre-treatment storage, usually upstream of other pollution control measures - for example, larger-size wet detention basins or constructed wetlands. In the latter case the sediment settling basin may be pre-designed to form part of a deep upstream settling bay or pond, (see B15: Constructed Wetlands) - in this circumstance flow spreading, and other suitable design features discussed in B15, may be appropriate.

Possible limitations of wet basins include: potential risk of breakdown and release of some pollutants in the permanently wet environment, limited removal rates anticipated for very fine particulates, the long settling time and consequent large size of basin necessary to achieve modest removal rates for medium and finer particulates (see Table C4-1 for settling velocities under ideal conditions), and the potential for previously retained sediment to re-entrain during large storms. Limited monitoring of sediment traps has been undertaken in Australia.

Table C4-1 Particle Settling Velocities Under Ideal Conditions

Particle Size (mm)	Settling Velocity (m/s)	Basin Surface Area Required ($m^2/m^3/sec$)
0.10	0.0070	140
0.05	0.0019	530
0.02	0.00029	3,400

Notes:

1. Due to the difficulties in estimating actual settling velocities, which may be site specific, design is generally based on ideal settling characteristics.
2. NSW Department of Housing (1998), recommends adopting a “design particle size” of 0.02 mm. This may be adopted, unless otherwise known.

Source: NSW Department of Housing (1998).

Dry Basins (coarse sediment retention)

Dry basins detain runoff to allow sediment (of particulate size greater than 0.02 mm) to be retained by direct filtration through a suitable geofabric, or through providing suitable detention time for particulates to settle. They may be designed as either rock and geofabric, gabion and geofabric, or earth and porous riser structures. It should be noted that earth structures can become stressed by complete drainage of water between storm events, and are more likely to fail than if they are maintained as wet basins. To overcome the risk, NSW Department of Housing (1998) suggests that earth-constructed dry basins must be stabilised by:

- ❖ Optimal compaction.
- ❖ Batter grades less than 1(V):3(H).
- ❖ Using topsoil with vegetative cover.
- ❖ Proper keying of the foundation with subgrade.
- ❖ Using a solid clay core.
- ❖ Use chemical stabilisation with lime, cement or gypsum in dispersive or highly expansive soils.

Advantages of dry sediment basins are:

- ❖ They are simple to construct.
- ❖ Removal of coarse sediment loads (typically designed to remove up to 0.02 mm particulates).

Key Points

Wet Sediment Basin Volume Sizing Procedure

The procedure for planning and sizing wet basins (based on NSW) is provided in the dot-points below. It should be noted that this should provide a first-estimate of the basin volume. Refer to NSW Department of Housing (1998) for more information, and other pertinent, site-specific factors; to assist in actual design.

Dry sediment detention basin
Adelaide – Crafers project

- ❖ Draw a site plan indicating the full extent of disturbed area and site boundary.
- ❖ Determine the plan area, A, within the site boundary which will be disturbed.
- ❖ Determine the average annual rainfall for the site, R, in millimetres.
- ❖ Determine the required stormwater treatment storage capacity, S, from:

S (in m^3/ha) = (R-200)/1.6

If calculated S is less than 125 m^3/ha, use S = 125 m^3/ha

- Calculate the "active" basin volume, V_a:

$$V_a\ (m^3) = S \times A$$

- Calculate the required basin volume, V_b:

$$V_b\ (m^3) = S \times A \times 1.2$$

(The required basin volume is 20% greater than active volume, to allow for storage of sediment and/or flocculant).

Flocculation Practices

- A range of flocculating agents exist, however usage of these materials will require careful calibration and monitoring of the pH of discharge waters and potential toxic releases from the use of alum. However, gypsum (calcium sulphate) and alum (aluminium sulphate) are generally used for stormwater runoff. They are applied within 24 hours of cessation of each storm event. In large ponds, the flocculant is generally mixed into a slurry with water and sprayed over the pond. In small ponds, it is usually hand-cast over the pond surface.
- It should be noted that the trivalent (Al^{3+}) ion in alum is about 40 times more effective than the bivalent (Ca^{2+}) ion in gypsum; consequently, alum produces a more rapid flocculation rate. Indicative dosage rates are: gypsum - 2 kg per 100 m3 of stored water; alum - 1.5 kg to 8 kg per 100 m3 of stored water. However ponds should be calibrated using standard jar tests, after the initial two storms, to determine actual application rates and settling times. Alum must not be applied at higher than these rates as it may detrimentally lower the water pH. If pH lowers to less than 5.5 there is a danger of toxic releases of dissolved aluminium. NSW Department of Housing (1998) recommends dosing rates not exceeding 5 kg per 100 m^3 of stored water if the water pH is less than 5.5; however water should not be discharged if pH is less than 6 "unless eco-toxicity assessment shows that it is safe to do so". Further information may be found in the cited reference.
- Normally, sufficient flocculation should result within 36 to 72 hours (gypsum) or 24 hours (alum), and the resulting clarified water should be less than 50 mg/L in suspended solids. Thereafter, discharge of the clarified water should be achieved via a system that will drain the pond in less than 24 hours. It is essential that the discharge structure be designed with a floating inlet, or other device, which will prevent flocculated sediment being removed during discharge.

Dry Sediment Settling Basin Volume Sizing Procedure

- The final design sizing for dry basins may be based on the procedures provided in, NSW Department of Housing (1998), Tonkin & Associates (1992) or similar manual. The procedures outlined in, NSW Department of Housing (1998) will, in some circumstances, prove rigorous - for example, for sites with highly erodible soils - involving calculation of the Revised Universal Soil Loss Equation, RUSLE, which necessitates laboratory soil tests and other site information.

  In the absence of such data the following simple, dot-point "first-estimate" basin sizing procedure is suggested, which is a "hybrid" between procedures outlined in NSW Environment Protection Authority (1996), and more up-to-date, but rigorous, procedures of NSW Department of Housing (1998). The basin size may be amended when appropriate site soil and other data are available, at which time the full design procedure detailed in NSW Department of Housing (1998), or other appropriate design manual, may be used.

❖ Determine the plan area within the site boundary that will be disturbed.

❖ Calculate the volume of runoff that will enter the basin from the plan area, during 15 minutes of the 1 year ARI, one hour storm event. (ie. the volume of 25 percent of the 1 year ARI storm event).

❖ Increase the calculated volume by 100 percent to accommodate sediment retention between sediment cleaning operations.

References and Further Information

- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. Sections 6, 8, Appendix D and Appendix I.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6.
- Tonkin & Associates (1992) *Urban Stormwater Runoff Quality Control Measures for the Mount Lofty Ranges Watershed – Guideline Manual*.

