Conceptual Construction-Phase Soil and Water Management Plan

for Major Project 05-0113
Seniors Living Resort, Frenchs Forest - Proposed Concept Plan

Lots 1110, 1111, 1113, 1336, DP 752038;
Lot 20, DP 842523; Lot 80, DP 846099
Oxford Falls Road, FRENCHS FOREST

Prepared by:

Andrew Macleod
23 October 2008

SEEC Reference: 08000336

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Document Certification

This report has been developed based on agreed requirements as understood by SEEC Morse McVey at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.

Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

Andrew Macleod B.Sc (Hons), CPSS CPESC
Director, Environmental Services
SEEC Morse McVey

23 October 2008

Contents

1 Introduction

This *Conceptual Soil and Water Management Plan* (SWMP) (the "plan") has been prepared to support an application for a proposed seniors living resort on Oxford Falls Rd, Frenchs Forest (Major Project 05-0113, Seniors Living Resort - Proposed Concept Plan).

This plan contains background information and fundamental advice relating to erosion and sediment control during the construction phase of the development. It demonstrates to the consent authorities that appropriate measures can be implemented in accordance with relevant guidelines to ensure that no undue pollution of receiving waters occurs during or after construction as a result of land disturbance.

This plan relates to demolition of existing structures, construction of all buildings, road construction, drainage line works, installation of services and renovations to existing buildings. A copy of the concept masterplan for the development is included in Appendix 1 of this report.

Note that a plan such as this would normally be accompanied by a drawing or series of drawings showing the location of various erosion and sediment control works during construction. However, this project is at masterplanning stage, and a comprehensive staging plan has not yet been finalised. As such, this report is not accompanied by any drawings although these would be prepared later for the various stages of construction.

This plan is to serve as a background document when the final construction-phase SWMPs are prepared. It gives all relevant calculations for predicting soil loss and makes recommendations for appropriate management. It has been prepared following guidelines contained in *Managing Urban Stormwater: Soils and Construction (*4th Edition) (Landcom, 2004) (the "Blue Book").

This plan aims to address the Department of Planning Director General's Environmental Assessment Requirements for water quality protection during construction.

2 Background

2.1 This SWMP provides fundamental erosion and sediment control advice for this site. We consider the proposed development can proceed without undue impact on the receiving waters both during and after the construction stages providing that:

(i) the measures recommended here are implemented;

(ii) works are appropriately staged to minimise the amount of land disturbance at any one time;

(iii) erosion and sediment control works are appropriately sized and sited (e.g. sediment basins, diversion drains);

(iv) any conditions of consent that might be placed on the development following approval are appropriately addressed.

2.2 This plan should be read with the following documents also relating to this development:

(i) Water Quality Management Concept (SEEC Morse McVey);

(ii) Stormwater Concept Plan (John M Daly & Associates);

(iii) any other consultant reports relating to the site.

3 Soil and Landscape Conditions

3.1 Soil Landscape mapping for the area suggests that the proposed development lies wholly on the Oxford Falls Soil Landscape, with the Lambert and Hawkesbury Soil Landscapes occurring on surrounding lands (Chapman and Murphy 1989). An investigation of the soils reveals that this is mostly correct, although minor adjustments are made based on slope and terrain observations by experienced SEEC Morse McVey soil scientists. The updated landscape delineations are shown in Figure 1.

3.2 This report is based on the following assumptions:

(i) the lands mapped as Hawkesbury Soil Landscape in Figure 1 will not be disturbed except for installation of essential erosion and sediment control works. These lands have an extreme erosion risk due to their slope and soil conditions;

(ii) the majority of lands to be disturbed for the development are on the Oxford Falls Soil Landscape;

(iii) the soils of the Oxford Falls Soil Landscape:

- are prone to waterlogging and/or high water tables
- can become highly erodible if soil organic content decreases significantly;

3.3 Refer to Table 1 for relevant erosion and sediment control information on the Oxford Falls Soil Landscape.

3.4 Although Table 1 suggests that soils are Type C (coarse), we recommend that site-specific testing be undertaken to confirm or deny this. Sediment basins might need to be designed as total storm capture structures (i.e. for Type F - fine, or Type D - dispersible soils).

Table 1 Soil and Site Physical Characteristics (from Chapman and Murphy, 1989 and Landcom, 2004)

Landscape name	**Oxford Falls**
K–Factor	0.023
Erodibility	Low to moderate
Erosion hazard	
Concentrated flows	Very high
Non-conc. flows	High
Site slope gradients	0% to 6%
Soil textures	Coarse sands to loams
Sediment type	Type C * see note in 3.4, above
Annual soil loss[1]	185 t/ha/yr on 6% slopes (Soil Loss Class 2)
Soil Hydrologic Group	Class C/D (moderate to high runoff potential)

1 Likely annual soil loss figures are calculated using the Revised Universal Soil Loss Equation (RUSLE) (see Appendix 3) and are based on site conditions, where:

- R–Factor (Rainfall Erosivity) is 4200, and Rainfall Zone is 1, as derived from RAINER (Refer to Appendix 2),
- The maximum K–Factor for each soil landscape has been used (not site-specific) as derived from Chapman and Murphy, 1989,
- LS (Length/Slope) factor: Oxford Falls: 1.47 (6% slope, 80 m length),
- The P–Factor (erosion control factor) is assumed to be 1.3,
- The C–Factor (cover factor) is assumed to be 1.0 for bare soil on construction areas.

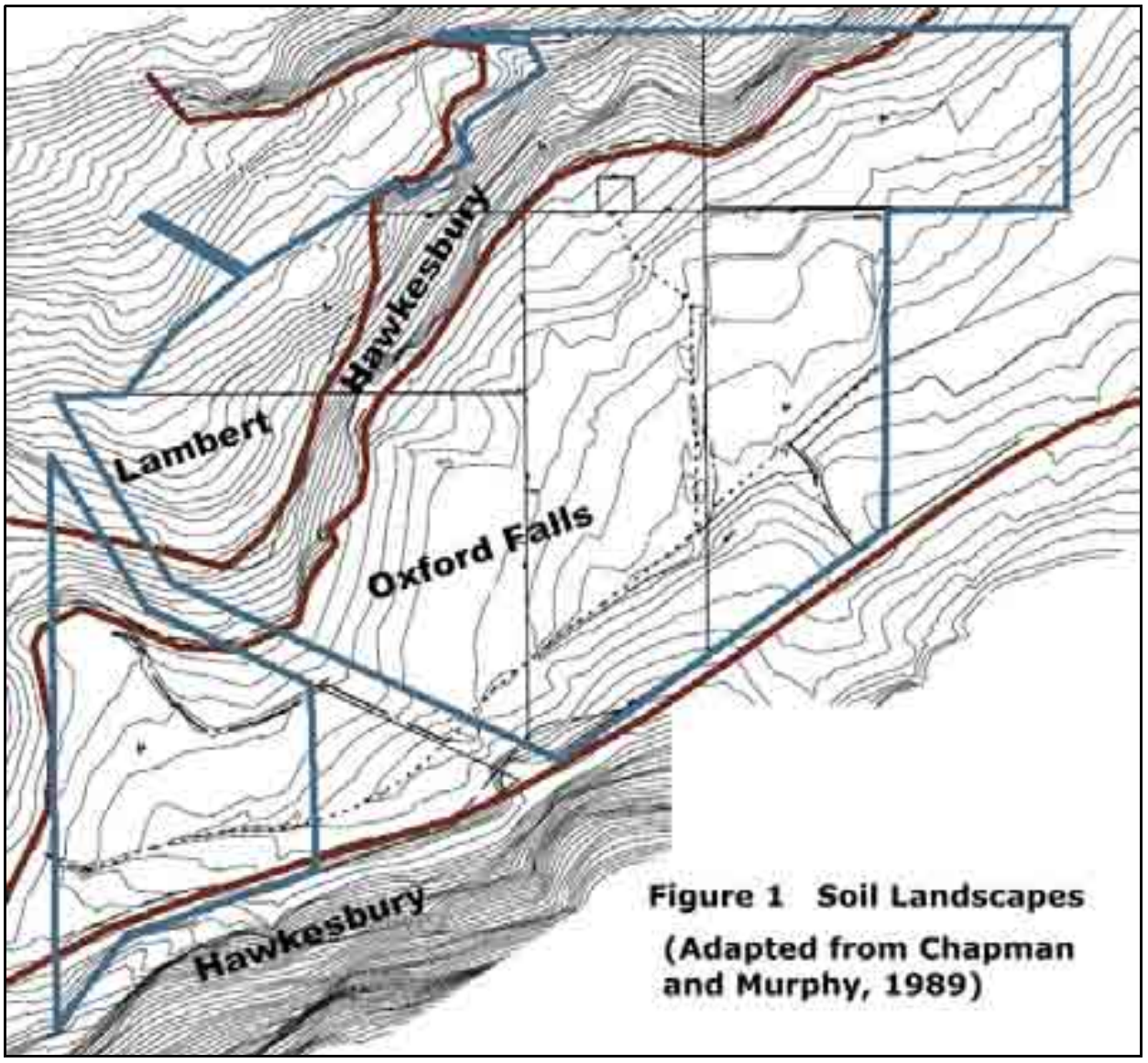

Figure 1 Soil Landscapes
(Adapted from Chapman and Murphy, 1989)

4 Background Data

4.1 When calculating the required volumes in sediment basins, use the following inputs:

(i) the 5-day 75th percentile rain depth for this site is 29.0 mm (Mona Vale - Landcom, 2004). If the receiving waters are deemed sensitive and there is a significant risk of extensive land disturbance, the 5-day 80th percentile rain depth of 35.2 mm might be used;

(ii) IFD data for Oxford Falls is contained in Appendix 2. This will be required when establishing the dimensions and lining characteristics of basin spillways or if basins will be designed for Type C (coarse) sediment;

(iii) the volumetric runoff coefficient (C_v) is 0.56 (Landcom, 2004);

(iv) the runoff coefficient (C_{10}) is 0.90 (Landcom, 2004);

(v) use the Annual Soil Loss figures from Table 1 to calculate anticipated sediment loads into sediment basins according to the area of each Soil Landscape disturbed (refer to Figure 1). Refer to Appendix 3 for further information on the Revised Universal Soil Loss Equation (RUSLE), which underpins Annual Soil Loss calculations.

4.2 When calculating the dimensions and lining characteristics of catch drains, spillways etc., use the following inputs:

(i) IFD data for Oxford Falls is contained in Appendix 2;

(ii) the runoff coefficient (C_{10}) is 0.90 (Landcom, 2004);

(iii) Tables A3, D1 and 5.2 from Landcom, 2004 provide information concerning appropriate stabilisation of catch drains, spillways, diversion structures etc. A copy of each is included in either Appendix 3 or Appendix 6.

4.3 Calculations for all permanent structures including outlet structures and permanent catch drains should assume:

(i) IFD values as shown at Appendix 2,

(ii) stability in the design storm event as dictated by Council DCPs.

4.4 Calculations for temporary structures should assume stability in at least the 10-year ARI time of concentration storm events.

4.5 According to Chapman and Murphy (1989), the Oxford Falls Soil Landscape has sediment type C soils and, as such, sediment basins can be "wet" or "dry" basins (See Standard Drawings SD 6-1, SD 6-2, SD 6-3, SD 6-4 or SD 6-5, Appendix 5). However, we recommend that type D "wet" basins (See SD 6-4 in Appendix 5) be used at this site due to the highly sensitive receiving waters.

4.6 Soils of the Oxford Falls Soil Landscape are generally unsuitable for

constructing sediment basin walls. If the basin is to have earth walls, they will need to be constructed from imported fill of an appropriate material. Alternatively, select a different style of basin wall.

5 General Instructions

5.1 Ensure that erosion and sediment control measures are in place before earthworks and engineering works commence. For each stage of the construction, the basic sequence for securing the site is as follows:

(i) install a stabilised access at every site entry/exit point. Note that a wheel wash facility will be required if tracking of sediment is to be prevented;

(ii) using barrier fence (on the upslope sides) and sediment fence (on the downslope edges), delineate the areas to be disturbed by this stage of the works program. All other areas should be clearly marked as "no-go" zones;

(iii) install the site offices, sheds and delineate parking areas;

(iv) provide rough access to enable construction of diversion structures and sediment basins. Construct in this order:

- Firstly, install 'clean' water diversions to send run-on away from works areas. Stabilise (line) them;
- Secondly, install sediment basins and stabilise them;
- Lastly, install 'dirty' water diversion to convey sediment-laden runoff from works areas into the sediment basins. Stabilise (line) them.

(v) Earthworks or construction works can now commence.

5.2 Sediment basins are to be sited at natural low points within construction areas. Note that this will most likely necessitate staging the construction program so that buildings closest to the main creek are erected last, because those locations will be required for sediment basins during other stages.

5.3 Works at this site will be staged to facilitate appropriate soil and water management works.

5.4 Soil and water management works will be coordinated according to the disturbed areas, with sediment basins and catch drains sized and designed appropriately.

5.5 Works within a creek, on creek banks, within the riparian corridor (buffer zone as determined by officers from the Department of Water and Energy) and the urban fringe zone (10 m from the edge of the riparian corridor) are all considered to be on "waterfront lands" under the guidelines in Landcom, 2004 and are therefore constrained according to timeframe. All lands within this zone are automatically assumed to be Soil Loss Class 6 (very high erosion hazard). Therefore:

(i) From 1st June to 15th November, works can proceed within the riparian areas (including the creek and its banks) using basic erosion and sediment control measures and without additional specialised provisions;

(ii) From 16th November to 31st May, works can only proceed in this zone providing that:

- ground cover lowers C-factors to less than 0.1 (Appendix 3) at all times unless the 3-day weather forecast suggests rain is unlikely; and
- ground cover materials are available onsite that can lower C-factors in disturbed areas to less than 0.1 (Appendix 3) within 24 hours if the forecast proves wrong and a rain event occurs.