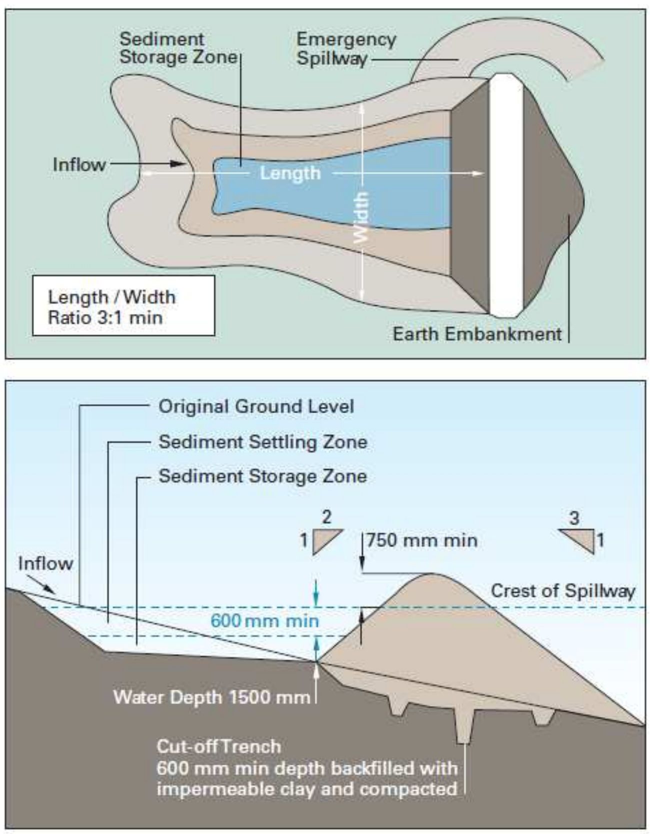


Figure C4-1 Earth Basin – Wet

(Source: NSW Dept of Housing 1998

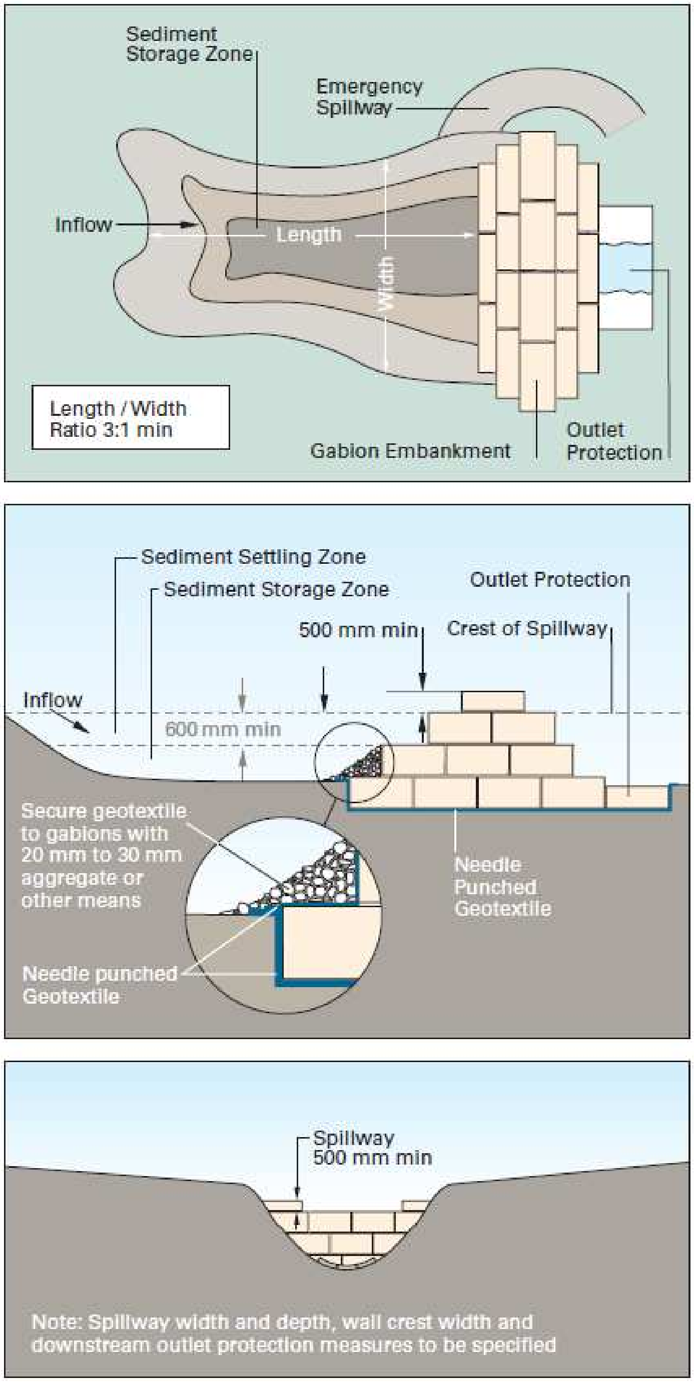


Figure C4-2 Gabion Sediment Basin

(Source: NSW Dept of Housing 1998)

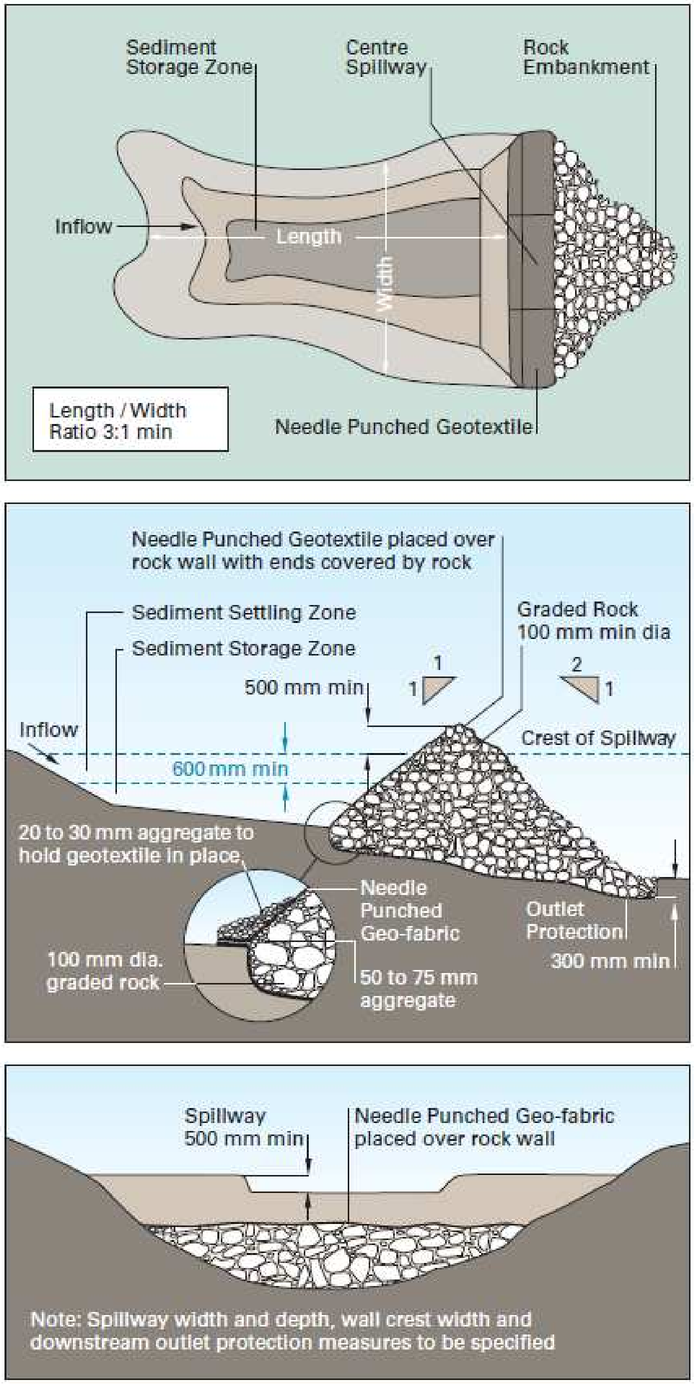


Figure C4-3 Rock Sediment Basin

(Source: NSW Dept of Housing 1998)

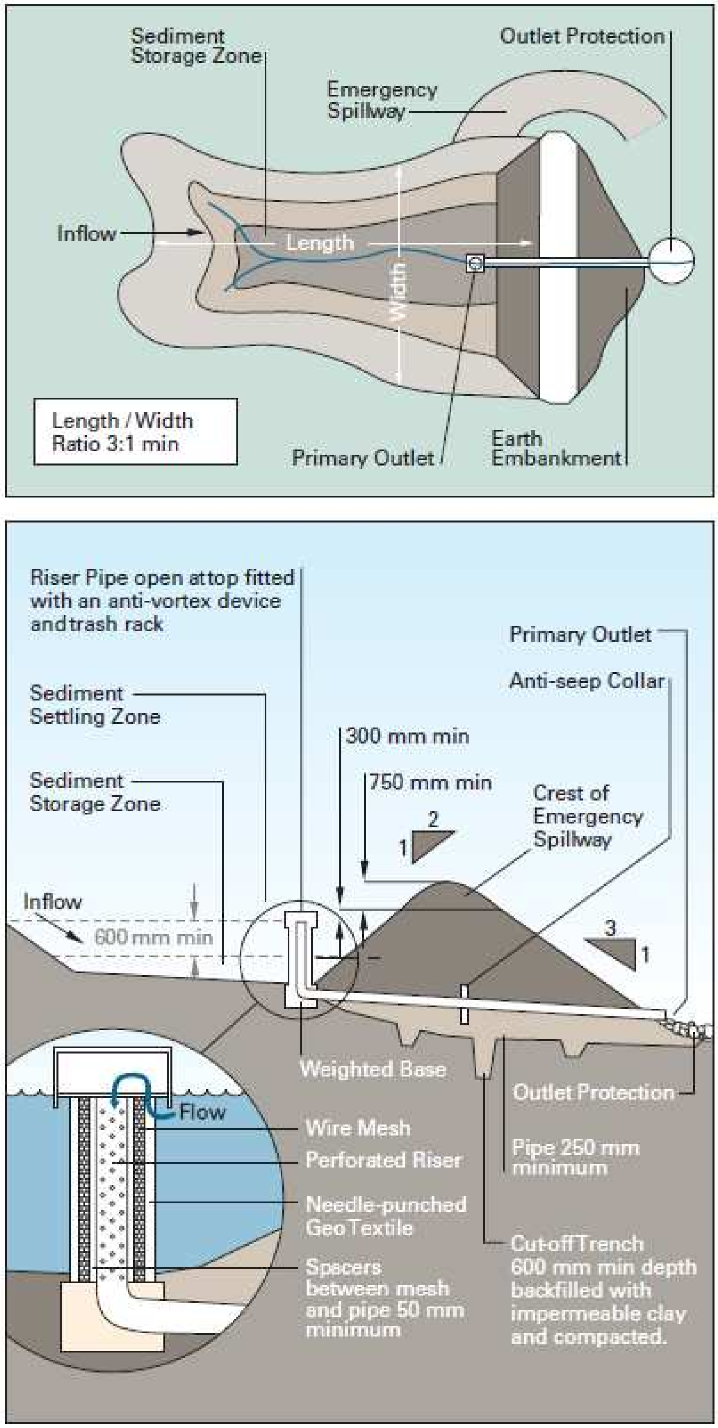


Figure C4-4 Earth Basin – Dry

(Source: NSW Dept of Housing 1998)

C5 SITE EXITS

Description

Measures should be put in place in frequently used site exits to prevent sediment from being tracked off site and along adjacent roads. This may take the form of a stabilised site exit or sediment treatment measures such as shaker ramps, a wash down bay or street sweeping.

Stabilised Site Exit

Where sediment will be a problem stabilised vehicle exits should be located at all site access points (other than where vehicles might be engaged on an intermittent or casual basis), prior to site disturbance. They are typically constructed from coarse aggregate. They are not intended to remove mud from vehicle tyres but to prevent heavily trafficked routes from developing into a source of sediment. They should be positioned so that vehicles cannot bypass them, unless exiting from a stabilised “hard stand” area

Key Points

- The structures should be long enough to allow at least one (preferably three) revolutions of the largest vehicle tyre, and at least 3 metres wide.
- Remove any excessive sediment build up from the structure. Add extra gravel or aggregate if required to maintain the “humps”.

Shaker Ramp

A timber or metal shaker ramp is often located on top of a gravel pad. Drainage from the ramp should be directed to a sediment trap or basin. A mountable berm, adjacent to the site boundary may be needed to prevent drainage from the ramp discharging onto the exit road.
It should be ensured that the ramps are cleaned out on a regular basis to retain their effectiveness. They should be placed in a way that they cannot be bypassed by exiting site vehicles.

Vehicle Wash Down Bay

On sites where there will be significant traffic of sediment off-site a vehicle wash down bay should be considered. These should be formally constructed and include appropriate disposal of sediment laden wash waters.

Shaker Ramp

References and Further Information

- EPA (1997) *Stormwater Pollution Prevention - Code of Practice for Local, State and Federal Government.* EPA. Section 5.
- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. Section 5.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6.