Practically, this means that any works within this zone should occur in the period 1st June to 15th November. Note that all other works on the Oxford Falls Soil Landscape, which is Soil Loss Class 2, can proceed at any time of year (refer to Table 4.3 in Landcom, 2004).

5.6 Contractors will ensure that all soil and water management works are undertaken as appropriate and constructed following the guidelines stated in Landcom, 2004.

5.7 All subcontractors will be informed of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas.

5.8 Waters discharged from the site are not to have sediment volumes in excess of 50 mg/L at any time. In order to meet this requirement, the onus is on the site supervisor to make changes or additions to this plan as is appropriate and to monitor discharge water quality.

5.9 Site rehabilitation is to occur progressively as works proceed to minimise the amount of disturbed land at any one time.

6 Erosion Control - General Conditions

6.1 Site disturbance will be limited in extent and nature to minimise the total area that is disturbed at any one time.

6.2 Development works will be undertaken in stages to facilitate successful erosion and sediment control.

6.3 Barrier fencing will be erected to minimise disturbance by preventing vehicular and pedestrian access to restricted areas.

6.4 Establish a site office near the entrance to the site to limit vehicular movements on disturbed areas.

6.5 Vehicular access to disturbed lands will be confined to that essential for construction work. All non essential vehicles will park at a specified location near the site office or external to the site.

6.6 The soil erosion hazard on the site will be kept as low as practicable by minimising land disturbance and ensuring quick rehabilitation. Some ways of doing this are outlined in Table 2.

Table 2 Limitations to access

Land use	Limitation	Comments
Construction areas	Limited to 5 (preferably 2) metres from the edge of any essential construction activity as shown on the engineering plans	All site workers should clearly recognise these areas that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (downslope) or similar materials.
Access areas	Limited to a maximum width of 10 metres (preferably 5 m)	The site manager will determine and mark the location of these zones on site. They can vary in position so as to best conserve existing vegetation and protect downstream areas while being considerate of the needs of efficient works activities. All site workers will clearly recognise these boundaries
Remaining lands, including revegetation areas	Entry prohibited except for essential management works	Thinning of growth might be necessary, for example, for fire reduction or weed removal

6.7 Limit disturbance to that essential for works being undertaken at any given time. Limit access to other areas through the use of barrier fence. Note that barrier fencing can be as simple as tape strung between star pickets, providing it clearly delineates no-go areas.

6.8 Where possible, stockpiles of topsoil (SD 4-1, Appendix 5), and other building and landscaping materials, will be at least five metres from areas of likely concentrated or high velocity flows, especially earth banks and roads. If

necessary, low flow earth banks (SD 5-5, Appendix 5) or drains will be constructed to divert localised run-on.

6.9 Where practicable, each phase of the construction program will be scheduled so that:

(i) the time from starting land disturbance activities to final stabilisation is a duration of less than six months; and

(ii) the duration from the conclusion of land shaping to completion of final rehabilitation is less than 15 working days.

Here, stabilisation means achieving a C-factor (Appendix 3) of less than 0.1 and setting in motion a program that should ensure it will drop permanently, by vegetation, paving, armouring, etc. to less than 0.05 within a further 60 days. Note that local water restrictions might affect this in drought times.

6.10 While C-factors are likely to rise to 1.0 during the work's program, they will not exceed those given in Table 3.

Table 3 Maximum Acceptable *C*-factors at Nominated Times During Works. Refer to Appendix 3 for further information regarding C-factors

Lands	Maximum *C*-factor	Remarks
Waterways and other areas subjected to concentrated flows, post construction	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows will be limited to those shown in Table 5.2 of Landcom, 2004 (see Appendix 6). Foot and vehicular traffic will be prohibited in these areas
Stockpiles, post construction	0.10	Applies after ten working days from completion of formation. Maximum *C*-factor of 0.10 equals 60% ground cover
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later. Maximum *C*-factor of 0.15 equals 50% ground cover
All lands, post development	0.1 to 0.05	Achieve a C-factor of 0.1 within 15 working days of completion of works, and initiate a program to further reduce C-factors to 0.05 or less within 60 days.

6.11 In the short term, the requirements of Table 3 can be achieved, for example:

(i) in areas exposed to sheet flow, with a temporary vegetative cover — a suggested listing of suitable plant species is shown in Table 4 (note, these plants only protect the ground surface for up to six months). Other temporary options include the use of a suitable soil binder, e.g. Terra-Control® or equivalent;

(ii) in areas exposed to concentrated flow (e.g. diversion banks and waterways) where stabilisation is to be undertaken by temporary means the requirements of Table 3 can be met by stabilising with hessian cloth tacked with a soil binder, such as anionic bitumen emulsion (0.5 L/m^2). Also, see Table 5.2 in Landcom, 2004 (included in Appendix 6 of this report). Apply soil binders following the manufacturer's instructions.

Table 4 Plant Species for Temporary Cover

Growing Season	Seed Mix
Autumn / Winter	oats @ 40 kg/ha
	Japanese millet @ 10 kg/ha
Spring / Summer	Japanese millet @ 20 kg/ha
	oats @ 20 kg/ha

6.12 While only minimal cut and fill is likely at this site, batter gradients should not exceed:

- 2.5(H):1(V) on easterly and southerly-facing slopes
- 3(H):1(V) on northerly and westerly facing slopes;

Cut and fill areas that cannot meet these criteria will be stabilised with retaining walls.

6.13 Roofs of buildings are to be immediately connected to the stormwater infrastructure. Preferably, stormwater infrastructure (including rainwater tanks, where applicable) will be in place prior to roof completion.

6.14 Temporary cut-off drains (SD 5-5, Appendix 5) will be installed across all disturbed lands (including the accessways) to limit slope lengths to no more than 80 m under the following scenarios:

(i) if work on the site is to cease for more than three days,

(ii) at any time if rain appears likely.

The cut-off drains will limit slope length to less than 80 metres and will discharge water where it is unlikely to create an erosion or flooding hazard. Do not direct flows towards stockpiles or other hazard areas.

6.15 Where practicable, the various service and drainage connections will be coordinated so that common trenching can be used.

6.16 Where practicable, the time trenches are open will be limited to less than five working days.

6.17 Where possible, place spoil on the uphill side of trenches to divert water flow

away from the trench line. Alternatively, use temporary bunds for similar effect.

6.18 Trenches will be backfilled with subsoil and compacted to 95 per cent Standard Proctor. Then, topsoil will be replaced with sods to match surrounding ground levels.

6.19 On completion of all major works and before revegetation, disturbed soils will be left with a loose surface to encourage water infiltration and help with keying topsoil later (SD 4-2 and SD 7-1, Appendix 5).

6.20 Final site landscaping will be undertaken as soon as possible and within 15 working days from completion of construction activities. This will include revegetation to provide a quick, temporary cover before a more permanent cover is established (Clause 6.9 to 6.11 and Table 3).

6.21 Plants will be watered regularly until an effective cover has established properly and plants are growing vigorously. Fertilisers will be applied as required to help growth. Watering, fertiliser and soil amelioration requirements should be described in a separate landscape plan.

6.22 During windy weather, large, unprotected areas will be kept moist (not wet) by sprinkling with water to reduce wind erosion hazard.

6.23 Where applicable, place kerbside turf strips (SD 6-13, Appendix 5) at the edges of kerbs to stabilise the soil/kerb interface where there is a risk of run-on causing concentrated flows behind the gutter. Locations are to be determined by the site supervisor.

7 Sediment and Pollution Control - General Conditions

7.1 Stabilised site accesses (SD 6-14, Appendix 5) will be installed to all areas that are subject to disturbance and accessed from sealed roads.

7.2 Sediment fencing (SD 6-8, Appendix 5) and/or other sediment traps will be installed downslope of all disturbed lands to retain the coarser sediment fraction.

7.3 Sediment removed from any trapping device (including sediment fences) will be disposed in locations where further erosion and consequent pollution to downslope lands and waterways will not occur.

7.4 Acceptable receptacles will be provided as required, for concrete and mortar slurries, paints, acid washings, lightweight waste materials and litter.

7.5 Safe storage areas will be provided for fuels, oils, paint, poisons, fertilisers, chemicals and other hazardous materials.

7.6 Any water accumulation in an excavated area is to be pumped into a sediment basin. It is not to be discharged directly into the creek system.

7.7 Discharge waters from the site are to have sediment loads less than 50 mg/L in all rainfall events up to and including the design storm.

7.8 Sediment basins are to be flocculated (if required) before water is discharged (refer to Appendix 4 for further information on flocculation).

7.9 Demolition material can be stockpiled on site if it is expected to be re-used, otherwise it should be removed from the site.

7.10 Progressively rehabilitate and stabilise disturbed areas as works are completed. Refer to Sections 6.8 to 6.10 of this report for C-factor requirements on ground surfaces.

7.11 As stormwater infrastructure is completed, install temporary control measures to minimise the risk of sediment ingress (e.g. into gully pits along roads). See SD 6-11 and SD 6-12 in Appendix 5 for examples.

7.12 Sediment basins are to remain in place until the likelihood of sediment laden waters being washed into them becomes low. When 80 to 90% of works are complete, remove sediment basin(s) and rehabilitate the ground surface following the requirements for ground cover in Sections 6.8 to 6.10 of this report.

7.13 Sediment basins must be dry before they can be removed. Sediment laden waters accumulated in basins are not to be artificially pumped out unless it can be demonstrated that discharge waters will not have sediment values exceeding 50 mg/L.

7.14 The stabilised access(es) are to remain in place until 90% of roads are sealed and the likelihood of tracking sediment onto surrounding streets becomes very low.

7.15 As stockpile sites are no longer required, rehabilitate the ground surface using a temporary ground cover (see Sections 6.8 to 6.10) and set in motion a regime to permanently stabilise it within a further 60 days.

7.16 Secure all existing stormwater pit inlets using kerb rolls/filters (or equivalent) to prevent the ingress of sediment (SD 6-11 and SD 6-12, Appendix 5). Establish a regime for regular clearing of accumulated sediment and disposal to a suitable location away from concentrated flows.

7.17 Remove sediment and barrier fencing where appropriate as works are completed. Note that newly planted areas might require limited fencing to restrict public access until vegetation has stabilised and is maturing.

8 Erosion and Sediment Controls - Riparian Areas

8.1 Any temporary water crossings are to be designed according to SD 5-1 (Appendix 5). Wherever possible, use existing watercourse crossings until permanent structures are constructed.

8.2 Ensure that riparian vegetation stands remain undisturbed unless disturbance has been approved by DWE and DECC.

8.3 Creek bed, bank or riparian corridor works are to occur in 40 m sections, working from upstream to downstream. The previous upstream section must be completed and stabilised before work can proceed on the next section. Refer to Sections 5.8 to 5.10 of this report for requirements for land stabilisation in creeks.

8.4 Install diversion banks (SD 5-5 and 5-6, Appendix 5) at the edge of the riparian corridor for the 40 m length of creek being worked on to prevent excess run-on of overland flow into the works zone. They are to deliver overland flow to a level spreader (SD 5-6, Appendix 5) immediately downstream of the works area. Earth banks are to be progressively removed and the surface rehabilitated (see Section 6.8 to 6.10 of this report) as 40 m creek sections are completed.

8.5 As each 40 m section of creek is completed, erect barrier fencing to limit access and prevent further disturbance.

8.6 *Immediately stabilise* creek beds, banks and any other areas subject to regular concentrated water flows following reshaping/rehabilitation using an appropriate erosion control measure (see Appendices 3 and 6).

8.7 Within the riparian corridor (i.e. those lands not subject to ongoing concentrated flows), progressively rehabilitate disturbed ground surfaces to bring C-factors below 0.05 within 10 days (or less if practicable).

8.8 Sediment basins are to outlet to existing drainage pathways via an energy dissipater (SD 5-8, Appendix 5) or level spreader (SD 5-6, Appendix 5).

8.9 For all works within a creek, on creek banks, within the riparian corridor (buffer zone as determined by officers from the Department of Water and Energy) and the urban fringe zone:

(i) From 1st June to 15th November, works can proceed within these zones using the standard suite of erosion and sediment control measures listed in Sections 6 and 7 of this report and without additional specialised provisions;

(ii) From 16th November to 31st May, works can only proceed in this zone providing that:

- ground cover lowers C-factors to less than 0.1 (Appendix 3) at all times unless the 3-day weather forecast suggests rain is unlikely; and

- ground cover materials are available onsite that can lower C-factors in disturbed areas to less than 0.1 (Appendix 3) within 24 hours if the forecast proves wrong and a rain event occurs.

Practically, this means that any works within this zone should occur in the period 1st June to 15th November. Note that all other works on the Oxford Falls Soil Landscape can proceed at any time of year following the standard suite of erosion and sediment control measures listed in Sections 6 and 7 of this report.

9 Site Monitoring and Maintenance

9.1 Waste receptacles will be emptied as necessary. Disposal of waste will be in a manner approved by the site superintendent and in accordance with standard safe disposal techniques.