Vehicle Washdown Bay – M5 Project Sydney

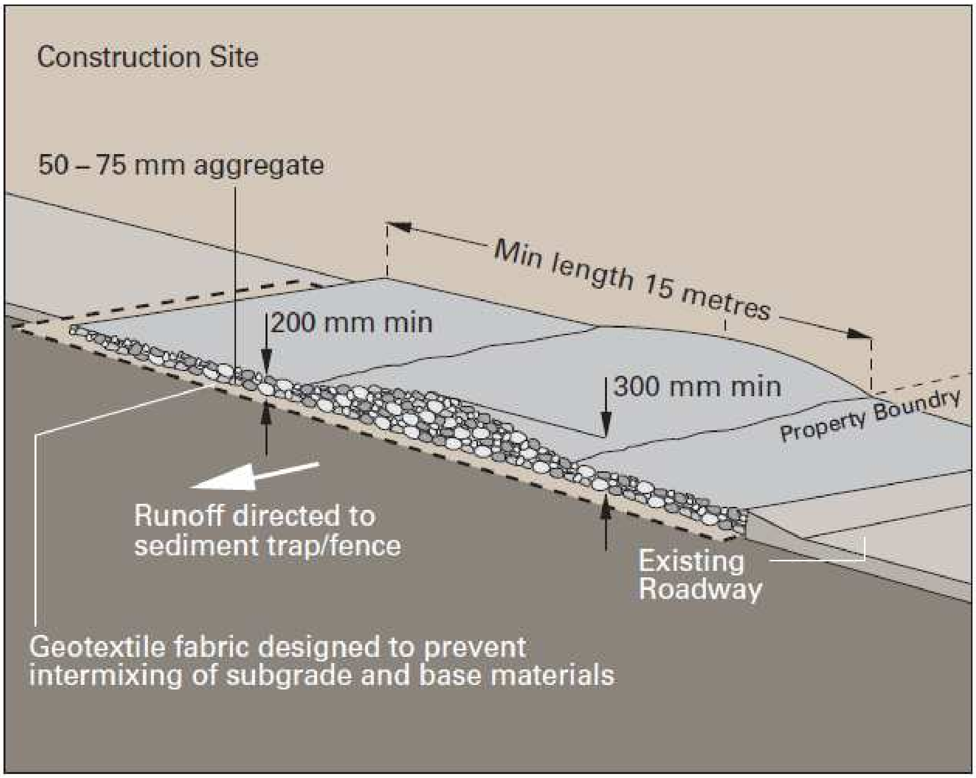


Figure C5-1 Temporary Construction Exit

(Source: EPA 1997)

C6 STOCKPILES

Description

Timber, mulch, topsoil and subsoil, gravel, sand, rock and overburden from service cuts, are commonly held on-site in stockpiles. Each material should be stored in a manner that does not pollute the environment.

Key Points

- ❖ Locate stockpiles clear of areas of drainage flow paths.
- ❖ Wherever possible maintain stockpiles of topsoil as low, flat, elongated mounds to retain air flow to soil.
- ❖ Protect stockpiles from overland flow by employing earth banks upslope. For minor temporary diversions, it is usually reasonable to use topsoil (particularly soil from greater than 50 mm depth) to form earth banks without cutting channels.
- ❖ Install sediment controls down slope of stockpiles where there is a risk to water bodies.
- ❖ Where stockpiles are long term, vegetate, or use a binder to the stockpile to reduce the risk of wind and water erosion.
- ❖ As part of the site's routine inspection program, check that the sediment control measures such as silt fences and any other sediment control devices, have been correctly installed and maintained.

References and Further Information

- NSW Environment Protection Authority (1998) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79, September 1996. ISBN 0 7310 3809

Sediment fence around stockpile - constructed from hay bales and

Sediment fence located around a stockpile.

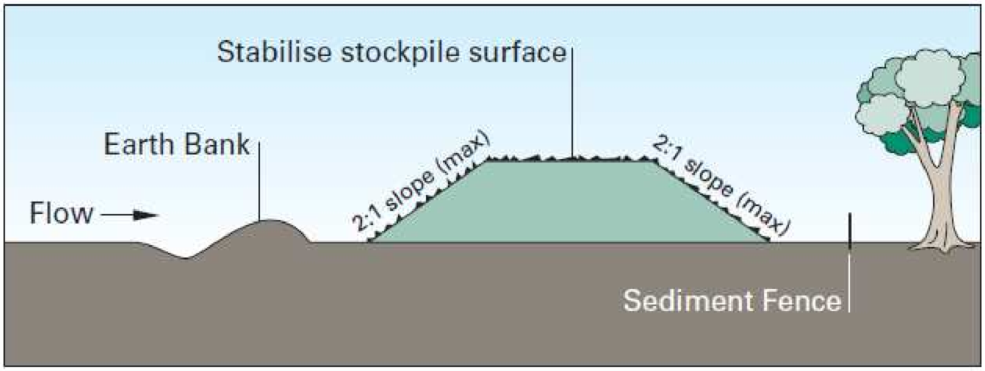


Figure C6-1 Stockpiles

(Source: NSW Dept of Housing 1998)

C7 REVEGETATION

Description

All surfaces should be protected from erosion during and on completion of a project. This can be undertaken by a temporary cover to stabilise disturbed areas during construction, or permanent revegetation as part of the landscape plan. Site managers should use both of these practices, as appropriate. Protection of disturbed areas should be undertaken as soon as possible and the permanent landscaping should be integrated into the site works.

Grass Cover Crop
Adelaide – Crafers Project

The advice of the Landscape Unit of the Road and Landscape Design Section should be obtained for appropriate temporary treatments and the preparation of a Landscape Plan and landscape contract. The Landscape Plan should be prepared prior to letting the construction contract.

Temporary Vegetation Cover

Temporary cover provides short-term protection of disturbed sites that are subject to an immediate risk of eroding. Its purpose is to protect critical areas that might not otherwise stabilise within an acceptable period. It can take the form of matting, mulch or temporary cover crop of grass or cereal plants.

Non-regenerating cereal plants such as oats and rye, or sterile rye grass are suitable for this purpose, as their roots bind the soil and they flatten during rainfall impact, creating a protective layer over the soil. These plants also establish more quickly than permanent vegetation, but are relatively short-lived.

Cover crops can be established by conventional seeding or hydroseeding. **Conventional seeding** can be undertaken where there are large areas where the soil can be cultivated and seeded with conventional farming machinery.

Hydroseeding uses a mix of seed, a fibrous matrix of wood or paper pulp and an adhesive binder sprayed with water onto the soil surface. Hydroseeding is particularly suited to steeply sloping sites or not otherwise accessible areas, and to high rainfall areas where seed has a better chance of survival on an exposed soil surface. The soil binder and mulch provides temporary erosion protection while the crop is growing (see C9).

When and where to use temporary vegetation cover

- ❖ Areas typically appropriate for temporary revegetation include exposed (stripped) areas, soil stockpiles, bunds, earth banks, dams, sediment retention basins side walls, and temporary drainage outlets. Temporary cover should be applied on stripped or stockpiled areas that are not otherwise protected (e.g. by sediment fences) if they will be left standing for more than 30 days.

Key Points

- ❖ Temporary cover treatments should be identified in the EMP and SEDMP on risk sites and an appropriate work plan prepared. If necessary, water the area to provide adequate moisture for germination.
- ❖ Exclude traffic from stabilised and revegetating areas with fencing and signs.

Maintain revegetating areas as follows:

- ❖ When necessary, apply light irrigation at a rate that will not generate runoff and apply fertiliser if necessary.
- ❖ Promptly treat any area where vegetation has not properly established.
- ❖ Monitor conditions more frequently if the soil structure is poor, seed is broadcast (rather than drilled), mulch has not been applied, or when weather is consistently hot, dry, or very wet.

Permanent Revegetation

Permanent revegetation involves implementation of the landscape scheme for the project. If this involves re-establishment of native vegetation indigenous to the area, care will be taken to source seed from the local area and to re-establish the mix of species, including trees, bushes, groundcovers, and grasses, local to the area.

Preparing the ground for tubestock planting

In urban areas the landscape scheme may include native or non-indigenous species designed to complement and enhance the amenity of the area.

Re-vegetation is possible only when soil fertility, soil moisture and soil temperature are appropriate to stimulate growth. Regard must be given to use of suitable soil material (eg. topsoil), site preparation, selection and use of appropriate planting technique, plant species, fertilisers, weed control and thoroughness of the maintenance programme. These matters will be specified in the landscape plan and landscape contract.