9.2 The site superintendent will inspect the site at least weekly paying particular attention to:

(i) removal of spilled sand, soil or other materials from near hazard areas;

(ii) ensuring barrier fencing is maintained and no-go areas are being observed by all site workers and contractors;

(iii) ensuring progressive and prompt rehabilitation of lands, that rehabilitation has effectively reduced the erosion hazard — initiate upgrading or repair as appropriate;

(iv) constructing additional erosion and/or sediment control works as might become necessary to ensure the desired water control is achieved, i.e. make ongoing changes to the SWMP;

(v) maintaining erosion and sediment control measures in a functioning condition until all earthwork activities are completed and the site is rehabilitated;

(vi) removal of trapped sediment and disposal to safe areas; and

(vii) removal of temporary soil conservation structures as the last activity in the rehabilitation program.

9.3 Revegetation areas will be inspected regularly to investigate failures and program necessary replanting as necessary.

9.4 An adequate watering and fertilising system will be maintained in revegetation areas.

9.5 Areas of localised soil erosion will be identified and appropriate preventive measures implemented. These might include:

- planting additional stabilising vegetation or wind breaks
- stabilising soils with mulches or alternative soil binders
- taking steps to minimise any concentrated stormwater flows.

9.6 Any areas of localised poor drainage will be identified and appropriate remedial action taken.

9.7 A regime for cleaning out accumulated debris is to be established for any sediment traps to remove rubbish and organic material (leaves, sticks etc.).

10 References

Chapman, G.A. and Murphy, C.L. (1989). *Soil Landscapes of the Sydney 1:100,000 sheet.* Soil Conservation Service of N.S.W., Sydney.

Chapman, G.A., Murphy, C.L., Tille, P.J., Atkinson, G., and Morse, R.J. (1989). Soil Landscape Series Sheet 9130 Sydney. Soil Conservation Service of N.S.W.

Landcom (2004). *Managing Urban Stormwater: Soils and Construction* (4th edition). NSW Government.

11 Appendices

11.1 Appendix 1: Site Masterplan by URBIS

Note - indicative landscaping concept plan only. For full details of the proposed development, refer to plans prepared by Urbis.

11.2 Appendix 2: IFD Data for Oxford Falls

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********************** ARI&AP ****************************
       DEPARTMENT of INFRASTRUCTURE and LAND MANAGEMENT
Date : 27/08/2006


Rainfall Intensity (mm/h) for OXFORD FALLS
       1 hour, 2 years : 41.50
      12 hour, 2 years :  9.11
      72 hour, 2 years :  2.70
       1 hour, 50 years : 64.00
      12 hour, 50 years : 16.66
      72 hour, 50 years :  6.03
                Skewness :  0.00
Geographical factor 52 :  4.20
Geographical factor F50: 15.85

  ARI  6m    6m    12m   20m   30m   1h    2h    3h    6h    12h   24h   48h   72h   Over
ARI
1       111    95    78    67  44.3  31.6  21.3  16.4  10.7  7.06  4.52  2.80  2.06  0.10
2       129   121   110    94    62  41.6  27.1  21.2  13.9  9.10  5.84  3.65  2.70  0.10
5       164   153   137   114    77    54  35.4  27.6  18.2  11.8  7.68  4.84  3.66  0.10
10      181   171   142   106    87    61  40.0  31.4  20.4  13.3  8.77  5.64  4.24  0.10
20      207   195   162   122   101    71  46.7  36.3  23.6  15.3  10.2  6.60  5.00  0.10
50      241   226   189   142   118    84    55  42.8  27.7  18.0  12.1  7.89  6.00  0.10
100     264   250   209   158   132    94    61  47.7  30.9  20.0  13.5  8.88  6.78  0.10
Over   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00

Areal Rainfall Factor (Ri): 4200   Estimated 1:10 Storm (y10): 2250
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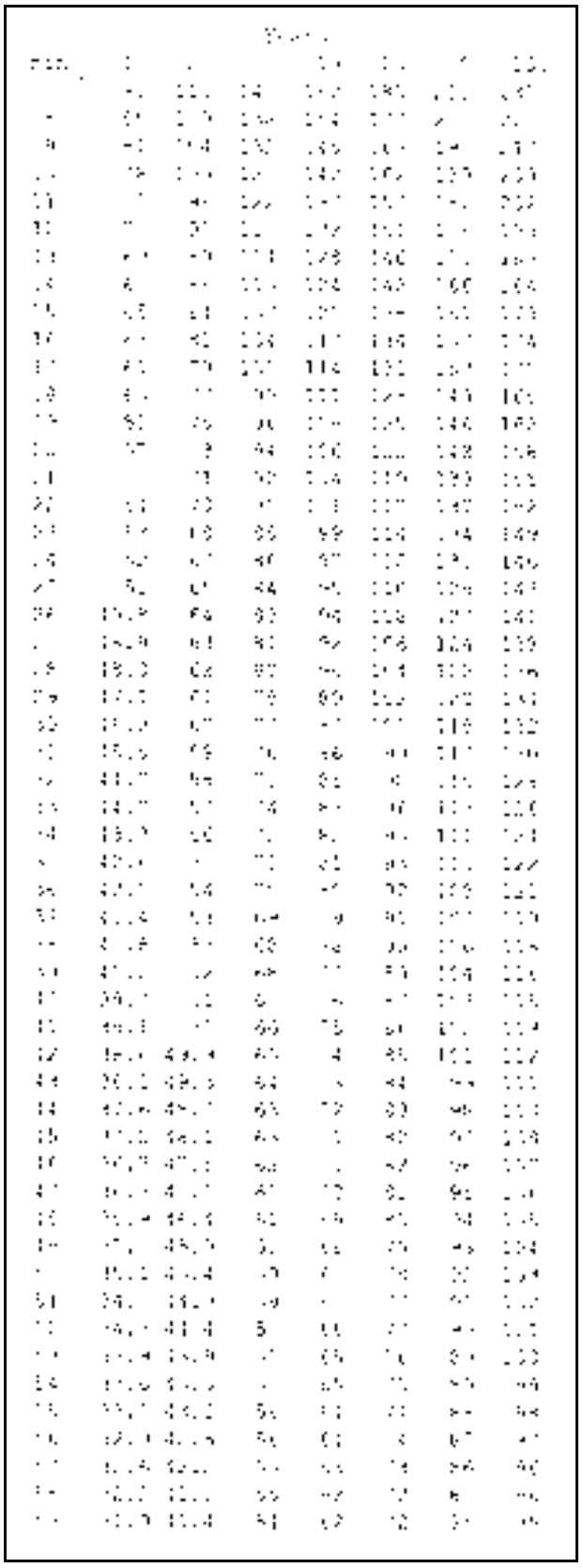


11.3 Appendix 3: Revised Universal Soil Loss Equation

While assessment of runoff is commonplace in the urban planning process, estimating possible soil loss is not. Nonetheless, estimates of soil loss have four important applications to soil and water management. These are to:

- assess the erosion risk at a site
- identify suitable measures to overcome the erosion risk
- estimate the required capacity of sediment retarding basins
- compare the effectiveness of various erosion control measures.

Therefore, by estimating likely soil loss levels, land planners can gear erosion and sediment control measures to each part of any development site. Consequently, they can mitigate possible soil erosion and consequent sediment pollution to downslope lands and waterways.

The Revised Universal Soil Loss Equation (RUSLE) is designed to predict the long term, average, annual soil loss from sheet and rill flow at nominated sites under specified management conditions. The predicted losses are empirically derived. The original application is described by Wishchmeier and Smith (1978) and revised by Renard, Foster, Weesies and Porter (1991) and Renard, Foster, Weesies, McCool and Yoder (1997). It has been adapted to urban sites and modified for Australian conditions in a computer program called SOILOSS (Rosewell, 1993). The equation is represented by:

$$A = RKLSPC$$

where, A = computed soil loss (tonne/ha/yr)
R = rainfall erosivity factor
K = soil erodibility factor
LS = slope length/gradient factor
P = erosion control practice factor
C = ground cover and management factors.

Typical values are given in Table 5.

Because the RUSLE takes into consideration all major components likely to affect sheet erosion, it is the most widely used (and abused) soil loss equation available. While it does have great practical value, its limitations should be recognised and understood.

The main limitations of the RUSLE are that it:

(i) only predicts sediment entrained in the erosion process and does not predict sediment yields into particular sediment basins; [1]

(ii) predicts average annual soil loss and not that for a particular storm event;

(iii) is effective for erosion through sheet and rill flow only on short slopes (<300 m) and not for concentrated flow or long slopes; and

[1] In most situations, not all the sediment entrained on eroding lands is transported away from the site. However, at urban development sites where sediment trapping devices are very close to areas of erosion and most fine particles are flocculated, it can be assumed that most sediment entrained can be trapped.

(iv) does not adequately take into account soil dispersibility in assessment of the *K*-factor.

Despite these matters, the RUSLE has its benefits and should be applied at all urban development sites, even at a cursory level, provided that any unmeasured factors are on the conservative side.

Table 5 Factors Used in the Interpretation of the RUSLE

Factors	Remarks
R - rainfall erosivity	Rainfall erosivity is a measure of the erosive force and intensity of rain in a normal year. In NSW, it varies from 500 to 9,500 while at the subject site it is 4,200 (Appendix 2)
K - soil erodibility	Soil erodibility is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. It can be normally expected to range from 0.005 to 0.02 on soils with low erodibility, from 0.021 to 0.04 to soils with moderate erodibility, and from 0.041 to 0.07 on soils with high erodibility.
LS - slope length and gradient	Both slope length (metres) and gradient (per cent) have major effects on possible soil loss. They should be recorded as typical upper values for the site or unit in question. In the RUSLE, slope and length criteria are normally treated as a single entity, *LS*. On construction sites the *LS*-factor commonly ranges from 0.10 (flat, short slopes) to 5.0 (steep, long slopes).
P - erosion control practice	The erosion control practice is reflected in the roughening or smoothing of the soil surface by machinery, i.e. those practices that can reduce both the velocity of runoff and the tendency of runoff to flow directly downhill. *P*-factors normally range from 0.8 (low) to 1.3 (high). On construction sites assuming a worst case scenario of 1.3 is normal.
C - cover	The cover or *C*-factor, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from tilled, bare soil and taken as 1.0 — typical of urban construction sites. It normally ranges from about 0.005 on very well vegetated lands to 1.0 where the vegetation has been completely removed.

Table 6 and Figure 2 provide indicative *C*-factors for some cover types. Tables A3 and D1 from the Blue Book are also appended here, both of which should be used when selecting erosion control products or ground cover types for rehabilitation.

Table 6 *C*-factors for Various Cover Types

Type of cover	*C*-factor
No mulching or seeding, no plant roots	1.00
Little or no above-ground plant material but roots still intact and undisturbed (see figure A1)	0.45
Open-weave jute mesh (<40% coverage of soil surface)	0.40
Straw anchored * *to the soil at:*	
(i) 2.2 tonnes/ha and	
(a) 6-10% slope, up to 30 m long	0.20
(b) ≤5% slope, up to 60 m long	0.20
(ii) 4.5 tonnes/ha and	
(a) 34-50% slope, up to 10 m long	0.20
(b) 26-33% slope, up to 15 m long	0.17
(c) 21-25% slope, up to 22.5 m long	0.14
(d) 16-20% slope, up to 30 m long	0.11
(e) 11-15% slope, up to 45 m long	0.07
(f) 6-10% slope, up to 60 m long	0.06
(g) ≤5% slope up, to 120 m long	0.06
Woodchip applied at:	
(I) 16 tonnes/ha and	
(a) 16-20% slope, up to 15 m long	0.08
(b) ≤15% slope, up to 22.5 m long	0.08
(ii) 27 tonnes/ha and -	
(a) 21-33% slope, up to 22.5 m long	0.05
(b) 16-20% slope, up to 30 m long	0.05
(c) ≤15% slope, up to 45 m long	0.05
(iii) 56 tonnes/ha and -	
(a) 34-50% slope, up to 22.5 m long	0.02
(b) 21-33% slope, up to 30 m long	0.02
(c) 16-20% slope, up to 45 m long	0.02
(e) ≤15% slope, up to 60 m long	0.02
Woven straw blanket	0.08
Seeding grasses after 60 days (average conditions using perennial rye, small grains, millet or Sudan grass)	0.05
Bitumen emulsion (12,000 l/ha)	0.02
Jute fine mat (100% coverage of soil surface)	0.01
Sod (turf)	<0.01
Undisturbed native vegetation or well-established exotic grasses providing 100% cover	<0.01

* Rill erosion might occur beneath the mulch if it is not properly anchored. Accordingly, the soil loss factors could double those shown, especially on moderate or steep slopes and soils with moderate erodibilities.

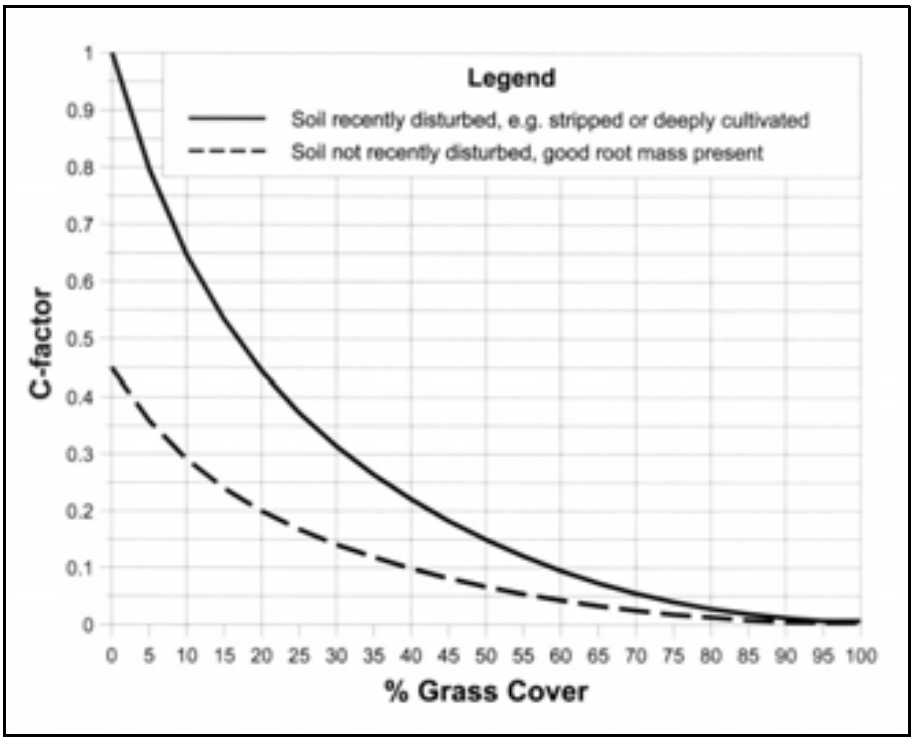


Figure 3 C-factors for established grass cover

Class	Type	Suitable for Vegetation Type [1]	Design Life (months)	Use in Concentrated Flow [2]	Availability (days) [3]	Relative Cost Bracket [4]	Residual Impact [5]	C-factor [6] <33%, <5m	C-factor <33%, 5-15m	C-factor <33%, >15m	C-factor 33-60%, <5m	C-factor 33-60%, 5-15m	C-factor 33-60%, >15m
BIODEGRADABLE MULCHES [7]													
Straw (anchored)	4.5 tonnes per hectare	Grass	1 to 6	No	< 5days	Low	Moderate	0.17	0.17	0.20	0.20	0.20	0.20
Wood Chip	16 tonnes per hectare	Grass/Shrubs	1 to 6	No	< 5days	Low	Moderate	0.08	0.08	0.08	No data		
Wood Chip	27 tonnes per hectare	Shrubs	1 to 6	No	< 5days	Low	Moderate	0.05	0.05	0.05	No data		
Wood Chip	56 tonnes per hectare	Shrubs	1 to 6	No	< 5days	Low	Moderate	0.02	0.02	0.02	0.02	0.02	0.02
Hydromulching	1.5 tonnes mulch + 300 litres binder per hectare	Grass	1 to 3	No	< 5days	Low	Low	0.00	0.03	0.07	0.03	0.06	0.10
Bonded Fibre	5 tonnes fibre per hectare	Grass	1 to 6	No	< 5days	Low	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
Blown compost, bonde	Minimum 50 mm blanket	Grass/Shrubs	6 to 18	No	<5days	Medium	Low	0.00	0.03	0.07	0.03	0.06	0.10
ROLLED EROSION CONTROL PRODUCTS (RECPs) [7]													
Biodegradable	Jute mesh	Grass	6 to 12	Yes	< 5days	Low	Moderate	0.10	0.20	0.40	0.20	0.40	0.60
	Coconut fibre mesh (~400 gsm)	Grass	24	Yes	< 5days	Low	Moderate	0.10	0.20	0.40	0.20	0.40	0.60
	Coconut fibre mesh (~700 gsm or more)	Grass	48	Yes	< 5days	Medium	Moderate	0.10	0.10	0.20	0.10	0.15	0.20
	Curled wood fibre	Grass	6 to 12	Yes	< 5days	Medium	Moderate	0.01	0.05	0.10	0.10	0.15	0.20
	Jute matting (~350 gsm)	Grass	0 to 18	Yes	< 5days	Medium	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
	Jute matting (~600 gsm)	Shrubs	12 to 24	Yes	< 5days	Medium	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
	Coconut fibre matting (~400 gsm)	Grass	12 to 18	Yes	< 5days	Medium	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
	Coconut fibre matting (~900 gsm)	Shrubs	18 to 24+	Yes	< 5days	Medium	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
Photodegradable	Mesh (< 5 mm openings)	Grass	1 to 6	Yes	< 5days	Low	Moderate	0.01	0.05	0.10	0.10	0.15	0.20
Non Biodegradable TRMs, all categories	Plastic fibres with netting	Grass	> 48	Yes	< 5days	High	High	0.00	0.05	0.10	0.03	0.05	0.10
	Composite with biodegradable	Grass/Shrubs	> 12	Yes	< 5days	High	High	0.00	0.03	0.07	0.03	0.06	0.10
HYDRAULIC SOIL STABILISERS [8]													
	Polymers/Polyacrylamide (rate depends on type)	Grass	1 to 6	No	< 5days	Low	Low	0.01	0.05	0.10	0.10	No data	
	Bitumen emulsion (12,000 l/ha)	Grass	1 to 6	No	< 5days	Low	Low	0.01	0.05	0.10	0.10	No data	
TEMPORARY SEEDING													
	Annual	NA	6 to 12	No	< 5days	Low	Low	0.05	0.05	0.10	0.10	No data	
	Perennial	NA	> 12	No	< 5days	Low	Low to moderate	0.05	0.05	0.10	0.10	No data	
INSTANT TURF [9]													
	Kikuyu	Grass	> 12	Yes	< 5days	Medium	Low	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Reinforced turf (pregrown)	Grass	> 12	Yes	5 - 15 days	High	High	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes

1. Whether vegetation is required and its type if so, will affect the technique used. Biodegradable mulches, RECPs and hydraulic soil stabilisers can all be used on their own to provide short term protection. However, their effectiveness is less when used in isolation than when used with vegetative growth. Most techniques are used to help establish vegetative growth using sown grasses. Should the client specify shrubs (primarily planted as sub-strocks), then thicker mulches, RECPs or biodegradable mulches should be used. Non biodegradable RECP's are used to reinforce grasses (turf) permanently. They are not suitable for use with individual shrubs. They can work synergistically with the established grass to increase its resistance to shear stress and, therefore, increase its resistance to erosion by concentrated flow.
2. Products might or might not be suitable for use in areas of concentrated flow. All products are suitable for sheet flow conditions, although some would be over designed in such cases.
3. Whether or not a product is readily available is critical to the selection process. Many RECP and hydraulic soil stabiliser techniques use products that might be "off the shelf" and available from several suppliers. Biodegradable mulches can be affected by seasonal variation, although they might also be available on site after initial clearing and grubbing. Temporary seeding might also be seasonal.
4. For any given technique, cost can vary greatly depending on geographic location, size of project and installation requirements. In addition, costs can vary over time. Because of these factors, giving accurate installed costs is not possible. However, if a product is relatively inexpensive to purchase and install close to its point of manufacture, it will still be relatively inexpensive to purchase and install remote from it.
5. This criterion relates to the impact that a particular practice might have on construction activities once they are resumed on an area that was temporarily stabilised.
6. The performance of an erosion control technique is quantified by assigning it with a C-factor (Appendix A). The C-factor will vary from close to zero for full cover, to 1.0 for no cover on highly disturbed soils. The C-factor strongly affects the soil loss calculation (RUSLE) and users need to be careful in specifying its value, particularly when values <0.01 are quoted. Note that the C-factor does not apply to concentrated flow.

   Values for the C-factor are given for various slopes gradients and lengths and show that it can change dramatically with them. The values given are compiled from existing data and from inference between products of a similar nature. They are given as a guide only and do not profess to be accurate in all respects. Overall, accurate C-factors are only available for manufactured products, primarily from the USA (RECP's in particular) where extensive independent testing has been undertaken. Unfortunately, very little data is available for the "lower cost" options such as biodegradable mulches, jute mesh and hydraulic soil stabilisers. Wherever possible, the manufacturers should be contacted for their latest data on acceptable C-factors.

   For the RECP's in particular, the C-factors given here are for the product as installed with no vegetation. Note however that lower C-factors can be expected if vegetation is promoted with many RECP's. Indeed, non biodegradable RECP's are designed to work synergistically with turf and must be established.
7. For information on trade names and suppliers of these products, please phone the office of Australasian Chapter of the International Erosion Control Association on 1800 354 322 or (+61 2) 4677 0901.

Table A3 from Landcom, 2004.

Erosion control practice (generic type) [1]	Type	Effect on vegetation				Controlling erosion and pollution				Structural Performance						Constraints
		enhances germination of grass seeds	controls weeds	enhances growth of tubestock	reinforces root-holding ability	protects soil surfaces	reduces runoff	filters or traps sediment	stops seepage	reinforces steep slopes	resists waves	stable in low (<2 m/sec) channel flows	stable in moderate (2-5 m/sec) channel flows	stable in high (5-7 m/sec) channel flows [2]	stabilises pavements	
ORGANIC PRODUCTS (can be recycled)																Might need anchoring
Composted Coarse Mulch	16 tonnes per hectare	1	1	1	0	3	3	2	0	0	0	0	0	0	0	
Composted Coarse Mulch	27 tonnes per hectare	0	2	3	0	3	3	3	0	0	0	0	0	0	0	
Composted Coarse Mulch	56 tonnes per hectare	0	3	3	0	3	3	3	0	0	0	0	0	0	0	
Composted soil conditioner	100 L per m² (max)	3	1	3	2	1	1	0	0	0	0	0	0	0	0	Product needs incorporation into existing soil
Manufactured soils	150 L per m² (max)	3	1	3	2	1	1	0	0	0	0	0	0	0	0	
SPRAY ON PRODUCTS																
Hydromulching	2.0 tonnes mulch + 300 litres binder per hectare	3	0	0	0	3	1	1	0	0	0	0	0	0	0	
Bonded Fibre	5 tonnes fibre per hectare	3	1	1	0	3	2	1	0	0	0	0	0	0	0	
ROLLED EROSION CONTROL PRODUCTS (RECPs)																Ensure RECP's have intimate contact with subsoils (good preparation), are well anchored and have check slots in conditions of concentrated flow
Biodegradable **ECB's**	Jute mesh	2	1	0	1	2	1	0	0	0	0	1	1	0	0	
	Coconut fibre mesh (400gs/m)	2	1	0	1	2	1	1	0	0	0	1	1	0	0	
	Coconut fibre mesh (700gs/m)	2	1	1	1	2	1	1	0	0	0	2	2	0	0	
	Curled wood fibre in plastic mesh	3	1	1	1	3	2	1	0	0	0	1	1	0	0	Nets might trap fauna
	Jute matting (~350 gsm)	3	1	1	1	3	2	1	0	0	0	2	1	0	0	Allows weed growth
	Jute matting (~600 gsm)	0	3	3	0	3	2	1	0	0	0	2	1	0	0	Not for grass growth
	Cocconut fibre matting (~400 gsm)	3	1	1	1	3	2	1	0	0	0	2	1	0	0	Allows weed growth
	Coconut fibre matting (~900 gsm)	0	3	3	0	3	2	1	0	0	0	2	1	0	0	Not for grass growth
Photodegradable **ECB's**	Mesh (< 5 mm openings)	2	0	0	1	2	1	0	0	0	0	1	0	0	0	Little moisture retention
	Super light weight nonwoven (~30gs/m)	2	0	0	1	2	1	0	0	0	0	1	1	0	0	Little moisture retention; net (if included) can trap fauna
Non Biodegradable **TRM's**	Plastic fibres with netting	2	1	0	3	3	2	1	0	0	3	3	3	0	0	Soil-filled and vegetated
	Light performance 3D welded fibres	2	1	0	3	3	2	1	0	0	1	3	2	0	0	Soil-filled and vegetated
	Medium performance 3D welded or woven fibres	2	1	0	3	3	2	1	0	0	2	3	3	0	0	Soil-filled and vegetated
	High performance 3D woven fibres	2	1	0	3	3	2	1	0	0	3	3	3	3	1	Soil-filled and vegetated
	Med. perform. composited with degradable material	2	1	0	3	3	2	1	0	0	2	3	3	0	0	Soil-filled and vegetated
HYDRAULIC SOIL STABILISERS																
	Polymers/Polyacrylamide (rate depends on type)	0	0	0	0	2	0	0	0	0	0	1	0	0	0	Needs water supply for application
	Bitumen emulsion (12,000 l/ha)	0	0	0	0	2	0	0	0	0	0	1	0	0	0	Environmental concerns
TEMPORARY SEEDING																
	Annual	0	1	0	0	3	2	2	0	0	0	1	0	0	0	Minimum 28 days to establish
	Perennial	0	2	0	0	3	2	2	0	0	0	1	0	0	0	Needs water supply
INSTANT TURF																
	Kikuyu	0	1	0	0	3	2	2	0	1	0	1	0	0	0	Needs water supply
	Reinforced turf (pregrown)	0	1	0	3	3	2	2	0	1	1	2	2	0	0	Needs water supply
OTHER PRODUCTS																
Straw (anchored)	4.5 tonnes per hectare	3	1	1	0	3	3	2	0	0	0	0	0	0	0	
Weed mat		0	3	1	0	3	0	0	0	0	0	0	0	0	0	Restricts air and moisture
Geotextile		0	1	1	1	2	0	2	0	2	0	2	1	0	3	See general note for RECP's above if used in channels
Sediment fences		0	0	0	0	0	1	2	0	0	0	0	0	0	0	
Earth-filled geotextile tubes		0	0	0	0	0	0	3	0	0	0	0	0	0	0	Low profile
Floating sediment barriers		0	0	0	0	0	0	3	0	0	1	0	0	0	0	
Grout injected mats		0	1	0	0	3	0	0	1	0	2	3	3	3	0	Rigid structure
Gabion Mattresses		0	0	0	0	3	0	0	0	0	3	3	3	3	1	
Articulated concrete mats		0	0	0	0	3	0	0	0	0	3	3	2	2	0	
Reinforced armouring systems		0	0	0	0	3	0	0	0	0	3	3	2	2	0	
Cellular soil confinement (synthetic)		2	0	0	0	3	1	0	0	2	2	2	2	0	2	Anchor on steep slopes
Wind barrier fencing		0	0	0	0	2	0	1	0	0	0	0	0	0	0	
Flexible waterproof membranes		0	0	0	0	0	0	0	3	0	0	0	0	0	0	
Vertical soil moisture barriers		0	0	0	0	0	0	0	3	0	0	0	0	0	0	
Geosynthetic clay liners		0	0	0	0	0	0	0	3	0	0	0	0	0	0	
Prefabricated subsurface drainage		1	0	1	0	1	1	0	3	2	0	0	0	0	2	
Pipe inlet sediment barriers		0	0	0	0	0	0	3	0	0	0	0	0	0	0	Clean regularly
Wattles and logs		0	0	0	0	2	1	2	0	0	1	1	0	0	0	Needs pinning

Key to Rating System
0 – not designed for, and has no expected performance in this application
1 – not specifically designed for, but can enhance performance of other measures in this application
2 – generally designed for this application in conjunction with other applications, but performance is less able to deal with the range of conditions met by specific purpose materials
3 – specifically designed to meet a full range of requirements for this application

[1] There can be considerable differences between products within any generic type. For further information products, including trade names and suppliers, please phone the office of Australasian Chapter of the International Erosion Control Association on 1800 354 322 or (+61 2) 4677 0901.