Turf sods provide immediate, permanent erosion protection where an instant grass cover is required for landscaping or erosion control purposes. As the cost of turf sod is much higher than for other re-vegetation techniques it is generally used for special applications. Turf sods are appropriate for any graded or cleared surface that might erode. It is particularly suitable where there is likely to be significant water flows during rainfall, where a hardy and durable ground cover is needed - e.g. for lining earth banks, swales and stream banks. Turf also permits water infiltration and reduces site runoff. Sods can be applied any time during the year.

To facilitate revegetation:

- ❖ Topsoil should be stockpiled for reuse in areas to be landscaped.
- ❖ Batter slopes should be cultivated or finished on the contour to minimise erosion.
- ❖ Any hard or compacted surfaced should be scarified or ripped before placing topsoil.
- ❖ Vegetation required to be removed for the project should be chipped and stockpiled for reuse as a mulch (unless it contains weed or diseased material).

When and where to use permanent revegetation

- ❖ On all exposed/disturbed soils as soon as final grading is completed and as documented in the landscape plan.
- ❖ This should include all disturbed or degraded lands which are likely to contribute sediment to downslope areas including waterways, batter slopes, earth-based structures, such as the side slopes of detention basins and rehabilitation of temporary construction access tracks, stockpile sites, etc.
- ❖ Revegetation may be used to stabilise waterways and any other areas subjected to concentrated flows. For such locations, vegetation should be established as soon as possible on completion of formation, and at least 70% ground cover established before they carry any concentrated flow. If flow velocities are expected to be significant other protective systems such as erosion matting or rock lining of the channel may be needed to prevent scour.
- ❖ Revegetation is best undertaken during periods of seasonal growth or to make good use of anticipated rainfall (generally in autumn to spring).

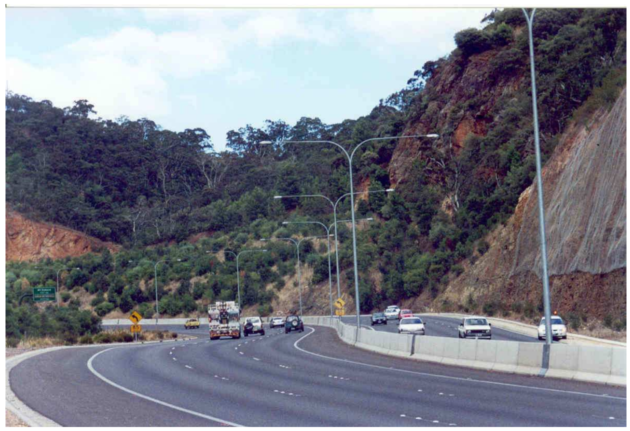
Key Points

The success of the landscaping will depend on suitable soil preparation, weed control and appropriate timing of planting and the following factors:

- ❖ Good soil preparation, where possible. Soils that have been compacted should be ripped and cultivated to a loose, granular structure ready for planting.
- ❖ Selection of appropriate planting time. Growth will be best in spring or autumn. Winter is acceptable in reasonably mild areas.
- ❖ Care in ensuring good soil moisture during establishment and early watering if necessary.
- ❖ Protection from disturbance while the crop is establishing.
- ❖ Monitoring of establishment and repair of any damaged areas.
- ❖ Effective weed control, including prior to establishment and on-going.

References and Further Information

- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. In particular, Section 7 and Appendix G.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6.



Successful revegetation – Adelaide/Crafers Project

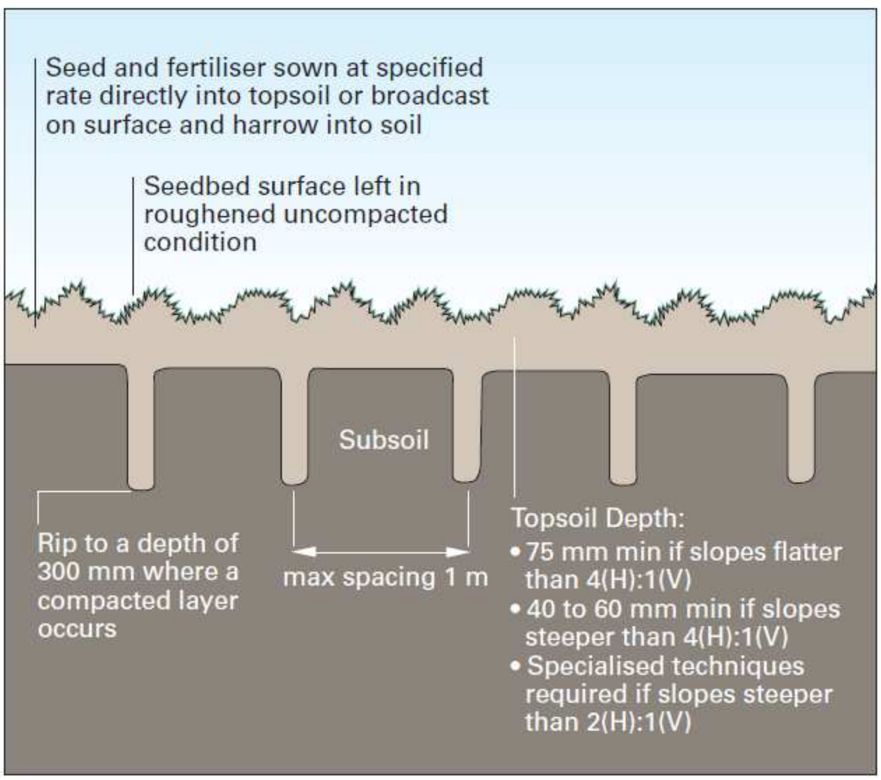


Figure C7-1 Seedbed Preparation

C8 MULCHES

Description

A range of mulches can be used to stabilise the soil and provide a protective cover. Mulches reduce soil erosion and provide protection to seedlings and growth during revegetation by reducing evaporation, weed invasion and increasing water infiltration. A wide variety of mulches exist, including straw mulches, brush mats, woodchips and hydromulches. Advice should be sought from the Landscape Unit of the Road and Landscape Design Section.

Straw Mulches

Straw mulches comprise remains of harvested cereal crops. They provide uniform bulky material that forms an open porous layer when strewn on the soil surface. Generally they will not pose a weed threat unless poor quality material is used. Hay mulches are similar, but contain leaf and head material, which raises the nutrient status, weed potential and shade effect. Hay should not be used because it poses a weed risk.

Protect mulch from scouring

Straw mulches are particularly useful for dispersive clay soil sites, and on sites posing high erosion risk (e.g. steep sites) and batters. Chopped straw mulches can be sprayed on steep slopes or less accessible areas with the aid of a soil binder. Coarse straw mulches can be secured to steep slopes using wire or other mesh. They can also be purchased in a prefabricated straw/mesh matrix.

Key Points

- ❖ Ensure the straw is dry and has a low leaf content.
- ❖ Use a certified seed and weed free mulch.
- ❖ Spread the mulch to achieve an average consolidated depth of 20 to 40 mm straw for general surface protection, or approximately 100 mm for weed control.
- ❖ Where practicable, press straw in place with one or more passes of a caterpillar-tracked vehicle - e.g. a bulldozer, traveling directly up and down the slope. Alternatively, in extremely exposed areas, keep straw in place with ungalvanised wire netting, stapled at 1 to 2 metre intervals with 150 to 200 mm wire staples.