[2] The designer should check shear stress as well as velocity. Shear stress becomes determining as slope gradient increases.

Table D1 from Landcom, 2004

11.4 Appendix 4: Flocculation

Gypsum (calcium sulfate) will be applied to sediment basins within 24 hours of the conclusion of each rainfall event more than 5 mm by mixing it into a slurry with water (Figure 3) and then spraying it over the basin surface. It is essential that the flocculating agent be spread evenly over the entire basin surface for proper treatment of water unless local experience or other criteria suggest differently.

The gypsum will be applied at a rate of at least 32 kilograms per 100 cubic metres of stored water, with the actual rate being determined by the ability of the agent to reduce non filterable residues to 50 milligrams per litre of water or less. The supernatant waters can be discharged from each basin once these levels have been reached. If the gypsum is applied properly, 50 milligrams per litre of water or less should be achieved within 36 to 72 hours from application.

A discharge system will be established that:

(i) has a floating inlet to prevent flocculated sediments being removed as well — any materials from the sediment layer must not be discharged in the pumping process; and

(ii) permits drainage of the pond in less than 24 hours.

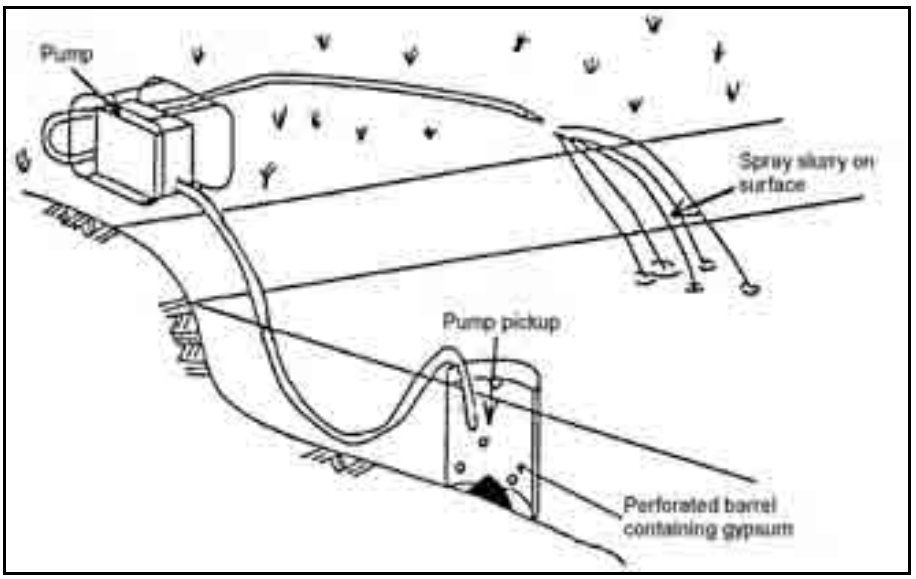
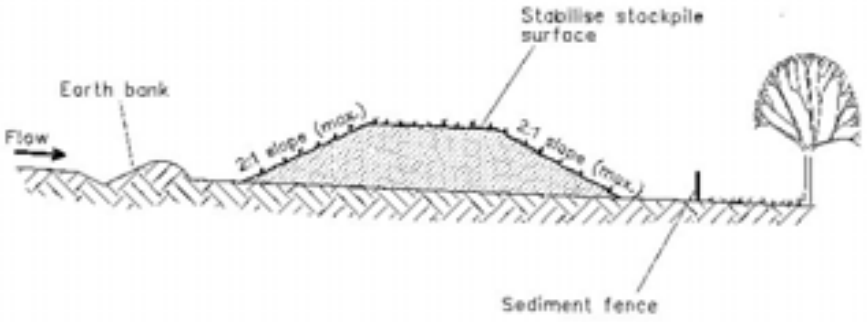


Figure 6 Application of gypsum. The drum will have about a 50 litre capacity with holes of about 25-mm diameter drilled on a 150-mm grid so pond water can enter.

Normally, discharge will be completed with five working days from the conclusion of a rainfall event. However, in the case of repeated high intensity storms, the gypsum dosage rates will be doubled so flocculation can be achieved within 24 hours from the conclusion of a storm and allowing discharge within three days.

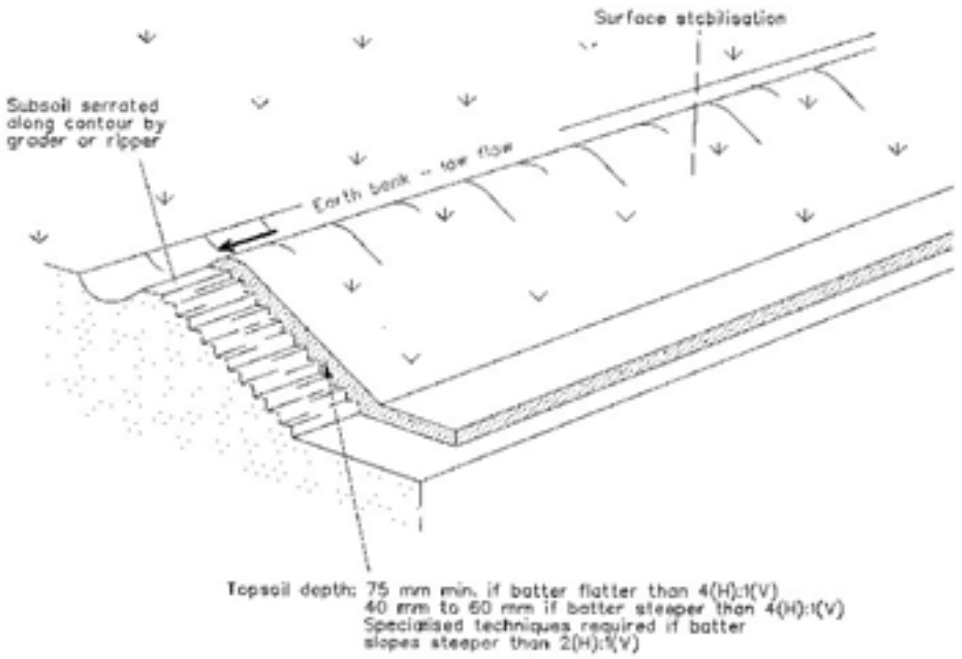
11.5 Appendix 5: Standard Drawings (from Landcom, 2004)



Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

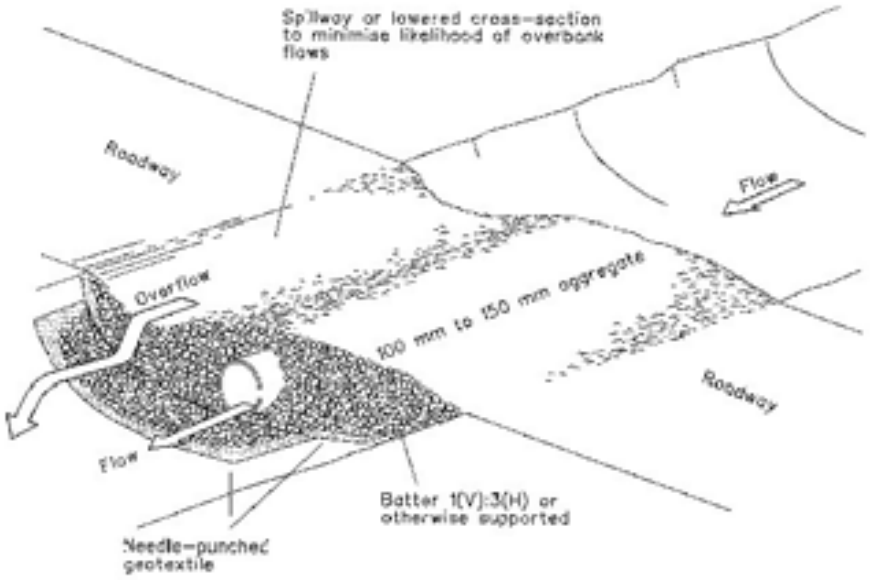
STOCKPILES **SD 4-1**



Construction Notes

1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.
2. Add soil ameliorants as required by the ESCP or SWMP.
3. Rip to a depth of 300 mm if compacted layers occur.
4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

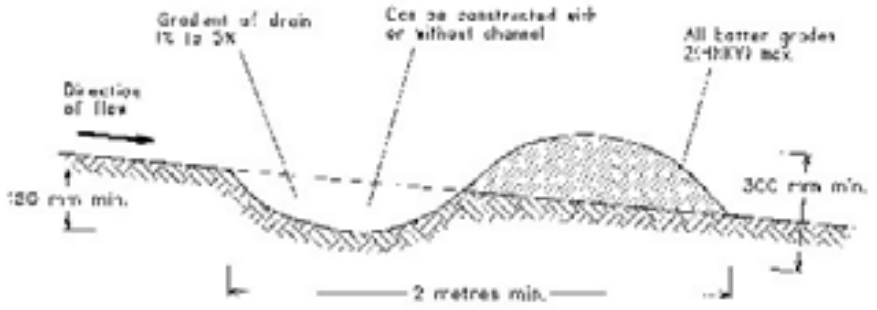
REPLACING TOPSOIL **SD 4-2**



Construction Notes

1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H): 1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than design storm events.
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

TEMPORARY WATERWAY CROSSING **SD 5-1**

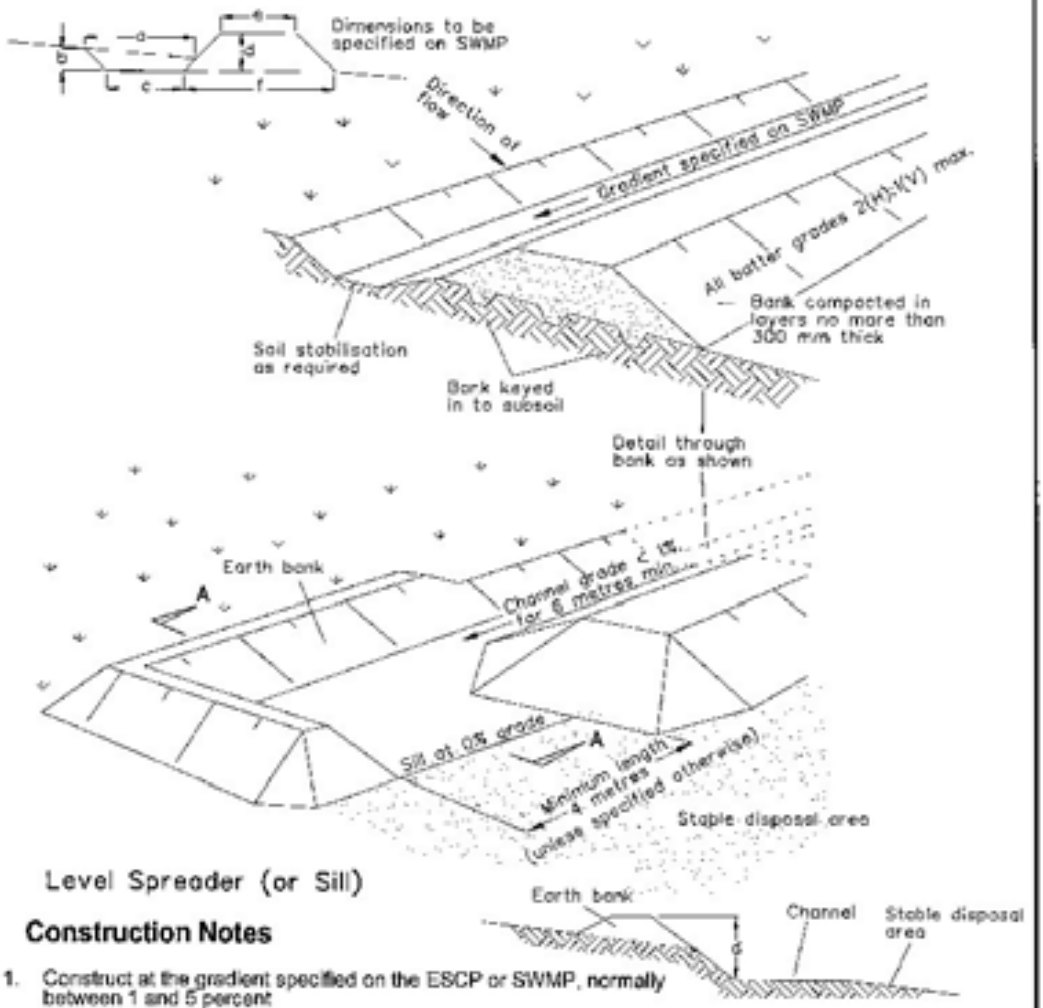


NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
6. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

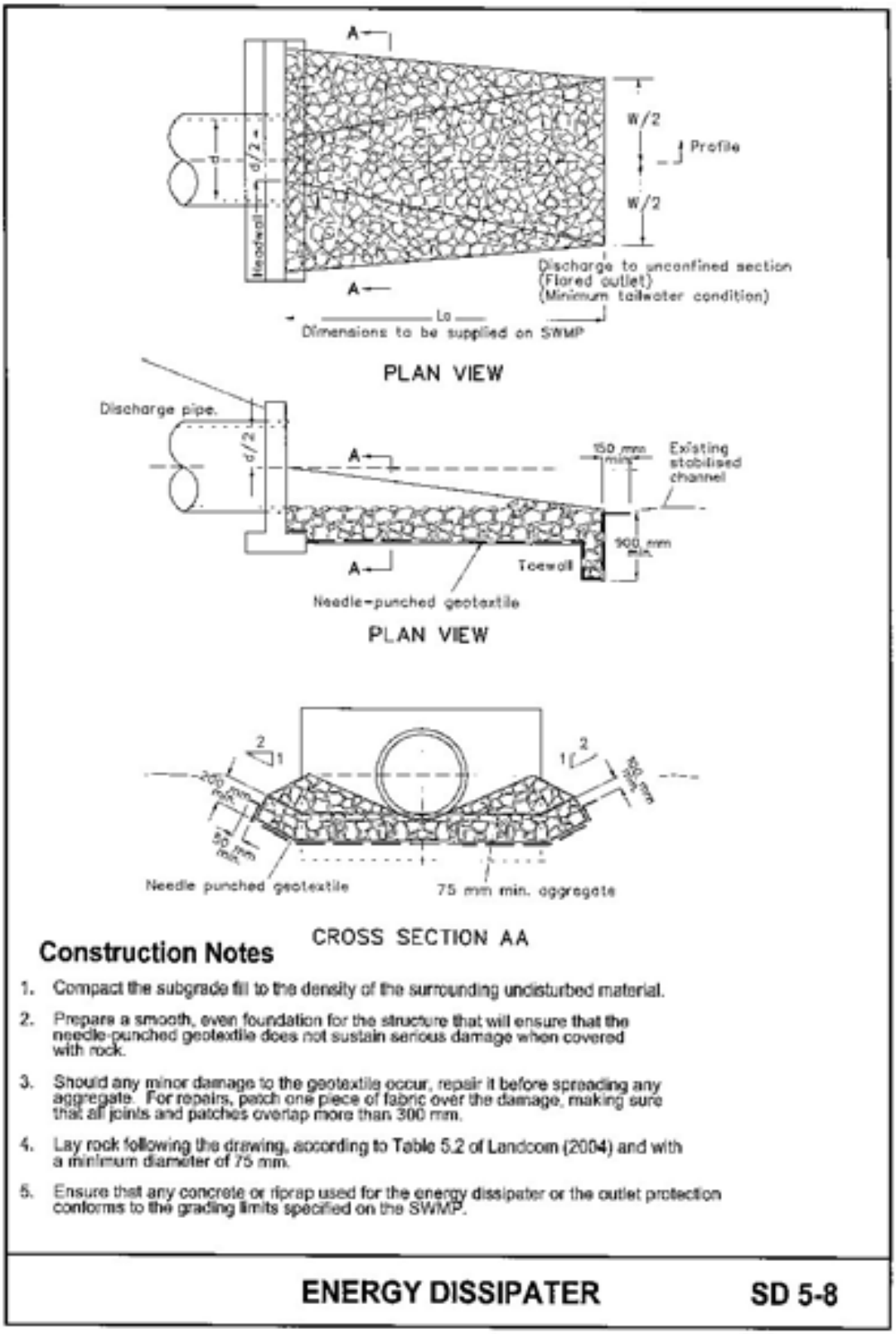
EARTH BANK (LOW FLOW) **SD 5-5**



Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

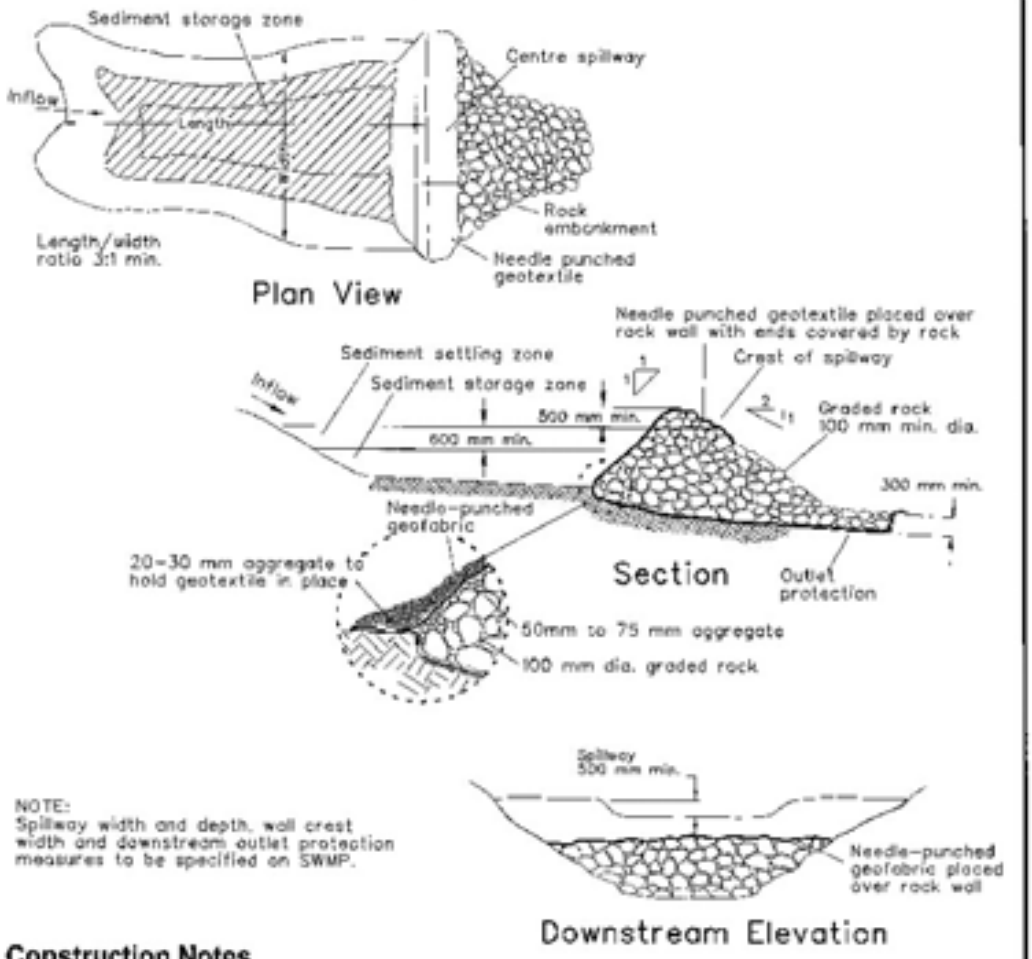
EARTH BANK (HIGH FLOWS) **SD 5-6**



Construction Notes

1. Compact the subgrade fill to the density of the surrounding undisturbed material.
2. Prepare a smooth, even foundation for the structure that will ensure that the needle-punched geotextile does not sustain serious damage when covered with rock.
3. Should any minor damage to the geotextile occur, repair it before spreading any aggregate. For repairs, patch one piece of fabric over the damage, making sure that all joints and patches overlap more than 300 mm.
4. Lay rock following the drawing, according to Table 5.2 of Landcom (2004) and with a minimum diameter of 75 mm.
5. Ensure that any concrete or riprap used for the energy dissipater or the outlet protection conforms to the grading limits specified on the SWMP.

ENERGY DISSIPATER **SD 5-8**



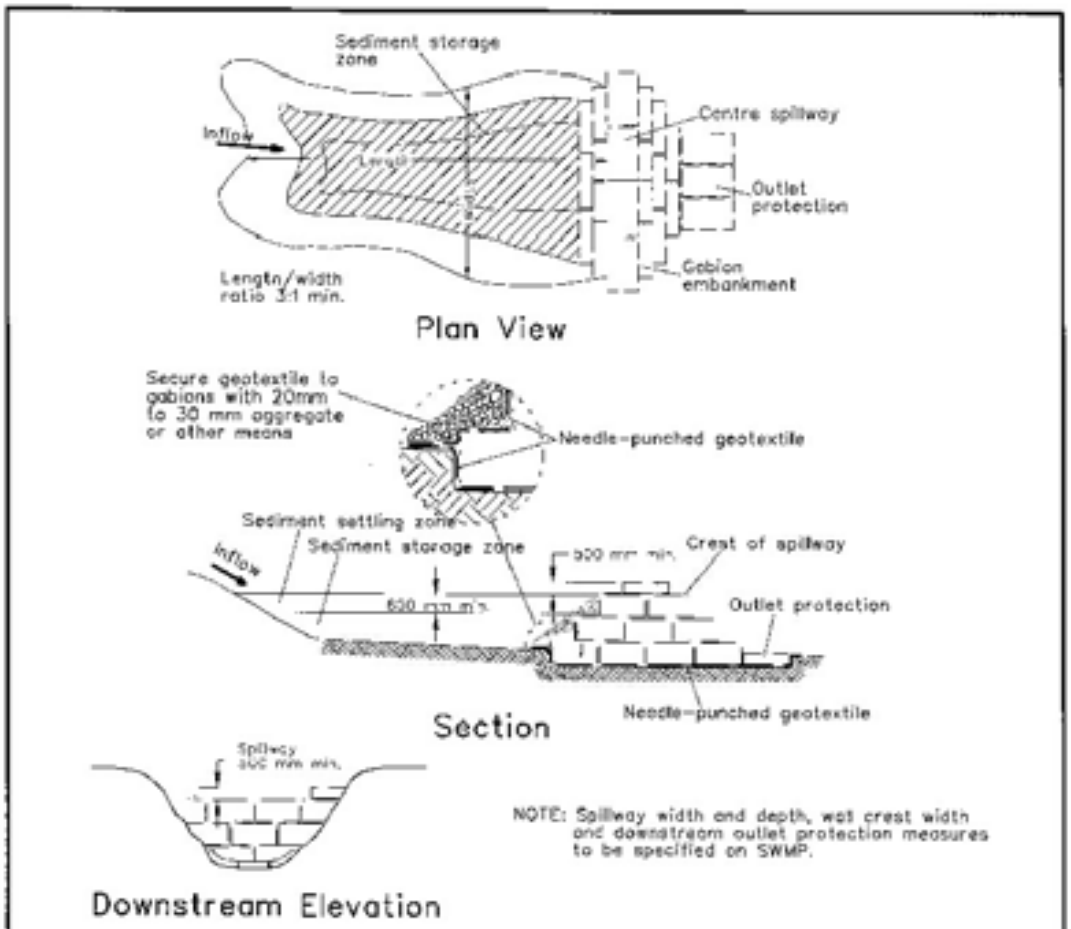
Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Excavate to 300 mm depth for base of the dam wall.
3. Line the excavation with a needle-punched geotextile allowing sufficient to line below the wall, and over the upstream rock and the spillway to 500 mm below the spillway exit on the downstream face.
4. Make up the wall profile and outlet protection with100 mm (min.) diameter graded rock. Spread a layer of 50 mm to 75 mm diameter aggregate over the upstream batter for a more even surface, and add 100 mm to 150 mm of 20 mm to 30 mm gravel over the 50 mm to 75 mm diameter aggregate.
5. Lay geotextile over the upstream batter and through the spillway, fixing in place with 100 mm rock.
6. Place a "Full of Sediment" marker to show when less than design capacity occurs and sediment removal is required.
7. Replace the upstream geotextile layer each time sediment is removed

ROCK SEDIMENT BASIN

(APPLIES TO 'TYPE C' SOILS ONLY)