Native Brush Mats and Natural Mulches

Native brush matting is the laying or spreading of locally pruned vegetation, (leaves and small branches) on the soil surface, to minimise erosion and to introduce local seed to facilitate regeneration.

Natural mulches involve chipping the locally pruned vegetation prior to spreading. If chipped material is spread too deeply, i.e. greater than 50 mm, it may suppress germination of native seed.

Care should be taken to ensure that the material is of locally appropriate species and that it does not include weed species such as olives, or radiata or aleppo pine trees.

Key Points

- ❖ Special care is required when handling native brush. It should be stockpiled in small piles. The brush donor area should be matched to the area to be mulched, and soil, moisture and other environmental factors should be comparable. A depth of 50 to 100 mm mulch should be applied parallel to the contour.
- ❖ Natural mulch has no specific maintenance requirement and is better left alone and undisturbed, so that natural ecological relationships can re-establish over the disturbed area.

Woodchip Mulches

Woodchip mulches are made from chipped tree loppings or prunings or sawmill wastes. They reduce germination of weeds and may be used wherever good erosion and weed control is required. They are not suitable for establishing grasses or direct seeded areas, and should only be used for applications involving planting tube stock. They are very effective for development of shrub and tree species that prefer surface litter and nutrients derived from slow decomposition of organic matter.

Woodchip mulch secured with mesh is suitable for steep slopes
Adelaide - Crafers Project

Key Points

Vegetation is chipped and stored for reuse on site – South Coast Road

- ❖ Avoid using fresh or un-aged pine as it can make the soil water repellent.
- ❖ Avoid applications where overland flow is likely to be sufficient to float the mulch.
- ❖ Apply to minimum depth of 50 mm for erosion control or 100 mm for weed control.

Hydromulching

Hydromulching on the Adelaide – Crafers Project

Hydromulching is the method of spraying a mix of seed, fibrous matrix of wood or paper pulp, soluble fertiliser and an adhesive binder mixed with water onto the soil surface to provide a protective surface. It is usually applied with seed for a grass cover crop. Hydromulches usually contain a high rate of cellulose fibre for forming a continuous, bonded layer on the treated surface. The technique has a broad range of applications. It is particularly appropriate for large sites with limited access, where it can also be applied with seed to temporarily stabilise unvegetated sites. A group of diverse commercial mulches exist which can be tailored for particular site conditions. They can be supplemented by straw applied as secondary mulch.

Key Points

- ❖ Hydromulching is applied by specialist contractors, who can design formulas appropriate for the site conditions.
- ❖ Hydromulching is essentially maintenance-free. Keep the ground surface damp until some early plant cover has established.
- ❖ Exclude all traffic from treated sites, and manually re-apply mulch in damaged areas.

References and Further Information

- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809.

C9 EROSION CONTROL MATS

Description

Erosion control mats are made from natural or synthetic materials and are designed to stabilise channels or slopes until vegetation has established. They limit soil erosion, increase water infiltration and reduce surface runoff. They can be used as an alternative to mulches or turf for stabilisation and are usually used with some form of grass or ground cover vegetation.

- ❖ Care should be taken to prevent damage to the fabric before and during installation. They should be protected from UV light from the sun and carefully handled so they are not torn or holed. The fabric should be secured in close contact with the soil it is to protect. The soil surface should be as smooth as possible and free from large rocks or earth clods.
- ❖ The edges of the fabric should be firmly fixed or buried.

Erosion control mats can be used:

- ❖ As a ”stand-alone” erosion control practice, or together with newly seeded slopes as protection for establishing plants.
- ❖ In areas of highly erodible soils.
- ❖ As temporary protection to earth channels intended for removal or upgrading within six months.
- ❖ To assist in establishing grassed waterways.
- ❖ On tidal or stream banks where moving water is likely to wash out new plantings.

Biodegradable Mats

Biodegradable mats may be made from jute, straw, coconut, wood fibres, and other similar materials, either woven together or enclosed in a polymer envelope.

Key Points

It is important to choose an appropriate fabric for the intended purpose. Particular care is needed when selecting blankets for slopes of 1(V):3(H) or steeper. It is necessary that a minimum vegetative cover of 80% on clay soils and 70% on sandy soils establishes within the life expectancy of the material. Other installation conditions include:

- ❖ The removal of rocks or clods from the surface before laying matting into channels.
- ❖ Application of topsoil as required to create a seed bed.
- ❖ Careful grading of the soil surface, so that the fabric will be in good contact.
- ❖ Laying the mat in a “shingle-fashion” with the end of the upstream (or upslope) roll overlapping the next roll placed.
- ❖ Pegging the matting at one metre centres, with overlap of at least 100 mm at the sides and 300 mm at the ends and the overlap facing “down flow”.
- ❖ Diverting the water away from treated slopes until vegetation is established.

- Spraying with a medium setting anionic soil binder, for example bitumen emulsion (at about 0.5 litre/m^2) for extra stability in areas where concentrated runoff might occur.
- Ensuring that there is sufficient matting to cover the full width of flow in the channel at full design capacity.

Biomats are general low-maintenance. However it may be necessary to occasionally inspect and repair tears or breaches in the fabric.

Erosion control matting on severe scour – Cobblers Creek (before and after)

Synthetic Polymer Blankets

Synthetic blankets can serve for soil protection until grass cover establishes. Like biodegradable blankets, they may have a woven or random structure. They are suited to permanent stabilisation of steep batter slopes, and watercourses. They can be used with revegetation, in which case they must provide space for growth, water and airflow, as well as protection. Usually synthetic blankets are designed for long life and used for special applications. They do not have wide application in the construction phase, unless treatment is to extend over a period of more than 6 months or the material can be easily removed and reused. They may be useful where temporary measures can later be modified to become permanent measures after construction is completed.

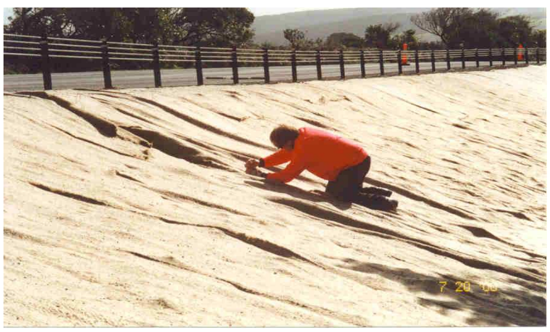
Key Points

Use synthetic polymer blankets only in consultation with the landscape designer and in accordance with the product manufacturer's recommendations.

- Synthetic polymer materials should be essentially maintenance free throughout duration of normal construction programs.

References and Further Information

- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. Section 5 and Appendix D.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6



Synthetic Blankets. Passing Lanes, Myponga – Victor Harbor Road

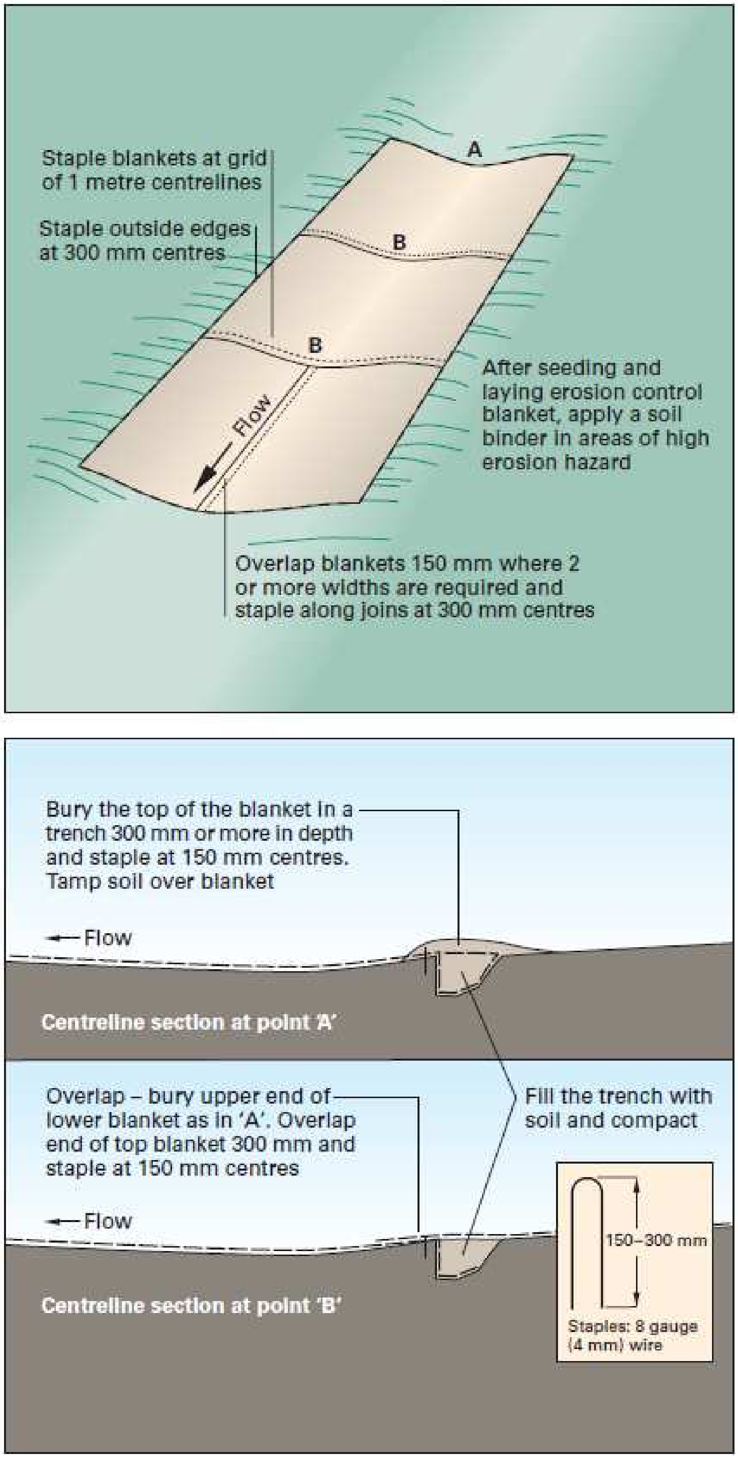


Figure C9-1 Biodegradable Blankets

(Source: NSW Dept of Housing 1998)

C10 SOIL BINDERS

Description

- ❖ Synthetic polymers, bitumen emulsion and resins can be used as chemical mulches or soil binders for temporary erosion control. They combine with soil to form a stable, lasting structure with increased resistance to erosion and overland flow. They provide immediate and inexpensive benefits, and can be used as an alternative to temporary seeding, or in combination with hydroseeding. Soil binders can be applied by themselves as a mulch, and are suitable for areas where cool season plants might be sown and soil moisture is not a major constraint to plant establishment. They are particularly appropriate for batters and overland drainage paths.
- ❖ Binders can impose various environment-related impacts that must be considered in relation to the receiving waters. These relate to its solubility in water, use of a solvent base, toxicity and biodegradability.

Key Points

Deep soil surface penetration is necessary to ensure good adhesion. To ensure this the following practices should be adopted:

- ❖ Apply the binder while the soil is at, or near to, maximum moisture content. Pre-water if necessary.
- ❖ Dilute bitumen emulsions 1:1 with water if optimum moisture conditions exist. Increase the dilution if conditions are hot or dry.
- ❖ When possible, avoid spraying bitumen during hot or dry conditions, as it will tend to form an impenetrable skin.
- ❖ For general applications, apply the diluted spray to provide an equivalent bitumen rate of between 1 and 2 litres per square metre. Increase the application to 4 to 6 litres per square metre for critical areas, such as treatment edges, crests or steep banks, and other areas likely to be significantly exposed to wind or water.
- ❖ Avoid using binders on poorly drained sites or any areas expected to remain wet for long periods.
- ❖ Select a soil binder after considering factors such as ease of handling and application, the volume required, and site factors.

References and Further Information

- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6

C11 TEMPORARY WATERWAY CROSSINGS

Description

These are usually formed from culverts or pipes, carrying flow under a raised gravel carriageway, to permit vehicles to safely cross the waterway without causing damage or erosion. They should be used wherever there is a need to provide vehicle access across a vegetated waterway.

Key Points

- ❖ Prohibit traffic until a formed access has been completed.
- ❖ Use a clean, non-polluting gravel of 50 to 75 mm, and minimum depth of 200 mm, supported on a geofabric base, to form the access path.
- ❖ Provide a 3 metre wide carriageway and sufficient length of culvert pipe to allow less than a 1(V):3(H) slope on side batters.
- ❖ Provide a lower section in the causeway to act as an emergency spillway in greater than 2 year ARI storm events.
- ❖ Ensure culvert outlets extend beyond the toe of fill embankments, to prevent gravel being eroded as per Figure C12-1.
- ❖ Keep the culvert clear of debris and sediment, to avoid overtopping during storms of less than 2 year ARI.
- ❖ Regularly recover ”spilled” gravel, to maintain minimum depth of 200 mm.
- ❖ Remove the crossing as soon as it is no longer needed.

References and Further Information

- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. In particular, Section 5.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6

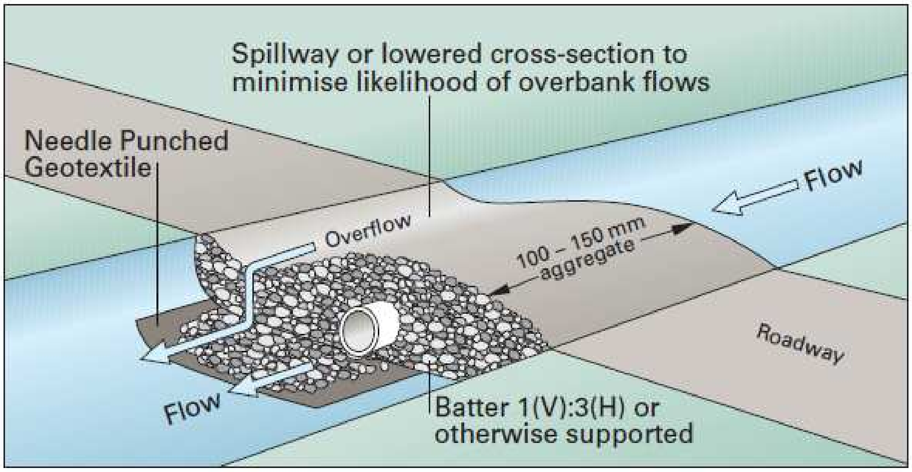


Figure C11-1 Temporary Water Crossings

(Source: NSW Dept of Housing 1998)

C12 STABILISED DRAINAGE LINES

Description

A number of methods are available for stabilising drainage lines. These include:

Check dams – are used to slow and reduce the erosive energy of the water flow and can be constructed from materials available on site, if suitable, or in conjunction with a geotextile fabric.