SD 6-1



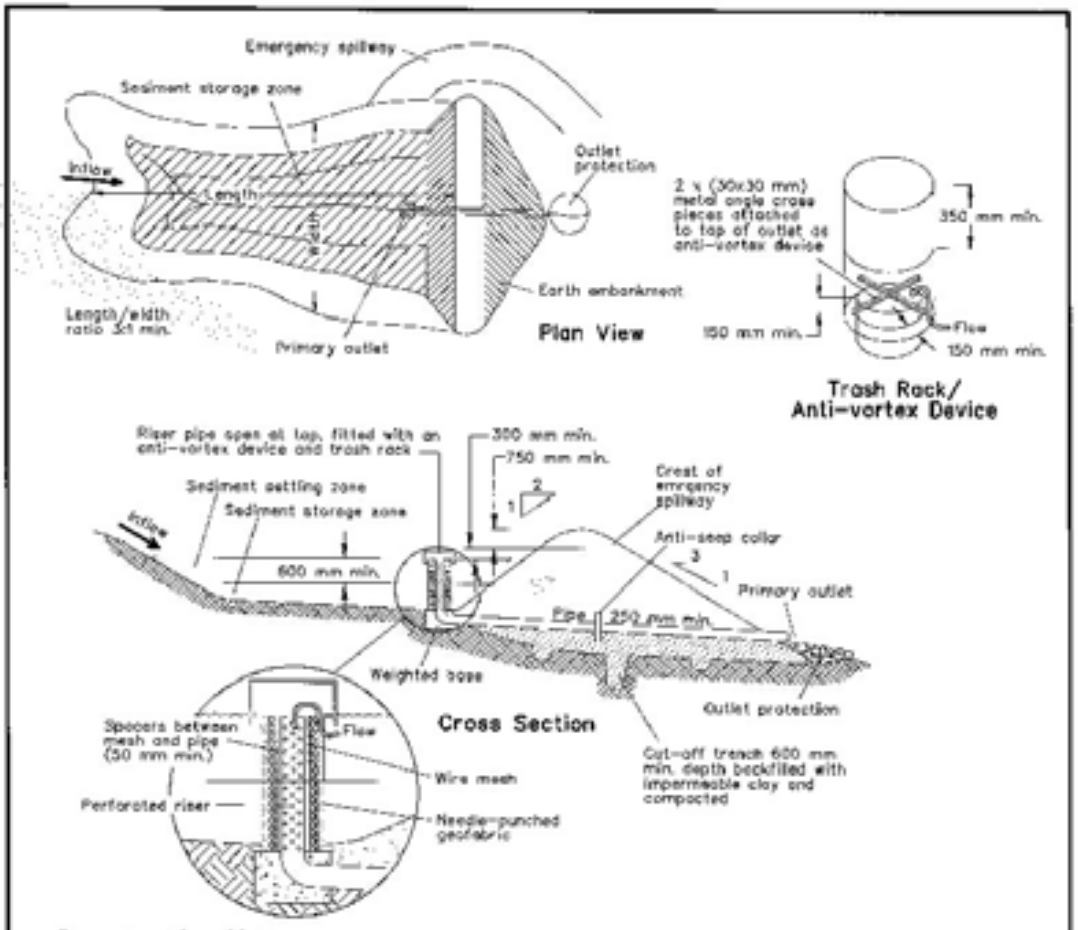
Construction Notes

(Applies to Type C soils only)

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Excavate to 300 mm depth for the base of the dam wall and form a level platform for the gabions.
3. Line the excavation with a needle-punched geotextile allowing sufficient to line below the wall, and over the upstream gabions and spillway to 500 mm below the spillway exit on the downstream face.
4. Make up the wall profile and outlet protection with gabion units filled with graded rock as specified on the SWMP.
5. Construct a spillway 500 mm below the crest of the dam and for the width specified on the SWMP.
6. Lap the geotextile over the upstream face and through the spillway and fix it in place with the top row of gabions.
7. Cover the upstream face of the wall with 20 mm to 30 mm gravel and geotextile (Standard Drawing 6-2b)
8. Place a 'Full of Sediment' marker to show when less than design capacity occurs and sediment removal is required.
9. Replace the upstream geotextile layer when sediment is removed if a dry basin is required.

GABION SEDIMENT BASIN
(APPLIES TO 'TYPE C' SOILS ONLY)

SD 6-2

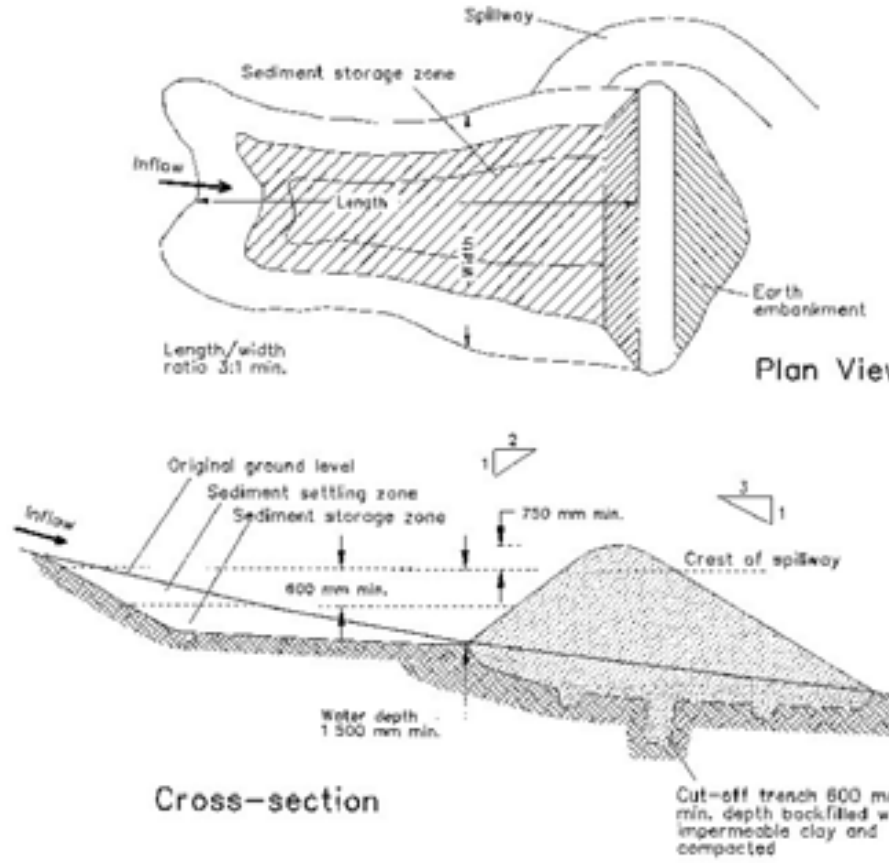


Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Form a cut off trench under the centreline of the embankment 600 mm deep and 1,200 mm wide, extending to a point on the watercourse wall above the riser sill level.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill according to the SWMP that is free from roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond the compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Install the pipe outlet with seepage collars as specified in the SWMP and Standard Drawing 6-3b.
8. Form batter grades at 2(H):1(V) upstream and 3(H):1(V) downstream or as specified in the SWMP

EARTH BASIN - DRY
(APPLIES TO 'TYPE C' SOILS ONLY)

SD 6-3

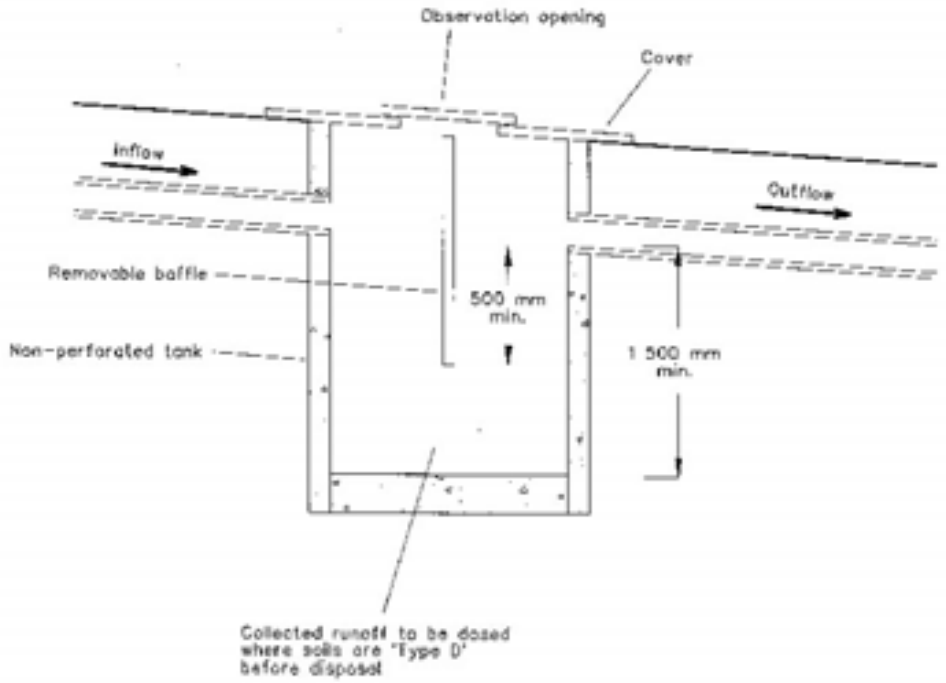


Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET
(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

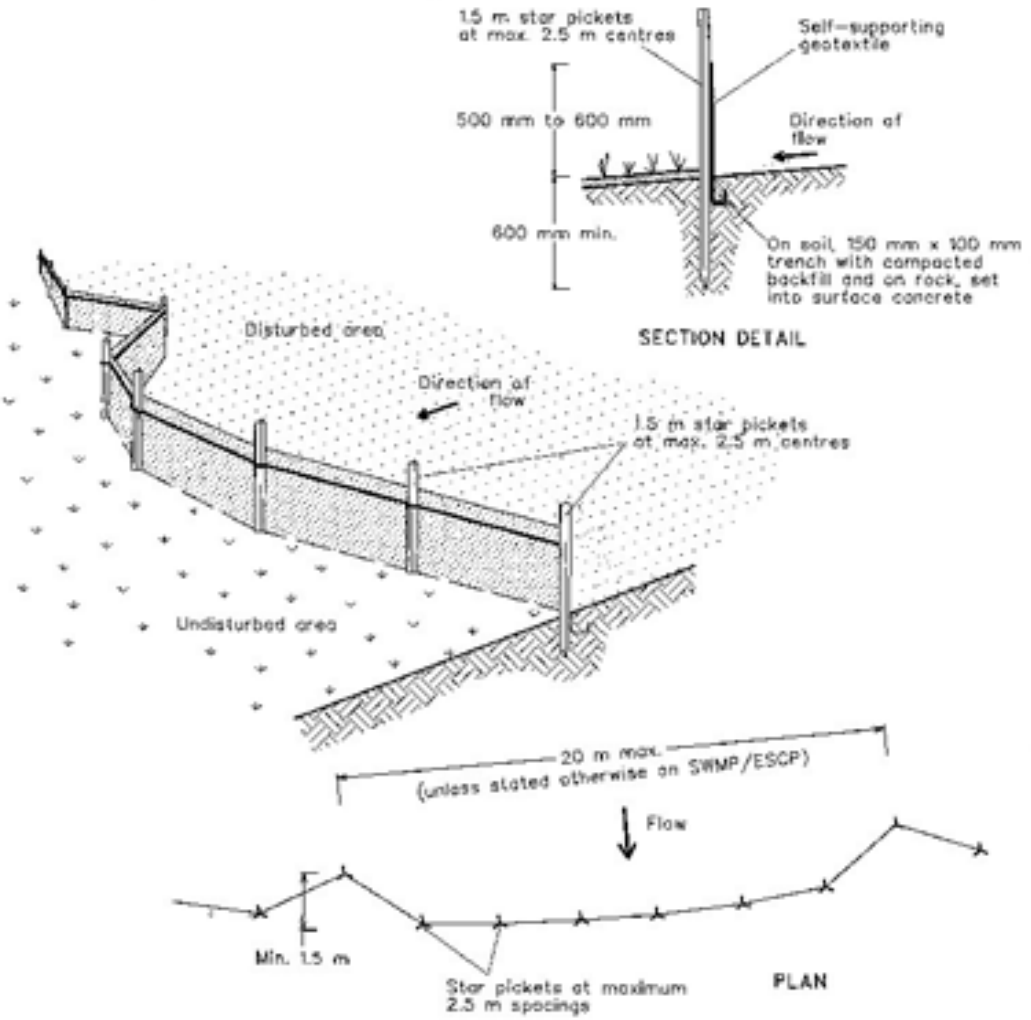
SD 6-4



Construction Notes

1. Join the inlet to the stormwater, taking any suitable steps to remove bulky or coarse material before it can enter the tank.
2. Connect the outlet to a safe disposal area following the SWMP.
3. Install a removable baffle, central to the inflow/outflow and normal to the direction of flow, ensuring that it reaches 500 mm below the invert of the outlet pipe.
4. Install a cover over the pit with an observation port and access cover.

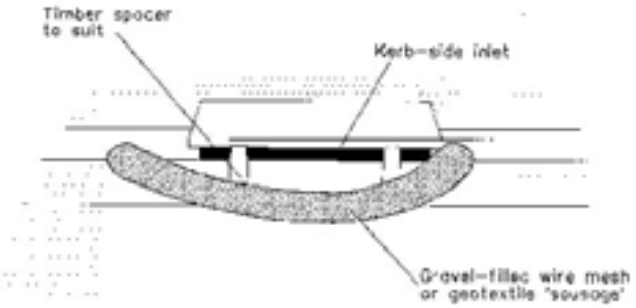
LINED TANK **SD 6-5**

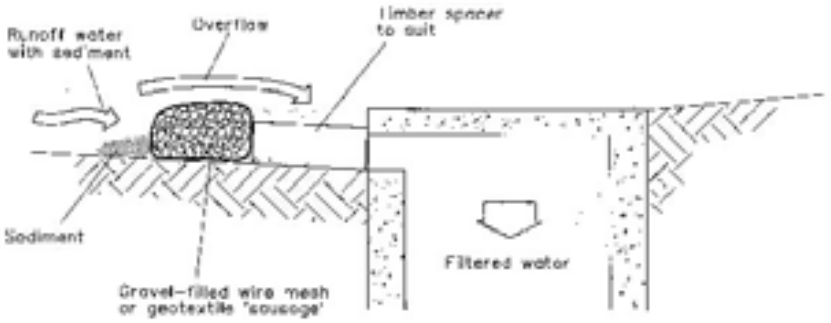


Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE **SD 6-8**



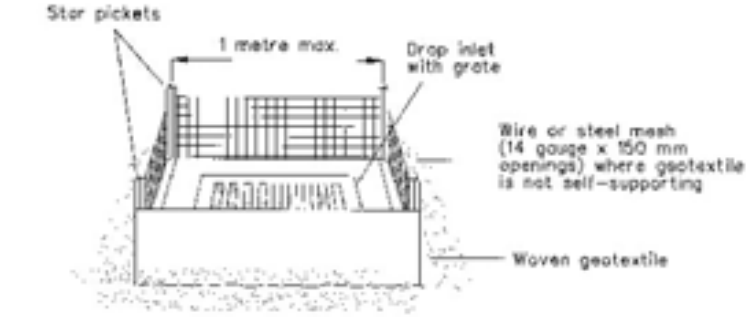


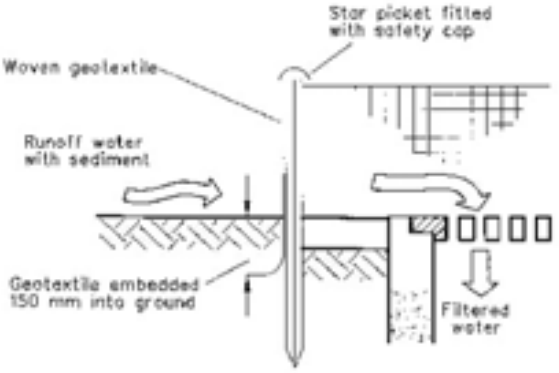
NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

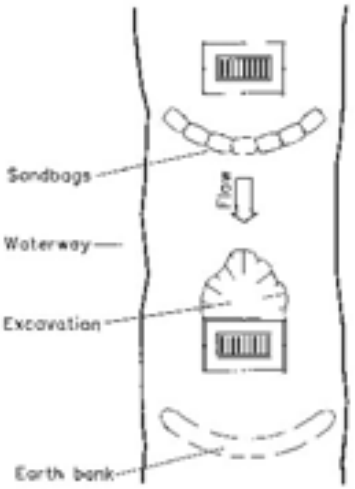
Construction Notes

1. Install filters to kerb inlets only at sag points.
2. Fabricate a sleeve made from geotextile or wire mesh longer than the length of the inlet pit and fill it with 25 mm to 50 mm gravel.
3. Form an elliptical cross-section about 150 mm high x 400 mm wide.
4. Place the filter at the opening leaving at least a 100-mm space between it and the kerb inlet. Maintain the opening with spacer blocks.
5. Form a seal with the kerb to prevent sediment bypassing the filter.
6. Sandbags filled with gravel can substitute for the mesh or geotextile providing they are placed so that they firmly abut each other and sediment-laden waters cannot pass between.

MESH AND GRAVEL INLET FILTER **SD 6-11**





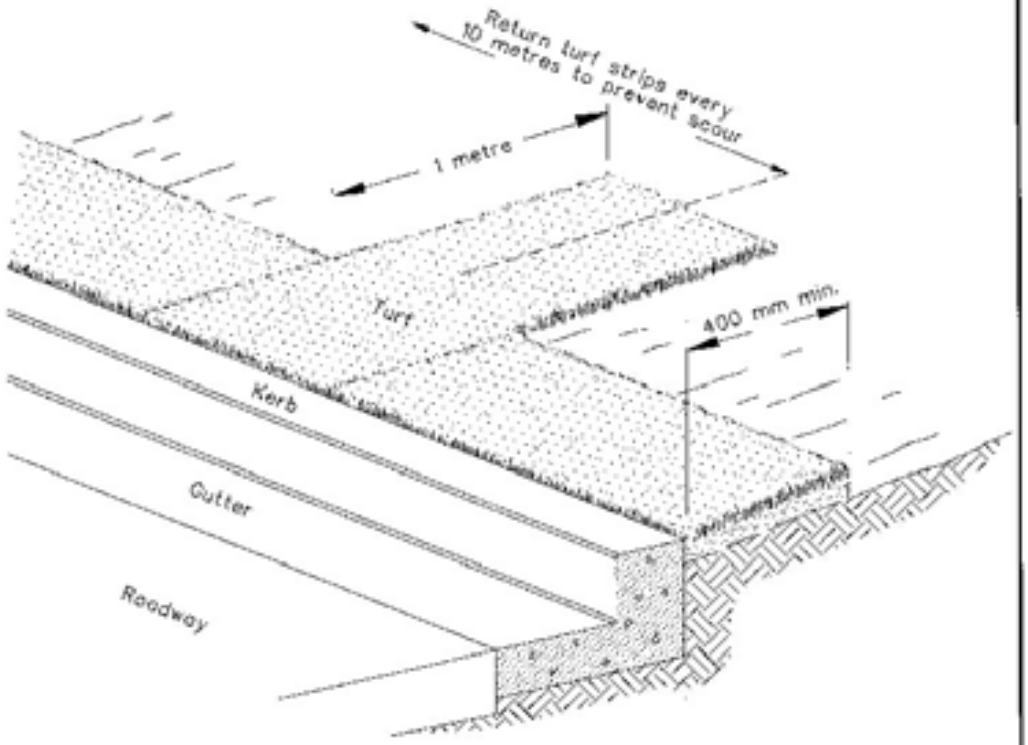


For drop inlets at non-sag points, sandbags, earth bank or excavation used to create artificial sag point

Construction Notes

1. Fabricate a sediment barrier made from geotextile or straw bales.
2. Follow Standard Drawing 6-7 and Standard Drawing 6-8 for installation procedures for the straw bales or geofabric. Reduce the picket spacing to 1 metre centres.
3. In waterways, artificial sag points can be created with sandbags or earth banks as shown in the drawing.
4. Do not cover the inlet with geotextile unless the design is adequate to allow for all waters to bypass it.

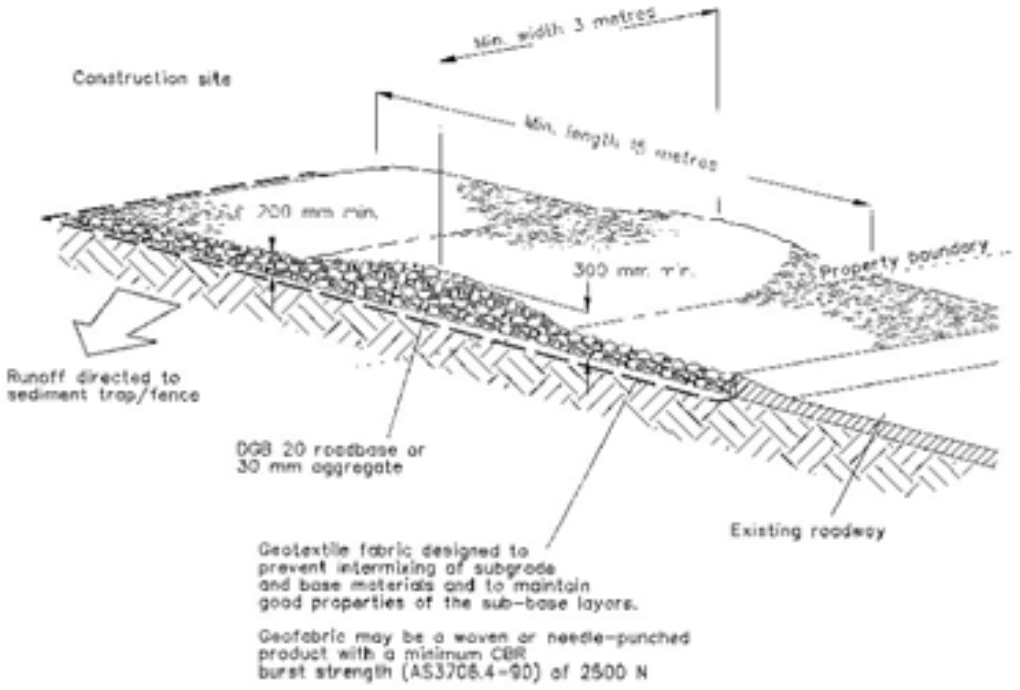
GEOTEXTILE INLET FILTER **SD 6-12**



Construction Notes

1. Install a 400-mm minimum wide roll of turf on the footpath next to the kerb and at the same level as the top of the kerb.
2. Lay 1.4 metre long turf strips normal to the kerb every 10 metres.
3. Rehabilitate disturbed soil behind the

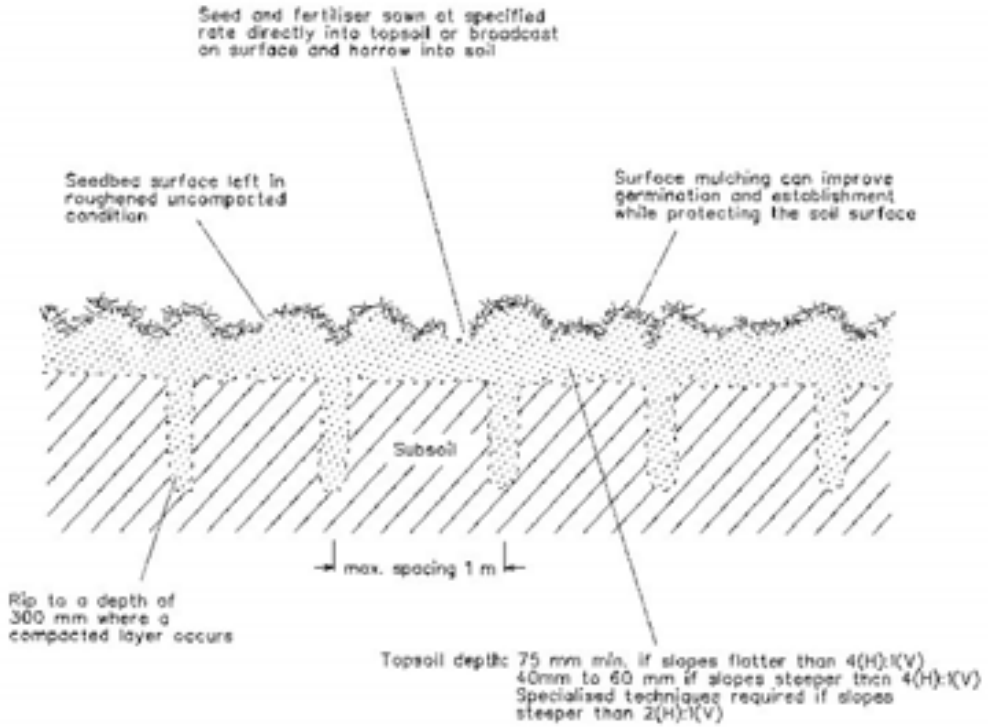
KERBSIDE TURF STRIP **SD 6-13**



Construction Notes

1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200-mm thick pad over the geotextile using road base or 30-mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence

STABILISED SITE ACCESS **SD 6-14**



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION **SD 7-1**

11.6 Appendix 6: Table 5.2 from Landcom, 2004

Material: Type	Material: Thickness (m)	Material: Aggregate size (mm)	Critical velocity (m/second)	
Gabions and reno mattresses	0.50	120-250	6.4	
	0.50	100-200	5.8	
	0.30	100-150	5.0	
	0.30	70-120	4.2	
	0.25	70-100	3.6	
	0.17	70-100	3.5	
	Weight each (kg)		Turbulent flow	Normal flow
Loose rock (assume 100 percent soil cover)	1,000		4.8	6.6
	500		4.2	5.7
	100		3.3	4.5
	50		2.8	3.8
	10		2.3	3.0
	Form			
Revetment mattresses	Storm mattress		>6.0	
	200 mm fp		6.0	
	125 mm fp		4.0	
	100 mm fp		2.0	

Assume that all soils with 10 percent or more dispersible fines have high erodibilities. Of those with less, soils with *K*-factors below 0.02 have low erodibilities, those between 0.02 and 0.045 have moderate erodibilities, while those above 0.045 have high erodibilities.

In addition, the figures here assume slope gradients of less than 10 percent and, where appropriate, good (>80 percent) ground cover. If good ground cover is not expected to be maintained properly (might die back seasonally or during short periods of drought) and is critical to the system, reduce all velocities by 1.0 metre per second. Alternately, seek the manufacurer's advice if these conditions are unlikely to be met.

Material	Critical velocity (m/second): Inundation <6 hours, Soil erodibility: Low	Moderate	High	Inundation <12 hours: Low	Moderate	High	Inundation <24 hours: Low	Moderate	High	Inundation <48 hours: Low	Moderate	High
High performance bonded plastic fibres (vegetated)	7.0	7.0	7.0	6.0	6.0	6.0	5.0	5.0	5.0	4.0	4.0	4.0
Plastic fibres with netting	5.0	5.0	5.0	4.3	4.3	4.3	3.6	3.6	3.6	3.0	3.0	3.0
Mesh reinforced pregrown turf	3.0	2.7	2.4	2.8	2.3	2.0	2.3	2.0	1.8	2.0	1.8	1.8
Kiku yu	2.5	2.2	1.9	2.1	1.9	1.6	1.9	1.7	1.4	1.6	1.4	1.2
Jute or coir mesh (close weave, bitumen sprayed)	2.3	2.0	1.7	1.9	1.7	1.5	1.7	1.5	1.3	1.5	1.3	1.1
Coconut/ jute fibre mats	2.3	2.0	1.7	1.9	1.7	1.5	1.7	1.5	1.3	1.5	1.3	1.1
Couch, carpet grass, Rhodes grass, etc	2.0	1.8	1.4	1.7	1.5	1.2	1.5	1.4	1.1	1.3	1.2	0.9
Bare soil	0.7	0.5	0.3	0.6	0.4	0.3	0.5	0.4	0.2	0.4	0.3	0.2

Table 5.2 from Landcom, 2004.