Matting – erosion control mats are made from synthetic or natural materials and can be used in low flow situations. See C9 for more details.

Vegetative stabilisation measures – are appropriate for low slopes and low flow velocities. Shallow natural or constructed waterways can be stabilised with matting and planted with suitable species such as grasses or native wetland plants.

Matting – Adelaide/Crafers Project.

Use site materials to create check dams and minor sediment traps

Vegetative Drainage Channel Stabilisation
Panatalinga Rd / Railway Tce, Reynella

Flexible piping – can be used to convey drainage flow, for example, to transport water down a slope, across a disturbed area, or protect a natural drainage line from scour. Flexible piping is a temporary measure to be removed following construction and site rehabilitation.

Armouring – is generally used for steep slopes, high flows and areas of high erosion potential. Depending on the erosion potential loose rock, gabion chutes, or by cement and rock line of channels (B17). Concrete-lined channels should be avoided wherever feasible alternatives exist.

Flow velocities can be reduced by use of check dams or riffles. If the drainage treatment is to be permanent, whenever possible, the drainage line should be constructed in as natural a manner as possible to reinstate fauna habitats and enhance amenity.

Flexible piping being used to reduce erosion in a drainage line.
Source: RibLoc Pty Ltd

Rock and Gabion stabilisation
Adelaide – Crafers Project

Rock and cement stabilised catch drain outflow
Adelaide – Crafers Project

Stabilisation using concrete bags

Gabion stabilised drainage line
Adelaide – Crafers Project

References and Further Information

- NSW Department of Housing (1998) *Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. Section 5.

C13 UTILITY CONSTRUCTION

Description

This measure refers to the installation of underground services, such as telecommunications, electricity and gas services. Disturbance of previously stable areas is a common problem of utility construction. Where possible, utility activities, particularly trenching should be scheduled to reduce both the area and frequency of disturbance. It is also essential that stabilisation or restoration work that may have been previously established, be completely reinstated immediately following service installation.

Key Points

The following practices should be adopted, or alternative steps taken to achieve the same objective:

- ❖ Where possible, coordinate utilities to using the same opening and closing sites, to reduce the frequency of disturbance and erosion risk.
- ❖ Do not open trenches if storms have been forecast.
- ❖ Locate overburden upslope of trenches, to provide a protective bund.
- ❖ Stockpile topsoil separately from subsoil.
- ❖ Backfill as illustrated in Figure C13-1
- ❖ Divert runoff from the line of the cut with diversions.
- ❖ Rehabilitate as appropriate for the site.

References and Further Information

- NSW Department of Housing (1998*) Managing Urban Stormwater: Soils and Construction*. ISBN 0731310969. Section 9.2.
- NSW Environment Protection Authority (1996) *Managing Urban Stormwater - Construction Activities*. Draft Report EPA 96/79. ISBN 0 7310 3809 6

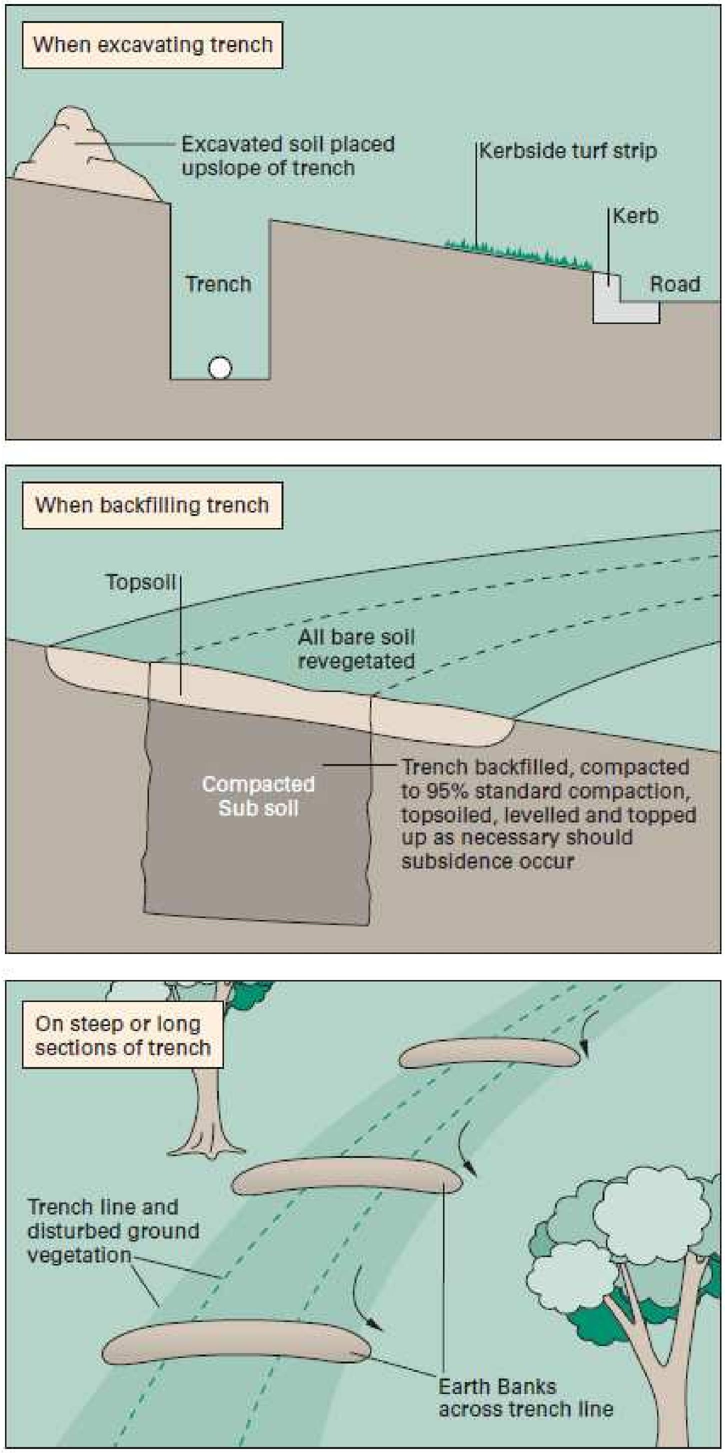


Figure C13-1 Utility Construction

(Source: NSW Dept of Housing 1998)